Third Benchmark Workshop

on

NUMERICAL ANALYSIS OF DAMS

Paris, France
September 29–30, 1994

Organized by
the **ICOLD**
"ad-hoc" Committee on Computational Aspects
of Dam Analysis and Design

CIGB
ICOLD

Under the auspices of the
French Committee on Large Dams
in cooperation with

COYNE ET BELLIER
Bureau d'Ingénieurs Conseils

and

CNEH
ELECTRICITE DE FRANCE

Volume I

INTRODUCTION

G.GIUSEPPETTI*, B.TARDIEU**

* *Chairman of the "ad-hoc Committee on Computational Aspects of Dam Analysis and Design"*
** *Vice Chairman of the "ad-hoc Committee on Computational Aspects of Dam Analysis and Design"*
** *C.EO. of Coyne et Bellier, Bureau d'Ingénieurs Conseils*

The idea to organize some Benchmark Workshop on validation of computer software for dam analysis first arose during a meeting of the "ad hoc Committee on Computational Aspects of Dam Analysis and Design" held in Capri (Italy) during November 1989. All members were convinced that the correct use of numerical tools by pratictioners was one of the most important aspects in dam engineering.

In fact, certain computational approaches, although of primary importance, are far from obvious or simple, and moreover they are frequently not considered with sufficient attention. In this field we need to distinguish three different critical aspects of computer software use (see ICOLD Bullettin n.92):

- the first aspect concerns the <u>justification</u> of the whole numerical simulation that is its relevance to physical reality;
- the second aspect is the <u>validation</u> of the software chosen for a particular application;
- the third aspect is associated with <u>quality assurance</u> of the whole computational process, which is really related to both the phases of <u>validation</u> and <u>justification</u>.

The main aim of the Benchmark Workshops is to give the "correct answer" to some computational problems, which should be used by dam engineers to validate their software.

The "ICOLD ad hoc Committee on Computational Aspects of Dam Analysis and Design" have organized three B-Ws. Permanent B-Ws Technical Secretariat has been set up at ISMES in Bergamo (Italy) with the support of ENEL Spa to collect and compare the results.
This third Benchmark Workshop has been held 2 years after the second one, due to the complexity of proposed themes. For the same reason, the next one will be held in 1996.

Following the first and the second Benchmark Workshops, held in Bergamo (Italy) at ISMES, this third session has further developed exercises on Concrete Dams (theme A) and Embankment Dams (theme B). In particular this Benchmark-Workshop, held in Gennevilliers-Paris at Coyne et Bellier headquarters, has been focused on the following themes:

A1 Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam,

A2 Evaluation of critical uniform temperature decrease for a cracked buttress dam,

B1 Evaluation of pore pressure and settlements of an mbankment dam under static loadings,

B2 Dynamic analysis of an embankment dam under a strong earthquake.

Third Benchmark Workshop on
NUMERICAL ANALYSIS OF DAMS
Gennevilliers, France, September 29-30, 1994

PROGRAMME

THURSDAY, SEPTEMBER 29 1994

8 h 30 - 9 h 00	Registration
9 h 00 - 9 h 20	Welcome address by B. TARDIEU, C.E.O. of Coyne et Bellier, and J. BRUNHES, député-maire de Gennevilliers
9 h 20 - 9 h 35	Opening address and presentation of the workshop aims by M. FANELLI, former Chairman of the " ad-hoc " Committee on Computational Aspects of Dam Analysis and Design

9 h 30 - 13 h 15 THEME A1 - Chairman : A. CARRERE (Coyne et Bellier)

9 h 35 - 10 h 00	General presentation of Theme A1 : " Non-linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam " by G.GIUSEPPETTI (ENEL/CRIS), Chairman of the " ad-hoc " Committee on Computational Aspects of Dam Analysis and Design
10 h 00 - 11 h 00	Presentation by the authors of the numerical method, they have used (5 papers)
11h 00 - 11 h 20	Coffee break
11 h 20 - 12 h 15	Presentation by the authors of the numerical method, they have used (5 papers)
12 h 15 - 12 h 45	Presentation of the synthesis of the results for Theme A1 by G. RUGGERI (ISMES, Bergamo, Italy)
12 h 45 - 13 h 15	Questions and Answers - Round table on Theme A1 : Members of the Workshop-Scientific Committee
13 h 15 - 14 h 45	Lunch

14 h 45 - 18 h 30 THEME A2 - Chairman : E. BOURDAROT (EDF-CNEH)

14 h 45 - 15 h 15	General presentation of Theme A2 : " Evaluation of critical uniform temperature decrease for a cracked buttress dam " by G. GIUSEPPETTI (ENEL/CRIS), present Chairman of the " ad-hoc " Committee on Computational Aspects of Dam Analysis and Design
15 h 15 - 16 h 15	Presentation by the authors of the numerical method, they have used (5 papers)
16 h 15 - 16 h 45	Coffee break
16 h 45 - 17 h 15	Presentation by the authors of the numerical method, they have used (2 papers)
17 h 15 - 17 h 45	Presentation of the synthesis of the results for Theme A2 by G. MAZZA (ENEL/CRIS, Milano, Italy)
17 h 45 - 18 h 30	Questions and Answers - Round table on Theme A2 : Members of the Workshop-Scientific Committee
at 19 h 30	Departure from Coyne et Bellier's office to the banquet

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FRIDAY, SEPTEMBER 30 1994

9 h 00 - 13 h 15 *THEME B1 - Chairman : G. MAZZA (ENEL-CRIS)*

9 h 00 - 9 h 30	General presentation of Theme B1 : " Evaluation of pore pressure and settlements of an embankment dam under static loadings " by B. TARDIEU (Coyne et Bellier, France)
9 h 30 - 11 h 00	Presentation by the authors of the numerical method, they have used (6 papers)
11h 00 - 11 h 30	Coffee break
11 h 30 - 12 h 00	Presentation by the authors of the numerical method, they have used (2 papers)
12 h 00 - 12 h 30	Presentation of the synthesis of the results for Theme B1 by O.OZANAM (Coyne et Bellier, France)
12 h 30 - 13 h 15	Questions and Answers - Round table on Theme B1 : Members of the Workshop-Scientific Committee
13 h 15 - 14 h 45	Lunch

14 h 45 - 18 h 00 *THEME B2 - Chairman : G. RUGGERI (ISMES)*

14 h 45 - 15 h 15	General presentation of Theme B2 : " Dynamic analysis of an embankment dam under a strong earthquake " by B.TARDIEU (Coyne et Bellier, France)
15 h 15 - 16 h 15	Presentation by the authors of the numerical method, they have used (4 papers)
16 h 15 - 16 h 45	Coffee break
16 h 45 - 17 h 15	Presentation of the synthesis of the results for Theme B2 by O.OZANAM (Coyne et Bellier, France)
17 h 15 - 18 h 00	Questions and Answers - Round table on Theme B2 : Members of the Workshop-Scientific Committee

Third Benchmark Workshop on
NUMERICAL ANALYSIS OF DAMS
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THEME A1

Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam

PRESENTATION

&

REFERENCE INFORMATION AND DATA

Third Benchmark Workshop on Numerical Analysis of Dams
Gennevilliers (France) - September 29-30, 1994

Theme A1 :

NON-LINEAR ANALYSIS OF JOINT BEHAVIOUR UNDER THERMAL AND HYDROSTATIC LOADS FOR AN ARCH DAM

GENERAL ASPECTS

G.GIUSEPPETTI

Chairman of the "ad-hoc Committee on Computational Aspects of Dam Analysis and Design"

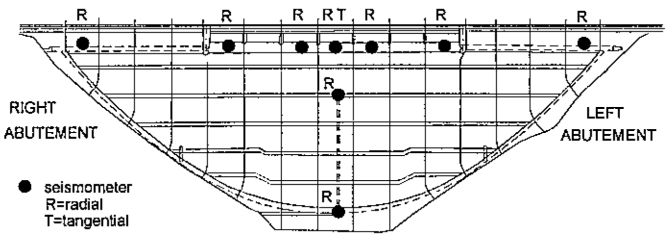
Theme A1 is concerned with the numerical analysis of non-linear joint behaviour of an arch dam subjected to static and thermal loads. Arch dams are composed by a certain number of vertical cantilevers put beside each other to make up the vault. These cantilevers are built separately and joints are grouted only after concrete setting. For this reason the tensile arch stress bearing capacity relevant to these joints becomes practically zero so that, under cyclic loads, contraction joints undergo openings and closures.
Opening of contraction joints has two major consequencies for static and dynamic analysis of dams.

The static stress distribution can result quite different from that relevant to the monolithic dam: openings of joints increase cantilever loads near the base and decrease the arch behaviour of the dam. Neglecting the joints presence can lead to an overestimation of stresses in some parts of the structure (for example arch tensile stresses) and an underestimation in others (for example the upstream cantilever tensile stresses near the base). It is evident that the computation of safety factors will be also affected by this approximation. Stresses redistribution can be computed by means of a non-linear analysis in order to correctly reproduce the effects of construction joints.

The global dynamic response of the structure is also directly influenced by joints opening. For this reason the evaluation of joint status could become an important point also for dynamic analysis, helping us to set up a representative dynamic model or to explain dynamic experimental data from seismic monitoring systems. Nowdays, several effective numerical approaches capable to treat the contact problem are available; it follows the necessity of an extensive investigation, aimed to clarify which methods are most suitable in representing the joint behaviour in dams.

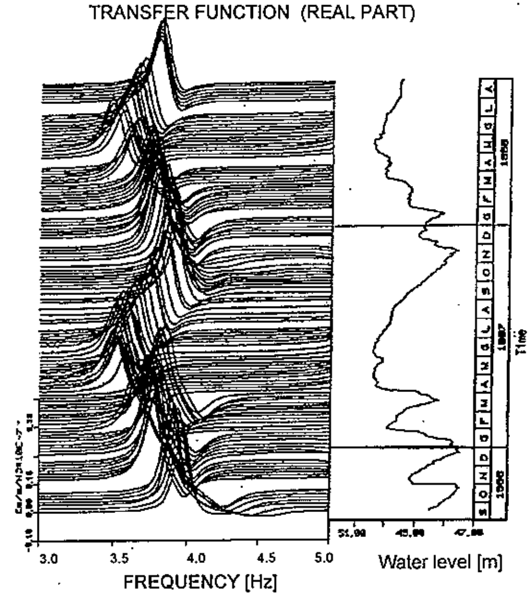
To clarify the importance of knowing the opening status of joints we can mention the results from automatic dynamic monitoring of Talvacchia arch dam carried out from September 1986 to April 1988. During this period two forced excitation tests were automatically carried out every day (with a frequency range from 3 to 11 Hz) by means of an eccentric mass exciter. The dynamic instrumentation network was made up of 10 seismometers (8 on the crest and 2 along the central cantilever, see figure above). In addition to the dynamic monitoring system, static and seismic systems were also installed on the dam. The aims underlying the installation of the control system were as follows:

DYNAMIC MONITORING NETWORK



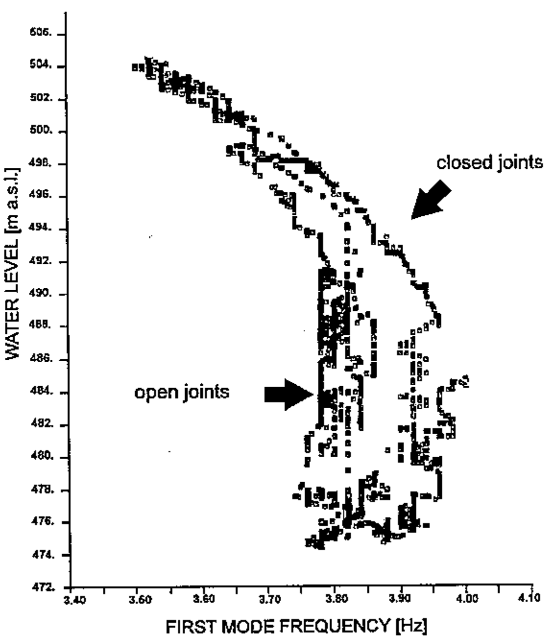
- to measure the structural response over a long period of time, with varying external condition (water level and ambient temperatures);
- to acquire the values of static quantities that make up an index of the general behaviour of the structure and which, at the same time, may have a determinant influence on the dynamic behaviour;
- to record the seismic events that could interest the dam.

TRANSFER FUNCTION (REAL PART)



The results of the dynamic tests may be summarized in a series of response curves. For instance, the real part of the transfer functions relevant to a point located on the crest arch are shown in the figure above; the same figure includes the associated time history of water level. It results evident from the figure that water level affects remarkably the first frequency of the dam, due to the fluid-structure interaction phenomenon; the higher the water level, the lower the first natural frequency. But besides the reservoir level, other quantities, as well, have a relevant bearing on the structural behaviour of the dam. In particular it have to be underlined the role played by the temperature variation and the associated contact conditions of the vertical joints.

WATER LEVEL VERSUS FIRST FREQUENCY



The influence of joint openings on natural frequencies can be highlighted looking at the diagram beside where the first frequency of the dam and the related water level are displayed. It can be noted that the first modal frequency for a fixed water level can assume different values between two limit frequencies relevant to the open and the closed joints boundaries; the amplitude of this frequency range becomes smaller as the water level increases (because the hydrostatic pressure tends to keep the joints closed). Since below a certain water level the influence of fluid-structure interaction on the first frequency of the dam becomes less important than joint openings, such openings cannot be neglected to correctly understand the causes of these structural responses.

Therefore, the reproduction of the unilateral behaviour of contraction joints is an important step toward a better comprehension of arch dam static and dynamic behaviour. The current computational capabilities of computers and the availability of reliable non-linear finite element codes make it possible an effective solution of these problems. The Benchmark Workshop represents an occasion to compare results obtained from different codes and different numerical approaches, and to assess the reliability of this kind of analysis for practical uses. Accordingly, theme A1 proposes the study of the response of Talvacchia Dam in terms of displacements and stresses due to static and thermal loads. Detailed specifications are provided in the following section.

THIRD BENCHMARK WORKSHOP ON NUMERICAL ANALYSIS OF DAMS
THEME A1: Double curvature arch dam

TALVACCHIA Dam (Italy)

NON LINEAR ANALYSIS OF JOINT BEHAVIOUR UNDER THERMAL AND HYDROSTATIC LOADS

INTRODUCTION

Two static analyses are requested; both analyses have to be carried out considering a mathematical model which is able to take into account the behaviour of vertical contraction joints.

The first analysis assumes a "summer" distribution of temperature with maximum level of impounded water; the second analysis assumes a "winter" distribution of temperature with a reduced level of impounded water.

Information to perform the analyses will be provided in the following chapters. In more detail the following data will be suggested:

- finite element discretization;
- physical-mechanical parameters of the materials;
- nodal distribution of temperature;
- impounded water levels;
- forms of the selected set of results to be presented.

Results in terms of displacements and stresses obtained by different participants will be compared. A particular attention will be paid to results regarding the state of contraction joints (closed with no sliding; closed with sliding; open).

1.0 GEOMETRICAL DATA

Drawings relevant to the geometry of the dam are enclosed in Annexes 1÷6. Suggested finite element mesh of dam and rock foundation is recorded on the diskette enclosed as Annex 7.

Annex 3 shows the positions of joints reproduced in the model; nodes belonging to joint faces have been doubled and disconnected.

2.0 PHYSICAL-MECHANICAL PARAMETERS

The following data have to be assumed in the numerical analyses:

- Young's elastic modulus (concrete)........ E_c = 3.60 exp^{10} Nm^{-2}
- Young's elastic modulus (rock)............ E_r = 1.20 exp^{10} Nm^{-2}
- Poisson ratio coefficient (concrete)...... ν_c = 0.20
- Poisson ratio coefficient (rock).......... ν_r = 0.16
- Thermal dilatation coeff. (concrete)...... α = 0.7 exp^{-5} $°C^{-1}$
- Specific weight (concrete) .... γ_c = 24000 Nm^{-3}
- Specific weight (water) .... γ_w = 10000 Nm^{-3}
- friction factor on joint faces .... f = 0.75

3.0 LOADING CONDITIONS

The following loadings should be considered:

3.1 - dead weight + "summer" thermal distribution + water level 507 m a.s.l.

3.2 - dead weight + "winter" thermal distribution + water level 471 m a.s.l.

For both conditions calculations may be performed under the assumption of the presence, or absence, of friction on joint faces.

The weight of rock foundation should be neglected. The weight of dam should be applied entirely in a single step with joints considered to be working.

Nodal distribution of temperatures is recorded on diskette (Annexe 7); "winter" distribution (see figure 1) is related to a water level of 471 m a.s.l.; "summer" distribution (see figure 2) has been determined for an impounded water level equal to 507 m a.s.l..

Nodal distribution of temperatures producing a null distribution of thermal stresses is assumed to be uniformly equal to 0 °C.

Joints are assumed to be in contact, with no stress trasmitted, in this thermal condition and with neither dead weight nor hydrostatic load applied.

4.0 PRESENTATION OF RESULTS

In order to simplify the comparison of results obtained by different participants, it would be worthwhile collecting a selected set of results (displacements and principal stresses) according to the forms suggested in figures 3 and 4.

Positive displacements will correspond to the positive directions of the global reference axes (see figure 3).

The principal stresses will be identified as P1 (maximum algebric values), P2 (intermediate values) and P3 (minimum algebric values). Tensile stresses have to be assumed as positive.

Results are required in S.I. units (Pa, meter).

As far as joints are concerned, displacements relevant to the nodes belonging to both faces of each joint are requested (see figure 5, 6, 7, 8). Furthermore it would be worth providing maps of joint openings.

Participants are kindly requested to provide all data mentioned above recorded on a diskette.

NOTE: While color images are recommended for presentation and discussion of contributions, black-and-white (or grey tones) maps are suggested for publication of proceedings.

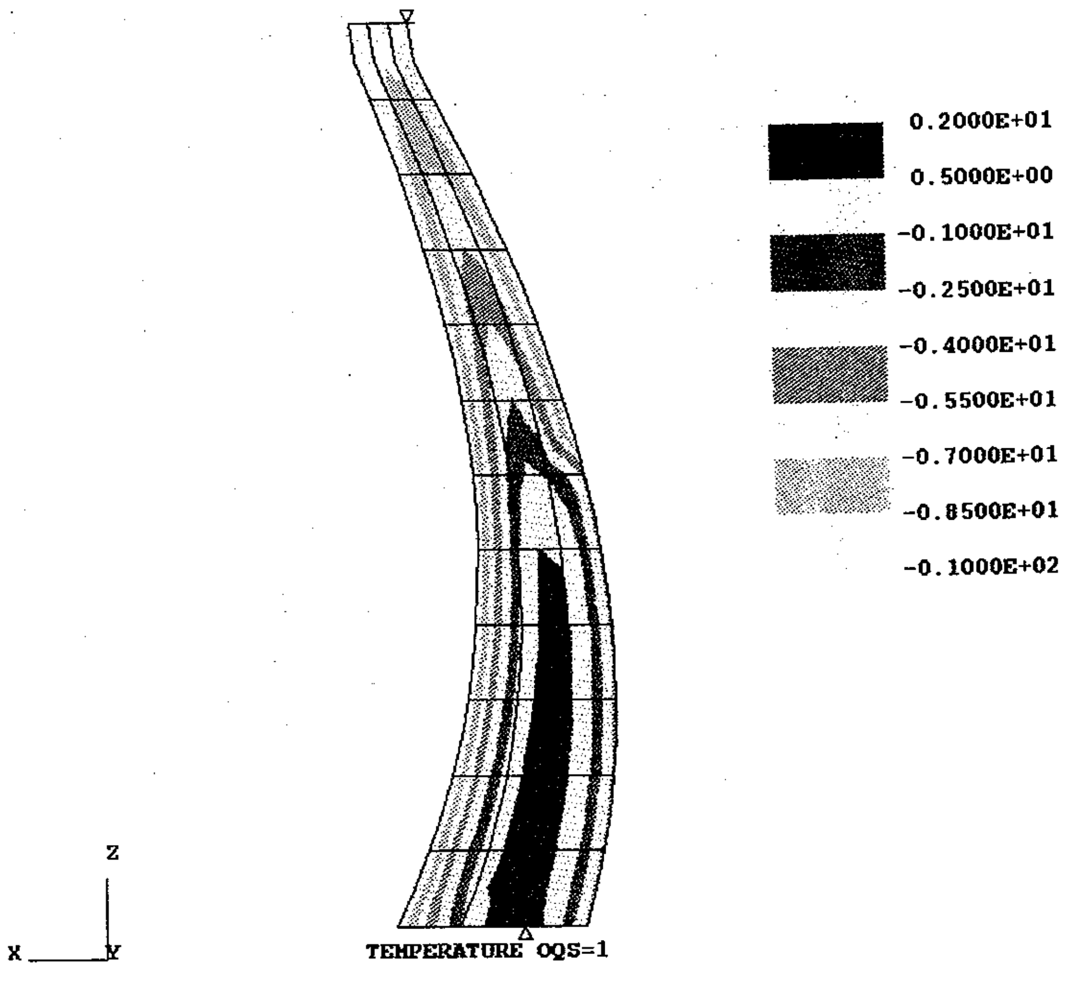


Fig. 1 - Central cantilever: "winter" distribution of temperature.
(Water level 471 m a.s.l.)

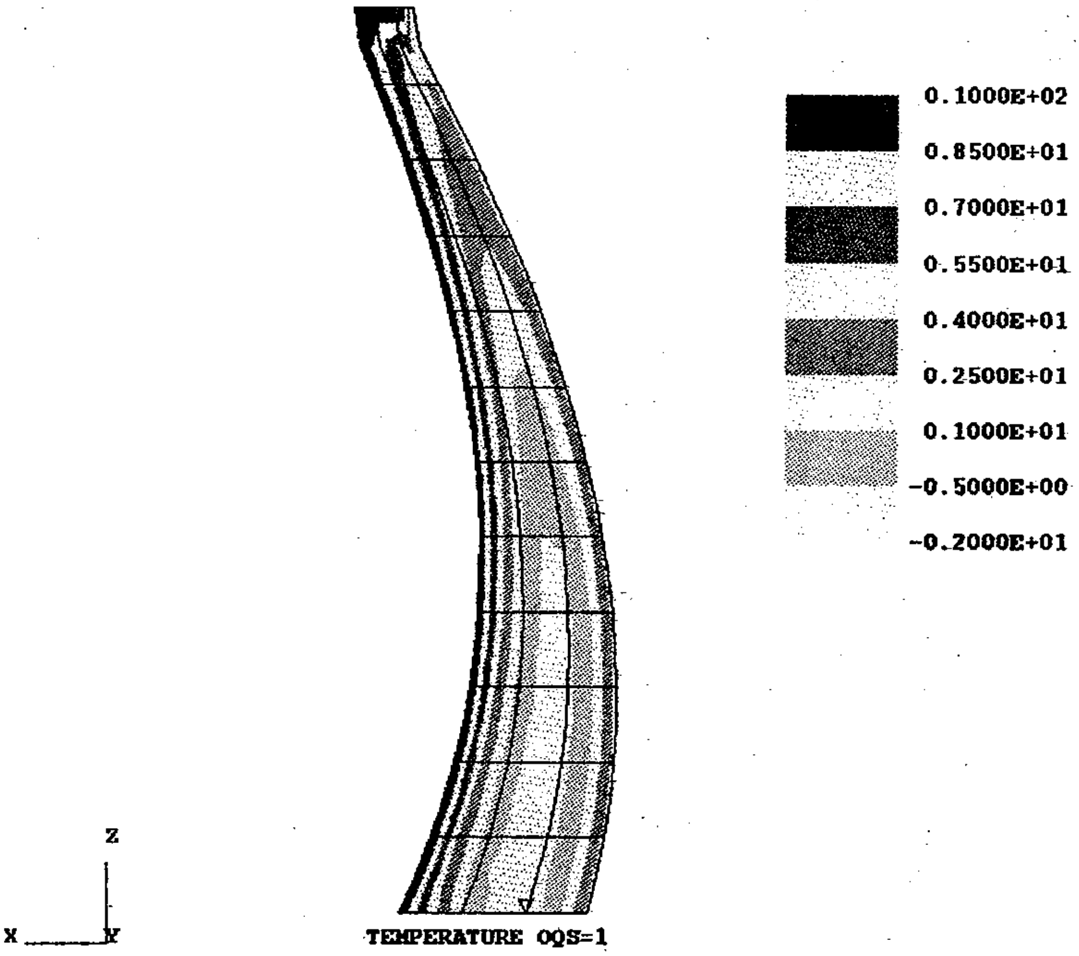
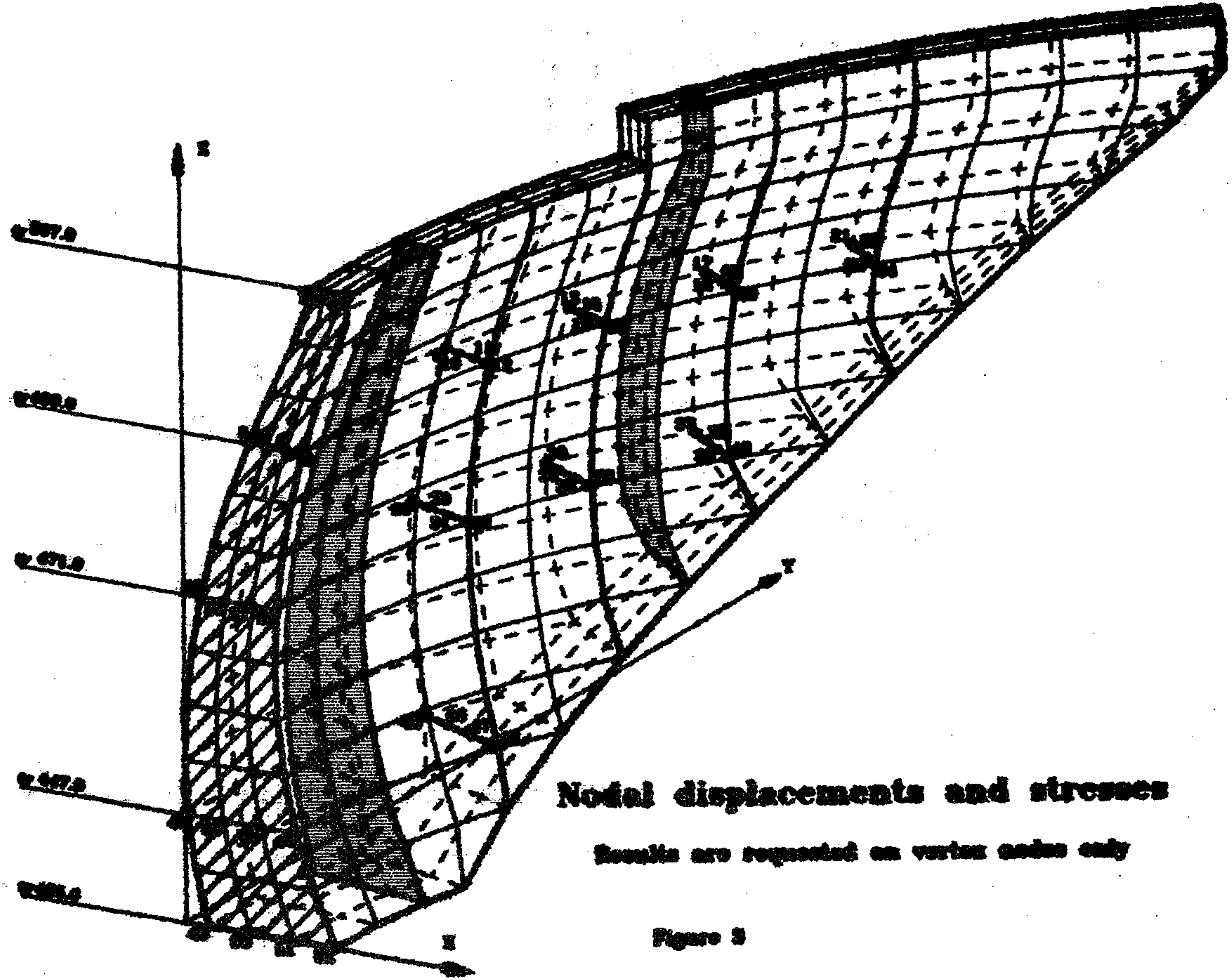


Fig. 2 - Central cantilever: "summer" distribution of temperature. (Water level 507 m a.s.l.)



Nodal displacements and stresses

Results are requested on vertex nodes only

Figure 3

Figure 4

Nodal displacements and stresses

Node	[m]			[MPa]		
	Dx	Dy	Dz	P1	P2	P3
1						
2						
3						
4						
...						
...						
...						
...						
52						

Tensile stresses have to be assumed as positive.

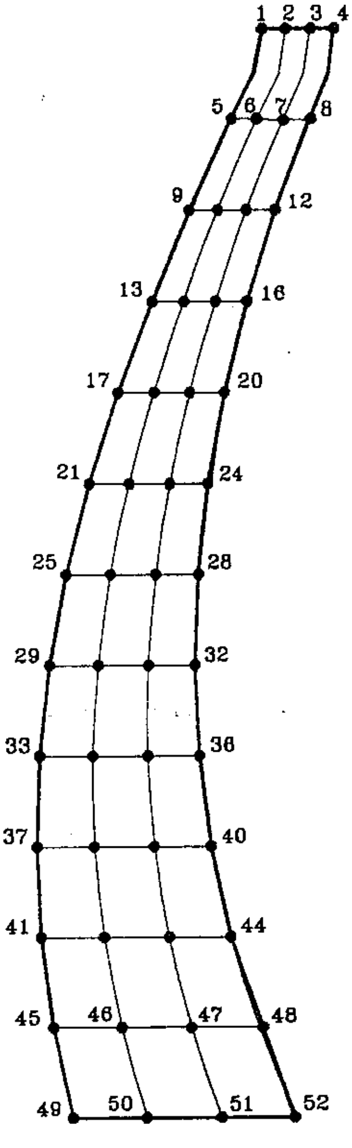


Figure 5

JOINTS 2 AND 3

Location of nodes where results are requested

Figure 6

Displacements at Joints 2 and 3

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1						
2						
3						
4						
...						
...						
...						
...						
52						

Indices ' and " are referred respectively to right and left face of joint.
(right and left are intended in the orographic sense, i.e. looking the dam from upstream)

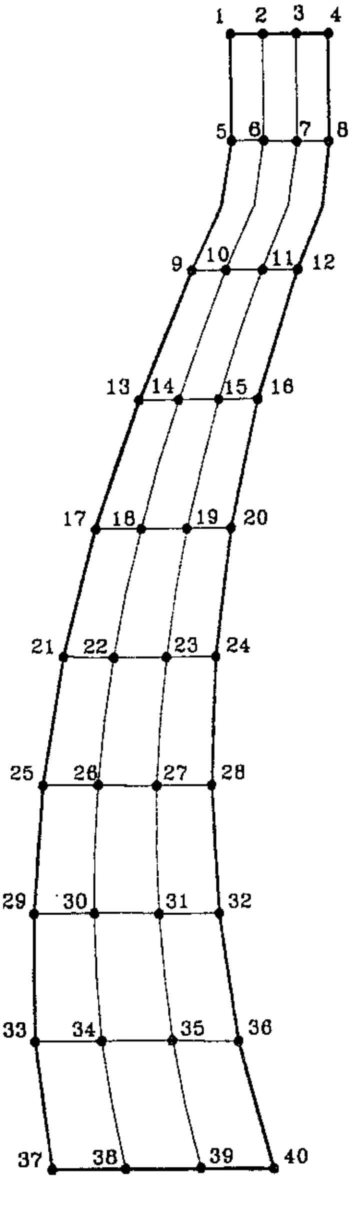


Figure 7

JOINTS 1 AND 4

Location of nodes where results are requested

Figure 8

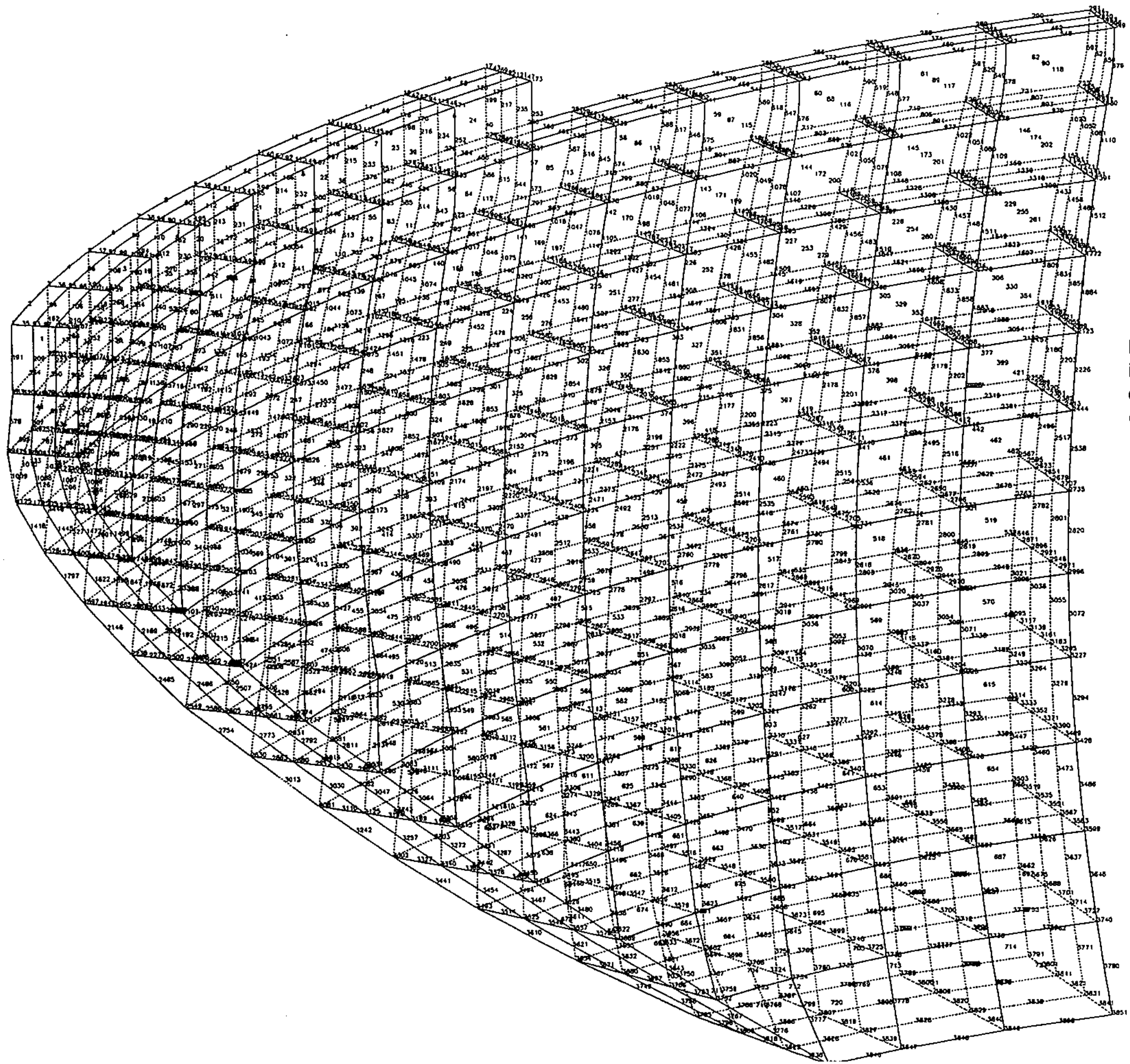
Displacements at Joints 1 and 4

Node	[m]					
	D'x	D"x	D'y	D"y	D'z	D"z
1						
2						
3						
4						
...						
...						
...						
...						
40						

Indices ' and " are referred respectively to right and left face of joint.
(right and left are intended in the orographic sense, i.e. looking the dam from upstream)

ANNEX 1

MESH OF THE DAM



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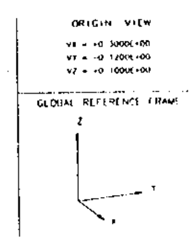
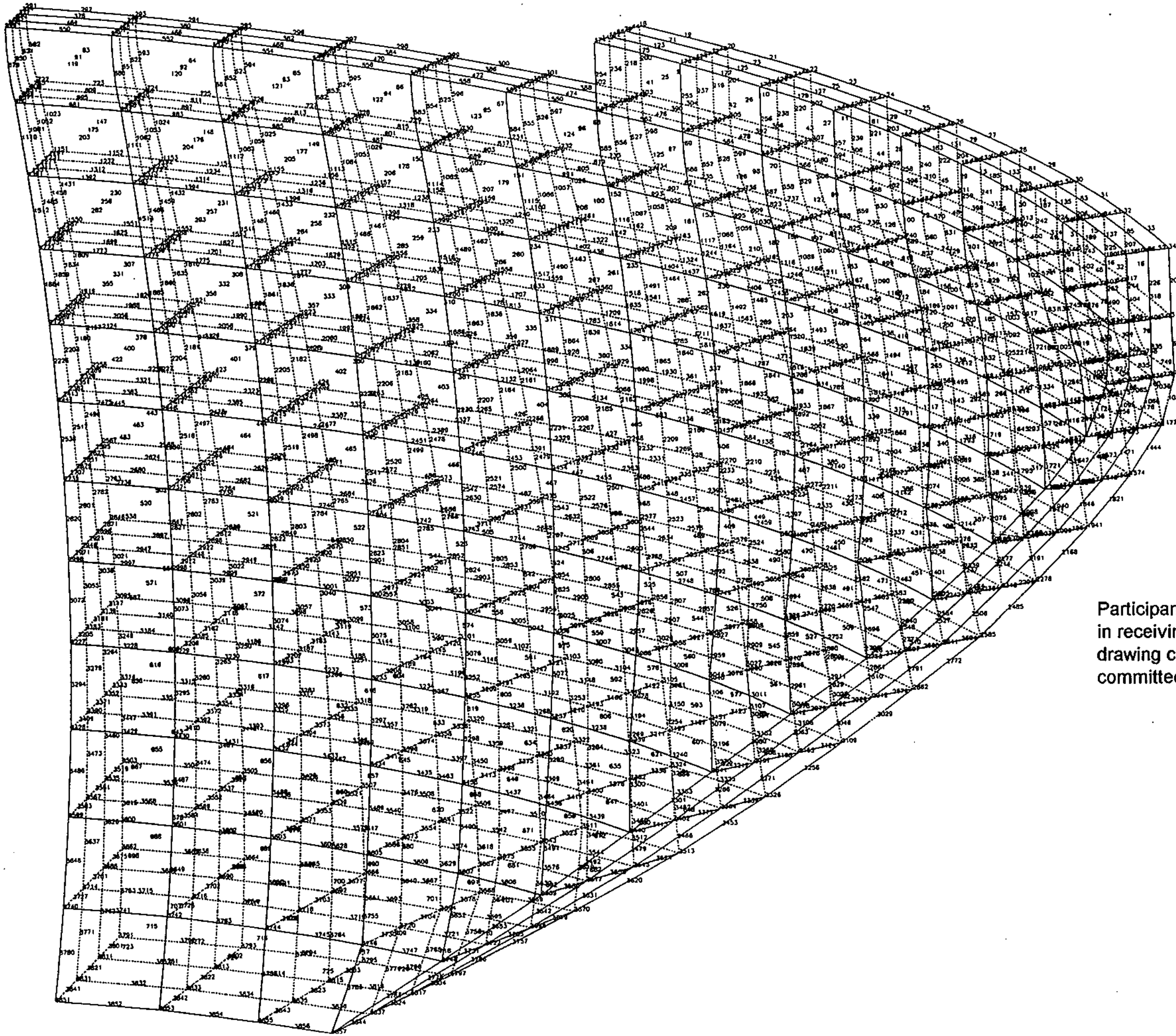


ANNEX 2

MESH OF THE DAM



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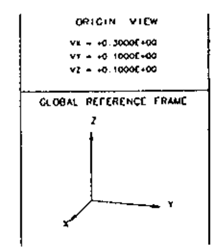
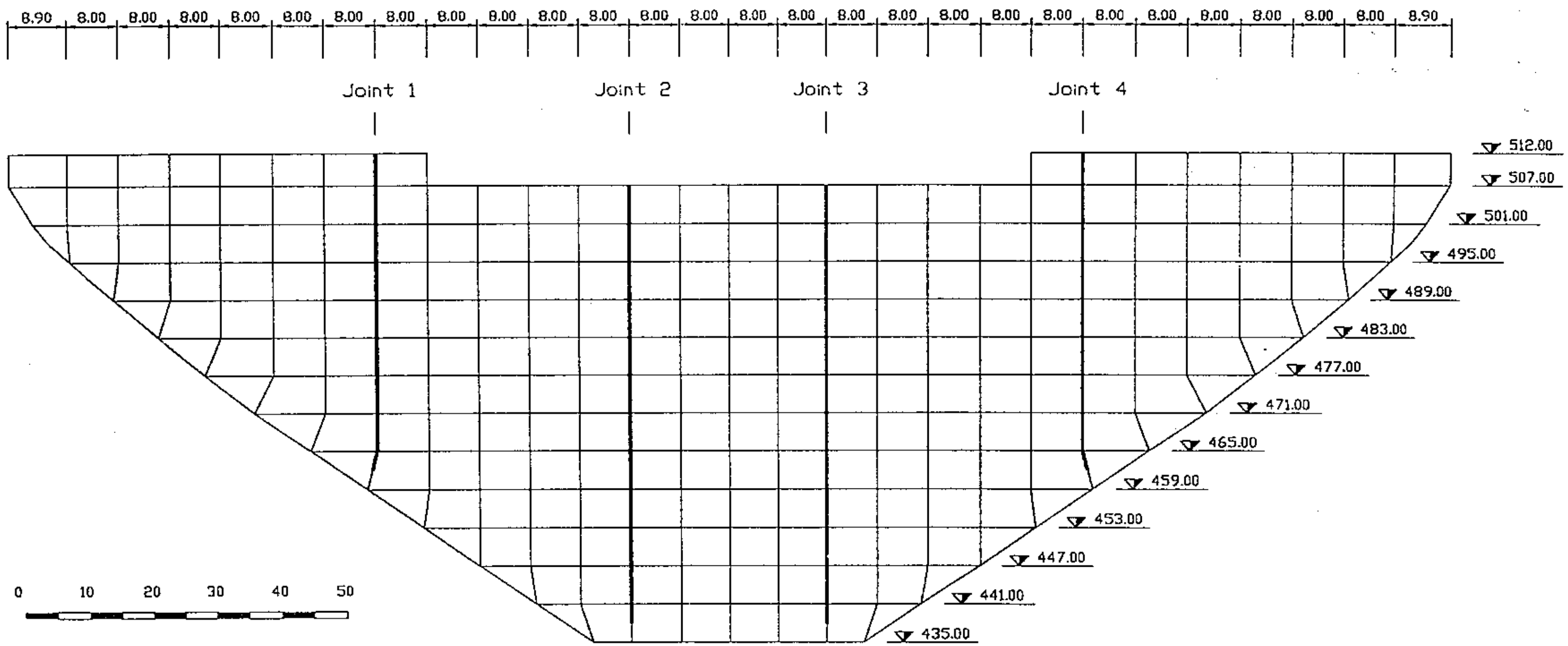


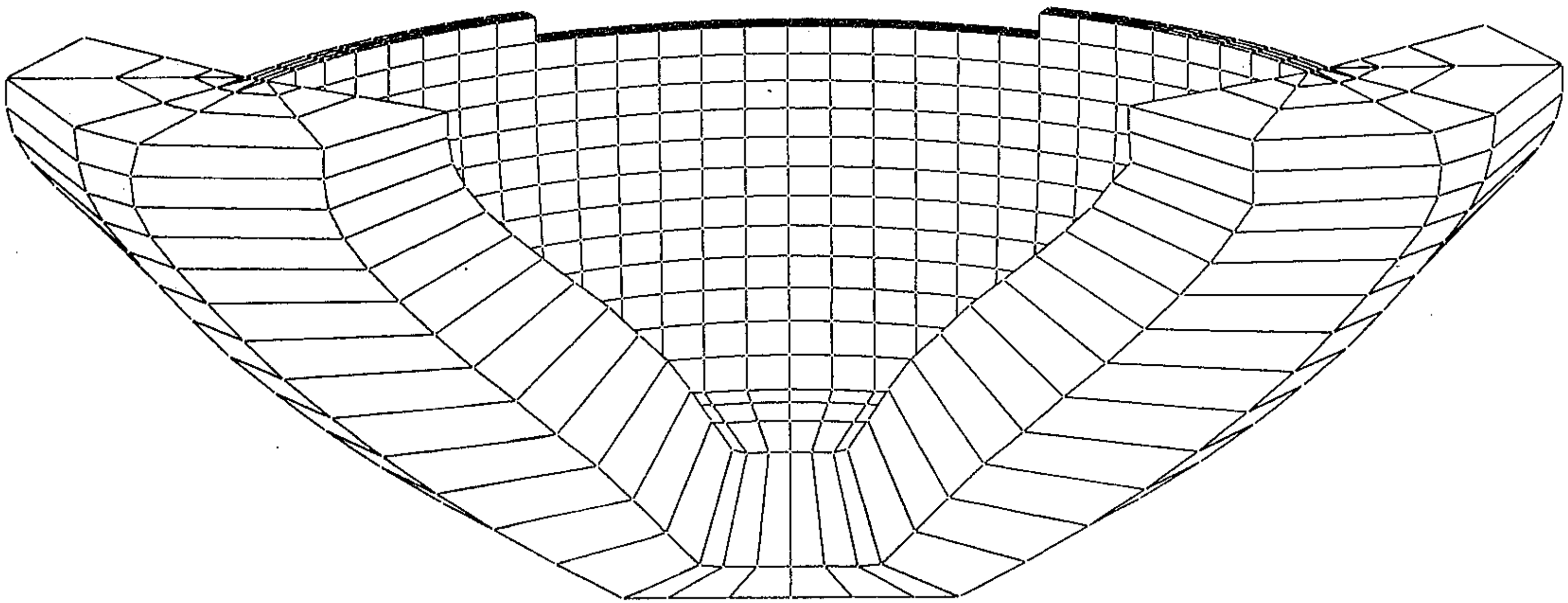
ANNEX 3

DEVELOPED DOWNSTREAM VIEW



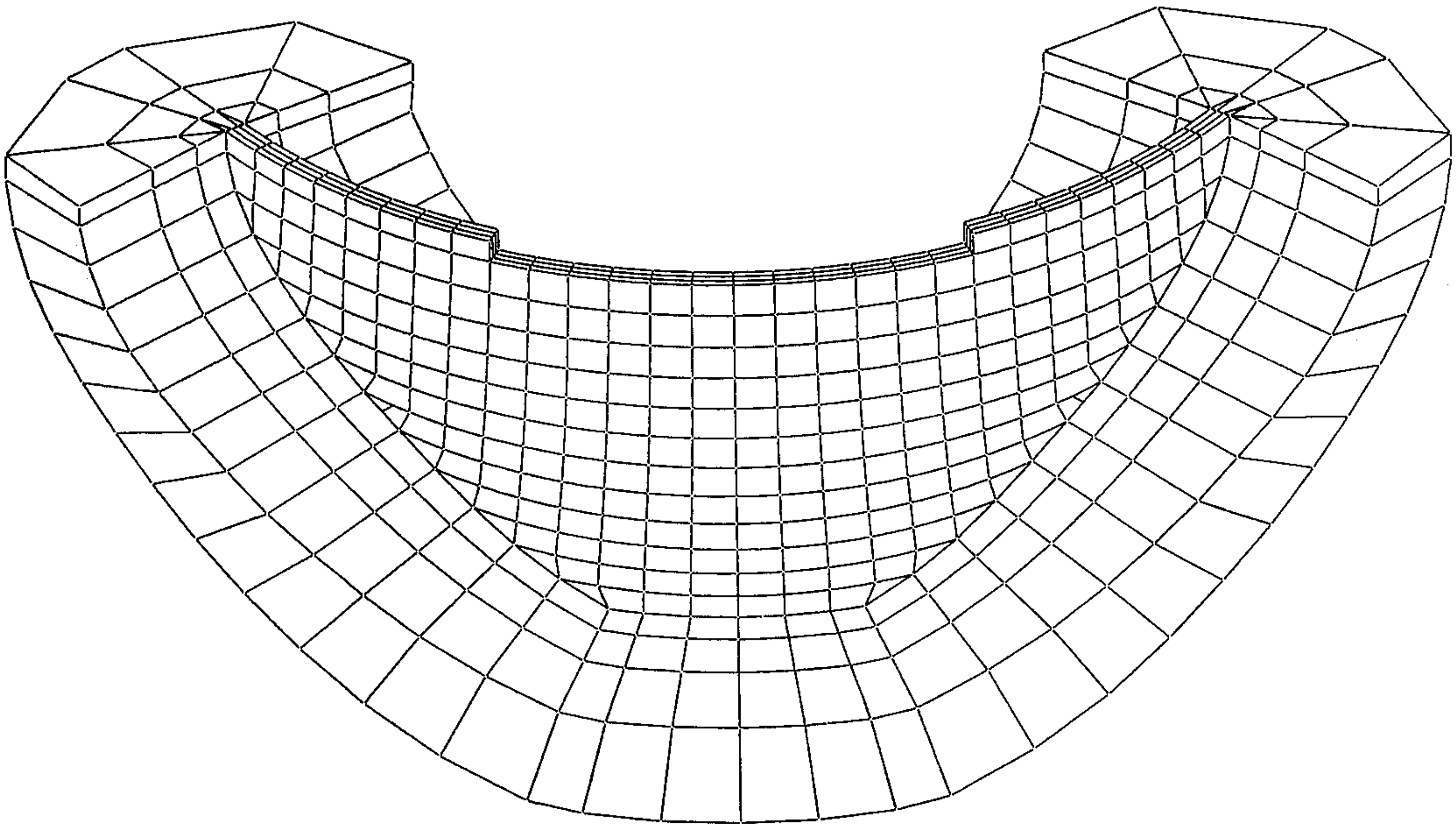
ANNEX 4

MESH OF THE DAM AND FOUNDATION
DOWNSTREAM VIEW



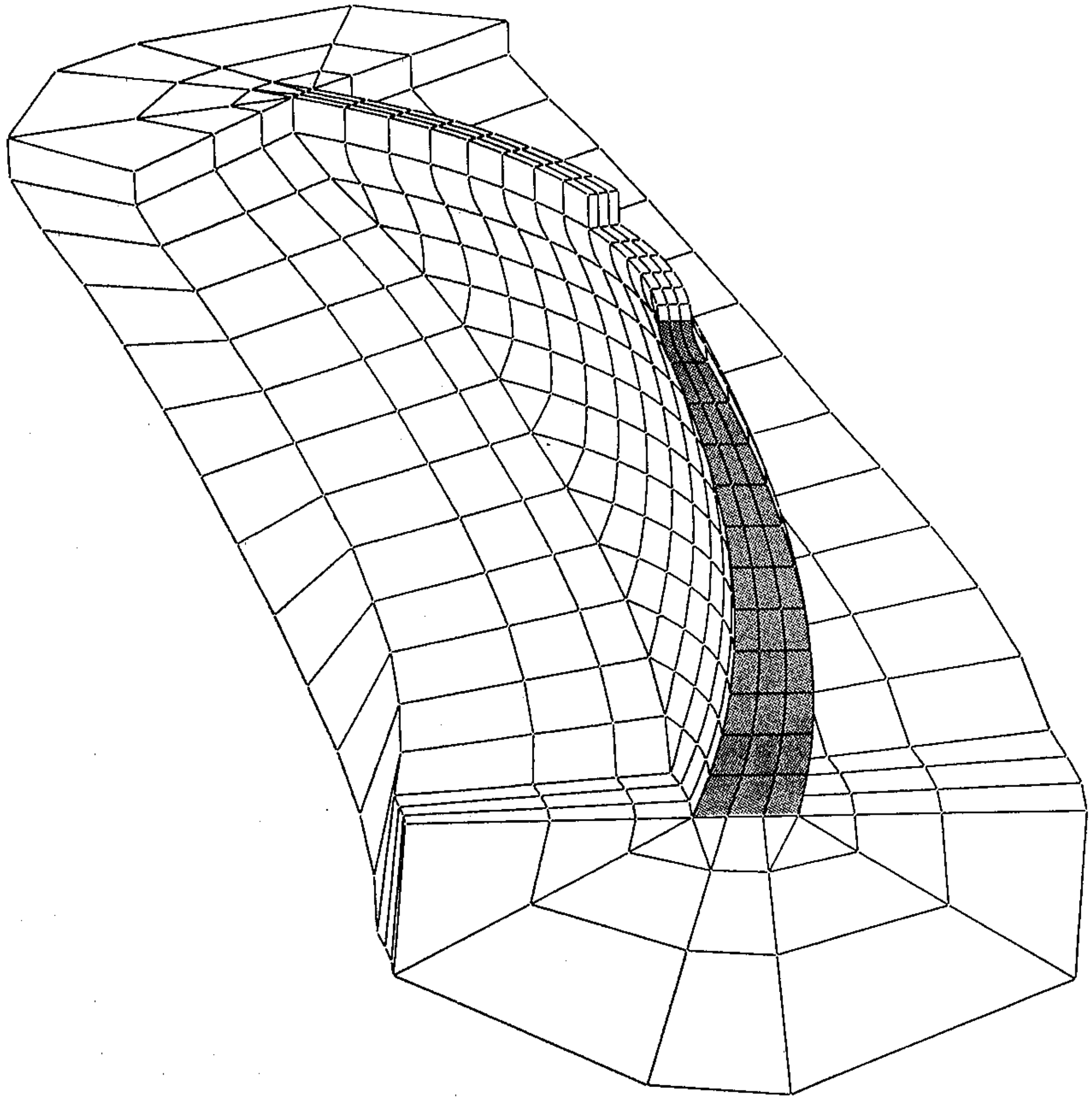
ANNEX 5

MESH OF THE DAM AND FOUNDATION
UPSTREAM VIEW



ANNEX 6

MESH OF THE DAM AND FOUNDATION
VIEW OF THE CENTRAL CANTILEVER



THEME A1

Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam

SYNTHESIS

&

COMPARISON OF RESULTS

SYNTHESIS REPORT

G.RUGGERI, P.PALUMBO

ISMES S.p.A.

PARTICIPANTS

As in the previous Benchmark Workshops, the numerical analysis of the arch dam has collected a remarkable number of participants: 10 companies and reasearch institutes from 6 different countries which have presented a global amount of 37 non-linear static analyses. It would be worth mentioning that only 4 of these were already present among participants in the previous Benchmark Workshop.

The solution of theme A1 has been carried out using either the penalty method or the Lagrange multiplyers technique and in some cases both these techniques together.

Participants have used 9 different computational codes to carry out the analyses and they have applied loads following different loading histories; moreover the contact elements employed ranged from the simple 1 dimensional contact element to the complex surface elements and solid tridimensional elements with specific constitutive laws.

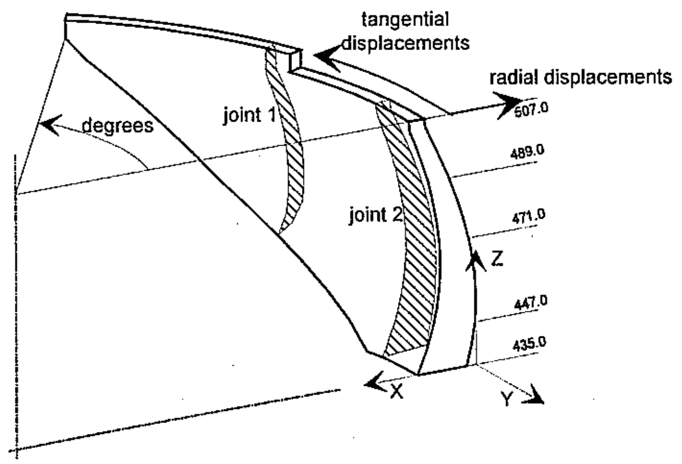
Despite of this wide variety of different approaches, final results show a remarkable agreement.

	Authors	*Company*	*Code*	*Contact element*	*Method*
P01	Dalmagioni, Meghella, Palumbo, Rebecchi	ISMES, ENEL	ABAQUS FIESTA	18 nodes surf. elem. (ABAQUS) 1D elements (FIESTA)	Lagrange for contact and penalty for friction
P02	Bolognini, Masarati Bettinali, Galimberti	CISE, ENEL	CANT-SD	joint elements with finite thickness	no-tension constitutive model
P03	Malla, Wieland	Electrowatt Engineering Services	ADINA	4 nodes surface elements	penalty
P04	Cervenka, Boggs Plizzari, Saouma	Dept. of civil Engineering University of Colorado	MERLIN		specific constitutive law
P05	Ilie, Schaller, Vadez	ADDL	ANSYS	1D elements connecting vertex nodes	penalty
P06	Sarghiuta, Abdulamit	Civil Engineering Institute of Bucharest	ANSYS	1D elements	penalty
P07	Carrère, Fournel, Perrin	Coyne et Bellier	COBEF		penalty
P08	Kojic, Grujovic, Zivkovic	Energoprojekt	PAK	3D elements	Lagrange
P09	Divoux, Bourdarot	CNEH	GEFDYN	8 nodes surface elements	penalty
P10	Zenz, Obernhuber, Perner	Tauernplan Consulting GmbH	ABAQUS	18 nodes surface elements	Lagrange for contact and penalty for friction

COMPARISON OF RESULTS

The comparison of results among all participants has been performed for the complete set of output quantities requested in the specifications, i.e. principal stresses and displacements in the dam body and across the vertical joints. Moreover displacements have been treated to compute for all the participants the joints opening.

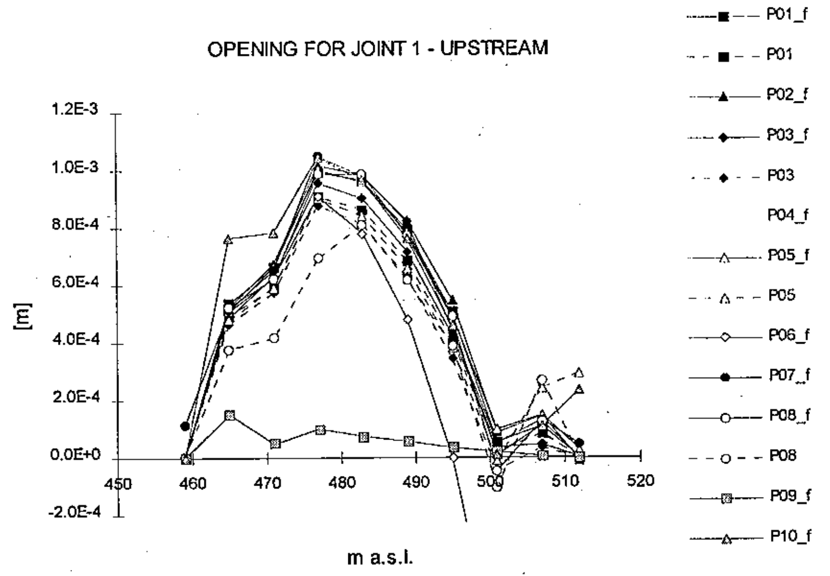
All the following graphs make reference to coordinate systems described in the figure below.



The continuous lines in all the following graphs are relevant to analyses with friction, dotted lines are relevant to analyses without friction.

RESULTS FOR WINTER CONDITION

The principal aim of contraction joints is to avoid tensile stress growth when the dam is subjected to winter loading; in this condition low reservoir level and temperature can work together to open vertical joints. Under the winter loads described by theme A1 specifications, both joints 1 and 2 are open: joint 1 on upstream and downstream side, and joint 2 on the downstream side only. Comparisons of results relevant to joint 1 openings (upstream and downstream) are reported in the following figures; it appears quite evident a good general agreement with some minor discrepancies. Observing these graphs we can point out that participant P09 underestimates the joint openings both upstream and downstream; the authors declared problems connected to poor convergence of their joint elements (see P09 report). Results of participant P07 set out an opening at level 460 m a.s.l. because the finite element



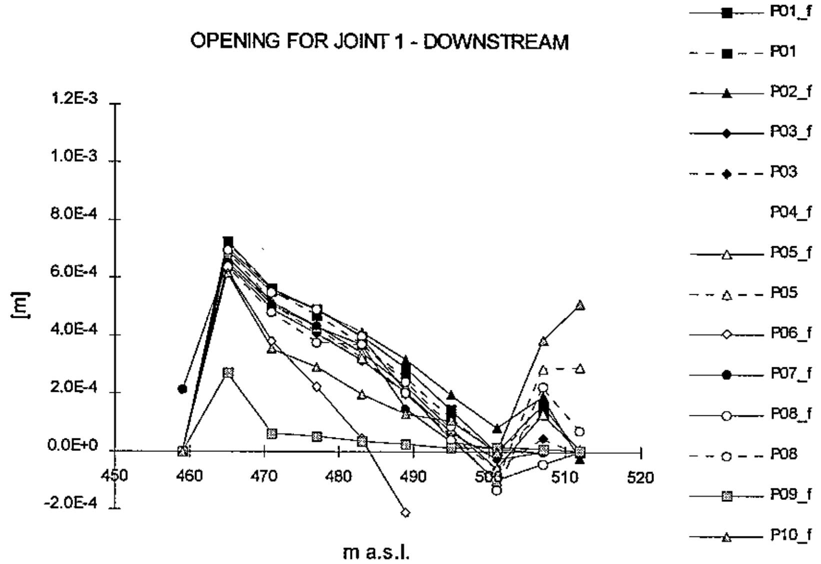
model he used was modified with an extension of vertical joints. Results of participant P06 show penetrations from level 495 m a.s.l. up to the crest; this is probably due to a particular orientation of their 2-nodes contact elements, in fact openings computed by the authors near the crest do not present penetrations (see P06 report).

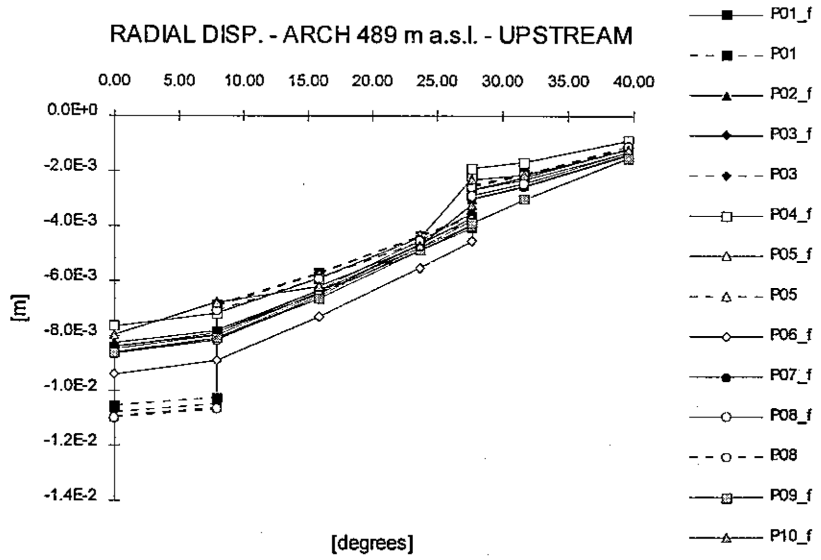
As general observation it could be noted that openings computed with and without friction are very close to each other, i.e. the friction coefficient does not affect remarkably the behaviour of joints and accordingly the stress redistribution (see in the following).

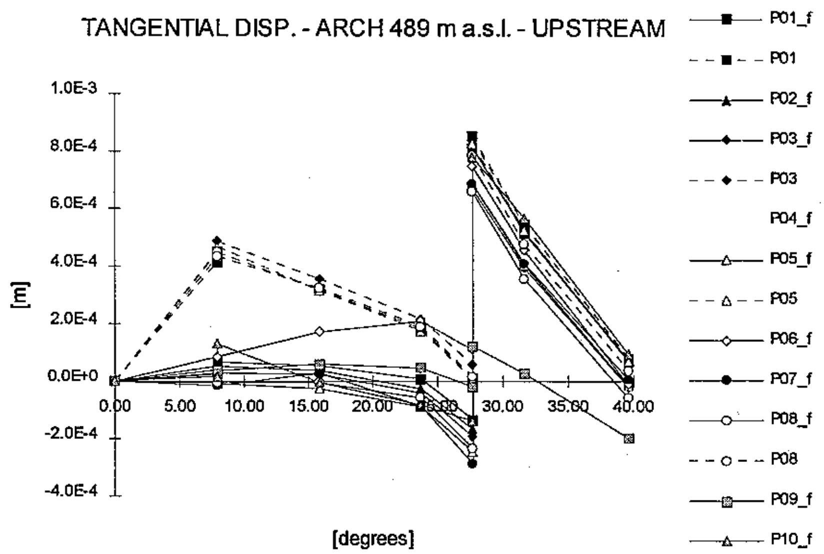
The comparison of upstream tangential and radial displacements along the arch at 489 m a.s.l. make it possible to draw additional observations.

For a correct understanding of displacements graphs it would be worth noting that all discontinuities in tangential displacement graphs indicate a penetration (if the "jump" is negative) or an opening (if the "jump" is positive) while discontinuities in radial displacement graphs indicate a slip across the joint. The abscissa is measured in degrees from the symmetry plane.

From displacement graphs the results relevant to analyses with

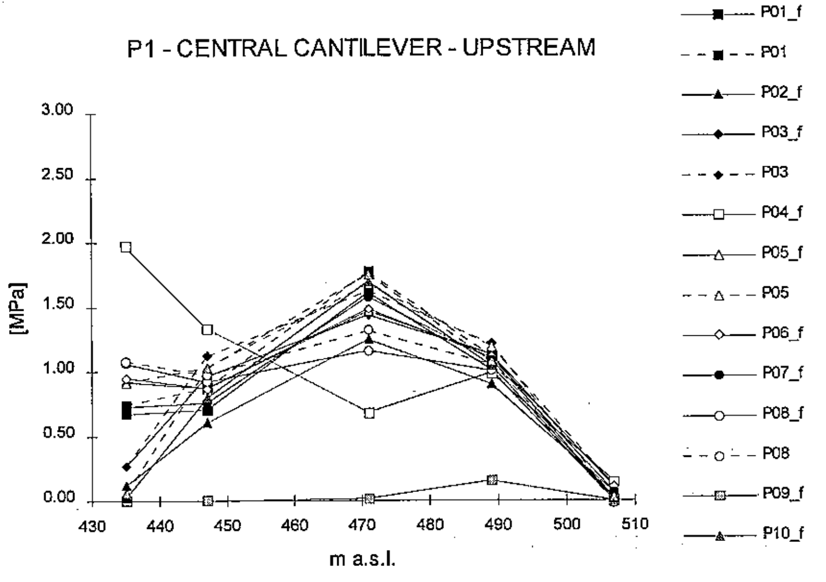






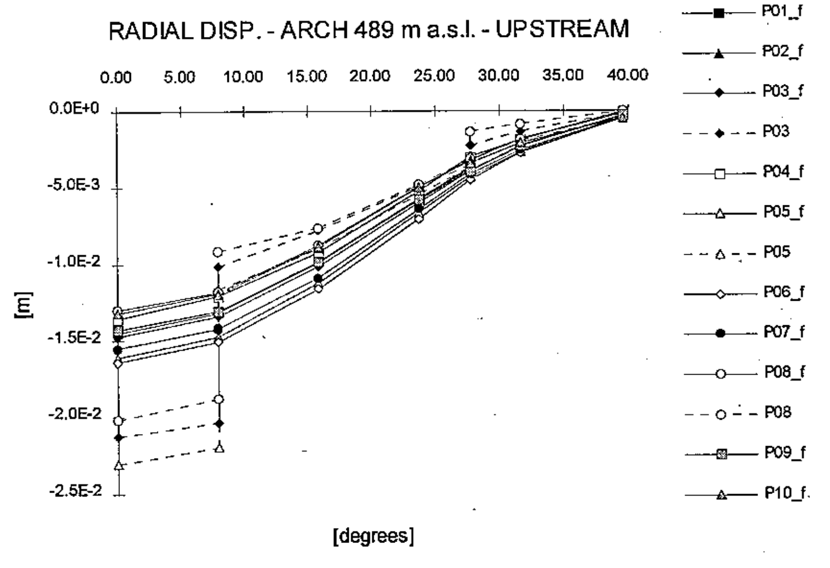
and without friction can be easily identified, expecially looking at the radial displacements, in fact the absence of friction causes an evident slip on the joint 2 (the nearest to the symmetry plane). The influence of friction can be easily recognized also from the tangential displacement graph, where the absence of friction increase displacements of nodes from the symmetry plane up to joint 1; on the other hand the openings across joint 1 become slightly smaller than those computed considering friction (see also opening graphs in the previous pages). Similar conclusions could be drawn considering displacements relevant to downstream side (see the complete set of comparisons). It would be worth noting that all radial displacement agree resonably well despite of remarkable differencies in joint openings computed by some participant like P09 (see page before).

Principal stresses P1 computed along the upstream side of the central cantilever are reported in the graph beside. Likewise for the joints opening, the presence of friction does not affect significantly the results. Differencies found at level 435 m a.s.l. are due to different methods adopted in computing stresses along the dam-foundation interface, i.e. considering or not the foundation in the computation of average nodal stresses.

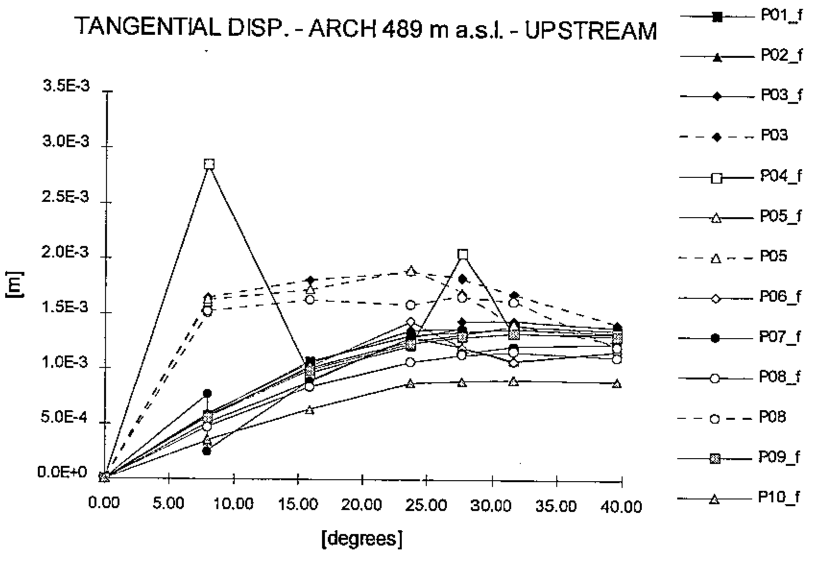


RESULTS FOR SUMMER CONDITION

With summer loading condition both hydrostatic and thermal loads contribute to keep joints closed, and the opening graphs, accordingly, highlight this phenomenon (see the complete set of comparison). Penetrations can occur either when penalty method is adopted or when particular orientations are defined for contact elements. Radial and tangential upstream displacements for the arch at level 489 m a.s.l. are reported in the following. As for the winter condition, results computed with friction are remarkably different from those computed without friction. Looking at tangential

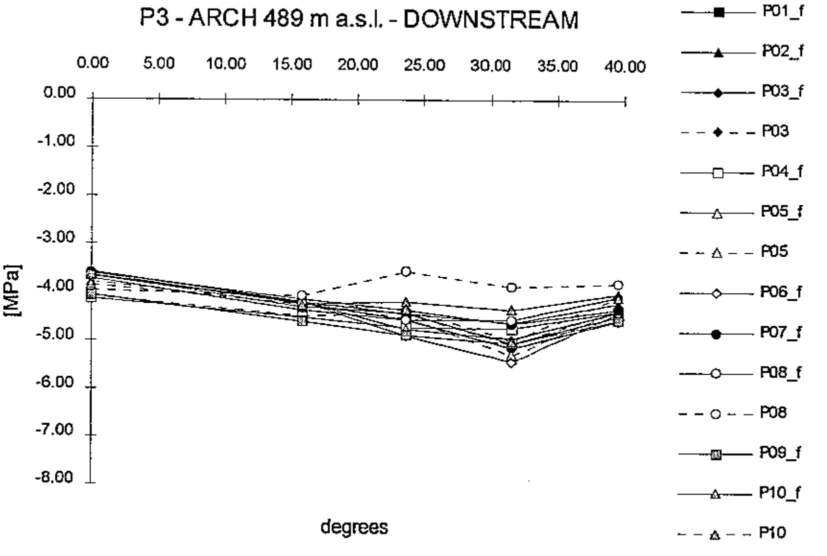


displacements it could be recognized some "negative jumps" which indicate the presence of penetrations across the joints. Also in this case, radial displacements show a well defined behaviour, with a slight scattering near the symmetry plane. The same conclusions can be achieved considering the downstream side (see the complete set of results).



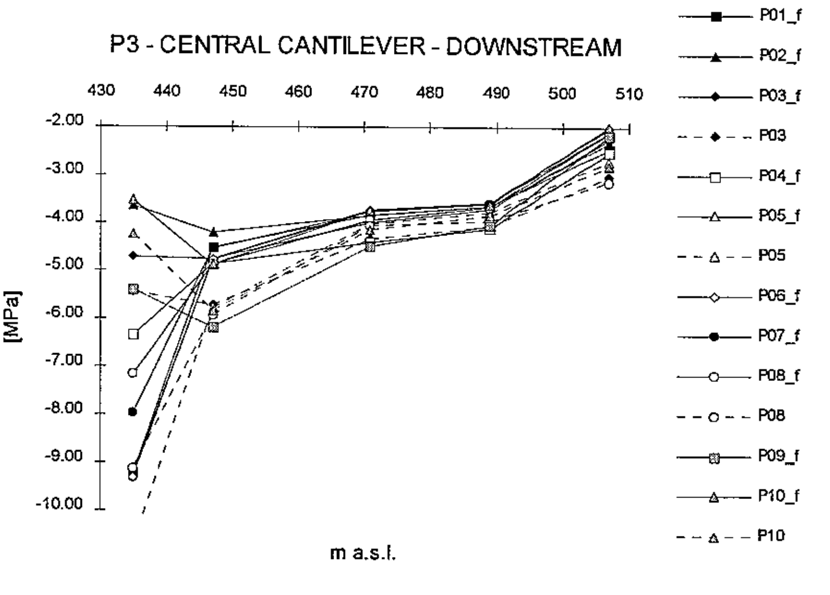
Principal stresses set out a rather good agreement, with a lower scattering in comparison with winter results.

Figures below set out the P3 (compressive) principal stresses along the downstream of the arch at level 489 m a.s.l. and the central cantilever.



Results relevant to the arch show a really good agreement from the symmetry plane up to the abutements.

Principal stresses P3 computed on central cantilever are still in good agreement, except near the dam-foundation boundary where different approaches used to compute nodal stresses contribute to scatter the results.



As for winter condition, principal stresses set out a low sentitivity to the friction coefficient: results obtained from analyses with and without friction are very close to each other.

Third Benchmark Workshop on
NUMERICAL ANALYSIS OF DAMS
Gennevilliers, France, September 29-30, 1994

THEME A1

Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam

ANNEX:

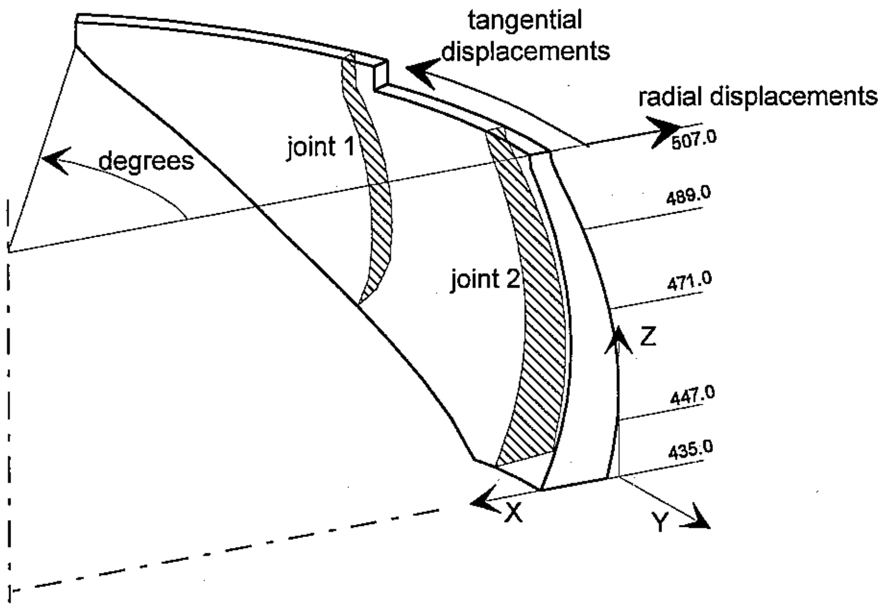
COMPARISON OF RESULTS

THEME A1

	Authors	Company	Code	Hardware	CPU (see note)	with friction	without friction	Contact element	Method	Note
P01	Dalmagioni Meghella Palumbo Rebecchi	ISMES ENEL	ABAQUS FIESTA	CONVEX	8h wf 2h nf	X	X	18 nodes surf. elem. (ABAQUS) 1D elements (FIESTA)	Lagrange for contact and penalty for friction	
P02	Bolognini Masarati Bettinali Galimberti	CISE ENEL	CANT-SD	ALLIANT FX80	18h 44' wf	X		Joint elements with finite stiffness	No-tension constitutive model	
P03	Malla Wieland	Electrowatt Engineering Services	ADINA	SUN SPARK system 10 model 51	95 h wf 63h nf	X	X	4 nodes surface elements	penalty	Load history: selfweight-hydrostatic load-thermal load
P04	Cervenka Boggs Plizzari Saouma	Dept. of civil Engineering University of Colorado	MERLIN			X			Specific constitutive law	All loads applied together
P05	Ilie Schaller Vadez	ADDL	ANSYS	Compaq 486 Pentium	5h wf 2h nf	X	X	1D elements connecting vertex nodes	penalty	
P06	Sarghiuta Abdulamit	Civil Engineering Institute of Bucharest	ANSYS	486 DX 33MHz	14h 44' wf	X		1D elements	penalty	
P07	Carrére Fournel Perrin	Coyne et Bellier	COBEF			X			penalty	Joints extended up to the rock
P08	Kojic Grujovic Zivkovic	Energoprojekt	PAK	IBM RISK		X	X	3D elements	Lagrange	8-node elements with incompatible displacements
P09	Divoux Bourdarot	CNEH	GEFDYN	Sparc server 1000		X		8 nodes surface elements	penalty	All loads applied together
P10	Zenz Obernhuber Perner	Tauernplan Consulting GmbH	ABAQUS	DEC Alpha AXP 7000	3h 12'	X	X	18 nodes surface elements	Lagrange for contact and penalty for friction	

Note: CPU times are relevant to winter analyses; "wf" and "nf" mean respectively "with friction" and "no-friction".

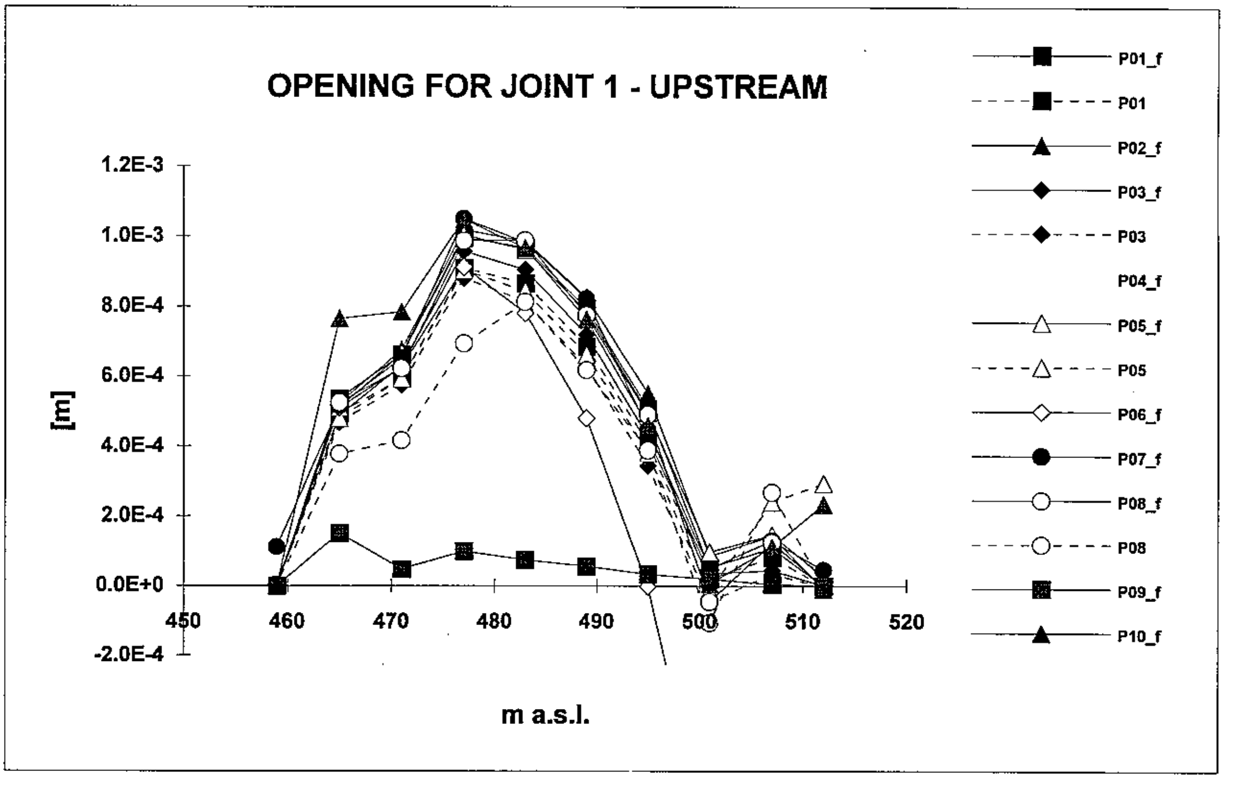
Coordinate systems used in the comparisons

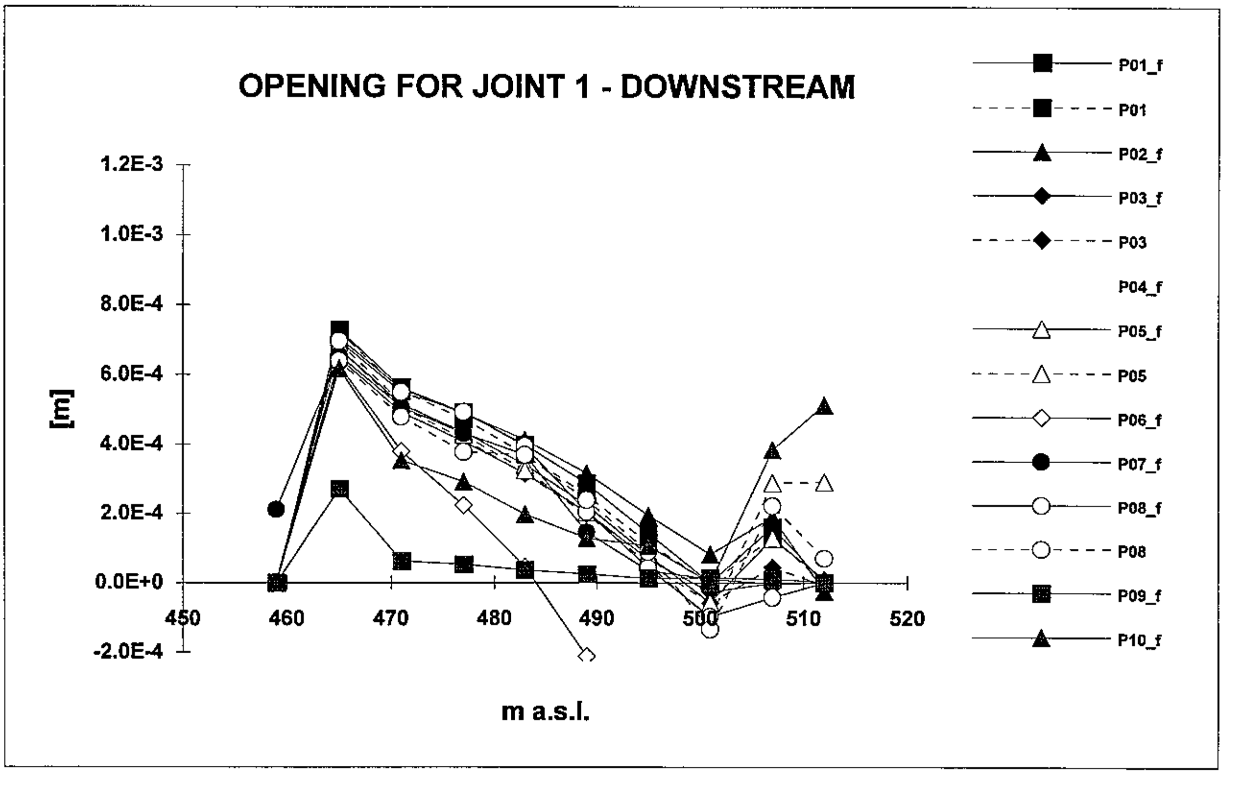


Remarks:

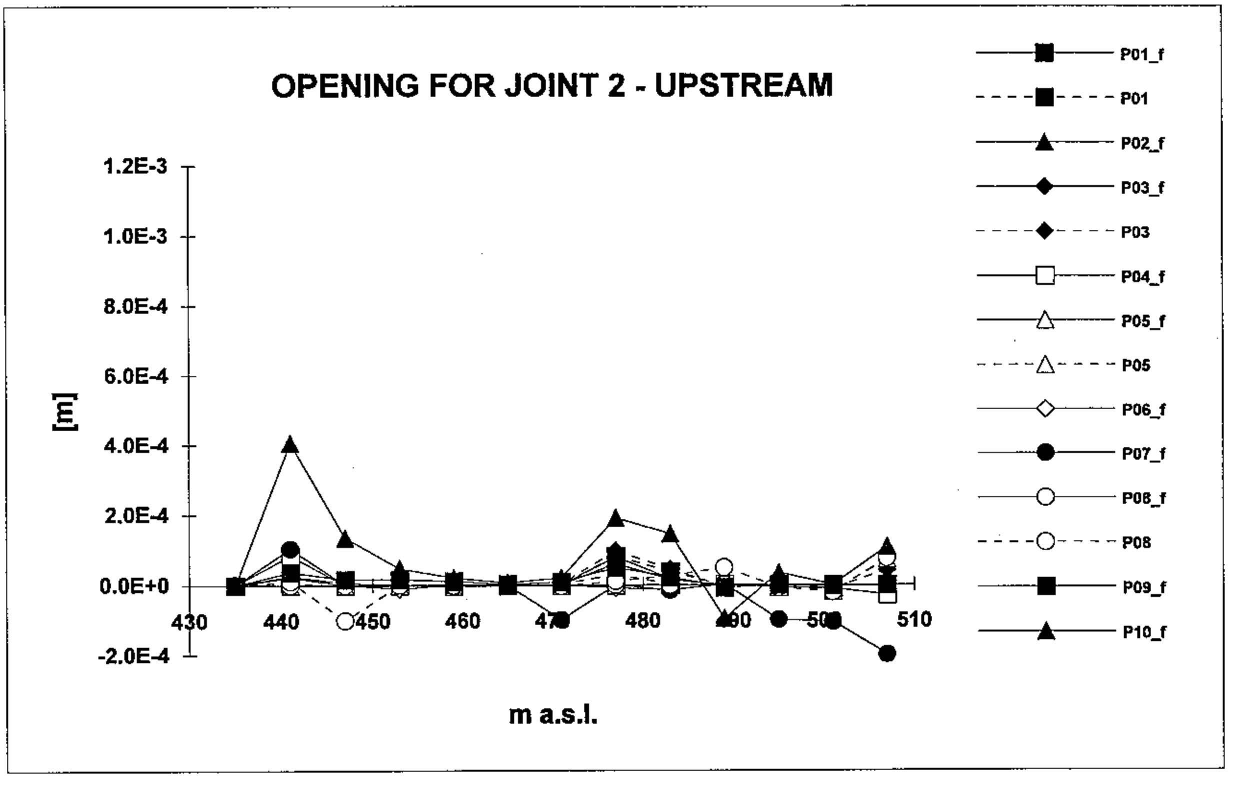
- All the continous lines (——) in the following diagrams are relevant to analyses with friction.
- All the dotted lines (-------) in the following diagrams are relevant to analyses without friction.

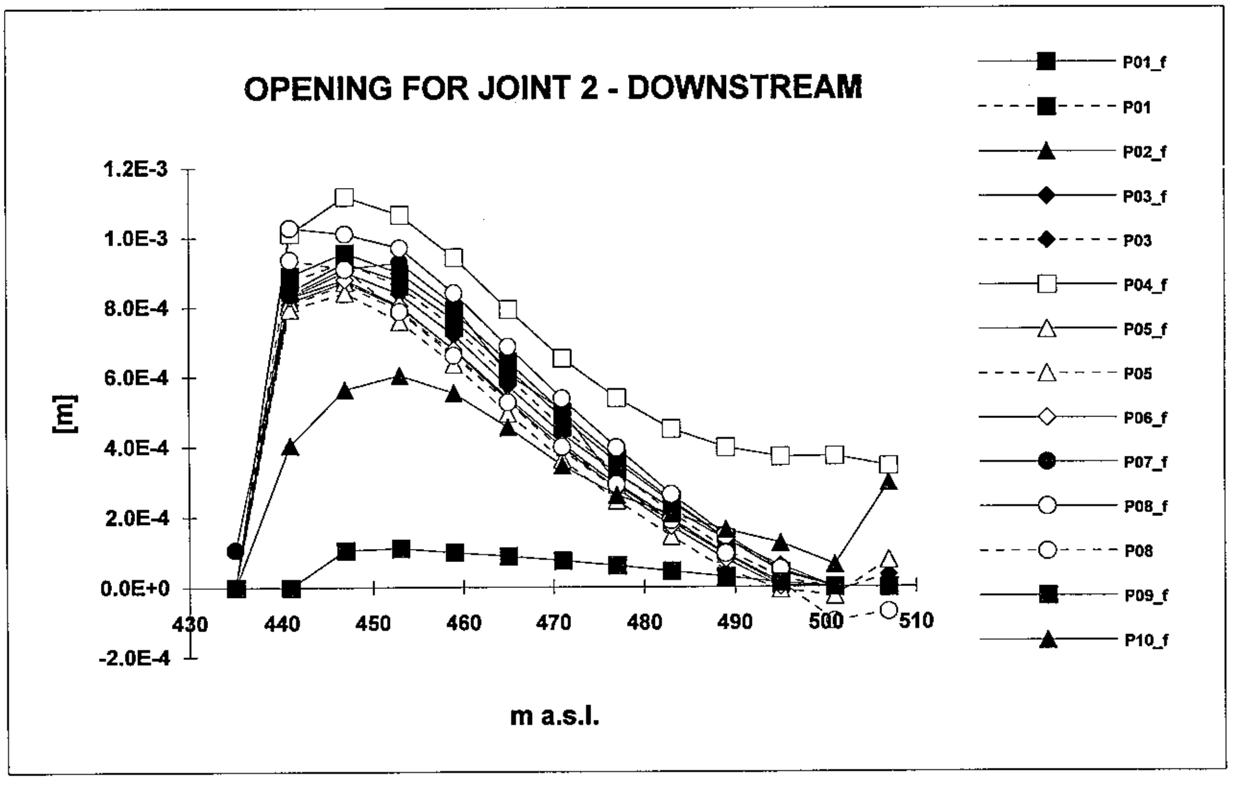
RESULTS FOR WINTER CONDITION



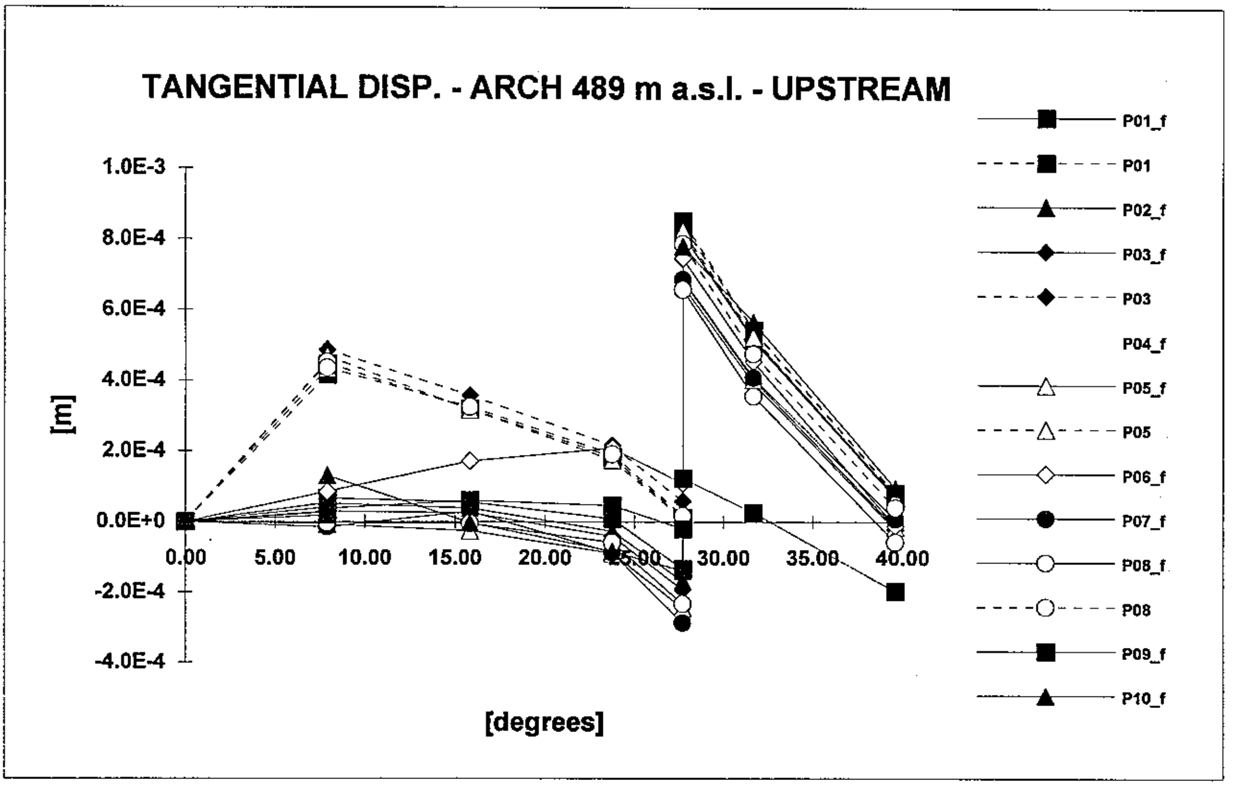


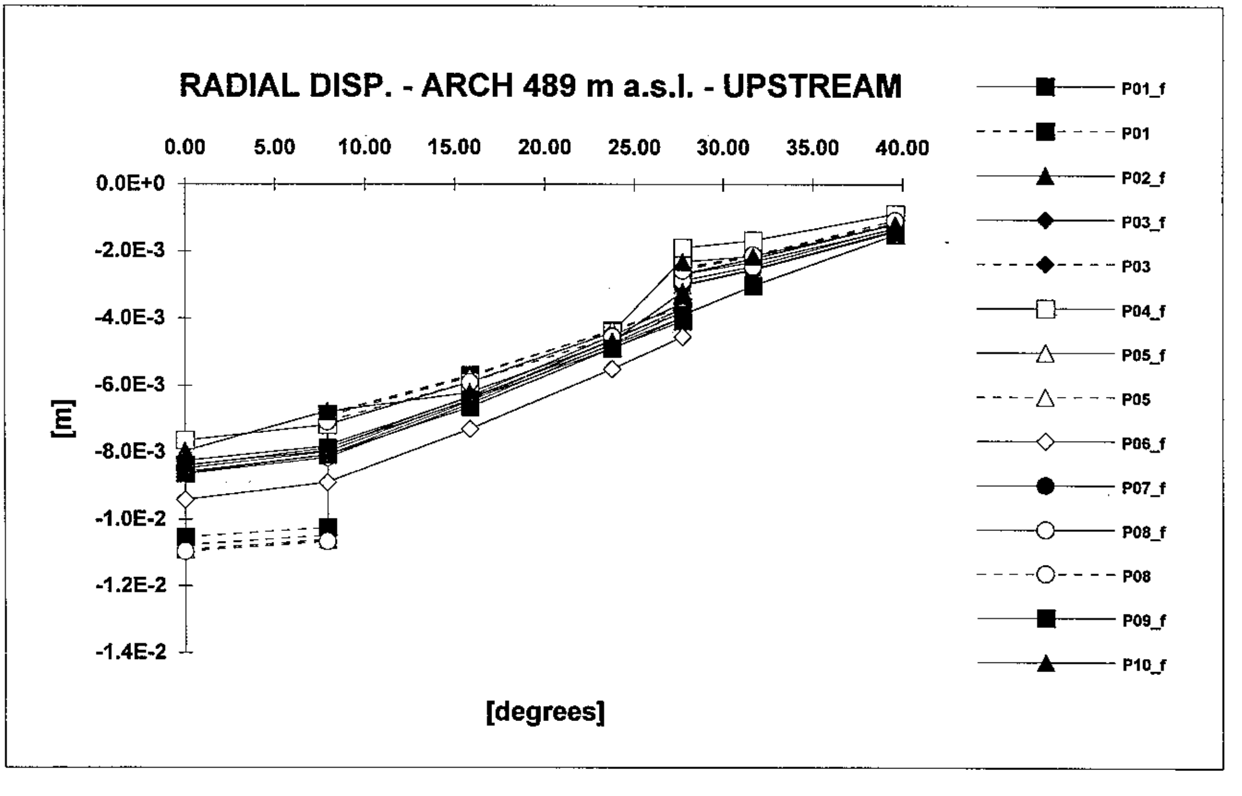
RESULTS FOR WINTER CONDITION



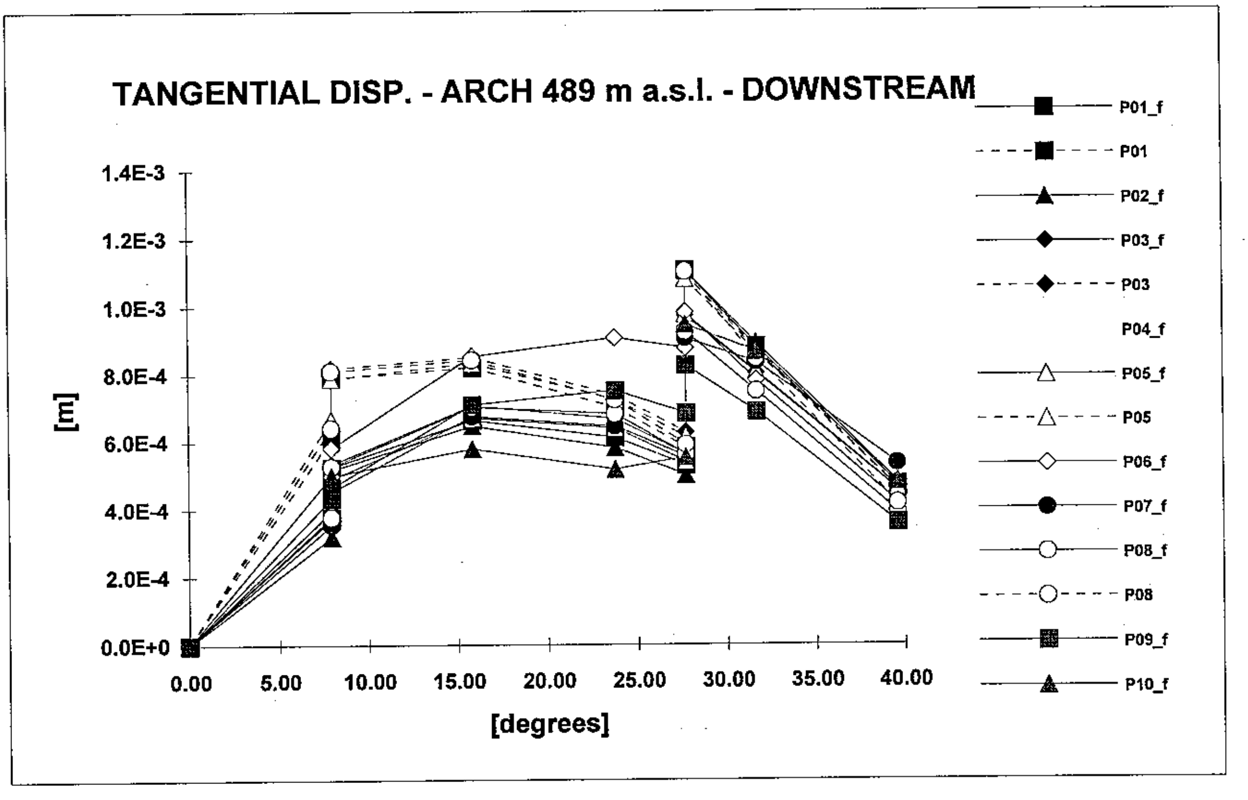


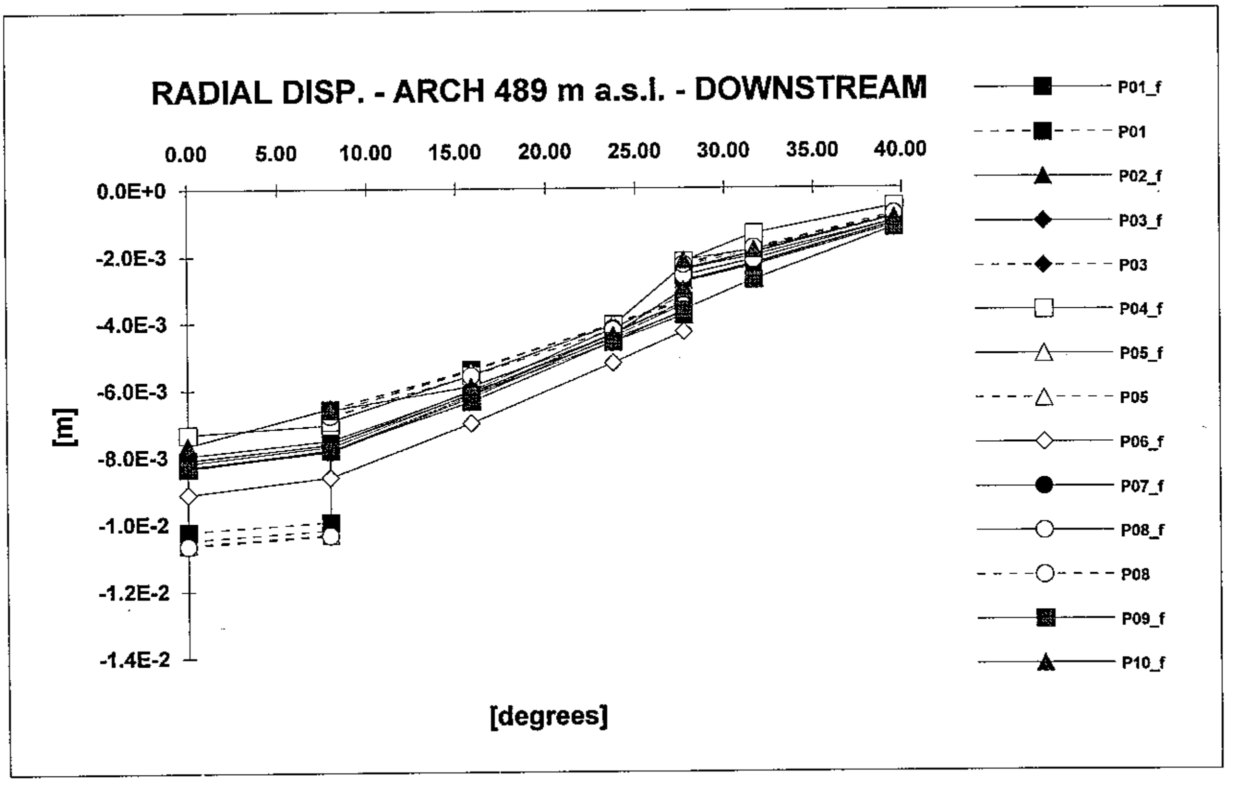
RESULTS FOR WINTER CONDITION



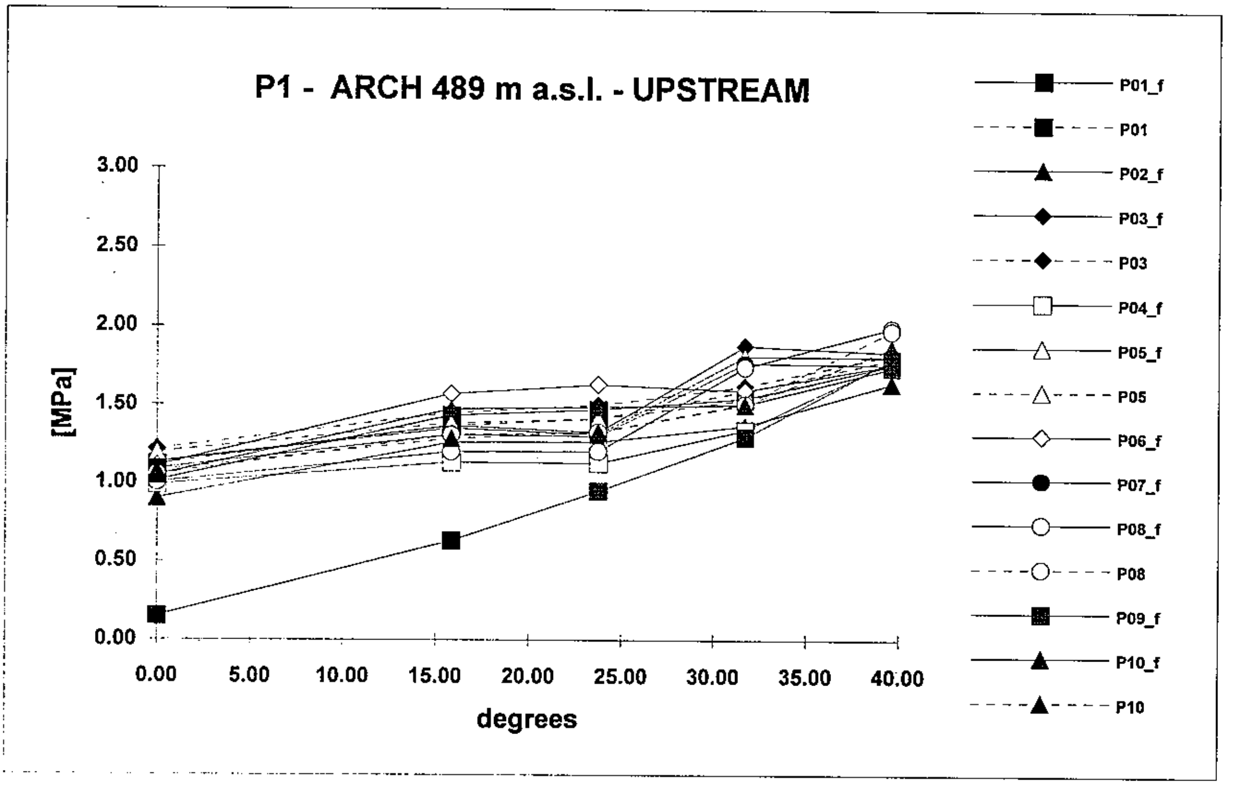


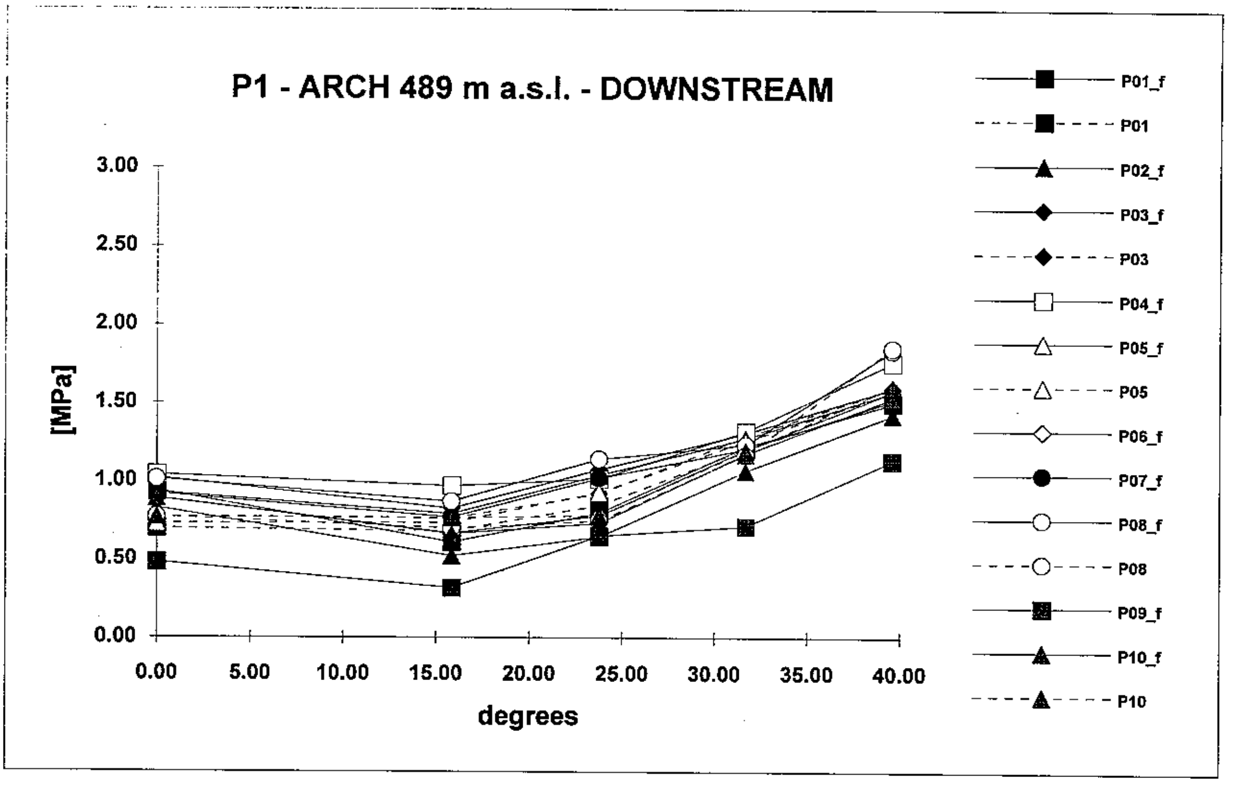
RESULTS FOR WINTER CONDITION



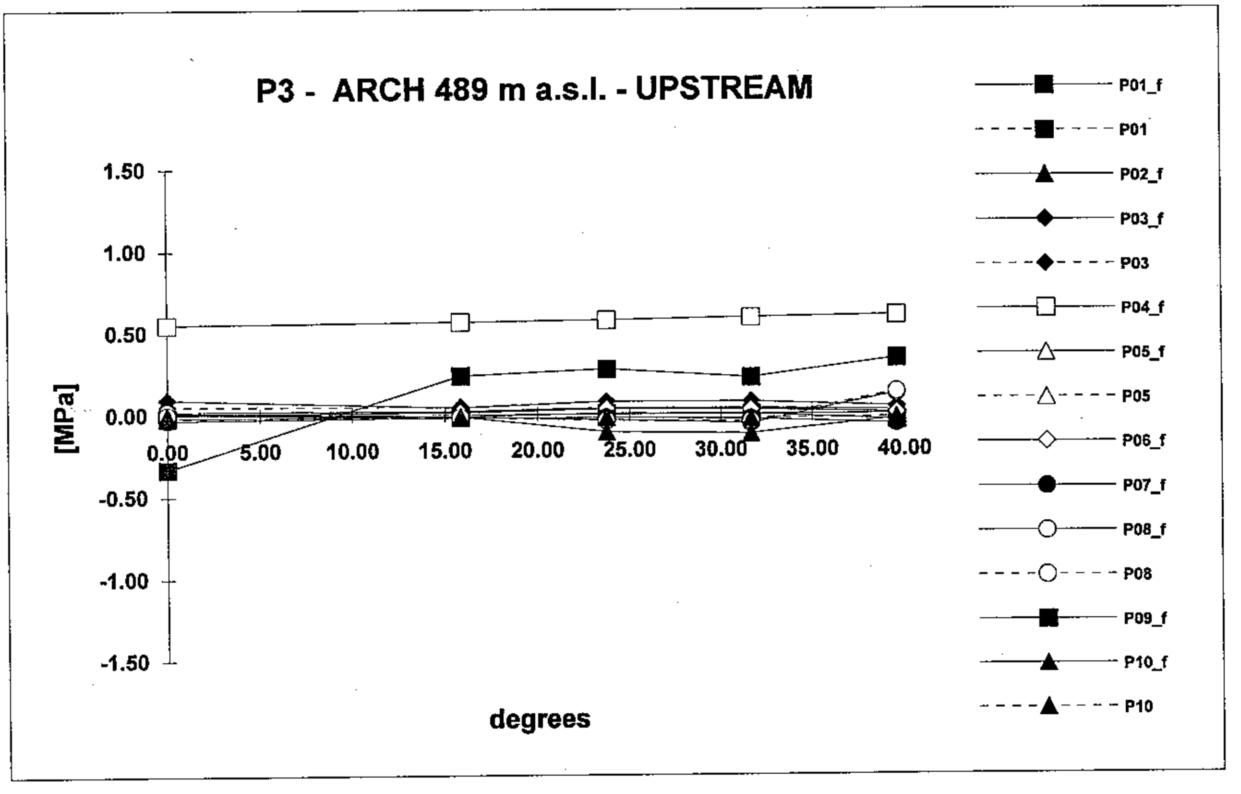


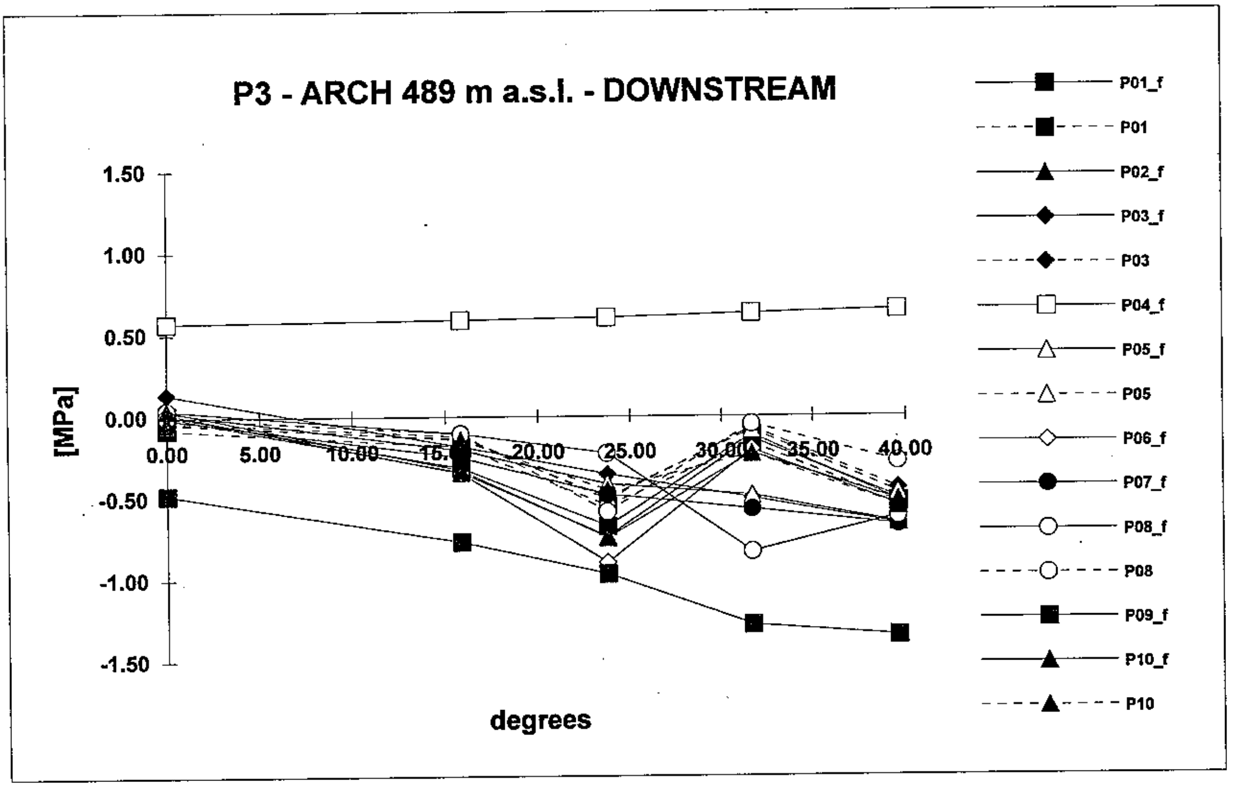
RESULTS FOR WINTER CONDITION





RESULTS FOR WINTER CONDITION





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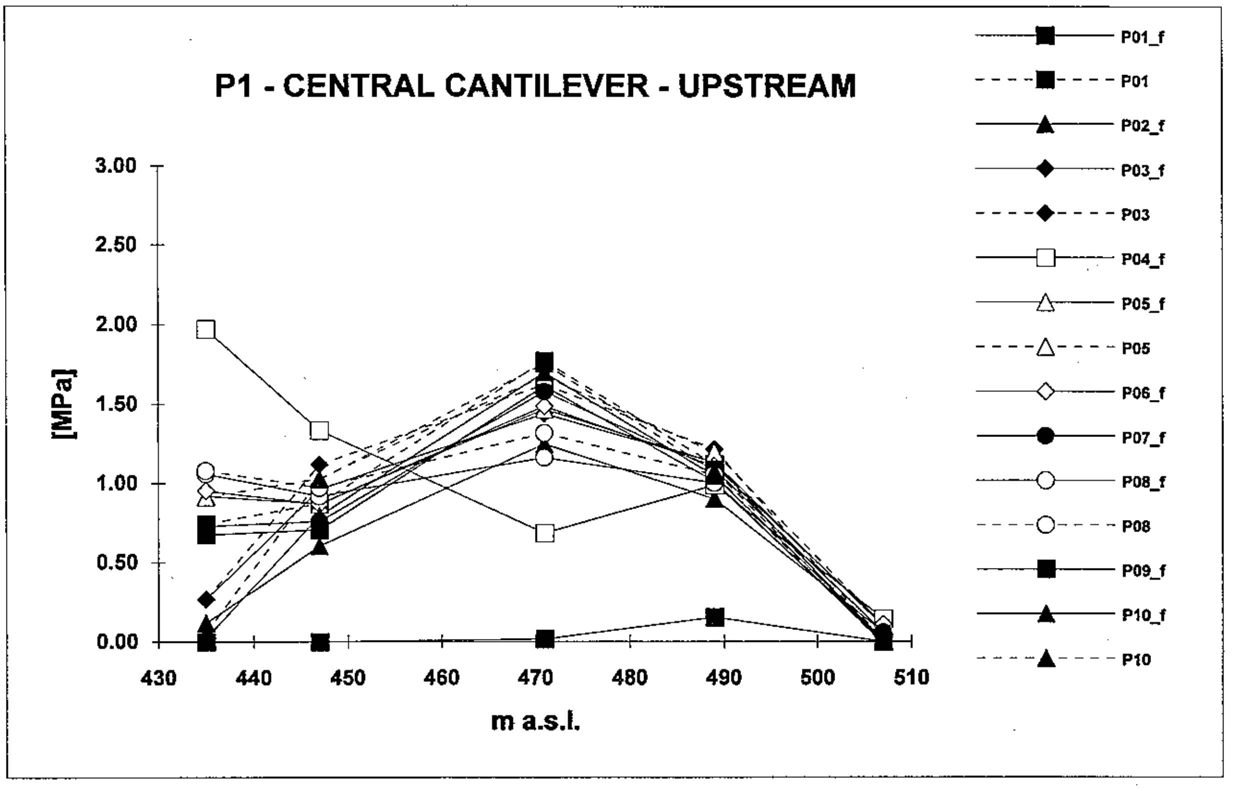
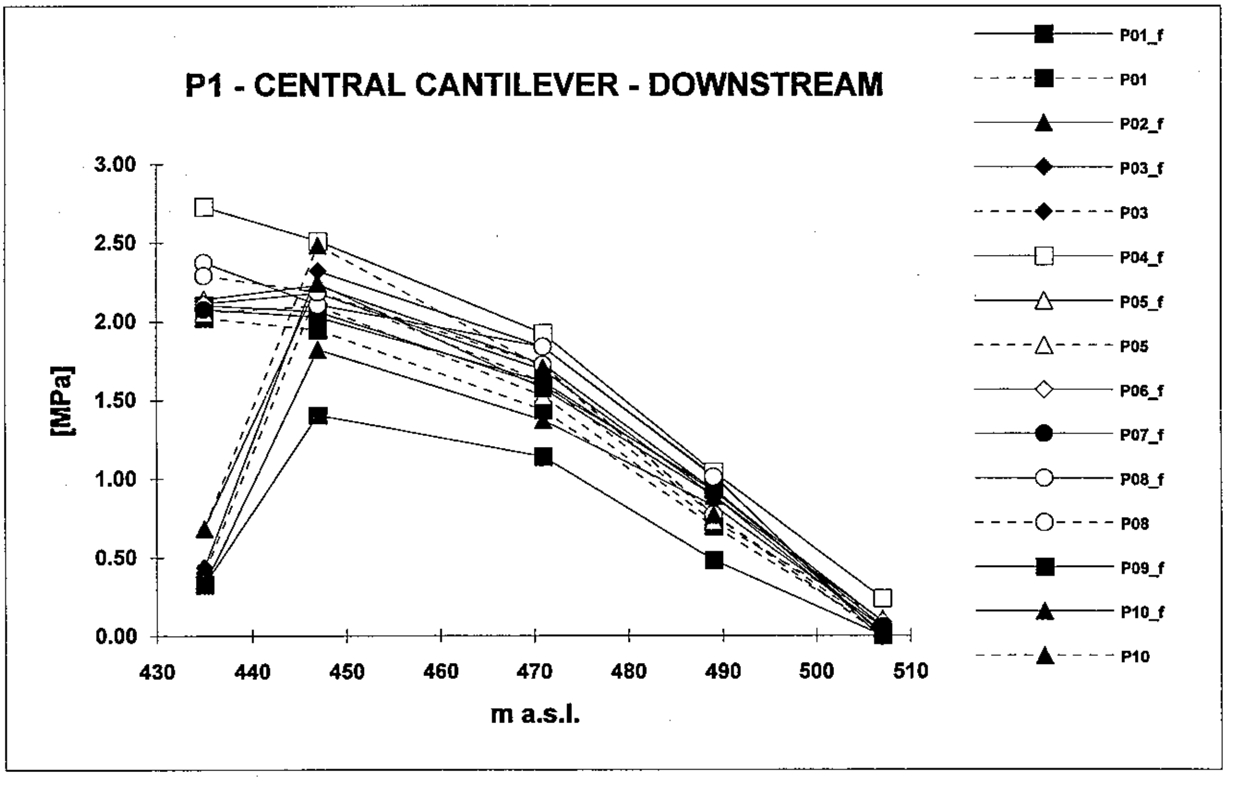
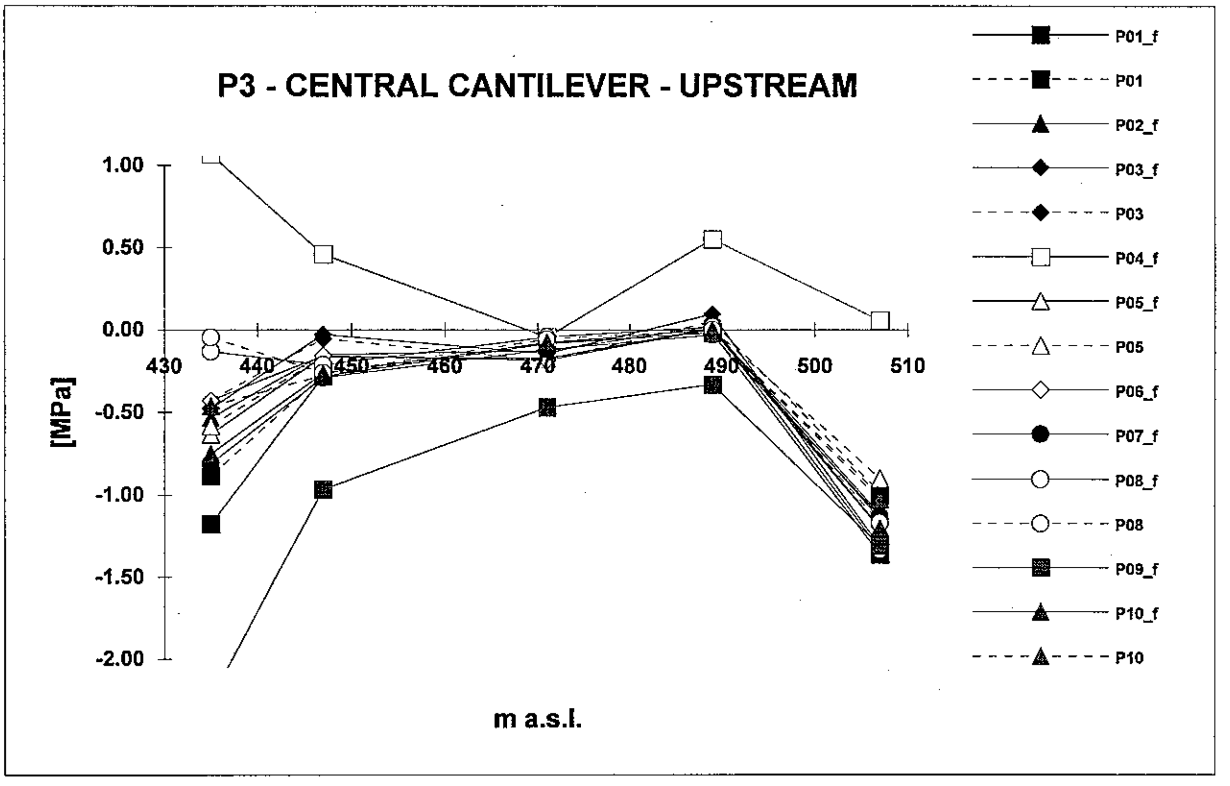
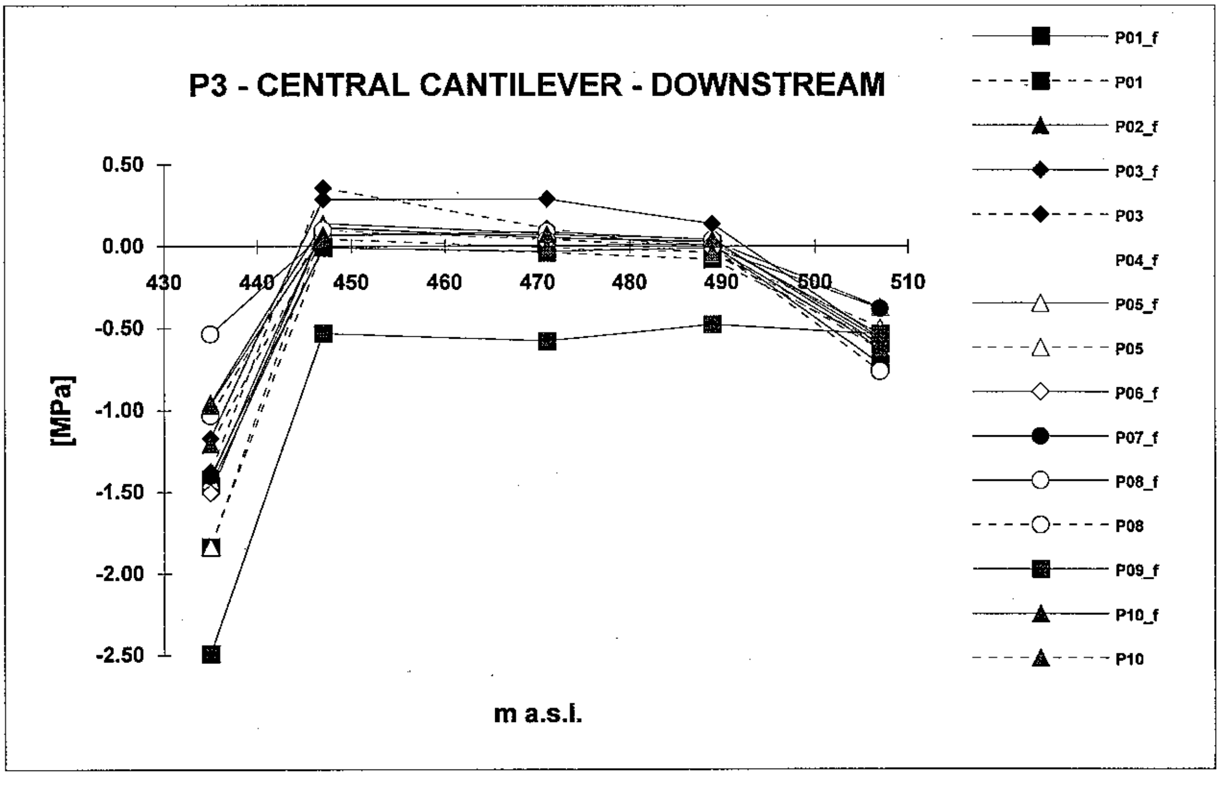


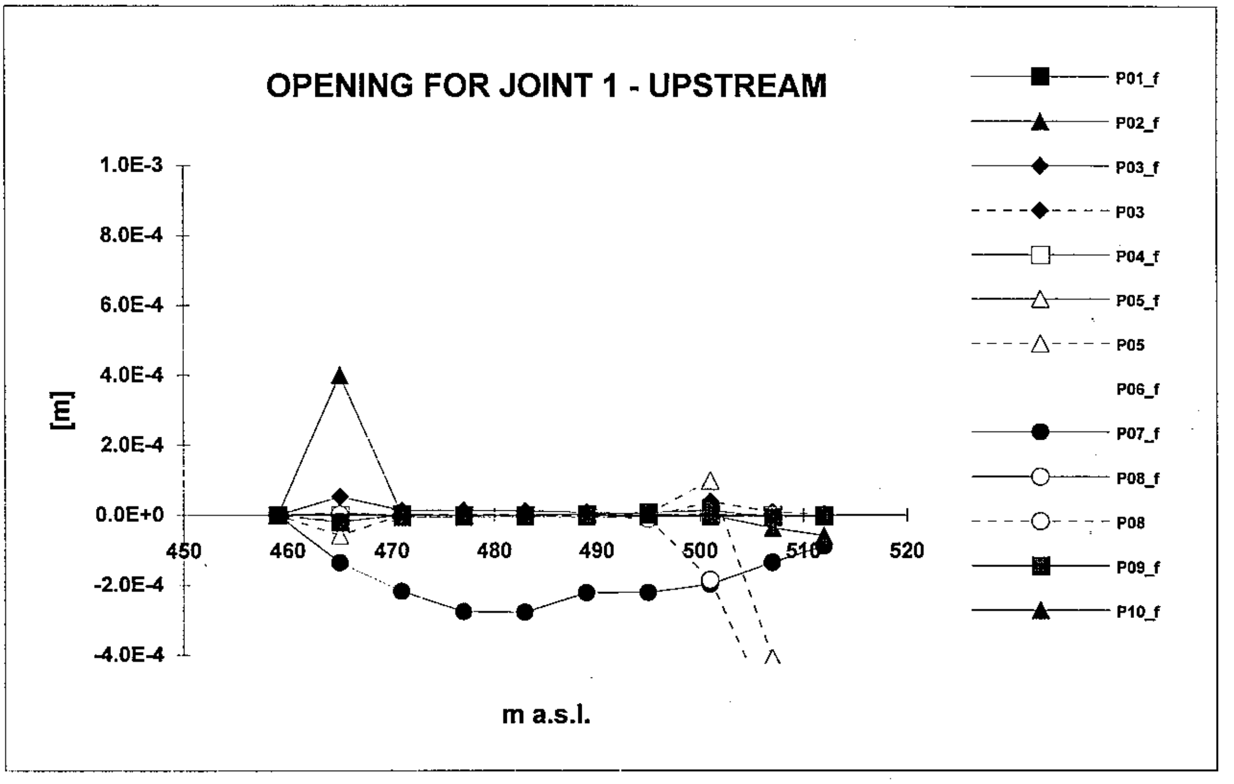


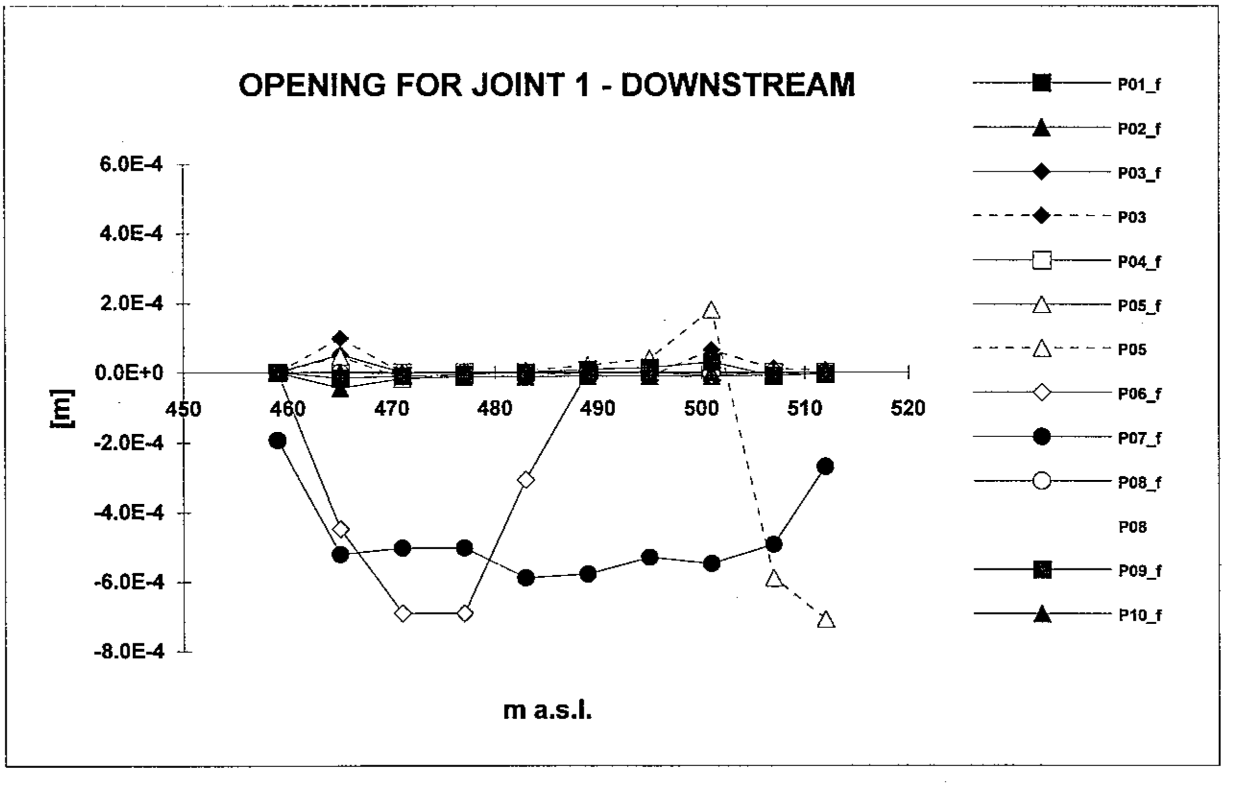
RESULTS FOR WINTER CONDITION





RESULTS FOR SUMMER CONDITION





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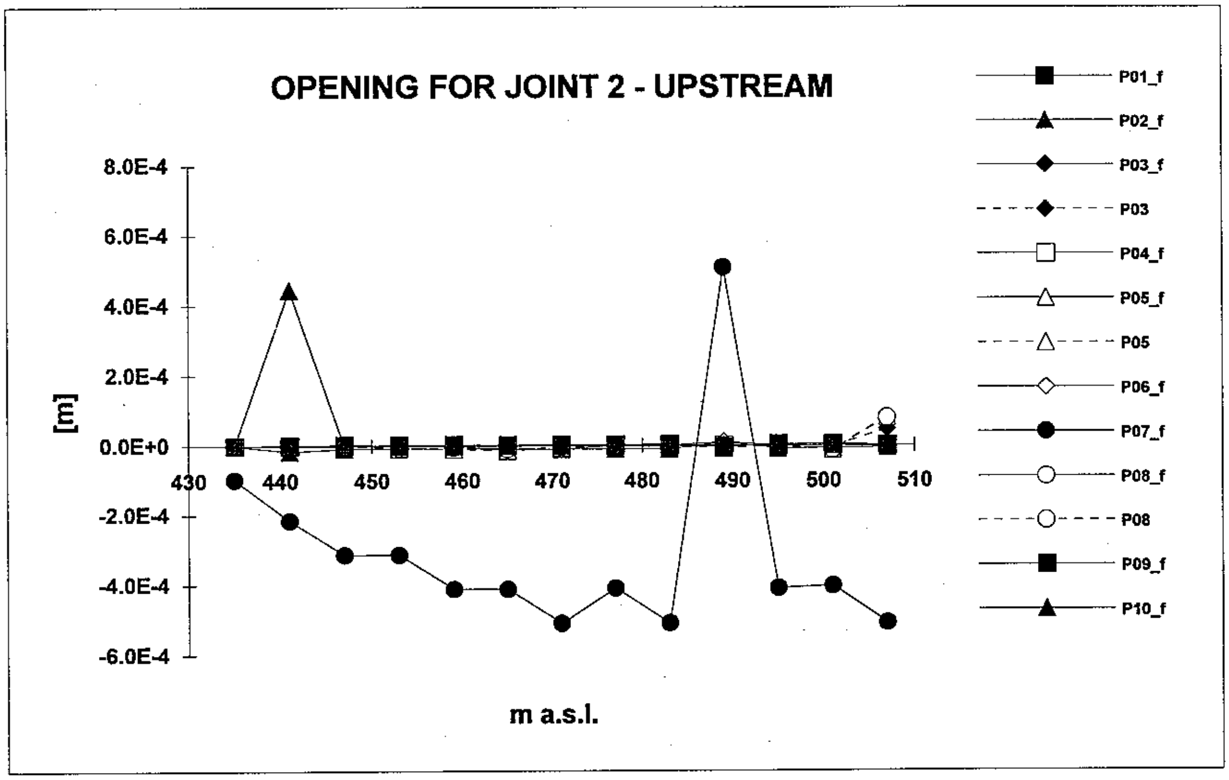

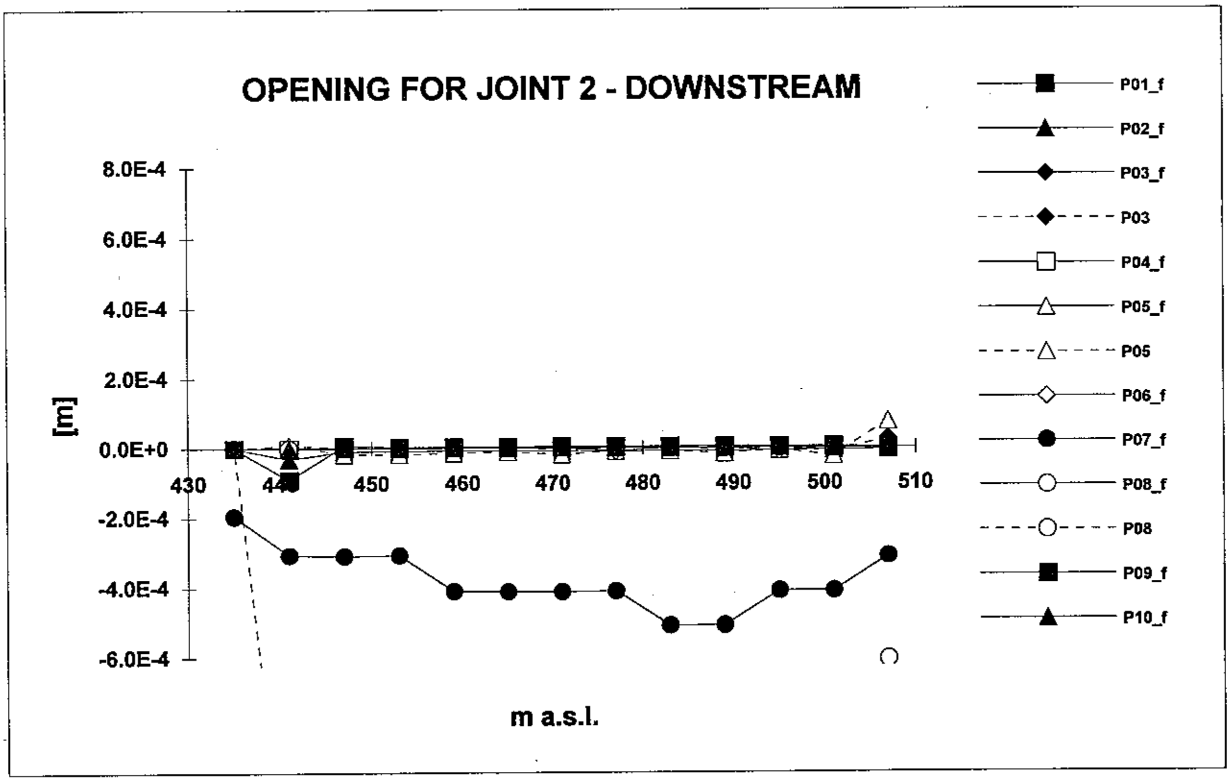

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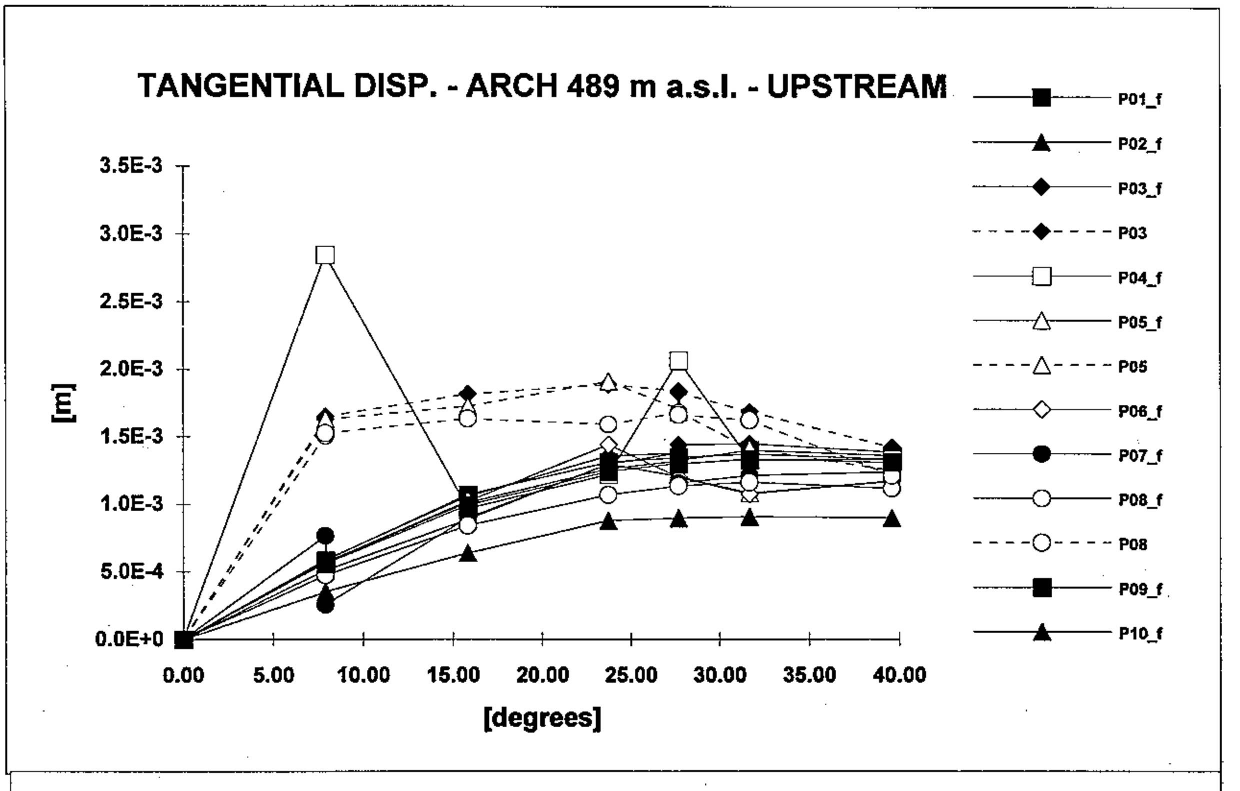

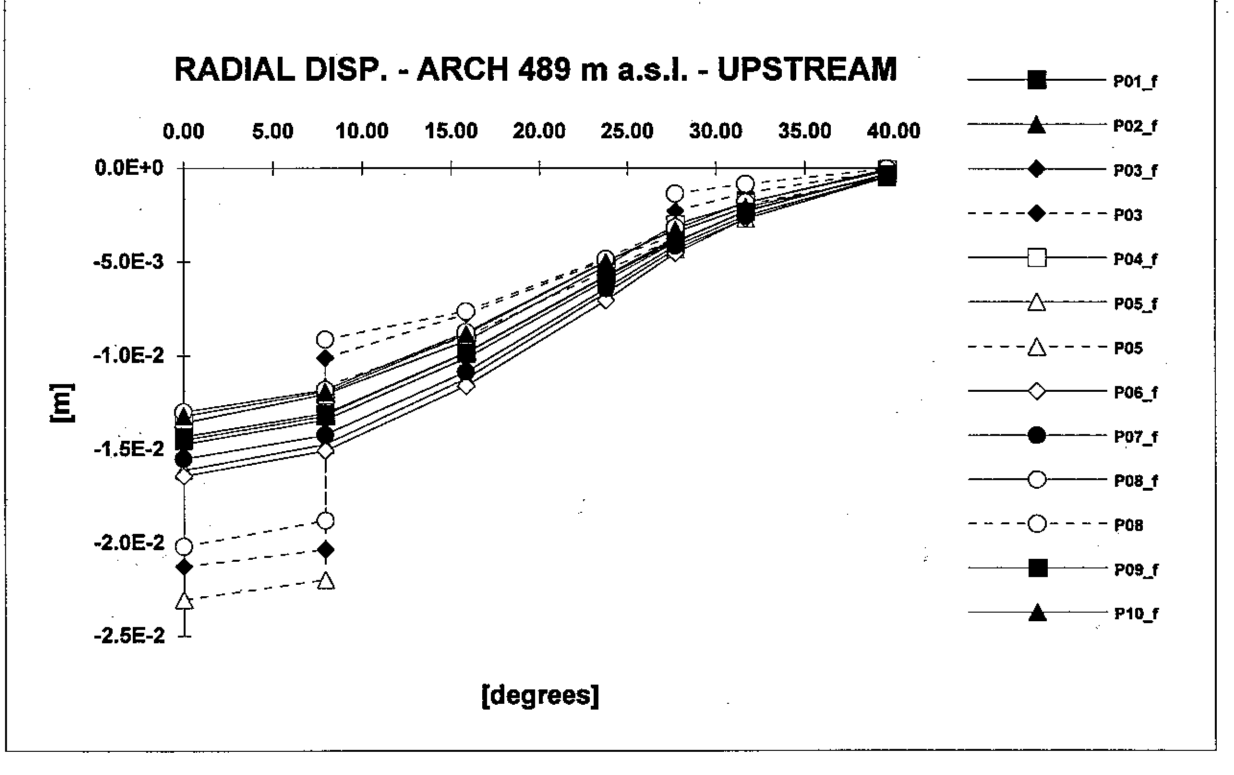

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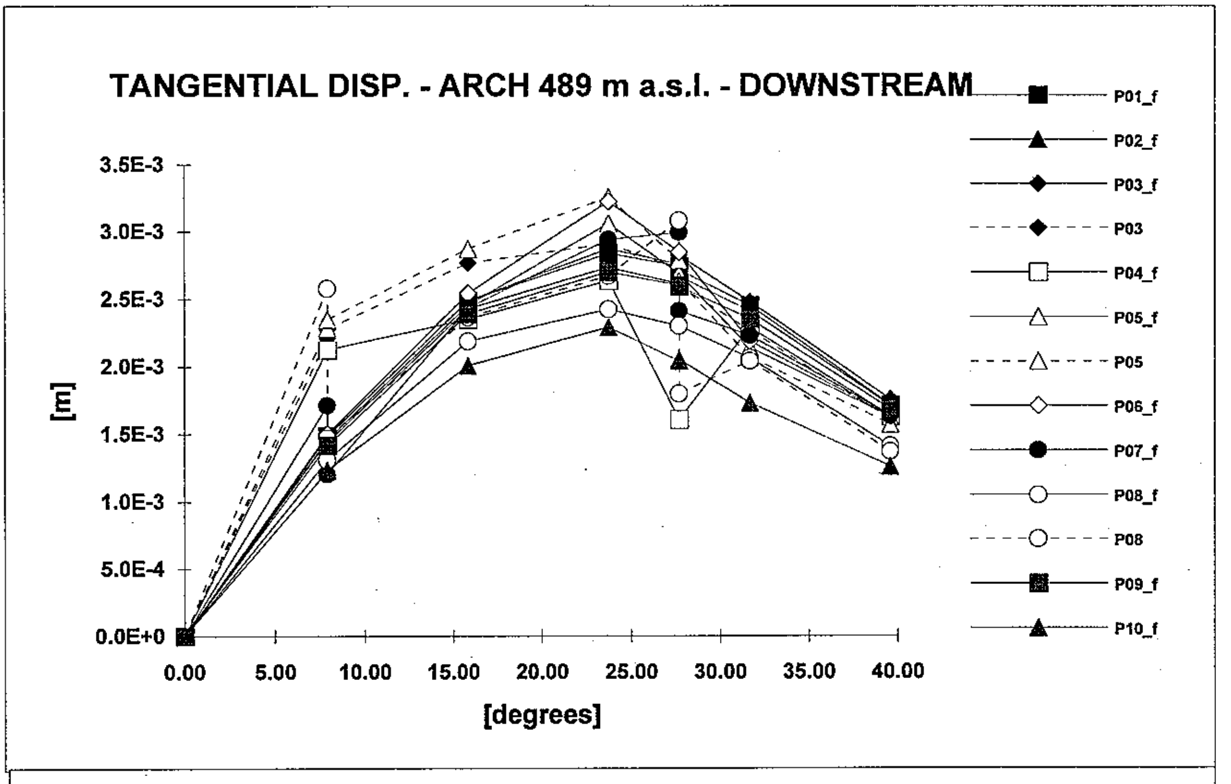

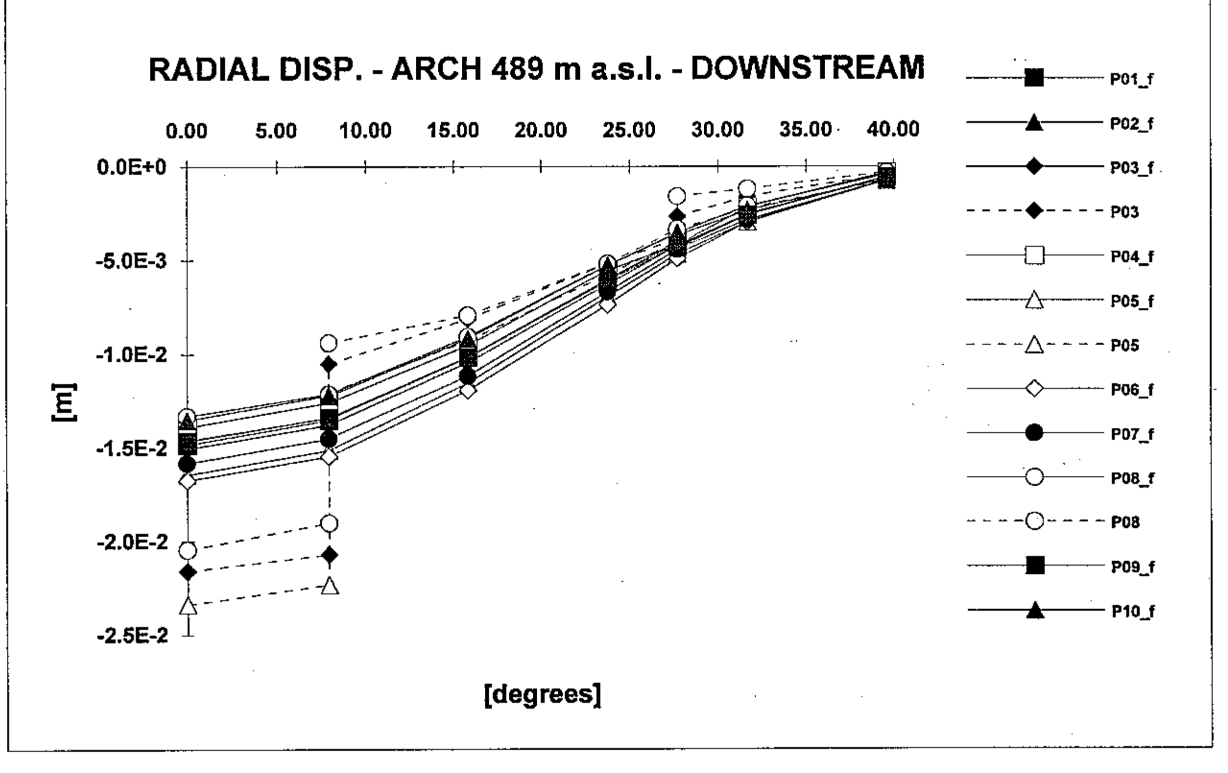

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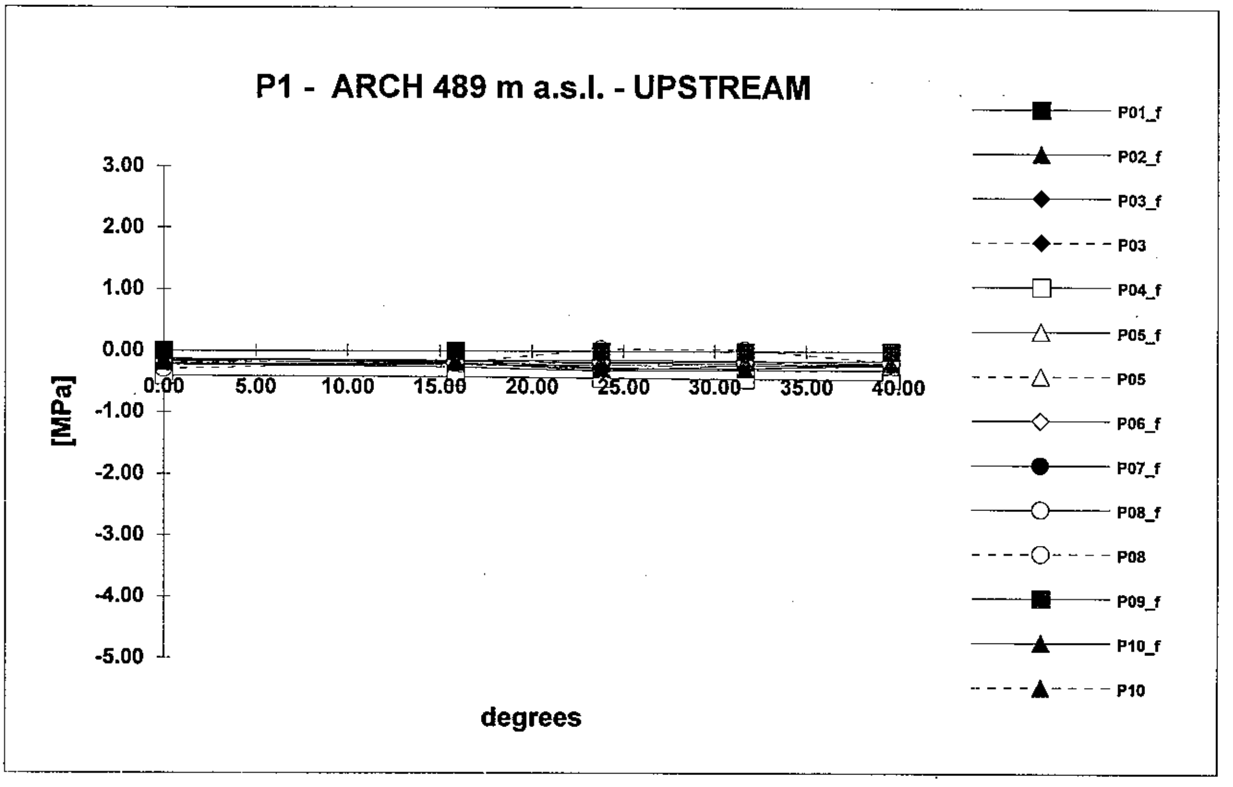

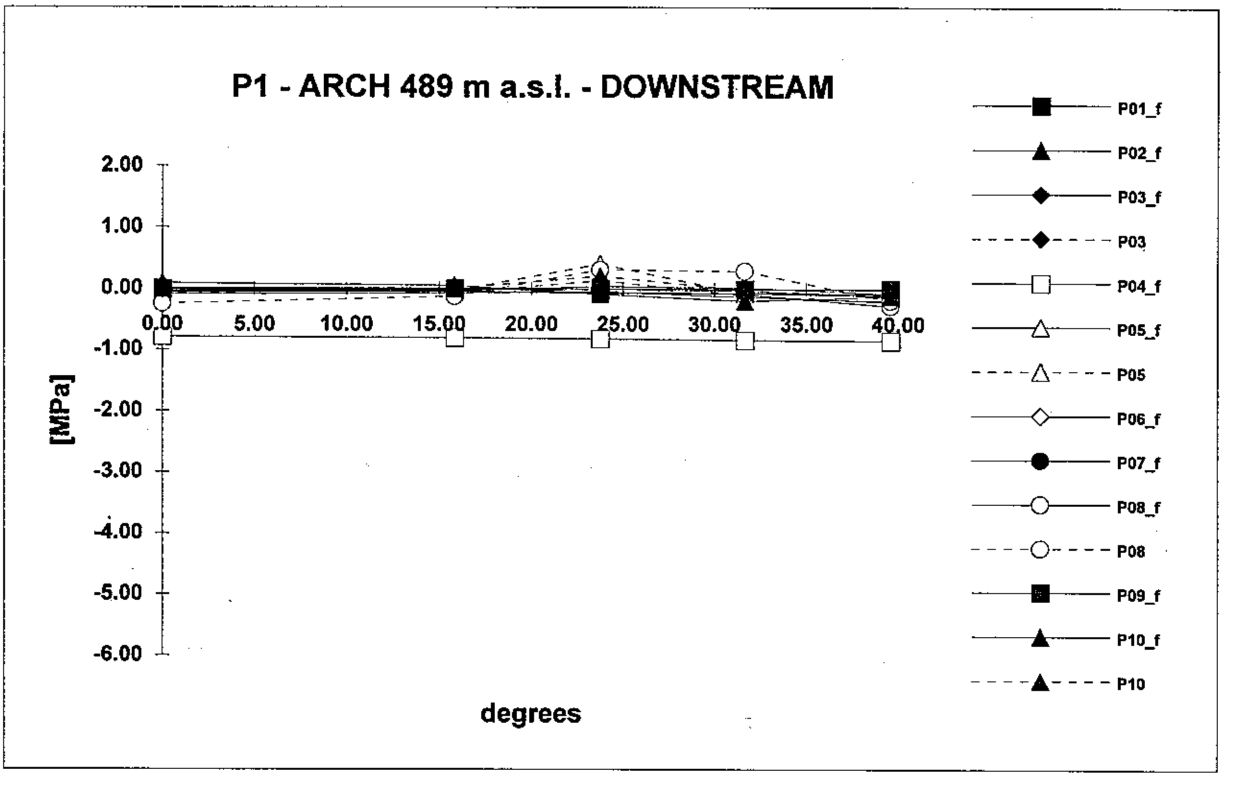

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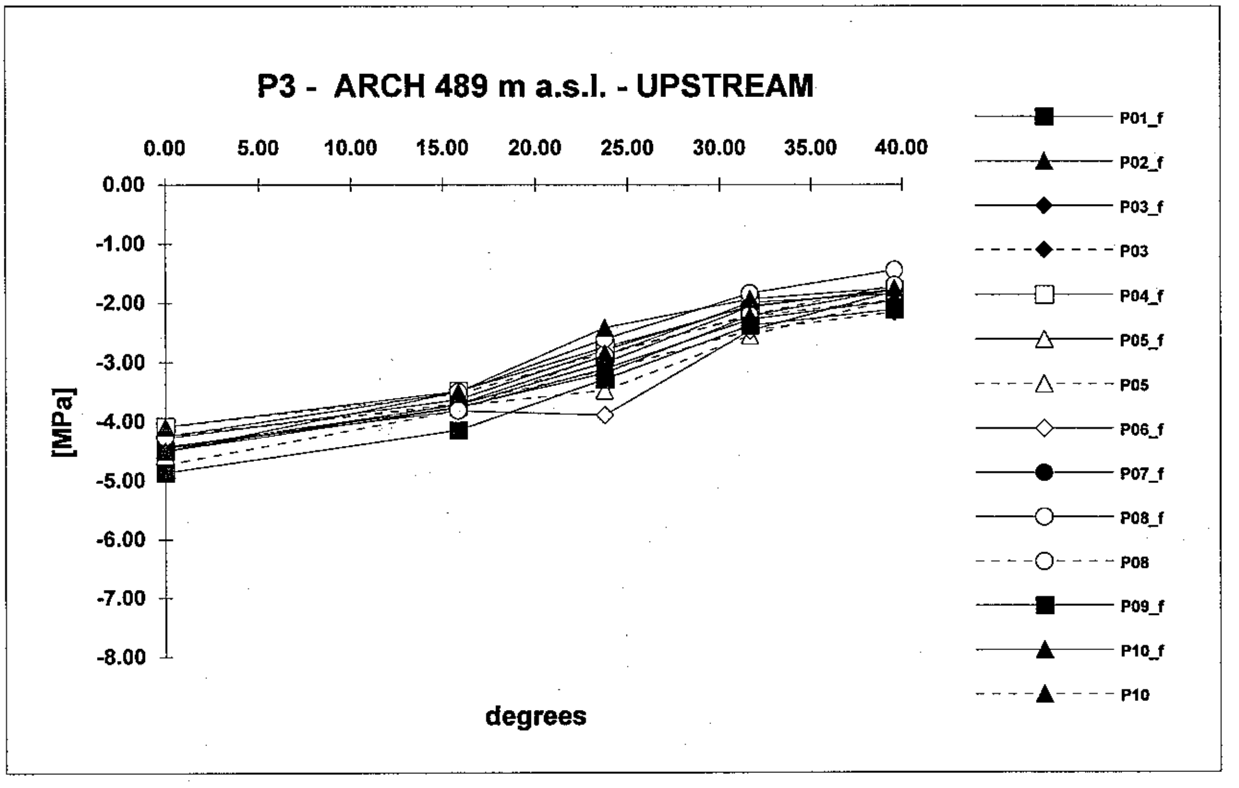

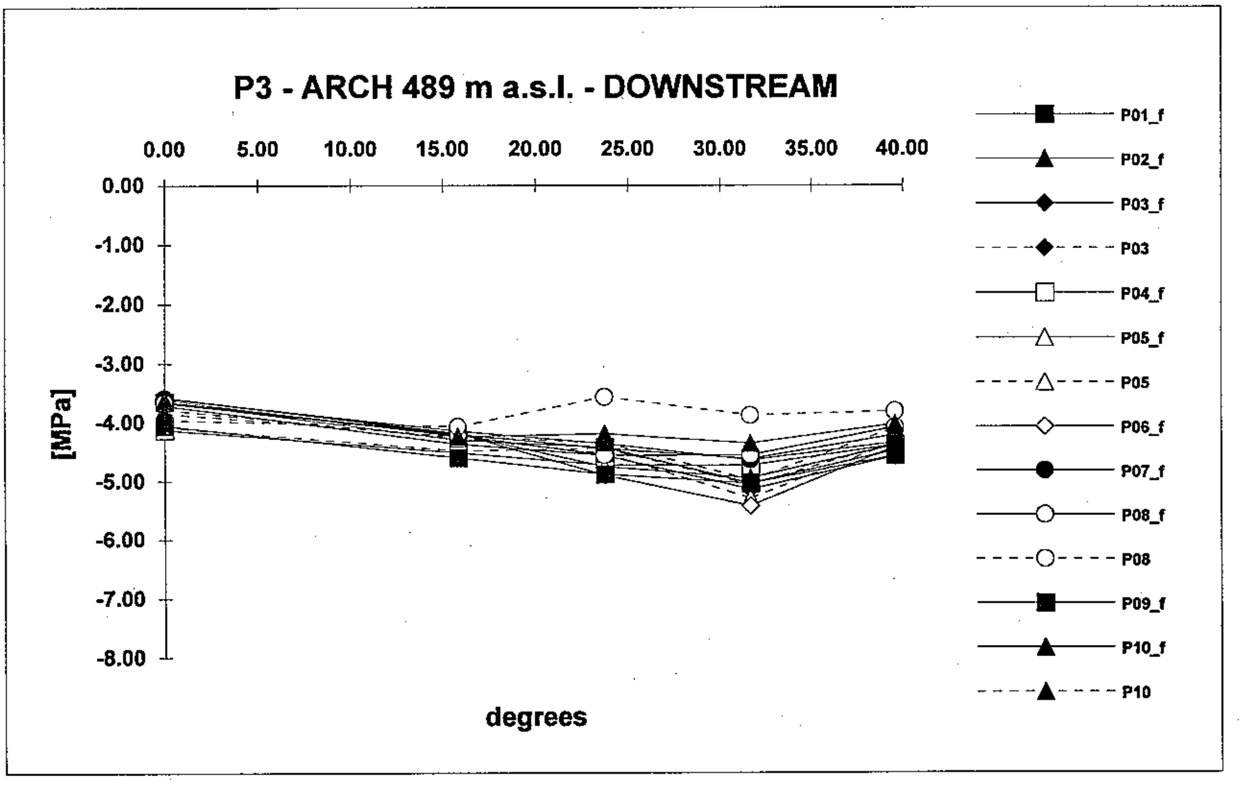

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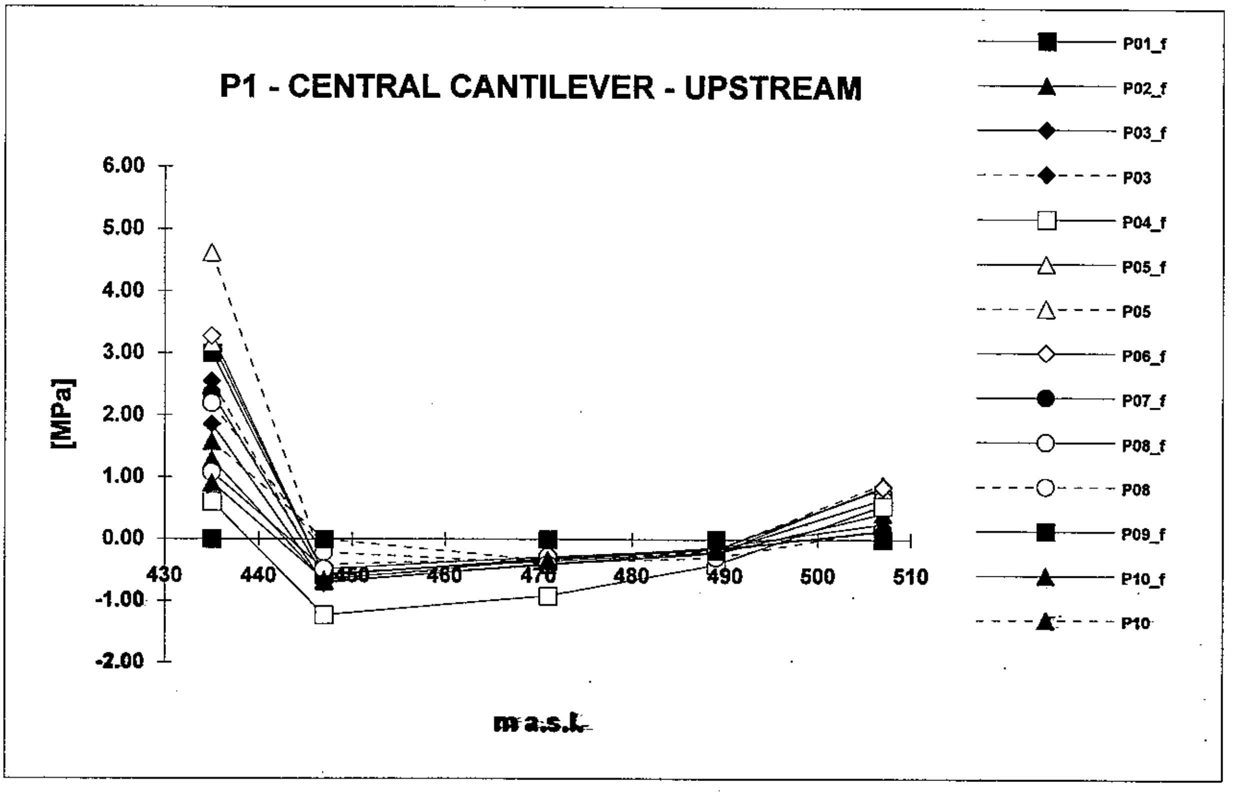
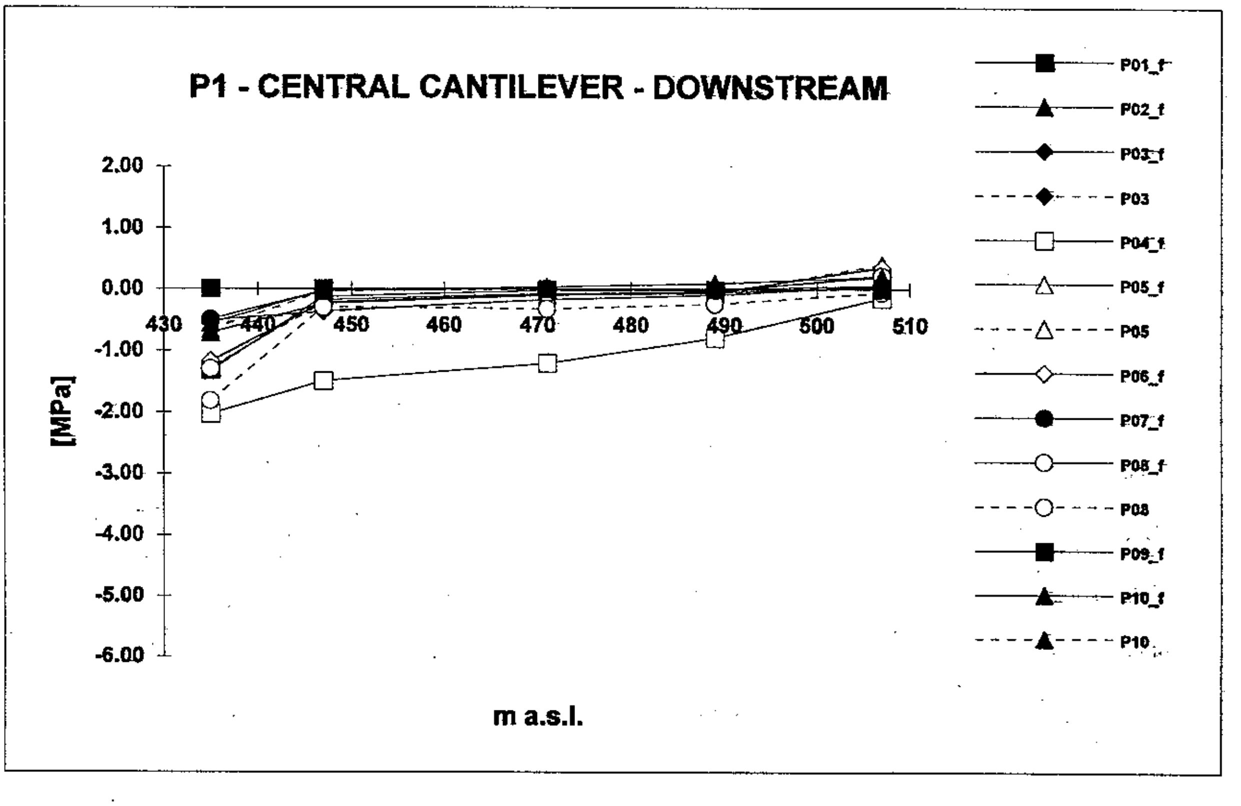
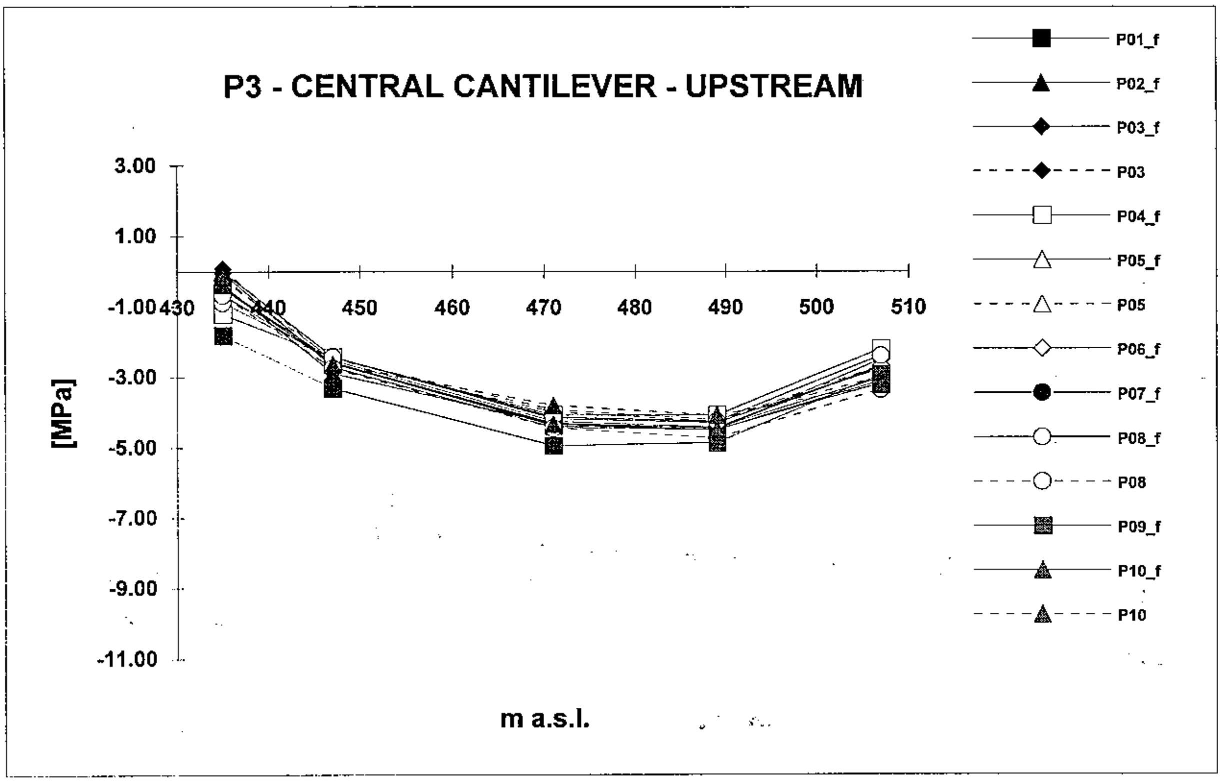
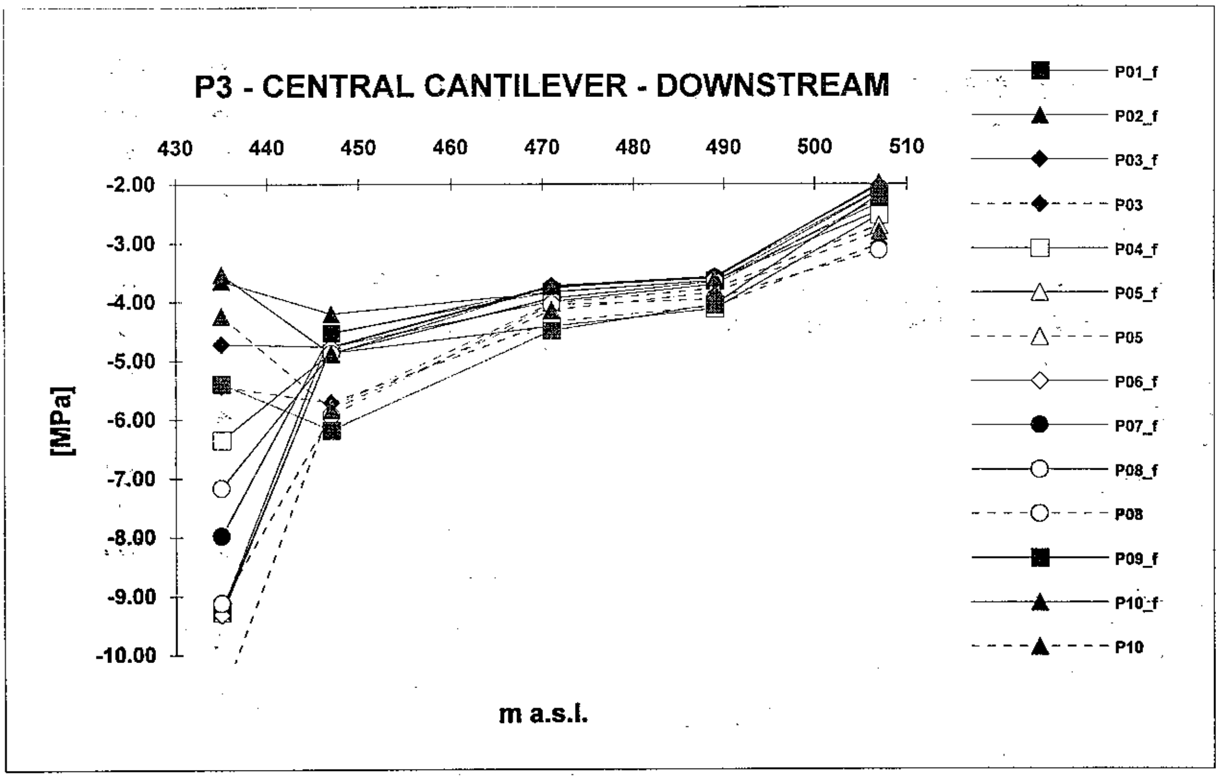




RESULTS FOR SUMMER CONDITION





Tables for winter condition

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DX" ACROSS JOINT 1
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	4.07E-3	3.13E-3	3.92E-3	-2.55E-4	3.27E-3	2.25E-3	9.30E-5	2.37E-3	5.78E-3	-1.00E-4	0.00E+0	3.39E-3	4.21E-5	2.88E-3
2	4.07E-3	3.13E-3	3.95E-3	-2.29E-4	3.27E-3	2.28E-3	1.02E-4	2.37E-3	5.77E-3	0.00E+0	0.00E+0	3.39E-3	3.51E-5	2.84E-3
3	4.08E-3	3.13E-3	3.94E-3	-2.15E-4	3.27E-3	2.30E-3	1.02E-4	2.38E-3	5.78E-3	0.00E+0	0.00E+0	3.38E-3	4.86E-5	2.80E-3
4	4.07E-3	3.13E-3	3.96E-3	-2.11E-4	3.27E-3	2.33E-3	1.00E-4	2.38E-3	5.78E-3	0.00E+0	0.00E+0	3.35E-3	4.52E-5	2.75E-3
5	3.32E-3	2.56E-3	3.19E-3	-2.60E-5	2.69E-3	1.90E-3	1.27E-4	2.05E-3	4.74E-3	-1.00E-4	-4.60E-5	2.71E-3	-5.99E-5	2.35E-3
6	3.32E-3	2.56E-3	3.19E-3	-1.60E-5	2.69E-3	1.94E-3	1.21E-4	2.03E-3	4.75E-3	-1.00E-4	0.00E+0	2.70E-3	-6.64E-5	2.31E-3
7	3.32E-3	2.56E-3	3.18E-3	-2.60E-5	2.69E-3	1.96E-3	1.15E-4	2.02E-3	4.76E-3	0.00E+0	-3.00E-6	2.69E-3	-5.68E-5	2.26E-3
8	3.30E-3	2.54E-3	3.16E-3	-3.50E-5	2.68E-3	1.98E-3	1.11E-4	2.01E-3	4.75E-3	0.00E+0	8.00E-6	2.73E-3	-6.91E-5	2.21E-3
9	2.35E-3	1.84E-3	2.21E-3	2.26E-4	1.93E-3	1.47E-3	3.18E-4	1.59E-3	3.49E-3	0.00E+0	3.10E-4	2.10E-3	-1.38E-4	1.58E-3
10	2.34E-3	1.83E-3	2.18E-3	2.53E-4	1.92E-3	1.51E-3	3.55E-4	1.61E-3	3.53E-3	1.00E-4	2.87E-4	2.08E-3	-1.41E-4	1.58E-3
11	2.30E-3	1.80E-3	2.14E-3	2.32E-4	1.89E-3	1.54E-3	3.55E-4	1.59E-3	3.56E-3	0.00E+0	2.80E-4	2.06E-3	-1.56E-4	1.56E-3
12	2.28E-3	1.79E-3	2.11E-3	2.28E-4	1.87E-3	1.56E-3	3.45E-4	1.57E-3	3.57E-3	0.00E+0	3.03E-4	2.05E-3	-1.74E-4	1.50E-3
13	1.53E-3	1.22E-3	1.39E-3	3.38E-4	1.29E-3	1.08E-3	3.62E-4	1.07E-3	2.35E-3	1.00E-4	4.33E-4	1.37E-3	-4.10E-5	9.16E-4
14	1.59E-3	1.28E-3	1.45E-3	4.07E-4	1.34E-3	1.13E-3	4.40E-4	1.13E-3	2.43E-3	1.00E-4	5.46E-4	1.44E-3	-3.82E-5	9.82E-4
15	1.62E-3	1.30E-3	1.48E-3	4.40E-4	1.36E-3	1.17E-3	4.82E-4	1.15E-3	2.48E-3	2.00E-4	6.55E-4	1.46E-3	-6.17E-5	1.01E-3
16	1.62E-3	1.29E-3	1.48E-3	4.49E-4	1.35E-3	1.18E-3	5.01E-4	1.16E-3	2.51E-3	2.00E-4	6.03E-4	1.45E-3	-8.84E-5	1.00E-3
17	8.02E-4	6.27E-4	6.82E-4	1.95E-4	6.73E-4	7.22E-4	1.84E-4	5.33E-4	1.35E-3	0.00E+0	4.04E-4	7.53E-4	8.00E-7	3.67E-4
18	9.04E-4	7.21E-4	7.86E-4	3.09E-4	7.68E-4	8.09E-4	3.05E-4	6.34E-4	1.47E-3	1.00E-4	5.20E-4	8.31E-4	1.33E-5	4.97E-4
19	9.59E-4	7.67E-4	8.42E-4	3.70E-4	8.14E-4	8.50E-4	3.73E-4	6.85E-4	1.56E-3	1.00E-4	5.72E-4	8.76E-4	-7.60E-6	5.72E-4
20	9.69E-4	7.68E-4	8.50E-4	3.81E-4	8.11E-4	8.44E-4	3.91E-4	6.88E-4	1.60E-3	2.00E-4	6.18E-4	8.76E-4	-3.98E-5	6.01E-4
21	2.23E-4	1.33E-4	1.34E-4	-4.10E-5	1.68E-4	4.13E-4	-6.80E-5	8.20E-5	5.70E-4	-2.00E-4	1.57E-4	2.26E-4	1.49E-5	-6.40E-5
22	3.74E-4	2.75E-4	2.90E-4	1.21E-4	3.13E-4	5.37E-4	1.00E-4	2.32E-4	7.40E-4	0.00E+0	3.20E-4	3.80E-4	3.86E-5	1.21E-4
23	4.52E-4	3.43E-4	3.69E-4	2.05E-4	3.83E-4	5.85E-4	1.88E-4	3.04E-4	8.50E-4	0.00E+0	4.17E-4	4.40E-4	2.06E-5	2.30E-4
24	4.53E-4	3.33E-4	3.67E-4	2.03E-4	3.70E-4	5.51E-4	1.93E-4	2.94E-4	8.80E-4	0.00E+0	4.09E-4	4.08E-4	-1.41E-5	2.68E-4
25	-1.51E-4	-1.85E-4	-2.16E-4	-2.41E-4	-1.65E-4	1.82E-4	-2.70E-4	-2.17E-4	4.00E-5	-4.00E-4	-6.70E-5	-2.70E-5	3.70E-6	-3.39E-4
26	4.44E-5	2.10E-8	-1.08E-5	-3.10E-5	3.00E-5	3.31E-4	-5.60E-5	-1.90E-5	2.60E-4	-1.00E-4	1.22E-4	8.10E-5	4.89E-5	-1.02E-4
27	1.29E-4	7.33E-5	7.97E-5	6.30E-5	1.11E-4	3.76E-4	4.10E-5	6.30E-5	3.80E-4	0.00E+0	2.02E-4	1.46E-4	4.34E-5	2.20E-5
28	8.93E-5	2.16E-5	3.93E-5	2.20E-5	5.90E-5	2.97E-4	2.00E-6	1.20E-5	3.70E-4	0.00E+0	1.77E-4	1.44E-4	9.50E-6	3.60E-5
29	-2.08E-4	-2.09E-4	-2.44E-4	-2.16E-4	-1.96E-4	1.12E-4	-2.40E-4	-2.25E-4	-1.20E-4	-2.00E-4	-1.00E-4	-8.70E-5	2.60E-5	-3.32E-4
30	-4.84E-5	-5.97E-5	-7.42E-5	-4.18E-5	-3.40E-5	2.27E-4	-6.50E-5	-6.20E-5	7.00E-5	-1.00E-4	2.40E-5	1.67E-4	5.17E-5	-1.33E-4
31	-6.64E-6	-2.96E-5	-2.56E-5	9.70E-6	5.80E-6	2.29E-4	-1.20E-5	-2.20E-5	1.30E-4	-1.00E-4	8.30E-5	1.91E-4	6.28E-5	-3.01E-5
32	-1.07E-4	-1.42E-4	-1.33E-4	-9.65E-5	-1.10E-4	8.53E-5	-1.11E-4	-1.33E-4	7.00E-5	-2.00E-4	-3.00E-5	-7.40E-5	4.24E-5	-6.41E-5
33	-2.18E-4	-2.06E-4	-2.25E-4	-1.91E-4	-1.90E-4	-5.77E-5	-2.05E-4	-2.01E-4	-1.80E-4	-2.00E-4	-2.17E-4	-1.75E-4	-2.84E-5	-3.30E-4
34	-5.59E-5	-5.16E-5	-5.61E-5	-2.14E-5	-2.73E-5	9.90E-5	-3.40E-5	-3.90E-5	0.00E+0	0.00E+0	-9.00E-6	-2.00E-5	4.60E-5	-9.48E-5
35	-2.92E-5	-3.46E-5	-2.74E-5	6.70E-6	-5.90E-6	1.02E-4	-8.00E-6	-2.00E-5	4.00E-5	0.00E+0	9.00E-6	-3.00E-6	9.53E-5	4.10E-6
36	-1.93E-4	-2.09E-4	-1.85E-4	-1.49E-4	-1.68E-4	-6.55E-5	-1.79E-4	-1.98E-4	-1.00E-4	-2.00E-4	-9.90E-5	-8.80E-5	2.74E-5	-6.94E-5
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DX" ACROSS JOINT 2
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	-4.54E-6	5.18E-3	0.00E+0	0.00E+0	5.57E-3	-1.00E-7	0.00E+0	5.64E-3	0.00E+0	0.00E+0	0.00E+0	5.45E-3	1.00E-6	-1.00E-4
2	-4.10E-6	5.18E-3	0.00E+0	0.00E+0	5.56E-3	1.40E-6	0.00E+0	5.64E-3	0.00E+0	0.00E+0	0.00E+0	5.45E-3	1.26E-2	-1.10E-4
3	-3.47E-6	5.18E-3	0.00E+0	0.00E+0	5.56E-3	-1.85E-5	0.00E+0	5.64E-3	0.00E+0	0.00E+0	0.00E+0	5.45E-3	3.00E-6	-1.10E-4
4	-1.92E-6	5.18E-3	0.00E+0	0.00E+0	5.56E-3	-5.23E-5	0.00E+0	5.64E-3	0.00E+0	0.00E+0	0.00E+0	5.47E-3	1.00E-6	-1.30E-4
5	-1.57E-5	4.56E-3	-1.00E-6	0.00E+0	4.90E-3	1.00E-7	0.00E+0	4.97E-3	0.00E+0	0.00E+0	0.00E+0	4.82E-3	0.00E+0	-9.70E-5
6	-1.18E-5	4.56E-3	0.00E+0	0.00E+0	4.90E-3	5.00E-7	0.00E+0	4.97E-3	0.00E+0	0.00E+0	0.00E+0	4.82E-3	0.00E+0	-9.20E-5
7	-1.22E-5	4.55E-3	0.00E+0	0.00E+0	4.89E-3	-1.84E-5	0.00E+0	4.97E-3	0.00E+0	0.00E+0	0.00E+0	4.82E-3	-1.00E-6	-9.60E-5
8	-1.70E-5	4.55E-3	-2.00E-6	0.00E+0	4.89E-3	-6.46E-5	0.00E+0	4.96E-3	0.00E+0	0.00E+0	0.00E+0	4.82E-3	-3.00E-6	-1.03E-4
9	-1.28E-5	3.96E-3	-3.67E-5	0.00E+0	4.25E-3	4.00E-7	0.00E+0	4.32E-3	0.00E+0	0.00E+0	0.00E+0	4.19E-3	0.00E+0	-7.30E-5
10	-1.05E-5	3.96E-3	-2.43E-5	0.00E+0	4.25E-3	4.00E-7	1.00E-6	4.31E-3	0.00E+0	0.00E+0	0.00E+0	4.19E-3	-2.00E-7	-7.40E-5
11	-2.08E-5	3.96E-3	-2.90E-5	0.00E+0	4.24E-3	-1.89E-5	0.00E+0	4.31E-3	0.00E+0	0.00E+0	0.00E+0	4.19E-3	-2.40E-6	-8.30E-5
12	-3.65E-5	3.95E-3	-4.64E-5	-2.20E-5	4.24E-3	-8.32E-5	-1.10E-5	4.30E-3	-1.00E-5	-1.00E-4	-1.20E-5	4.18E-3	-9.90E-6	-1.01E-4
13	7.83E-5	3.35E-3	2.19E-5	3.00E-6	3.59E-3	0.00E+0	0.00E+0	3.64E-3	0.00E+0	0.00E+0	0.00E+0	3.55E-3	0.00E+0	-3.30E-5
14	6.66E-5	3.35E-3	8.40E-6	1.00E-6	3.59E-3	-1.00E-7	0.00E+0	3.64E-3	0.00E+0	1.00E-4	0.00E+0	3.54E-3	3.00E-7	-3.40E-5
15	4.55E-5	3.34E-3	-9.10E-6	-1.30E-5	3.59E-3	-2.12E-5	-2.00E-6	3.64E-3	0.00E+0	0.00E+0	-6.00E-6	3.54E-3	-2.70E-6	-4.50E-5
16	1.73E-5	3.32E-3	-3.43E-5	-4.30E-5	3.57E-3	-1.08E-4	-2.50E-5	3.63E-3	-2.00E-5	0.00E+0	-3.20E-5	3.52E-3	-1.43E-5	-7.00E-5
17	1.34E-4	2.72E-3	8.74E-5	1.20E-5	2.93E-3	-2.00E-7	0.00E+0	2.97E-3	8.00E-5	1.00E-4	-1.00E-6	2.89E-3	1.50E-6	-1.00E-5
18	1.29E-4	2.73E-3	8.16E-5	7.00E-6	2.93E-3	-9.00E-7	1.00E-6	2.97E-3	5.00E-5	0.00E+0	0.00E+0	2.89E-3	2.30E-6	0.00E+0
19	1.14E-4	2.72E-3	6.78E-5	-2.00E-6	2.93E-3	-2.47E-5	-2.00E-6	2.97E-3	5.00E-5	0.00E+0	-9.00E-6	2.89E-3	-1.20E-6	-1.60E-5
20	7.55E-5	2.69E-3	3.00E-5	-4.50E-5	2.90E-3	-1.39E-4	-3.80E-5	2.95E-3	1.00E-5	0.00E+0	-4.80E-5	2.86E-3	-1.56E-5	-5.10E-5
21	7.08E-5	2.12E-3	4.54E-5	-1.40E-5	2.29E-3	-1.00E-7	4.00E-6	2.33E-3	5.00E-5	0.00E+0	1.00E-6	2.26E-3	4.00E-7	-4.70E-5
22	7.84E-5	2.13E-3	5.52E-5	-1.50E-5	2.30E-3	-7.00E-7	1.00E-6	2.33E-3	7.00E-5	1.00E-4	0.00E+0	2.26E-3	4.00E-6	-2.20E-5
23	6.67E-5	2.12E-3	4.55E-5	-1.80E-5	2.30E-3	-2.85E-5	2.00E-6	2.33E-3	5.00E-5	0.00E+0	-1.50E-5	2.27E-3	8.00E-7	-3.00E-5
24	1.62E-5	2.08E-3	-3.50E-6	-7.50E-5	2.26E-3	-1.70E-4	-4.80E-5	2.29E-3	1.00E-5	0.00E+0	-6.90E-5	2.22E-3	-1.41E-5	-6.80E-5
25	-4.67E-5	1.59E-3	-4.15E-5	-5.90E-5	1.73E-3	5.00E-7	1.00E-6	1.75E-3	0.00E+0	0.00E+0	0.00E+0	1.69E-3	1.40E-6	-9.10E-5
26	-4.30E-5	1.59E-3	-3.91E-5	-6.00E-5	1.73E-3	3.00E-7	1.00E-6	1.75E-3	0.00E+0	0.00E+0	0.00E+0	1.69E-3	3.50E-6	-8.50E-5
27	-4.73E-5	1.57E-3	-3.89E-5	-6.10E-5	1.73E-3	-2.85E-5	9.00E-6	1.75E-3	3.00E-5	0.00E+0	-1.50E-5	1.70E-3	3.70E-6	-8.40E-5
28	-1.14E-4	1.52E-3	-1.05E-4	-1.32E-4	1.67E-3	-1.91E-4	-6.20E-5	1.69E-3	-4.00E-5	-1.00E-4	-9.20E-5	1.64E-3	-1.11E-5	-1.35E-4
29	-1.57E-4	1.12E-3	-1.19E-4	-9.50E-5	1.23E-3	6.00E-7	1.00E-6	1.24E-3	0.00E+0	0.00E+0	0.00E+0	1.20E-3	1.80E-6	-1.50E-4
30	-1.57E-4	1.12E-3	-1.19E-4	-9.40E-5	1.23E-3	-2.60E-6	2.00E-6	1.24E-3	0.00E+0	0.00E+0	0.00E+0	1.20E-3	3.70E-6	-1.46E-4
31	-1.53E-4	1.10E-3	-1.20E-4	-8.80E-5	1.23E-3	-3.20E-5	1.40E-5	1.24E-3	3.00E-5	0.00E+0	-1.80E-5	1.21E-3	5.40E-6	-1.36E-4
32	-2.40E-4	1.02E-3	-2.08E-4	-1.91E-4	1.15E-3	-2.03E-4	-8.20E-5	1.17E-3	-7.00E-5	-1.00E-4	-1.17E-4	1.12E-3	-4.90E-6	-2.02E-4
33	-1.96E-4	7.32E-4	-1.54E-4	-1.05E-4	8.14E-4	-4.90E-6	1.00E-6	8.21E-4	0.00E+0	0.00E+0	0.00E+0	7.93E-4	1.00E-6	-1.64E-4
34	-2.00E-4	7.35E-4	-1.58E-4	-1.05E-4	8.18E-4	1.11E-5	1.00E-6	8.23E-4	0.00E+0	0.00E+0	0.00E+0	7.96E-4	3.70E-6	-1.56E-4
35	-1.95E-4	7.18E-4	-1.58E-4	-9.30E-5	8.15E-4	-3.95E-5	2.50E-5	8.32E-4	3.00E-5	0.00E+0	-2.40E-5	8.07E-4	1.31E-5	-1.48E-4
36	-3.05E-4	6.17E-4	-2.67E-4	-2.07E-4	7.14E-4	-1.72E-4	-1.01E-4	7.26E-4	-9.00E-5	-1.00E-4	-1.44E-4	6.97E-4	2.20E-6	-2.30E-4
37	-1.76E-4	4.38E-4	-1.48E-4	-8.60E-5	4.93E-4	0.00E+0	0.00E+0	4.96E-4	0.00E+0	0.00E+0	4.00E-6	4.78E-4	9.00E-7	-1.45E-4
38	-1.72E-4	4.44E-4	-1.51E-4	-8.40E-5	5.00E-4	0.00E+0	2.00E-6	5.02E-4	0.00E+0	0.00E+0	0.00E+0	4.84E-4	3.50E-6	-1.29E-4
39	-1.78E-4	4.26E-4	-1.47E-4	-7.40E-5	4.95E-4	0.00E+0	2.10E-5	5.12E-4	2.00E-5	0.00E+0	-2.90E-5	5.01E-4	2.18E-5	-1.20E-4
40	-3.08E-4	3.06E-4	-2.71E-4	-2.04E-4	3.75E-4	0.00E+0	-1.21E-4	3.85E-4	-1.20E-4	-2.00E-4	-1.69E-4	3.65E-4	1.72E-5	-2.13E-4
41	-1.36E-4	2.25E-4	-1.01E-4	-5.10E-5	2.57E-4	0.00E+0	0.00E+0	2.58E-4	0.00E+0	0.00E+0	3.00E-6	2.66E-4	-1.00E-6	-1.16E-4
42	-1.30E-4	2.36E-4	-9.93E-5	-4.40E-5	2.68E-4	0.00E+0	1.00E-6	2.68E-4	0.00E+0	0.00E+0	0.00E+0	2.58E-4	2.30E-6	-8.03E-5
43	-1.27E-4	2.23E-4	-8.88E-5	-4.00E-5	2.66E-4	0.00E+0	1.50E-5	2.78E-4	1.00E-5	0.00E+0	-3.00E-5	2.80E-4	2.47E-5	-6.20E-5
44	-2.64E-4	9.27E-5	-2.23E-4	-1.81E-4	1.37E-4	0.00E+0	-1.36E-4	1.42E-4	-1.30E-4	-1.00E-4	-1.75E-4	1.21E-4	3.17E-5	-1.50E-4
45	-7.44E-5	7.59E-5	-1.93E-5	-1.30E-5	9.39E-5	0.00E+0	0.00E+0	9.40E-5	1.00E-5	0.00E+0	9.00E-6	7.70E-5	1.90E-6	-1.20E-4
46	-6.02E-5	1.00E-4	2.58E-6	0.00E+0	1.13E-4	0.00E+0	1.00E-6	1.11E-4	1.00E-5	0.00E+0	0.00E+0	9.50E-5	5.88E-6	-2.23E-5
47	-5.70E-5	9.83E-5	-2.63E-5	-1.00E-5	1.21E-4	0.00E+0	9.00E-6	1.30E-4	1.00E-5	0.00E+0	-2.70E-5	9.50E-5	2.77E-5	1.02E-5
48	-1.79E-4	-1.50E-5	-1.52E-4	-1.34E-4	1.61E-5	0.00E+0	-1.22E-4	1.60E-5	-1.20E-4	-2.00E-4	-1.74E-4	-2.20E-5	7.73E-6	-2.72E-5
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DY" ACROSS JOINT 1
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	2.07E-3	1.59E-3	1.98E-3	-1.29E-4	1.66E-3	-3.04E-3	7.80E-5	1.54E-3	1.46E-3	0.00E+0	0.00E+0	-1.72E-3	2.13E-5	1.73E-3
2	2.07E-3	1.59E-3	1.99E-3	-1.16E-4	1.66E-3	-2.98E-3	6.30E-5	1.54E-3	1.45E-3	0.00E+0	0.00E+0	-1.72E-3	1.77E-5	1.80E-3
3	2.07E-3	1.59E-3	1.99E-3	-1.09E-4	1.66E-3	-2.93E-3	6.20E-5	1.54E-3	1.44E-3	-1.00E-4	0.00E+0	-1.72E-3	2.47E-5	1.89E-3
4	2.08E-3	1.60E-3	1.99E-3	-1.07E-4	1.66E-3	-2.88E-3	6.20E-5	1.54E-3	1.45E-3	0.00E+0	0.00E+0	-1.79E-3	2.59E-5	1.98E-3
5	1.82E-3	1.40E-3	1.80E-3	4.10E-5	1.41E-3	-2.76E-3	2.34E-4	1.32E-3	1.39E-3	1.00E-4	-1.18E-4	-1.69E-3	-2.31E-5	1.33E-3
6	1.82E-3	1.40E-3	1.79E-3	-8.00E-6	1.40E-3	-2.69E-3	2.19E-4	1.33E-3	1.35E-3	0.00E+0	0.00E+0	-1.71E-3	-3.21E-5	1.39E-3
7	1.84E-3	1.41E-3	1.80E-3	-1.40E-5	1.40E-3	-2.64E-3	2.09E-4	1.35E-3	1.34E-3	0.00E+0	2.00E-6	-1.73E-3	-2.73E-5	1.47E-3
8	1.87E-3	1.45E-3	1.84E-3	-1.70E-5	1.42E-3	-2.60E-3	2.03E-4	1.36E-3	1.34E-3	0.00E+0	4.30E-5	-1.65E-3	-2.17E-5	1.57E-3
9	1.75E-3	1.42E-3	1.73E-3	4.99E-4	1.40E-3	-2.56E-3	6.31E-4	1.25E-3	1.46E-3	4.00E-4	-3.04E-4	-1.41E-3	9.29E-5	1.25E-3
10	1.75E-3	1.43E-3	1.76E-3	4.07E-4	1.42E-3	-2.47E-3	5.14E-4	1.19E-3	1.36E-3	3.00E-4	-2.85E-4	-1.44E-3	7.39E-5	1.22E-3
11	1.79E-3	1.46E-3	1.81E-3	3.76E-4	1.44E-3	-2.41E-3	4.30E-4	1.20E-3	1.30E-3	3.00E-4	-2.27E-4	-1.47E-3	5.89E-5	1.23E-3
12	1.82E-3	1.48E-3	1.85E-3	3.43E-4	1.46E-3	-2.37E-3	4.04E-4	1.21E-3	1.28E-3	3.00E-4	-1.44E-4	-1.48E-3	4.77E-5	1.32E-3
13	1.63E-3	1.36E-3	1.61E-3	8.89E-4	1.32E-3	-2.36E-3	9.84E-4	1.25E-3	1.49E-3	8.00E-4	-9.53E-4	-1.41E-3	1.43E-4	1.25E-3
14	1.50E-3	1.24E-3	1.48E-3	7.26E-4	1.20E-3	-2.24E-3	8.07E-4	1.12E-3	1.32E-3	7.00E-4	-7.18E-4	-1.27E-3	1.07E-4	1.10E-3
15	1.43E-3	1.18E-3	1.41E-3	6.11E-4	1.14E-3	-2.16E-3	6.81E-4	1.04E-3	1.20E-3	5.00E-4	-4.73E-4	-1.21E-3	9.73E-5	1.02E-3
16	1.42E-3	1.18E-3	1.41E-3	5.59E-4	1.15E-3	-2.14E-3	6.14E-4	1.03E-3	1.15E-3	4.00E-4	-5.04E-4	-1.24E-3	9.90E-5	1.02E-3
17	1.49E-3	1.28E-3	1.47E-3	1.08E-3	1.24E-3	-2.12E-3	1.15E-3	1.20E-3	1.43E-3	1.10E-3	-1.22E-3	-1.27E-3	1.62E-4	1.23E-3
18	1.29E-3	1.09E-3	1.26E-3	8.44E-4	1.05E-3	-1.94E-3	9.02E-4	1.00E-3	1.19E-3	7.00E-4	-9.87E-4	-1.12E-3	1.14E-4	9.75E-4
19	1.17E-3	9.92E-4	1.14E-3	7.01E-4	9.47E-4	-1.86E-3	7.48E-4	8.91E-4	1.02E-3	7.00E-4	-8.52E-4	-1.03E-3	1.14E-4	8.15E-4
20	1.16E-3	9.96E-4	1.13E-3	6.64E-4	9.58E-4	-1.87E-3	7.00E-4	8.90E-4	9.60E-4	5.00E-4	-7.36E-4	-1.04E-3	1.40E-4	7.60E-4
21	1.32E-3	1.16E-3	1.29E-3	1.10E-3	1.12E-3	-1.83E-3	1.15E-3	1.10E-3	1.30E-3	1.10E-3	-1.29E-3	-1.14E-3	1.50E-4	1.16E-3
22	1.04E-3	9.00E-4	1.01E-3	8.01E-4	8.53E-4	-1.60E-3	8.43E-4	8.30E-4	9.90E-4	7.00E-4	-9.93E-4	-8.73E-4	9.33E-5	8.30E-4
23	9.06E-4	7.81E-4	8.67E-4	6.43E-4	7.31E-4	-1.51E-3	6.77E-4	7.04E-4	8.00E-4	6.00E-4	-8.20E-4	-7.77E-4	9.95E-5	6.32E-4
24	9.28E-4	8.21E-4	8.95E-4	6.51E-4	7.77E-4	-1.58E-3	6.78E-4	7.43E-4	7.80E-4	6.00E-4	-8.32E-4	-8.60E-4	1.43E-4	5.83E-4
25	1.09E-3	9.64E-4	1.07E-3	9.86E-4	9.42E-4	-1.45E-3	1.02E-3	9.38E-4	1.10E-3	1.00E-3	-1.12E-3	-8.07E-4	1.29E-4	1.04E-3
26	7.66E-4	6.63E-4	7.38E-4	6.44E-4	6.27E-4	-1.20E-3	6.74E-4	6.18E-4	7.50E-4	6.00E-4	-8.27E-4	-6.53E-4	5.54E-5	6.53E-4
27	6.42E-4	5.59E-4	6.05E-4	4.99E-4	5.11E-4	-1.13E-3	5.24E-4	5.00E-4	5.70E-4	4.00E-4	-7.01E-4	-5.70E-4	7.02E-5	4.58E-4
28	7.44E-4	6.79E-4	7.11E-4	5.90E-4	6.33E-4	-1.28E-3	6.11E-4	6.19E-4	6.10E-4	6.00E-4	-7.72E-4	-6.38E-4	1.35E-4	4.76E-4
29	6.05E-4	5.20E-4	5.97E-4	5.66E-4	5.07E-4	-8.65E-4	5.89E-4	5.09E-4	6.20E-4	6.00E-4	-6.44E-4	-3.95E-4	4.20E-5	6.66E-4
30	3.97E-4	3.29E-4	3.74E-4	3.37E-4	3.00E-4	-7.10E-4	3.56E-4	2.99E-4	3.80E-4	4.00E-4	-4.86E-4	-5.00E-5	1.36E-5	3.87E-4
31	3.99E-4	3.49E-4	3.70E-4	3.23E-4	3.10E-4	-7.39E-4	3.41E-4	3.09E-4	3.40E-4	3.00E-4	-4.52E-4	-8.80E-5	3.68E-5	2.98E-4
32	6.30E-4	5.96E-4	6.09E-4	5.50E-4	5.62E-4	-9.93E-4	5.68E-4	5.61E-4	5.30E-4	5.00E-4	-6.60E-4	-5.49E-4	1.21E-4	4.09E-4
33	3.13E-4	2.62E-4	2.89E-4	2.90E-4	2.45E-4	-4.82E-4	3.01E-4	2.47E-4	3.10E-4	3.00E-4	-3.97E-4	-2.03E-4	2.88E-5	4.97E-4
34	1.58E-4	1.21E-4	1.35E-4	1.24E-4	9.67E-5	-3.21E-4	1.36E-4	1.00E-4	1.40E-4	1.00E-4	-2.16E-4	-1.33E-4	-1.10E-5	2.47E-4
35	2.50E-4	2.27E-4	2.29E-4	2.08E-4	2.00E-4	-4.04E-4	2.17E-4	2.00E-4	2.00E-4	2.00E-4	-3.30E-4	-2.76E-4	3.47E-5	2.41E-4
36	5.89E-4	5.76E-4	5.71E-4	5.38E-4	5.48E-4	-7.35E-4	5.45E-4	5.47E-4	5.20E-4	5.00E-4	-6.79E-4	-6.06E-4	2.32E-4	5.48E-4
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DY" ACROSS JOINT 2
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	-5.92E-7	6.94E-4	-2.40E-6	0.00E+0	7.88E-4	2.73E-6	-1.00E-6	8.29E-4	0.00E+0	-2.00E-4	0.00E+0	-8.06E-4	-1.00E-6	9.60E-5
2	-5.39E-7	7.07E-4	-1.80E-6	0.00E+0	7.92E-4	-2.03E-5	-2.00E-6	8.36E-4	0.00E+0	-1.00E-4	0.00E+0	-8.12E-4	1.57E-3	1.46E-4
3	-4.58E-7	6.98E-4	-1.60E-6	0.00E+0	7.94E-4	-1.69E-4	-1.00E-6	8.43E-4	0.00E+0	-1.00E-4	0.00E+0	-8.18E-4	-4.00E-7	2.05E-4
4	-2.45E-7	7.10E-4	-1.30E-6	0.00E+0	7.97E-4	-4.10E-4	0.00E+0	8.49E-4	0.00E+0	0.00E+0	0.00E+0	-6.77E-4	-4.00E-7	2.82E-4
5	3.63E-7	7.06E-4	-1.30E-6	0.00E+0	7.45E-4	1.30E-6	-2.00E-6	7.46E-4	0.00E+0	-1.00E-4	0.00E+0	-7.25E-4	-5.00E-7	6.00E-6
6	5.11E-7	7.19E-4	-1.80E-6	0.00E+0	7.55E-4	1.24E-6	-3.00E-6	7.54E-4	0.00E+0	-1.00E-4	0.00E+0	-7.34E-4	-8.00E-7	6.00E-6
7	6.77E-7	7.33E-4	-1.10E-6	0.00E+0	7.64E-4	-1.52E-4	-2.00E-6	7.64E-4	0.00E+0	-1.00E-4	0.00E+0	-7.43E-4	-6.00E-7	2.51E-5
8	1.15E-6	7.37E-4	6.00E-7	0.00E+0	7.74E-4	-4.66E-4	0.00E+0	7.72E-4	0.00E+0	0.00E+0	0.00E+0	-6.81E-4	1.20E-6	6.83E-5
9	5.69E-6	5.90E-4	3.00E-7	0.00E+0	6.35E-4	1.96E-6	1.00E-6	6.38E-4	0.00E+0	-1.00E-4	0.00E+0	-6.16E-4	0.00E+0	4.16E-5
10	4.04E-6	6.04E-4	-1.50E-6	0.00E+0	6.44E-4	1.98E-6	-3.00E-6	6.47E-4	0.00E+0	0.00E+0	0.00E+0	-6.27E-4	-5.00E-7	2.26E-5
11	2.96E-6	6.10E-4	-1.03E-6	0.00E+0	6.55E-4	-1.56E-4	-1.00E-6	6.56E-4	0.00E+0	-1.00E-4	0.00E+0	-6.38E-4	-2.50E-7	4.98E-5
12	4.41E-5	6.46E-4	4.47E-5	6.02E-5	6.94E-4	-5.59E-4	6.00E-6	6.65E-4	0.00E+0	0.00E+0	-5.20E-5	-6.68E-4	1.29E-5	1.29E-4
13	2.36E-5	4.99E-4	1.44E-5	4.00E-6	5.37E-4	3.00E-8	-1.00E-6	5.42E-4	0.00E+0	0.00E+0	0.00E+0	-4.76E-4	8.20E-6	1.08E-4
14	2.08E-5	5.11E-4	1.01E-5	1.70E-6	5.46E-4	4.00E-8	-2.00E-6	5.50E-4	0.00E+0	-1.00E-4	0.00E+0	-5.31E-4	-3.20E-7	4.57E-5
15	3.59E-5	5.30E-4	2.29E-5	8.00E-7	5.58E-4	-1.67E-4	-1.00E-6	5.59E-4	0.00E+0	0.00E+0	-1.00E-6	-5.44E-4	-2.00E-8	6.54E-5
16	1.52E-4	6.42E-4	1.43E-4	1.34E-4	6.74E-4	-6.80E-4	9.20E-5	6.27E-4	8.00E-5	1.00E-4	-1.47E-4	-6.61E-4	3.03E-5	1.73E-4
17	4.39E-5	4.52E-4	3.84E-5	6.00E-6	4.90E-4	5.00E-8	0.00E+0	4.53E-4	0.00E+0	0.00E+0	0.00E+0	-4.65E-4	2.37E-5	1.59E-4
18	3.04E-5	4.24E-4	2.15E-5	5.30E-6	4.56E-4	1.40E-7	-3.00E-6	4.61E-4	0.00E+0	0.00E+0	0.00E+0	-4.42E-4	-1.00E-8	4.61E-5
19	6.98E-5	4.64E-4	5.42E-5	4.10E-6	4.67E-4	-2.01E-4	0.00E+0	4.69E-4	0.00E+0	0.00E+0	-2.80E-5	-4.53E-4	1.70E-7	6.22E-5
20	2.75E-4	6.57E-4	2.60E-4	2.24E-4	6.62E-4	-8.32E-4	1.84E-4	6.27E-4	1.80E-4	2.00E-4	-2.63E-4	-6.61E-4	4.70E-5	2.20E-4
21	7.66E-5	4.17E-4	9.18E-5	4.00E-7	4.60E-4	4.00E-8	1.00E-6	3.96E-4	0.00E+0	0.00E+0	0.00E+0	-3.68E-4	4.98E-5	1.92E-4
22	1.88E-5	3.42E-4	1.76E-5	7.00E-7	3.70E-4	7.00E-8	-3.00E-6	3.75E-4	0.00E+0	-1.00E-4	0.00E+0	-3.58E-4	1.40E-7	1.76E-5
23	8.29E-5	4.02E-4	6.89E-5	1.40E-6	3.80E-4	-2.56E-4	1.00E-6	3.82E-4	0.00E+0	0.00E+0	-7.00E-5	-3.67E-4	2.30E-7	4.09E-5
24	3.87E-4	6.87E-4	3.70E-4	3.21E-4	6.66E-4	-9.96E-4	2.90E-4	6.39E-4	2.90E-4	3.00E-4	-3.95E-4	-6.75E-4	6.26E-5	2.69E-4
25	-8.37E-6	2.64E-4	-8.65E-6	-9.10E-6	2.89E-4	-1.00E-8	-2.00E-6	2.93E-4	0.00E+0	-1.00E-4	0.00E+0	-2.78E-4	8.72E-6	3.80E-6
26	-5.93E-6	2.66E-4	-3.90E-6	-9.20E-6	2.90E-4	1.00E-8	-5.00E-6	2.95E-4	0.00E+0	-1.00E-4	0.00E+0	-2.79E-4	-5.30E-7	-1.25E-5
27	8.23E-5	3.42E-4	6.60E-5	-8.30E-6	2.97E-4	-3.08E-4	1.00E-6	2.99E-4	0.00E+0	0.00E+0	-9.00E-5	-2.85E-4	2.60E-7	1.84E-5
28	4.96E-4	7.33E-4	4.79E-4	4.25E-4	6.93E-4	-1.14E-3	4.07E-4	6.69E-4	4.00E-4	5.00E-4	-5.33E-4	-6.99E-4	7.67E-5	3.37E-4
29	-3.29E-5	1.97E-4	-2.46E-5	-1.81E-5	2.18E-4	9.10E-7	-3.00E-6	2.21E-4	0.00E+0	0.00E+0	0.00E+0	-2.08E-4	2.97E-6	-2.84E-5
30	-3.17E-5	1.94E-4	-2.00E-5	-1.83E-5	2.16E-4	8.00E-7	-6.00E-6	2.19E-4	0.00E+0	-1.00E-4	0.00E+0	-2.05E-4	-8.20E-7	-3.11E-5
31	8.75E-5	2.96E-4	7.10E-5	-1.63E-5	2.31E-4	-3.39E-4	1.00E-6	2.19E-4	0.00E+0	0.00E+0	-1.26E-4	-2.07E-4	1.90E-7	1.51E-5
32	6.14E-4	7.96E-4	5.99E-4	5.49E-4	7.44E-4	-1.20E-3	5.35E-4	7.15E-4	5.30E-4	6.00E-4	-6.79E-4	-7.39E-4	8.99E-5	4.29E-4
33	-4.65E-5	1.35E-4	-3.48E-5	-2.32E-5	1.53E-4	-8.83E-5	-3.00E-6	1.56E-4	0.00E+0	0.00E+0	0.00E+0	-1.45E-4	1.04E-5	-2.51E-5
34	-4.63E-5	1.31E-4	-3.04E-5	-2.33E-5	1.47E-4	8.13E-6	-6.00E-6	1.50E-4	-1.00E-5	-1.00E-4	0.00E+0	-1.38E-4	-7.40E-7	-4.13E-5
35	1.06E-4	2.61E-4	9.87E-5	6.25E-5	2.01E-4	-3.26E-4	2.00E-6	1.46E-4	3.00E-5	1.00E-4	-1.83E-4	-1.37E-4	5.60E-7	1.94E-5
36	7.36E-4	8.63E-4	7.22E-4	6.90E-4	8.08E-4	-1.09E-3	6.71E-4	7.76E-4	6.70E-4	8.00E-4	-8.26E-4	-7.96E-4	9.95E-5	5.13E-4
37	-4.82E-5	8.16E-5	-3.74E-5	-2.21E-5	9.52E-5	0.00E+0	-2.00E-6	9.60E-5	-1.00E-5	0.00E+0	0.00E+0	-9.00E-5	1.61E-5	1.30E-6
38	-4.61E-5	7.55E-5	-3.33E-5	-2.07E-5	8.76E-5	0.00E+0	-6.00E-6	8.90E-5	0.00E+0	-1.00E-4	0.00E+0	-8.10E-5	-7.40E-7	-4.22E-5
39	1.31E-4	2.29E-4	1.28E-4	9.94E-5	1.77E-4	0.00E+0	4.40E-5	1.08E-4	8.00E-5	1.00E-4	-2.25E-4	-7.60E-5	8.30E-7	2.14E-5
40	8.43E-4	9.17E-4	8.29E-4	8.07E-4	8.62E-4	0.00E+0	7.86E-4	8.30E-4	7.90E-4	9.00E-4	-9.49E-4	-8.54E-4	1.12E-4	5.61E-4
41	-4.12E-5	4.18E-5	-2.36E-5	-1.54E-5	4.75E-5	0.00E+0	-1.00E-6	4.80E-5	0.00E+0	0.00E+0	0.00E+0	5.40E-5	1.65E-5	9.58E-5
42	-3.87E-5	3.31E-5	-2.32E-5	-1.24E-5	4.06E-5	0.00E+0	-5.00E-6	3.90E-5	-1.00E-5	-1.00E-4	0.00E+0	-3.60E-5	-9.60E-7	-3.39E-5
43	1.53E-4	2.02E-4	1.48E-4	1.24E-4	1.52E-4	0.00E+0	7.30E-5	9.30E-5	1.10E-4	2.00E-4	-2.38E-4	-3.10E-5	4.91E-7	1.81E-5
44	9.08E-4	9.39E-4	8.91E-4	8.72E-4	8.83E-4	0.00E+0	8.53E-4	8.59E-4	8.60E-4	9.00E-4	-9.87E-4	-9.24E-4	1.07E-4	5.28E-4
45	-2.62E-6	3.57E-5	1.63E-5	-6.60E-6	1.84E-5	0.00E+0	0.00E+0	1.50E-5	0.00E+0	1.00E-4	-2.00E-6	-2.20E-5	3.71E-5	3.74E-4
46	-1.98E-5	6.90E-6	2.69E-6	0.00E+0	1.03E-5	0.00E+0	-5.00E-6	1.10E-5	0.00E+0	-1.00E-4	0.00E+0	-7.00E-6	-1.89E-6	-1.57E-5
47	1.41E-4	1.56E-4	1.23E-4	1.22E-4	1.21E-4	0.00E+0	7.70E-5	7.30E-5	1.10E-4	1.00E-4	-2.24E-4	-1.99E-4	-4.62E-7	-6.57E-6
48	8.59E-4	8.63E-4	8.21E-4	8.11E-4	8.03E-4	0.00E+0	7.97E-4	7.88E-4	8.10E-4	8.00E-4	-1.01E-3	-9.28E-4	1.65E+1	3.94E-4
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DZ" ACROSS JOINT 1
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	-2.39E-3	-2.05E-3	-2.45E-3	-9.79E-4	-2.08E-3	-1.27E-3	-1.13E-3	-1.94E-3	-2.71E-3	-1.10E-3	-5.00E-6	-2.08E-3	-2.68E-4	-1.94E-3
2	-2.63E-3	-2.24E-3	-2.94E-3	-8.50E-4	-2.28E-3	-1.40E-3	-1.11E-3	-2.06E-3	-3.01E-3	-1.10E-3	-9.00E-6	-2.26E-3	-2.92E-4	-2.14E-3
3	-2.88E-3	-2.43E-3	-2.70E-3	-8.84E-4	-2.48E-3	-1.54E-3	-1.07E-3	-2.20E-3	-3.32E-3	-1.10E-3	-3.00E-6	-2.46E-3	-3.36E-4	-2.36E-3
4	-3.12E-3	-2.61E-3	-3.17E-3	-8.37E-4	-2.68E-3	-1.68E-3	-1.04E-3	-2.32E-3	-3.61E-3	-1.00E-3	-6.00E-6	-2.66E-3	-3.89E-4	-2.56E-3
5	-2.37E-3	-2.08E-3	-2.44E-3	-1.13E-3	-2.10E-3	-1.27E-3	-1.18E-2	-1.95E-3	-2.73E-3	-1.20E-3	-3.49E-4	-2.10E-3	-3.48E-4	-1.97E-3
6	-2.61E-3	-2.25E-3	-2.67E-3	-1.05E-3	-2.29E-3	-1.40E-3	-1.10E-3	-2.07E-3	-3.01E-3	-1.20E-3	-2.62E-4	-2.28E-3	-3.61E-4	-2.16E-3
7	-2.86E-3	-2.44E-3	-2.92E-3	-9.75E-4	-2.49E-3	-1.54E-3	-1.05E-3	-2.20E-3	-3.32E-3	-1.10E-3	-2.21E-4	-2.47E-3	-3.97E-4	-2.37E-3
8	-3.10E-3	-2.61E-3	-3.16E-3	-9.01E-4	-2.67E-3	-1.67E-3	-1.02E-3	-2.33E-3	-3.60E-3	-1.20E-3	-1.67E-4	-2.67E-3	-4.32E-4	-2.57E-3
9	-2.08E-3	-1.93E-3	-2.13E-3	-1.41E-3	-1.95E-3	-1.13E-3	-1.47E-3	-1.89E-3	-2.35E-3	-1.40E-3	-8.22E-4	-1.97E-3	-5.71E-4	-1.88E-3
10	-2.33E-3	-2.09E-3	-2.40E-3	-1.30E-3	-2.12E-3	-1.27E-3	-1.41E-3	-2.02E-3	-2.66E-3	-1.40E-3	-6.90E-4	-2.13E-3	-5.18E-4	-2.03E-3
11	-2.61E-3	-2.26E-3	-2.68E-3	-1.21E-3	-2.30E-3	-1.41E-3	-1.35E-3	-2.15E-3	-2.98E-3	-1.20E-3	-4.68E-4	-2.32E-3	-4.94E-4	-2.22E-3
12	-2.85E-3	-2.42E-3	-2.92E-3	-1.07E-3	-2.47E-3	-1.55E-3	-1.23E-3	-2.27E-3	-3.27E-3	-1.20E-3	-4.31E-4	-2.50E-3	-4.86E-4	-2.38E-3
13	-1.70E-3	-1.67E-3	-1.72E-3	-1.44E-3	-1.68E-3	-9.50E-4	-1.47E-3	-1.67E-3	-1.85E-3	-1.50E-3	-1.10E-3	-1.66E-3	-7.71E-4	-1.64E-3
14	-1.98E-3	-1.88E-3	-2.00E-3	-1.47E-3	-1.90E-3	-1.11E-3	-1.52E-3	-1.86E-3	-2.19E-3	-1.50E-3	-1.05E-3	-1.90E-3	-7.62E-4	-1.84E-3
15	-2.26E-3	-2.10E-3	-2.28E-3	-1.50E-3	-2.13E-3	-1.28E-3	-1.57E-3	-2.05E-3	-2.54E-3	-1.50E-3	-9.44E-4	-2.13E-3	-7.65E-4	-2.06E-3
16	-2.52E-3	-2.29E-3	-2.55E-3	-1.47E-3	-2.32E-3	-1.42E-3	-1.57E-3	-2.21E-3	-2.88E-3	-1.50E-3	-8.61E-4	-2.34E-3	-7.55E-4	-2.24E-3
17	-1.41E-3	-1.43E-3	-1.43E-3	-1.31E-3	-1.44E-3	-8.03E-4	-1.33E-3	-1.44E-3	-1.47E-3	-1.40E-3	-1.07E-3	-1.41E-3	-8.15E-4	-1.44E-3
18	-1.69E-3	-1.67E-3	-1.71E-3	-1.43E-3	-1.68E-3	-9.84E-4	-1.46E-3	-1.66E-3	-1.82E-3	-1.50E-3	-1.15E-3	-1.66E-3	-8.35E-4	-1.66E-3
19	-1.99E-3	-1.91E-3	-2.00E-3	-1.55E-3	-1.92E-3	-1.16E-3	-1.59E-3	-1.88E-3	-2.18E-3	-1.60E-3	-1.23E-3	-1.91E-3	-8.77E-4	-1.89E-3
20	-2.25E-3	-2.12E-3	-2.26E-3	-1.62E-3	-2.14E-3	-1.32E-3	-1.67E-3	-2.08E-3	-2.52E-3	-1.60E-3	-1.24E-3	-2.14E-3	-9.26E-4	-2.09E-3
21	-1.21E-3	-1.25E-3	-1.23E-3	-1.16E-3	-1.25E-3	-6.85E-4	-1.17E-3	-1.27E-3	-1.23E-3	-1.20E-3	-9.37E-4	-1.22E-3	-7.92E-4	-1.28E-3
22	-1.47E-3	-1.47E-3	-1.48E-3	-1.31E-3	-1.48E-3	-8.77E-4	-1.33E-3	-1.48E-3	-1.55E-3	-1.40E-3	-1.10E-3	-1.46E-3	-8.50E-4	-1.48E-3
23	-1.75E-3	-1.71E-3	-1.75E-3	-1.48E-3	-1.72E-3	-1.07E-3	-1.50E-3	-1.70E-3	-1.89E-3	-1.50E-3	-1.25E-3	-1.70E-3	-9.20E-4	-1.71E-3
24	-1.99E-3	-1.91E-3	-1.98E-3	-1.60E-3	-1.92E-3	-1.24E-3	-1.63E-3	-1.88E-3	-2.18E-3	-1.60E-3	-1.38E-3	-1.91E-3	-9.94E-4	-1.89E-3
25	-1.07E-3	-1.11E-3	-1.09E-3	-1.02E-3	-1.11E-3	-5.93E-4	-1.04E-3	-1.13E-3	-1.07E-3	-1.10E-3	-8.03E-4	-1.05E-3	-7.27E-4	-1.15E-3
26	-1.28E-3	-1.29E-3	-1.29E-3	-1.17E-3	-1.29E-3	-7.85E-4	-1.19E-3	-1.30E-3	-1.33E-3	-1.20E-3	-9.72E-4	-1.24E-3	-7.82E-4	-1.31E-3
27	-1.52E-3	-1.50E-3	-1.52E-3	-1.34E-3	-1.50E-3	-9.89E-4	-1.36E-3	-1.49E-3	-1.61E-3	-1.40E-3	-1.17E-3	-1.44E-3	-8.74E-4	-1.50E-3
28	-1.70E-3	-1.65E-3	-1.69E-3	-1.46E-3	-1.65E-3	-1.16E-3	-1.48E-3	-1.64E-3	-1.85E-3	-1.40E-3	-1.31E-3	-1.60E-3	-9.78E-4	-1.64E-3
29	-9.28E-4	-9.61E-4	-9.43E-4	-8.66E-4	-9.51E-4	-5.00E-4	-8.85E-4	-8.71E-4	-9.20E-4	-9.00E-4	-6.32E-4	-8.49E-4	-6.08E-4	-1.01E-3
30	-1.08E-3	-1.09E-3	-1.08E-3	-9.84E-4	-1.08E-3	-6.86E-4	-1.00E-3	-1.09E-3	-1.11E-3	-1.10E-3	-7.99E-4	-9.73E-4	-6.57E-4	-1.12E-3
31	-1.26E-3	-1.24E-3	-1.25E-3	-1.13E-3	-1.23E-3	-8.88E-4	-1.15E-3	-1.24E-3	-1.32E-3	-1.10E-3	-9.70E-4	-1.14E-3	-7.74E-4	-1.26E-3
32	-1.37E-3	-1.33E-3	-1.36E-3	-1.22E-3	-1.32E-3	-1.05E-3	-1.24E-3	-1.32E-3	-1.47E-3	-1.20E-3	-1.09E-3	-1.24E-3	-8.65E-4	-1.33E-3
33	-7.01E-4	-7.19E-4	-7.08E-4	-6.40E-4	-7.04E-4	-4.19E-4	-6.60E-4	-7.23E-4	-6.90E-4	-7.00E-4	-3.74E-4	-5.01E-4	-4.75E-4	-7.88E-4
34	-7.21E-4	-7.24E-4	-7.20E-4	-6.49E-4	-7.09E-4	-5.23E-4	-6.61E-4	-7.16E-4	-7.20E-4	-7.00E-4	-4.25E-4	-5.27E-4	-4.31E-4	-7.78E-4
35	-8.44E-4	-8.31E-4	-8.35E-4	-7.57E-4	-8.14E-4	-6.98E-4	-7.75E-4	-8.21E-4	-8.80E-4	-8.00E-4	-5.54E-4	-6.25E-4	-5.40E-4	-8.66E-4
36	-9.34E-4	-9.08E-4	-9.12E-4	-8.39E-4	-8.85E-4	-8.80E-4	-8.65E-4	-8.97E-4	-9.80E-4	-9.00E-4	-6.11E-4	-6.60E-4	-6.57E-4	-8.88E-4
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-9.00E-6	-8.00E-6	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-2.00E-6	0.00E+0	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-6.00E-6	-1.00E-6	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.00E-4	-9.00E-6	-3.00E-6	0.00E+0	0.00E+0

WINTER CONDITION

DIFFERENTIAL DISPLACEMENTS "DZ" ACROSS JOINT 2
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	-1.41E-5	-1.74E-3	-7.00E-7	0.00E+0	-1.82E-3	1.00E-7	0.00E+0	-1.79E-3	0.00E+0	0.00E+0	-9.00E-6	-1.83E-3	1.30E-6	-2.46E-4
2	-1.24E-5	-1.90E-3	-2.00E-7	0.00E+0	-1.99E-3	-1.80E-6	0.00E+0	-1.97E-3	0.00E+0	0.00E+0	-6.00E-6	-1.99E-3	-5.91E-3	-2.46E-4
3	-1.17E-5	-2.06E-3	-8.00E-7	0.00E+0	-2.17E-3	-9.00E-7	0.00E+0	-2.14E-3	0.00E+0	0.00E+0	-2.00E-6	-2.15E-3	-8.00E-7	-2.51E-4
4	-1.30E-5	-2.22E-3	-1.30E-6	0.00E+0	-2.34E-3	6.80E-6	0.00E+0	-2.32E-3	0.00E+0	-1.00E-4	-8.00E-6	-2.33E-3	-1.80E-6	-2.56E-4
5	-3.83E-5	-1.53E-3	-1.40E-6	0.00E+0	-1.59E-3	-4.00E-7	-1.00E-6	-1.57E-3	0.00E+0	-1.00E-4	-9.00E-6	-1.61E-3	7.00E-7	-2.95E-4
6	-3.27E-5	-1.70E-3	-6.00E-7	0.00E+0	-1.78E-3	-7.00E-7	0.00E+0	-1.76E-3	0.00E+0	0.00E+0	-3.00E-6	-1.79E-3	-1.30E-6	-2.83E-4
7	-3.60E-5	-1.88E-3	-3.00E-7	0.00E+0	-1.97E-3	-1.06E-5	0.00E+0	-1.95E-3	0.00E+0	0.00E+0	-3.00E-6	-1.97E-3	-4.30E-6	-2.80E-4
8	-4.05E-5	-2.05E-3	-8.20E-6	0.00E+0	-2.16E-3	-5.30E-6	0.00E+0	-2.14E-3	0.00E+0	0.00E+0	-5.00E-6	-2.15E-3	-8.60E-6	-2.76E-4
9	-1.65E-4	-1.24E-3	-1.27E-4	0.00E+0	-1.28E-3	-5.80E-7	0.00E+0	-1.25E-3	0.00E+0	0.00E+0	-4.00E-6	-1.30E-3	-3.00E-6	-3.74E-4
10	-1.17E-4	-1.44E-3	-7.52E-5	0.00E+0	-1.49E-3	-6.10E-7	-1.00E-6	-1.47E-3	0.00E+0	0.00E+0	-7.00E-6	-1.50E-3	-6.10E-6	-3.58E-4
11	-1.23E-4	-1.65E-3	-8.11E-5	0.00E+0	-1.71E-3	-2.32E-5	-1.00E-6	-1.70E-3	0.00E+0	0.00E+0	-7.00E-6	-1.72E-3	-1.53E-5	-3.50E-4
12	-1.20E-4	-1.84E-3	-8.84E-5	-3.30E-5	-1.92E-3	-2.28E-5	-2.90E-5	-1.91E-3	-2.00E-5	0.00E+0	-4.50E-5	-1.92E-3	-3.73E-5	-3.32E-4
13	-3.60E-4	-9.48E-4	-3.08E-4	-7.40E-5	-9.64E-4	1.27E-7	-1.00E-6	-9.40E-4	-4.00E-5	-1.00E-4	-2.00E-6	-9.92E-4	-2.03E-5	-4.57E-4
14	-3.08E-4	-1.18E-3	-2.65E-4	-4.10E-5	-1.21E-3	3.00E-7	-1.00E-6	-1.19E-3	-1.00E-5	-1.00E-4	-3.00E-6	-1.24E-3	-1.19E-5	-4.33E-4
15	-2.97E-4	-1.42E-3	-2.48E-4	-6.10E-5	-1.47E-3	-3.62E-5	-1.30E-5	-1.45E-3	-3.00E-5	-1.00E-4	-5.30E-5	-1.49E-3	-2.31E-5	-4.32E-4
16	-2.56E-4	-1.65E-3	-2.10E-4	-8.40E-5	-1.71E-3	-5.22E-5	-5.10E-5	-1.70E-3	-6.00E-5	-1.00E-4	-6.60E-5	-1.73E-3	-6.02E-5	-4.15E-4
17	-3.86E-4	-6.79E-4	-3.26E-4	-1.41E-4	-6.82E-4	4.80E-7	0.00E+0	-6.67E-4	-1.00E-4	0.00E+0	-1.40E-5	-7.17E-4	-3.08E-5	-4.88E-4
18	-4.10E-4	-9.38E-4	-3.47E-4	-1.41E-4	-9.55E-4	2.98E-6	-1.00E-6	-9.34E-4	-8.00E-5	0.00E+0	-7.00E-6	-9.79E-4	-1.65E-5	-4.96E-4
19	-4.20E-4	-1.21E-3	-3.57E-4	-1.35E-4	-1.24E-3	-5.96E-5	-4.80E-5	-1.22E-3	-1.10E-4	-1.00E-4	-9.60E-5	-1.26E-3	-3.00E-5	-5.10E-4
20	-4.08E-4	-1.46E-3	-3.41E-4	-1.62E-4	-1.51E-3	-9.35E-5	-8.30E-5	-1.50E-3	-1.10E-4	-1.00E-4	-1.02E-4	-1.54E-3	-8.40E-5	-5.06E-4
21	-3.32E-4	-4.59E-4	-2.71E-4	-1.39E-4	-4.51E-4	4.60E-7	-2.10E-5	-4.28E-4	-6.00E-5	0.00E+0	-1.40E-5	-4.84E-4	-3.18E-5	-4.56E-4
22	-3.93E-4	-7.30E-4	-3.29E-4	-1.60E-4	-7.36E-4	3.17E-6	-1.00E-6	-7.15E-4	-4.00E-5	-1.00E-4	-2.00E-6	-7.65E-4	-1.77E-5	-4.99E-4
23	-4.48E-4	-1.01E-3	-3.76E-4	-1.82E-4	-1.04E-3	-9.40E-5	-7.40E-5	-1.02E-3	-1.50E-4	-1.00E-4	-1.07E-4	-1.06E-3	-3.42E-5	-5.46E-4
24	-4.84E-4	-1.28E-3	-4.04E-4	-2.22E-4	-1.32E-3	-1.52E-4	-1.13E-4	-1.31E-3	-1.70E-4	-1.00E-4	-1.32E-4	-1.35E-3	-1.05E-4	-5.73E-4
25	-2.71E-4	-3.03E-4	-2.02E-4	-1.20E-4	-2.85E-4	-1.03E-6	0.00E+0	-2.60E-4	0.00E+0	0.00E+0	-7.00E-6	-3.24E-4	-1.03E-5	-4.10E-4
26	-3.47E-4	-5.67E-4	-2.63E-4	-1.51E-4	-5.64E-4	-5.66E-7	-1.00E-6	-5.43E-4	0.00E+0	-1.00E-4	-9.00E-6	-5.96E-4	-1.25E-5	-4.67E-4
27	-4.28E-4	-8.52E-4	-3.46E-4	-1.81E-4	-8.64E-4	-1.35E-4	-8.10E-5	-8.49E-4	-1.30E-4	-1.00E-4	-1.22E-4	-8.99E-4	-3.78E-5	-5.28E-4
28	-4.93E-4	-1.12E-3	-4.05E-4	-2.46E-4	-1.15E-3	-2.17E-4	-1.40E-4	-1.14E-3	-1.90E-4	-2.00E-4	-1.64E-4	-1.18E-3	-1.24E-4	-5.74E-4
29	-2.43E-4	-2.10E-4	-1.68E-4	-1.09E-4	-1.84E-4	-5.56E-6	-1.00E-6	-1.62E-4	0.00E+0	0.00E+0	-7.00E-6	-2.30E-4	-8.06E-6	-3.81E-4
30	-2.95E-4	-4.55E-4	-2.00E-4	-1.29E-4	-4.45E-4	1.50E-6	-2.00E-6	-4.26E-4	0.00E+0	0.00E+0	-6.00E-6	-4.85E-4	-1.14E-5	-4.27E-4
31	-3.90E-4	-7.22E-4	-3.03E-4	-1.86E-4	-7.28E-4	-1.64E-4	-9.70E-5	-7.15E-4	-1.40E-4	-2.00E-4	-1.33E-4	-7.61E-4	-3.45E-5	-4.89E-4
32	-4.57E-4	-9.74E-4	-3.69E-4	-2.49E-4	-9.96E-4	-2.65E-4	-1.67E-4	-9.86E-4	-2.10E-4	-2.00E-4	-1.84E-4	-1.03E-3	-1.38E-4	-5.36E-4
33	-2.41E-4	-1.65E-4	-1.61E-4	-1.04E-4	-1.36E-4	-3.95E-6	-1.00E-6	-1.16E-4	0.00E+0	0.00E+0	-4.00E-6	-1.70E-4	-1.01E-5	-3.63E-4
34	-2.62E-4	-3.82E-4	-1.67E-4	-1.08E-4	-3.70E-4	-5.72E-5	-1.00E-6	-3.51E-4	0.00E+0	0.00E+0	-6.00E-6	-4.07E-4	-7.90E-6	-3.86E-4
35	-3.50E-4	-6.20E-4	-2.68E-4	-2.07E-4	-6.22E-4	-1.57E-4	-1.36E-4	-6.09E-4	-1.60E-4	-1.00E-4	-1.40E-4	-6.52E-4	-6.58E-5	-4.39E-4
36	-4.04E-4	-8.43E-4	-3.25E-4	-2.53E-4	-8.60E-4	-2.25E-4	-1.91E-4	-8.51E-4	-2.20E-4	-2.00E-4	-2.07E-4	-8.85E-4	-1.47E-4	-4.74E-4
37	-2.33E-4	-1.49E-4	-1.55E-4	-9.83E-5	-1.20E-4	0.00E+0	0.00E+0	-1.04E-4	0.00E+0	0.00E+0	-1.40E-5	-1.48E-4	-9.56E-6	-3.36E-4
38	-2.39E-4	-3.30E-4	-1.44E-4	-8.40E-5	-3.17E-4	0.00E+0	-1.00E-6	-3.02E-4	0.00E+0	-1.00E-4	-2.00E-6	-3.43E-4	-7.20E-6	-3.41E-4
39	-3.08E-4	-5.33E-4	-2.29E-4	-1.87E-4	-5.32E-4	0.00E+0	-1.37E-4	-5.21E-4	-1.60E-4	-1.00E-4	-1.42E-4	-5.48E-4	-7.99E-5	-3.80E-4
40	-3.49E-4	-7.17E-4	-2.76E-4	-2.41E-4	-7.30E-4	0.00E+0	-2.09E-4	-7.24E-4	-2.30E-4	-2.00E-4	-2.26E-4	-7.41E-4	-1.54E-4	-4.02E-4
41	-2.04E-4	-1.37E-4	-1.37E-4	-7.98E-5	-1.13E-4	0.00E+0	0.00E+0	-1.01E-4	0.00E+0	0.00E+0	-1.20E-5	-1.14E-4	-4.53E-6	-2.98E-4
42	-1.88E-4	-2.80E-4	-8.16E-5	-5.40E-5	-2.69E-4	0.00E+0	0.00E+0	-2.58E-4	0.00E+0	-1.00E-4	-5.00E-6	-2.81E-4	-5.10E-6	-2.82E-4
43	-2.50E-4	-4.41E-4	-1.77E-4	-1.60E-4	-4.41E-4	0.00E+0	-1.31E-4	-4.31E-4	-1.50E-4	-1.00E-4	-1.41E-4	-4.35E-4	-7.24E-5	-3.06E-4
44	-2.86E-4	-5.80E-4	-2.28E-4	-2.21E-4	-5.92E-4	0.00E+0	-2.13E-4	-5.88E-4	-2.30E-4	-2.00E-4	-2.16E-4	-5.84E-4	-1.48E-4	-3.17E-4
45	-1.55E-4	-1.12E-4	-9.06E-5	-6.08E-5	-9.69E-5	0.00E+0	0.00E+0	-8.40E-5	-1.00E-5	-1.00E-4	5.00E-6	-8.60E-5	-5.13E-6	-2.50E-4
46	-1.05E-4	-2.07E-4	-1.68E-5	0.00E+0	-2.05E-4	0.00E+0	-1.00E-6	-1.93E-4	0.00E+0	0.00E+0	-3.00E-6	-1.81E-4	-1.12E-5	-2.07E-4
47	-1.71E-4	-3.16E-4	-1.21E-4	-1.22E-4	-3.19E-4	0.00E+0	-1.11E-4	-3.12E-4	-1.20E-4	-1.00E-4	-1.06E-4	-2.97E-4	-7.83E-5	-2.18E-4
48	-1.94E-4	-3.80E-4	-1.68E-4	-1.70E-4	-3.85E-4	0.00E+0	-1.69E-4	-3.81E-4	-1.80E-4	-2.00E-4	-1.50E-4	-3.47E-4	-1.38E-4	-2.00E-4
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-7.00E-6	-5.00E-6	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.00E-6	-5.00E-6	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-4.00E-6	-7.00E-6	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-5.00E-6	-6.00E-6	0.00E+0	0.00E+0

WINTER CONDITION

NODAL DISPLACEMENTS "DX" IN THE DAM BODY
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	1.37E-2	1.72E-2	1.36E-2	1.39E-2	1.76E-2	1.03E-2	1.40E-2	1.78E-2	1.53E-2	1.38E-2	1.39E-2	1.77E-2	1.39E-2	1.34E-2	1.82E-2
2	1.36E-2	1.71E-2	1.35E-2	1.38E-2	1.75E-2	1.02E-2	1.39E-2	1.77E-2	1.52E-2	1.37E-2	1.38E-2	1.76E-2	1.38E-2	1.33E-2	1.81E-2
3	1.35E-2	1.70E-2	1.34E-2	1.37E-2	1.74E-2	1.01E-2	1.38E-2	1.76E-2	1.51E-2	1.36E-2	1.37E-2	1.75E-2	1.37E-2	1.32E-2	1.80E-2
4	1.34E-2	1.69E-2	1.33E-2	1.36E-2	1.73E-2	9.97E-3	1.37E-2	1.75E-2	1.50E-2	1.35E-2	1.36E-2	1.74E-2	1.36E-2	1.31E-2	1.79E-2
5	8.38E-3	1.05E-2	8.25E-3	8.48E-3	1.08E-2	7.64E-3	8.58E-3	1.09E-2	9.41E-3	8.40E-3	8.65E-3	1.10E-2	8.63E-3	7.96E-3	1.12E-2
6	8.27E-3	1.04E-2	8.14E-3	8.36E-3	1.07E-2	7.52E-3	8.47E-3	1.08E-2	9.30E-3	8.30E-3	8.53E-3	1.08E-2	8.52E-3	7.84E-3	1.11E-2
7	8.19E-3	1.03E-2	8.07E-3	8.29E-3	1.06E-2	7.44E-3	8.40E-3	1.07E-2	9.22E-3	8.20E-3	8.46E-3	1.08E-2	8.45E-3	7.77E-3	1.10E-2
8	8.08E-3	1.02E-2	7.95E-3	8.18E-3	1.05E-2	7.31E-3	8.29E-3	1.06E-2	9.11E-3	8.10E-3	8.34E-3	1.07E-2	8.33E-3	7.65E-3	1.09E-2
9	6.22E-3	5.57E-3	6.13E-3	6.19E-3	5.60E-3	5.70E-3	6.23E-3	5.62E-3	7.08E-3	6.10E-3	6.30E-3	5.77E-3	6.42E-3	5.97E-3	5.63E-3
10	6.16E-3	5.51E-3	6.08E-3	6.14E-3	5.54E-3	5.63E-3	6.18E-3	5.56E-3	7.03E-3	6.10E-3	6.25E-3	5.70E-3	6.36E-3	5.91E-3	5.56E-3
11	6.15E-3	5.49E-3	6.07E-3	6.13E-3	5.51E-3	5.61E-3	6.18E-3	5.54E-3	7.01E-3	6.10E-3	6.24E-3	5.67E-3	6.35E-3	5.90E-3	5.53E-3
12	6.10E-3	5.43E-3	6.01E-3	6.09E-3	5.45E-3	5.54E-3	6.14E-3	5.48E-3	6.97E-3	6.00E-3	6.20E-3	5.61E-3	6.31E-3	5.85E-3	5.46E-3
13	4.47E-3	4.07E-3	4.38E-3	4.23E-3	4.10E-3	4.01E-3	4.23E-3	4.05E-3	5.13E-3	4.10E-3	4.34E-3	4.25E-3	4.49E-3	4.26E-3	4.31E-3
14	4.45E-3	4.03E-3	4.35E-3	4.21E-3	4.06E-3	3.97E-3	4.22E-3	4.02E-3	5.12E-3	4.10E-3	4.31E-3	4.19E-3	4.48E-3	4.23E-3	4.25E-3
15	4.47E-3	4.04E-3	4.37E-3	4.25E-3	4.07E-3	3.98E-3	4.26E-3	4.03E-3	5.15E-3	4.10E-3	4.34E-3	4.19E-3	4.51E-3	4.25E-3	4.24E-3
16	4.45E-3	4.01E-3	4.36E-3	4.25E-3	4.04E-3	3.94E-3	4.26E-3	4.01E-3	5.14E-3	4.10E-3	4.34E-3	4.17E-3	4.50E-3	4.24E-3	4.20E-3
17	2.16E-3	2.08E-3	2.17E-3	2.38E-3	2.07E-3	1.92E-3	2.37E-3	2.11E-3	2.21E-3	2.40E-3	2.27E-3	2.05E-3	2.59E-3	2.12E-3	2.20E-3
18	2.12E-3	2.03E-3	2.13E-3	2.35E-3	2.02E-3	1.87E-3	2.34E-3	2.07E-3	2.16E-3	2.40E-3	2.24E-3	2.02E-3	2.60E-3	2.07E-3	2.17E-3
19	2.13E-3	2.03E-3	2.15E-3	2.37E-3	2.03E-3	1.86E-3	2.35E-3	2.08E-3	2.16E-3	2.40E-3	2.24E-3	2.01E-3	2.66E-3	2.06E-3	2.19E-3
20	2.10E-3	2.00E-3	2.12E-3	2.35E-3	1.99E-3	1.80E-3	2.33E-3	2.04E-3	2.12E-3	2.40E-3	2.20E-3	1.97E-3	2.69E-3	2.02E-3	2.18E-3
21	9.60E-4	9.41E-4	9.63E-4	1.05E-3	9.40E-4	9.22E-4	1.05E-3	9.52E-4	1.01E-3	1.10E-3	9.64E-4	8.57E-4	1.04E-3	9.92E-4	9.46E-4
22	9.43E-4	9.19E-4	9.47E-4	1.05E-3	9.19E-4	8.79E-4	1.04E-3	9.33E-4	1.00E-3	1.10E-3	9.51E-4	8.34E-4	1.05E-3	9.72E-4	9.35E-4
23	9.73E-4	9.45E-4	9.78E-4	1.09E-3	9.44E-4	8.74E-4	1.09E-3	9.61E-4	1.02E-3	1.10E-3	1.01E-3	8.71E-4	1.11E-3	9.99E-4	9.70E-4
24	9.71E-4	9.38E-4	9.77E-4	1.11E-3	9.37E-4	8.35E-4	1.10E-3	9.56E-4	1.03E-3	1.20E-3	1.01E-3	8.60E-4	1.14E-3	9.93E-4	9.73E-4
25	4.05E-3	5.12E-3	3.98E-3	4.17E-3	5.26E-3	4.77E-3	4.29E-3	5.37E-3	4.76E-3	4.10E-3	4.30E-3	5.41E-3	4.43E-3	3.56E-3	5.39E-3
26	4.00E-3	5.06E-3	3.92E-3	4.12E-3	5.21E-3	4.72E-3	4.24E-3	5.32E-3	4.71E-3	4.10E-3	4.25E-3	5.35E-3	4.38E-3	3.50E-3	5.33E-3
27	4.01E-3	5.08E-3	3.94E-3	4.13E-3	5.22E-3	4.71E-3	4.25E-3	5.33E-3	4.70E-3	4.10E-3	4.26E-3	5.36E-3	4.39E-3	3.52E-3	5.34E-3
28	3.90E-3	4.97E-3	3.83E-3	4.02E-3	5.11E-3	4.58E-3	4.14E-3	5.22E-3	4.59E-3	4.00E-3	4.15E-3	5.25E-3	4.28E-3	3.41E-3	5.23E-3
29	2.49E-3	2.23E-3	2.44E-3	2.53E-3	2.25E-3	3.04E-3	2.55E-3	2.28E-3	2.86E-3	2.50E-3	2.58E-3	2.35E-3	2.79E-3	2.23E-3	2.21E-3
30	2.60E-3	2.23E-3	2.45E-3	2.55E-3	2.25E-3	3.06E-3	2.57E-3	2.29E-3	2.89E-3	2.50E-3	2.60E-3	2.36E-3	2.79E-3	2.23E-3	2.20E-3
31	2.59E-3	2.31E-3	2.54E-3	2.64E-3	2.32E-3	3.14E-3	2.66E-3	2.36E-3	2.96E-3	2.60E-3	2.68E-3	2.42E-3	2.88E-3	2.31E-3	2.27E-3
32	2.56E-3	2.27E-3	2.50E-3	2.61E-3	2.28E-3	3.09E-3	2.63E-3	2.32E-3	2.95E-3	2.60E-3	2.65E-3	2.38E-3	2.84E-3	2.28E-3	2.21E-3
33	1.19E-3	1.09E-3	1.16E-3	1.20E-3	1.10E-3	1.66E-3	1.20E-3	1.10E-3	1.38E-3	1.10E-3	1.23E-3	1.20E-3	1.50E-3	9.39E-4	1.14E-3
34	1.22E-3	1.11E-3	1.19E-3	1.24E-3	1.13E-3	1.69E-3	1.24E-3	1.13E-3	1.43E-3	1.20E-3	1.25E-3	1.18E-3	1.53E-3	9.75E-4	1.15E-3
35	1.33E-3	1.20E-3	1.30E-3	1.35E-3	1.22E-3	1.77E-3	1.35E-3	1.23E-3	1.54E-3	1.30E-3	1.33E-3	1.24E-3	1.64E-3	1.08E-3	1.25E-3
36	1.33E-3	1.19E-3	1.30E-3	1.36E-3	1.21E-3	1.75E-3	1.36E-3	1.22E-3	1.56E-3	1.30E-3	1.33E-3	1.24E-3	1.64E-3	1.08E-3	1.22E-3
37	5.19E-4	5.02E-4	5.17E-4	5.20E-4	4.97E-4	6.34E-4	5.21E-4	5.04E-4	5.20E-4	5.00E-4	4.73E-4	4.43E-4	5.41E-4	4.67E-4	3.94E-4
38	5.10E-4	4.88E-4	5.13E-4	5.17E-4	4.89E-4	6.31E-4	5.19E-4	4.97E-4	5.20E-4	5.00E-4	4.49E-4	4.46E-4	5.70E-4	4.40E-4	3.85E-4
39	5.57E-4	5.31E-4	5.62E-4	5.68E-4	5.32E-4	6.65E-4	5.69E-4	5.42E-4	5.50E-4	6.00E-4	4.71E-4	4.59E-4	6.54E-4	4.61E-4	4.35E-4
40	4.96E-4	4.65E-4	5.03E-4	5.12E-4	4.68E-4	5.97E-4	5.16E-4	4.83E-4	5.00E-4	5.00E-4	3.59E-4	3.26E-4	6.32E-4	3.68E-4	3.68E-4
41	1.24E-3	1.47E-3	1.23E-3	1.32E-3	1.50E-3	1.77E-3	1.38E-3	1.54E-3	1.49E-3	1.30E-3	1.33E-3	1.53E-3	1.48E-3	8.20E-4	1.26E-3
42	1.20E-3	1.42E-3	1.18E-3	1.27E-3	1.46E-3	1.68E-3	1.33E-3	1.49E-3	1.45E-3	1.30E-3	1.27E-3	1.46E-3	1.43E-3	7.73E-4	1.21E-3
43	1.26E-3	1.48E-3	1.25E-3	1.33E-3	1.52E-3	1.70E-3	1.39E-3	1.56E-3	1.48E-3	1.30E-3	1.33E-3	1.53E-3	1.49E-3	8.40E-4	1.28E-3
44	1.13E-3	1.35E-3	1.11E-3	1.20E-3	1.39E-3	1.52E-3	1.25E-3	1.43E-3	1.35E-3	1.20E-3	1.18E-3	1.39E-3	1.35E-3	6.99E-4	1.14E-3
45	5.99E-4	5.76E-4	5.92E-4	6.09E-4	5.77E-4	7.52E-4	9.40E-4	8.86E-4	6.50E-4	6.00E-4	6.18E-4	5.99E-4	6.80E-4	4.36E-4	4.53E-4
46	6.10E-4	5.80E-4	6.02E-4	6.21E-4	5.83E-4	7.42E-4	9.42E-4	8.82E-4	6.60E-4	6.00E-4	5.94E-4	5.70E-4	6.89E-4	4.28E-4	4.37E-4
47	6.90E-4	6.52E-4	6.78E-4	6.99E-4	6.53E-4	8.14E-4	1.04E-3	9.69E-4	7.30E-4	7.00E-4	6.54E-4	6.23E-4	7.60E-4	4.93E-4	4.88E-4
48	5.86E-4	5.40E-4	5.71E-4	5.94E-4	5.40E-4	6.90E-4	9.47E-4	8.71E-4	6.40E-4	6.00E-4	5.04E-4	4.68E-4	6.49E-4	3.62E-4	3.45E-4
49	5.49E-4	5.70E-4	5.44E-4	5.56E-4	5.71E-4	4.98E-4	5.61E-4	5.76E-4	5.70E-4	5.00E-4	5.30E-4	5.59E-4	5.97E-4	2.89E-4	3.51E-4
50	5.67E-4	5.91E-4	5.63E-4	5.79E-4	5.96E-4	5.41E-4	5.86E-4	6.02E-4	6.00E-4	6.00E-4	5.31E-4	5.63E-4	6.34E-4	2.76E-4	3.62E-4
51	6.15E-4	6.46E-4	6.09E-4	6.25E-4	6.50E-4	5.82E-4	6.35E-4	6.57E-4	6.40E-4	6.00E-4	5.55E-4	5.90E-4	6.76E-4	3.42E-4	4.27E-4
52	3.86E-4	4.16E-4	3.80E-4	3.93E-4	4.16E-4	3.71E-4	4.06E-4	4.27E-4	4.10E-4	4.00E-4	3.61E-4	3.91E-4	4.39E-4	9.61E-5	1.69E-4

WINTER CONDITION

NODAL DISPLACEMENTS "DY" IN THE DAM BODY
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	1.1E-35	-3.0E-32	-8.5E-25	3.51E-8	-5.08E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
2	-1.4E-30	-4.6E-30	-2.1E-24	-4.09E-8	-4.67E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
3	-1.6E-30	-5.7E-30	-2.0E-24	-4.67E-8	-4.23E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
4	-8.6E-37	4.1E-32	-1.2E-24	-5.25E-8	-3.81E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
5	-9.8E-31	-3.8E-30	-1.7E-24	-1.70E-8	-3.13E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
6	-6.7E-31	-2.1E-30	-4.0E-24	-2.13E-8	-2.89E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
7	-1.9E-30	-1.0E-29	-3.5E-24	-2.59E-8	-2.50E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
8	-9.7E-32	-2.1E-30	-2.0E-24	-3.07E-8	-2.11E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
9	1.71E-3	1.25E-3	1.70E-3	1.73E-3	1.22E-3	1.57E-3	1.79E-3	1.27E-3	1.83E-3	-1.70E-3	-1.79E-3	-1.30E-3	1.76E-3	1.70E-3	1.13E-3
10	1.48E-3	1.06E-3	1.47E-3	1.48E-3	1.03E-3	1.35E-3	1.54E-3	1.07E-3	1.58E-3	-1.50E-3	-1.55E-3	-1.11E-3	1.52E-3	1.48E-3	9.61E-4
11	1.27E-3	8.76E-4	1.26E-3	1.24E-3	8.49E-4	1.13E-3	1.30E-3	8.82E-4	1.34E-3	-1.20E-3	-1.30E-3	-9.25E-4	1.29E-3	1.27E-3	8.00E-4
12	1.04E-3	6.86E-4	1.03E-3	9.93E-4	6.62E-4	9.11E-4	1.04E-3	6.87E-4	1.09E-3	-1.00E-3	-1.03E-3	-7.16E-4	1.05E-3	1.06E-3	6.29E-4
13	1.96E-3	1.59E-3	1.95E-3	1.91E-3	1.57E-3	1.86E-3	1.96E-3	1.59E-3	2.03E-3	-1.90E-3	-1.97E-3	-1.66E-3	1.93E-3	1.97E-3	1.48E-3
14	1.73E-3	1.39E-3	1.72E-3	1.65E-3	1.36E-3	1.65E-3	1.69E-3	1.36E-3	1.77E-3	-1.60E-3	-1.73E-3	-1.47E-3	1.67E-3	1.74E-3	1.31E-3
15	1.52E-3	1.20E-3	1.51E-3	1.40E-3	1.17E-3	1.45E-3	1.44E-3	1.18E-3	1.52E-3	-1.40E-3	-1.46E-3	-1.28E-3	1.42E-3	1.52E-3	1.15E-3
16	1.29E-3	1.00E-3	1.28E-3	1.14E-3	9.73E-4	1.23E-3	1.17E-3	9.73E-4	1.27E-3	-1.10E-3	-1.17E-3	-1.05E-3	1.16E-3	1.30E-3	9.80E-4
17	7.28E-4	6.42E-4	7.30E-4	1.01E-3	6.40E-4	7.32E-5	9.89E-4	6.88E-4	8.30E-4	-1.00E-3	-9.84E-4	-7.06E-4	1.57E-3	6.43E-4	9.55E-4
18	5.62E-4	4.85E-4	5.64E-4	8.32E-4	4.86E-4	-7.14E-5	8.14E-4	5.31E-4	6.80E-4	-9.00E-4	-7.91E-4	-5.18E-4	1.32E-3	4.84E-4	7.64E-4
19	4.22E-4	3.55E-4	4.23E-4	6.80E-4	3.58E-4	-1.93E-4	6.64E-4	4.00E-4	5.40E-4	-7.00E-4	-6.37E-4	-3.65E-4	1.10E-3	3.72E-4	5.96E-4
20	2.58E-4	2.02E-4	2.58E-4	5.04E-4	2.05E-4	-3.38E-4	4.90E-4	2.44E-4	3.90E-4	-5.00E-4	-4.80E-4	-2.18E-4	8.52E-4	2.26E-4	4.07E-4
21	7.04E-4	6.71E-4	7.01E-4	8.96E-4	6.75E-4	2.71E-4	8.85E-4	6.99E-4	8.50E-4	-9.00E-4	-8.72E-4	-6.57E-4	1.11E-3	6.96E-4	7.99E-4
22	5.17E-4	4.90E-4	5.13E-4	6.90E-4	4.95E-4	1.16E-4	6.80E-4	5.13E-4	6.60E-4	-7.00E-4	-6.89E-4	-4.90E-4	8.88E-4	5.16E-4	6.07E-4
23	3.67E-4	3.46E-4	3.62E-4	5.21E-4	3.51E-4	-6.82E-6	5.10E-4	3.65E-4	4.90E-4	-5.00E-4	-5.04E-4	-3.28E-4	6.94E-4	3.70E-4	4.48E-4
24	1.91E-4	1.76E-4	1.85E-4	3.26E-4	1.80E-4	-1.57E-4	3.16E-4	1.91E-4	3.10E-4	-3.00E-4	-3.30E-4	-1.72E-4	4.79E-4	1.97E-4	2.65E-4
25	-6.2E-32	-2.8E-32	-1.3E-24	-4.25E-9	-1.26E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
26	-1.5E-30	-4.5E-30	-2.9E-24	-7.09E-9	-1.17E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
27	-4.0E-30	-1.7E-29	-2.4E-24	-1.01E-8	-9.43E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
28	-2.6E-33	-1.1E-30	-1.6E-24	-1.31E-8	-7.59E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
29	8.71E-4	6.22E-4	8.57E-4	8.86E-4	6.09E-4	9.69E-4	9.36E-4	6.60E-4	9.80E-4	-9.00E-4	-9.05E-4	-6.73E-4	8.97E-4	8.66E-4	5.57E-4
30	6.46E-4	4.28E-4	6.38E-4	6.58E-4	4.19E-4	7.27E-4	7.02E-4	4.62E-4	7.30E-4	-7.00E-4	-6.72E-4	-4.74E-4	6.81E-4	6.57E-4	3.89E-4
31	4.44E-4	2.57E-4	4.39E-4	4.48E-4	2.50E-4	4.97E-4	4.88E-4	2.87E-4	4.90E-4	-4.00E-4	-4.56E-4	-3.01E-4	4.86E-4	4.70E-4	2.46E-4
32	2.04E-4	4.72E-5	2.04E-4	2.02E-4	4.40E-5	2.29E-4	2.38E-4	7.40E-5	2.20E-4	-2.00E-4	-1.79E-4	-5.90E-5	2.53E-4	2.45E-4	6.17E-5
33	7.43E-4	5.71E-4	7.38E-4	7.40E-4	5.63E-4	8.67E-4	7.79E-4	5.97E-4	8.10E-4	-7.00E-4	-7.84E-4	-5.97E-4	7.35E-4	7.81E-4	5.12E-4
34	5.56E-4	4.08E-4	5.54E-4	5.49E-4	4.00E-4	6.78E-4	5.85E-4	4.30E-4	5.90E-4	-6.00E-4	-6.09E-4	-4.83E-4	5.39E-4	5.88E-4	3.44E-4
35	4.08E-4	2.84E-4	4.08E-4	3.95E-4	2.76E-4	5.15E-4	4.25E-4	3.01E-4	4.10E-4	-4.00E-4	-4.42E-4	-3.35E-4	3.79E-4	4.34E-4	2.24E-4
36	2.05E-4	1.02E-4	2.09E-4	1.87E-4	9.70E-5	2.93E-4	2.14E-4	1.17E-4	1.80E-4	-2.00E-4	-1.92E-4	-8.00E-5	1.67E-4	2.19E-4	4.73E-5
37	5.54E-5	1.87E-5	5.94E-5	8.00E-5	1.84E-5	-8.82E-5	8.80E-5	4.00E-5	6.00E-5	-1.00E-4	-3.60E-5	-1.45E-4	3.43E-4	-3.41E-5	2.14E-4
38	-5.63E-5	-8.55E-5	-4.59E-5	-2.60E-5	-7.87E-5	-2.02E-4	-2.00E-5	-6.10E-5	-4.00E-5	0.00E+0	7.30E-5	1.10E-5	1.89E-4	-1.11E-4	1.03E-4
39	-1.10E-4	-1.34E-4	-1.02E-4	-8.24E-5	-1.27E-4	-2.82E-4	-7.70E-5	-1.13E-4	-1.00E-4	1.00E-4	1.64E-4	1.13E-4	9.33E-5	-1.37E-4	4.59E-5
40	-2.33E-4	-2.51E-4	-2.28E-4	-2.08E-4	-2.46E-4	-4.31E-4	-2.04E-4	-2.34E-4	-2.20E-4	2.00E-4	2.95E-4	2.31E-4	-6.38E-5	-2.34E-4	-7.93E-5
41	-2.0E-30	-7.4E-30	-6.9E-25	4.74E-9	4.81E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
42	-2.9E-30	-1.0E-29	-1.8E-24	2.68E-9	4.10E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
43	-4.0E-30	-1.8E-29	-1.6E-24	7.46E-10	3.54E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
44	3.0E-31	-2.3E-31	-1.2E-24	-1.11E-9	2.75E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
45	2.16E-4	1.66E-4	1.97E-4	2.00E-4	1.65E-4	2.39E-4	3.32E-4	2.95E-4	2.50E-4	-2.00E-4	-2.12E-4	-2.31E-4	2.28E-4	1.96E-4	1.65E-4
46	5.94E-5	2.62E-5	4.61E-5	4.81E-5	2.89E-5	1.74E-5	1.54E-4	1.32E-4	8.00E-5	0.00E+0	-1.90E-5	-4.00E-5	8.16E-5	8.76E-5	8.00E-5
47	-4.34E-5	-6.01E-5	-5.13E-5	-5.28E-5	-5.60E-5	-1.31E-4	-3.00E-6	-1.10E-5	-4.00E-5	1.00E-4	7.10E-5	2.90E-5	-6.80E-6	3.30E-5	5.22E-5
48	-1.90E-4	-1.93E-4	-1.92E-4	-1.97E-4	-1.88E-4	-3.22E-4	-1.97E-4	-1.92E-4	-2.00E-4	2.00E-4	2.38E-4	1.90E-4	-1.45E-4	-6.63E-5	-2.83E-5
49	-1.5E-30	-6.6E-30	-2.4E-25	6.16E-9	7.26E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	-2.9E-30	-1.2E-29	-9.1E-25	4.68E-9	6.38E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	1.3E-30	3.6E-30	-8.2E-25	2.71E-9	5.07E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	1.5E-30	5.9E-30	-3.7E-25	5.06E-11	1.98E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

WINTER CONDITION

NODAL DISPLACEMENTS "DZ" IN THE DAM BODY
[m]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-6.88E-3	-7.62E-3	-6.80E-3	-6.73E-3	-7.64E-3	-4.07E-3	-6.70E-3	-7.64E-3	-6.90E-3	-6.70E-3	-6.78E-3	-7.76E-3	-6.60E-3	-7.07E-3	-7.85E-3
2	-7.40E-3	-8.25E-3	-7.31E-3	-7.26E-3	-8.28E-3	-4.33E-3	-7.23E-3	-8.29E-3	-7.47E-3	-7.20E-3	-7.26E-3	-8.39E-3	-7.10E-3	-7.59E-3	-8.50E-3
3	-7.93E-3	-8.90E-3	-7.85E-3	-7.79E-3	-8.95E-3	-4.60E-3	-7.77E-3	-8.95E-3	-8.05E-3	-7.80E-3	-7.80E-3	-9.03E-3	-7.62E-3	-8.13E-3	-9.17E-3
4	-8.44E-3	-9.52E-3	-8.36E-3	-8.32E-3	-9.59E-3	-4.87E-3	-8.29E-3	-9.59E-3	-8.61E-3	-8.30E-3	-8.30E-3	-9.66E-3	-8.13E-3	-8.66E-3	-9.83E-3
5	-3.46E-3	-3.62E-3	-3.38E-3	-3.30E-3	-3.59E-3	-1.68E-3	-3.26E-3	-3.58E-3	-3.29E-3	-3.30E-3	-3.32E-3	-3.69E-3	-3.23E-3	-3.59E-3	-3.71E-3
6	-4.07E-3	-4.38E-3	-3.99E-3	-3.91E-3	-4.36E-3	-2.04E-3	-3.87E-3	-4.36E-3	-3.94E-3	-3.90E-3	-3.94E-3	-4.47E-3	-3.82E-3	-4.21E-3	-4.52E-3
7	-4.72E-3	-5.19E-3	-4.64E-3	-4.57E-3	-5.19E-3	-2.41E-3	-4.53E-3	-5.18E-3	-4.65E-3	-4.50E-3	-4.61E-3	-5.30E-3	-4.46E-3	-4.88E-3	-5.37E-3
8	-5.35E-3	-5.98E-3	-5.27E-3	-5.20E-3	-5.99E-3	-2.77E-3	-5.16E-3	-5.99E-3	-5.33E-3	-5.20E-3	-5.25E-3	-6.11E-3	-5.08E-3	-5.53E-3	-6.20E-3
9	-2.74E-3	-2.67E-3	-2.74E-3	-2.76E-3	-2.65E-3	-1.39E-3	-2.77E-3	-2.66E-3	-2.77E-3	-2.80E-3	-2.78E-3	-2.70E-3	-2.74E-3	-2.75E-3	-2.71E-3
10	-3.32E-3	-3.19E-3	-3.32E-3	-3.32E-3	-3.17E-3	-1.74E-3	-3.34E-3	-3.17E-3	-3.42E-3	-3.30E-3	-3.35E-3	-3.23E-3	-3.29E-3	-3.34E-3	-3.23E-3
11	-3.96E-3	-3.75E-3	-3.94E-3	-3.93E-3	-3.73E-3	-2.11E-3	-3.95E-3	-3.73E-3	-4.12E-3	-3.90E-3	-3.96E-3	-3.80E-3	-3.88E-3	-3.98E-3	-3.80E-3
12	-4.58E-3	-4.30E-3	-4.56E-3	-4.52E-3	-4.28E-3	-2.45E-3	-4.54E-3	-4.28E-3	-4.81E-3	-4.50E-3	-4.56E-3	-4.36E-3	-4.46E-3	-4.60E-3	-4.34E-3
13	-2.53E-3	-2.56E-3	-2.52E-3	-2.52E-3	-2.55E-3	-1.19E-3	-2.52E-3	-2.55E-3	-2.61E-3	-2.50E-3	-2.47E-3	-2.57E-3	-2.40E-3	-2.56E-3	-2.66E-3
14	-3.10E-3	-3.07E-3	-3.09E-3	-3.03E-3	-3.06E-3	-1.62E-3	-3.04E-3	-3.05E-3	-3.26E-3	-3.00E-3	-2.97E-3	-3.09E-3	-2.90E-3	-3.14E-3	-3.17E-3
15	-3.72E-3	-3.63E-3	-3.70E-3	-3.58E-3	-3.63E-3	-1.87E-3	-3.59E-3	-3.60E-3	-3.96E-3	-3.60E-3	-3.51E-3	-3.65E-3	-3.42E-3	-3.77E-3	-3.73E-3
16	-4.33E-3	-4.18E-3	-4.30E-3	-4.12E-3	-4.18E-3	-2.20E-3	-4.13E-3	-4.14E-3	-4.65E-3	-4.10E-3	-4.04E-3	-4.21E-3	-3.95E-3	-4.39E-3	-4.27E-3
17	-1.20E-3	-1.24E-3	-1.18E-3	-1.20E-3	-1.24E-3	-4.94E-4	-1.19E-3	-1.21E-3	-1.27E-3	-1.10E-3	-1.31E-3	-1.27E-3	-1.36E-3	-1.24E-3	-1.27E-3
18	-1.49E-3	-1.52E-3	-1.47E-3	-1.56E-3	-1.52E-3	-6.35E-4	-1.54E-3	-1.50E-3	-1.58E-3	-1.50E-3	-1.69E-3	-1.55E-3	-1.75E-3	-1.53E-3	-1.57E-3
19	-1.81E-3	-1.83E-3	-1.78E-3	-1.96E-3	-1.82E-3	-7.92E-4	-1.94E-3	-1.81E-3	-1.92E-3	-1.90E-3	-2.12E-3	-1.86E-3	-2.19E-3	-1.86E-3	-1.90E-3
20	-2.12E-3	-2.13E-3	-2.09E-3	-2.36E-3	-2.12E-3	-9.36E-4	-2.32E-3	-2.12E-3	-2.25E-3	-2.30E-3	-2.54E-3	-2.16E-3	-2.60E-3	-2.18E-3	-2.23E-3
21	-1.03E-3	-1.05E-3	-1.03E-3	-9.88E-4	-1.06E-3	-5.42E-4	-9.82E-4	-1.04E-3	-1.03E-3	-1.00E-3	-1.01E-3	-1.07E-3	-1.03E-3	-1.08E-3	-1.12E-3
22	-1.25E-3	-1.26E-3	-1.24E-3	-1.25E-3	-1.27E-3	-6.55E-4	-1.24E-3	-1.26E-3	-1.27E-3	-1.20E-3	-1.27E-3	-1.28E-3	-1.31E-3	-1.31E-3	-1.34E-3
23	-1.48E-3	-1.49E-3	-1.47E-3	-1.53E-3	-1.50E-3	-7.76E-4	-1.52E-3	-1.49E-3	-1.53E-3	-1.50E-3	-1.57E-3	-1.51E-3	-1.61E-3	-1.55E-3	-1.58E-3
24	-1.71E-3	-1.72E-3	-1.70E-3	-1.81E-3	-1.72E-3	-8.92E-4	-1.80E-3	-1.72E-3	-1.79E-3	-1.80E-3	-1.84E-3	-1.71E-3	-1.90E-3	-1.78E-3	-1.82E-3
25	-1.35E-3	-1.21E-3	-1.31E-3	-1.23E-3	-1.16E-3	4.92E-5	-1.20E-3	-1.14E-3	-1.10E-3	-1.20E-3	-1.23E-3	-1.21E-3	-1.15E-3	-1.48E-3	-1.15E-3
26	-1.96E-3	-1.95E-3	-1.91E-3	-1.83E-3	-1.91E-3	-4.26E-4	-1.80E-3	-1.90E-3	-1.75E-3	-1.80E-3	-1.81E-3	-1.96E-3	-1.76E-3	-2.08E-3	-1.96E-3
27	-2.58E-3	-2.72E-3	-2.52E-3	-2.45E-3	-2.69E-3	-9.19E-4	-2.41E-3	-2.69E-3	-2.42E-3	-2.40E-3	-2.44E-3	-2.76E-3	-2.36E-3	-2.70E-3	-2.80E-3
28	-3.16E-3	-3.45E-3	-3.09E-3	-3.03E-3	-3.44E-3	-1.37E-3	-2.99E-3	-3.44E-3	-3.05E-3	-3.00E-3	-3.03E-3	-3.52E-3	-2.94E-3	-3.29E-3	-3.60E-3
29	-1.15E-3	-1.17E-3	-1.16E-3	-1.15E-3	-1.15E-3	4.05E-6	-1.16E-3	-1.15E-3	-1.08E-3	-1.20E-3	-1.16E-3	-1.18E-3	-1.08E-3	-1.18E-3	-1.16E-3
30	-1.64E-3	-1.60E-3	-1.64E-3	-1.64E-3	-1.59E-3	-3.86E-4	-1.66E-3	-1.59E-3	-1.63E-3	-1.70E-3	-1.64E-3	-1.61E-3	-1.59E-3	-1.66E-3	-1.61E-3
31	-2.13E-3	-2.04E-3	-2.13E-3	-2.14E-3	-2.03E-3	-8.22E-4	-2.16E-3	-2.03E-3	-2.18E-3	-2.10E-3	-2.14E-3	-2.05E-3	-2.10E-3	-2.15E-3	-2.07E-3
32	-2.59E-3	-2.45E-3	-2.58E-3	-2.60E-3	-2.43E-3	-1.23E-3	-2.62E-3	-2.44E-3	-2.70E-3	-2.60E-3	-2.61E-3	-2.47E-3	-2.58E-3	-2.60E-3	-2.49E-3
33	-1.20E-3	-1.25E-3	-1.20E-3	-1.19E-3	-1.25E-3	1.18E-5	-1.19E-3	-1.25E-3	-1.20E-3	-1.20E-3	-1.15E-3	-1.24E-3	-1.08E-3	-1.24E-3	-1.26E-3
34	-1.60E-3	-1.62E-3	-1.60E-3	-1.59E-3	-1.62E-3	-3.71E-4	-1.59E-3	-1.62E-3	-1.66E-3	-1.60E-3	-1.54E-3	-1.60E-3	-1.50E-3	-1.64E-3	-1.68E-3
35	-1.99E-3	-1.97E-3	-1.99E-3	-1.97E-3	-1.97E-3	-7.51E-4	-1.97E-3	-1.97E-3	-2.09E-3	-2.00E-3	-1.90E-3	-1.94E-3	-1.90E-3	-2.03E-3	-2.06E-3
36	-2.35E-3	-2.28E-3	-2.33E-3	-2.31E-3	-2.29E-3	-1.11E-3	-2.32E-3	-2.28E-3	-2.49E-3	-2.30E-3	-2.24E-3	-2.25E-3	-2.27E-3	-2.37E-3	-2.40E-3
37	-5.10E-4	-5.43E-4	-4.90E-4	-5.31E-4	-5.45E-4	1.62E-4	-5.19E-4	-5.26E-4	-5.60E-4	-5.00E-4	-6.99E-4	-6.27E-4	-5.76E-4	-5.36E-4	-5.06E-4
38	-7.08E-4	-7.30E-4	-6.94E-4	-7.50E-4	-7.35E-4	2.12E-5	-7.36E-4	-7.19E-4	-7.60E-4	-7.00E-4	-8.44E-4	-7.61E-4	-8.53E-4	-7.37E-4	-7.49E-4
39	-8.73E-4	-8.83E-4	-8.61E-4	-9.34E-4	-8.88E-4	-1.20E-4	-9.20E-4	-8.79E-4	-9.30E-4	-9.00E-4	-9.96E-4	-9.09E-4	-1.09E-3	-9.05E-4	-9.56E-4
40	-1.03E-3	-1.03E-3	-1.02E-3	-1.11E-3	-1.04E-3	-2.65E-4	-1.09E-3	-1.03E-3	-1.09E-3	-1.10E-3	-1.19E-3	-1.11E-3	-1.30E-3	-1.06E-3	-1.15E-3
41	-1.07E-3	-9.30E-4	-1.05E-3	-9.56E-4	-8.90E-4	4.05E-4	-8.96E-4	-8.60E-4	-7.80E-4	-9.00E-4	-8.54E-4	-8.28E-4	-8.11E-4	-1.21E-3	-8.76E-4
42	-1.33E-3	-1.29E-3	-1.30E-3	-1.24E-3	-1.26E-3	-3.02E-5	-1.19E-3	-1.25E-3	-1.13E-3	-1.20E-3	-1.14E-3	-1.22E-3	-1.12E-3	-1.46E-3	-1.28E-3
43	-1.57E-3	-1.63E-3	-1.53E-3	-1.50E-3	-1.61E-3	-4.40E-4	-1.47E-3	-1.61E-3	-1.45E-3	-1.50E-3	-1.42E-3	-1.58E-3	-1.41E-3	-1.68E-3	-1.66E-3
44	-1.80E-3	-1.95E-3	-1.77E-3	-1.75E-3	-1.95E-3	-8.85E-4	-1.75E-3	-1.96E-3	-1.77E-3	-1.70E-3	-1.73E-3	-1.96E-3	-1.70E-3	-1.89E-3	-2.02E-3
45	-9.97E-4	-1.01E-3	-1.01E-3	-9.98E-4	-9.99E-4	7.23E-5	-9.51E-4	-9.21E-4	-9.60E-4	-1.00E-3	-9.41E-4	-9.30E-4	-9.29E-4	-1.04E-3	-1.02E-3
46	-1.16E-3	-1.14E-3	-1.17E-3	-1.16E-3	-1.13E-3	-2.03E-4	-1.16E-3	-1.10E-3	-1.15E-3	-1.20E-3	-1.08E-3	-1.06E-3	-1.12E-3	-1.19E-3	-1.15E-3
47	-1.28E-3	-1.23E-3	-1.28E-3	-1.29E-3	-1.23E-3	-4.22E-4	-1.35E-3	-1.25E-3	-1.30E-3	-1.30E-3	-1.22E-3	-1.17E-3	-1.26E-3	-1.31E-3	-1.25E-3
48	-1.39E-3	-1.32E-3	-1.39E-3	-1.40E-3	-1.32E-3	-6.41E-4	-1.54E-3	-1.42E-3	-1.43E-3	-1.40E-3	-1.38E-3	-1.31E-3	-1.39E-3	-1.41E-3	-1.34E-3
49	-8.81E-4	-8.45E-4	-8.60E-4	-8.03E-4	-8.20E-4	9.14E-5	-7.71E-4	-8.08E-4	-7.10E-4	-8.00E-4	-7.09E-4	-7.60E-4	-7.02E-4	-1.05E-3	-9.00E-4
50	-1.24E-3	-1.26E-3	-1.22E-3	-1.18E-3	-1.24E-3	-2.57E-4	-1.16E-3	-1.24E-3	-1.11E-3	-1.20E-3	-1.08E-3	-1.17E-3	-1.09E-3	-1.34E-3	-1.27E-3
51	-1.30E-3	-1.37E-3	-1.27E-3	-1.25E-3	-1.37E-3	-4.52E-4	-1.25E-3	-1.37E-3	-1.23E-3	-1.20E-3	-1.16E-3	-1.31E-3	-1.19E-3	-1.35E-3	-1.39E-3
52	-1.07E-3	-1.16E-3	-1.05E-3	-1.05E-3	-1.17E-3	-4.20E-4	-1.05E-3	-1.18E-3	-1.05E-3	-1.00E-3	-9.24E-4	-1.06E-3	-1.01E-3	-1.10E-3	-1.19E-3

WINTER CONDITION

PRINCIPAL STRESSES "P1" IN THE DAM BODY
[MPa]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-0.0079	-0.0111	0.0615	-0.0136	-0.0005	0.1453	0.0976	0.1060	0.1123	0.0600	0.0100	-0.0204	0.0000	0.0155	0.02322
2	0.0733	0.0783	0.0827	0.1309	0.1316	0.2128	0.1122	0.1156	0.1057	0.0600	0.0128	-0.0381	0.0000	0.0847	0.09123
3	0.0666	0.0744	0.0699	0.0876	0.0892	0.2182	0.1172	0.1171	0.1053	0.0600	0.0216	-0.0318	0.0000	0.0520	0.06719
4	0.0119	0.0315	0.0511	-0.0259	-0.0033	0.2391	0.0902	0.1046	0.0908	0.0600	-0.0042	0.0001	0.0000	0.0203	0.03945
5	1.0123	1.1193	0.9015	1.1320	1.2160	0.9879	1.1318	1.1965	1.1081	1.0900	1.0030	1.0540	0.1539	1.0460	1.07600
6	0.0222	0.0227	0.0685	0.0719	0.0677	-0.2466	0.0702	0.0691	0.0365	0.0200	0.0718	0.0456	-0.0210	0.0161	0.02059
7	0.0056	0.0012	0.0655	0.0674	0.0858	-0.2408	0.0561	0.0526	0.0254	0.0100	0.0874	0.0503	-0.0635	-0.0240	0.01228
8	0.9398	0.6977	0.8271	1.0220	0.7689	1.0421	0.9276	0.7301	0.8920	0.9200	1.0130	0.7704	0.4828	0.8909	0.77110
9	1.4339	1.3661	1.2600	1.3660	1.4490	1.1315	1.3496	1.3829	1.5718	1.3100	1.2000	1.3070	0.6305	1.4740	1.28600
10	0.0199	0.0163	0.0722	0.0489	0.0372	-0.2557	0.0654	0.0621	0.0422	0.0200	0.0212	0.0067	-0.0860	0.0189	0.01331
11	-0.0001	0.0023	0.0569	0.0760	0.0855	-0.2539	0.0539	0.0547	0.0196	0.0100	0.0183	0.0106	-0.0419	-0.0059	0.00968
12	0.6099	0.6811	0.5245	0.8260	0.7634	0.9697	0.7914	0.7344	0.6685	0.7700	0.8706	0.7000	0.3183	0.6640	0.76490
13	1.4723	1.4116	1.2650	1.3260	1.5000	1.1277	1.3133	1.4124	1.6332	1.3000	1.2030	1.3280	0.9504	1.4870	1.32700
14	0.0424	0.0445	0.0550	0.0608	0.0401	-0.2831	0.0415	0.0363	0.0146	-0.0400	-0.0112	-0.0476	-0.1295	0.0553	0.01757
15	0.0318	0.0353	0.0470	0.0607	0.0726	-0.2860	0.0378	0.0335	-0.0061	-0.0400	-0.0529	-0.0591	-0.0857	0.0576	0.00263
16	0.7967	0.8466	0.6447	1.0760	0.9208	1.0155	1.0385	0.9287	0.7790	1.0200	1.1430	0.7460	0.6516	0.7315	0.77950
17	1.5451	1.5372	1.3690	1.8800	1.6240	1.3417	1.8122	1.5927	1.5961	1.7700	1.7440	1.5110	1.2940	1.5030	1.50600
18	0.0311	0.0262	0.0537	0.0121	0.0200	-0.2373	0.0103	0.0152	-0.0104	-0.0800	-0.0675	-0.0670	-0.1671	0.0574	-0.01192
19	0.0326	0.0315	0.0545	0.0294	0.0418	-0.2791	0.0247	0.0344	-0.0047	-0.0700	-0.0762	-0.0625	-0.0943	0.0603	0.00094
20	1.2230	1.2099	1.0670	1.3090	1.2890	1.3212	1.2775	1.2603	1.2026	1.2100	1.2370	1.1720	0.7143	1.1770	1.19700
21	1.7569	1.7632	1.6400	1.8390	1.8250	1.7864	1.8080	1.7948	1.7612	1.7600	1.9930	1.9760	1.7920	1.7420	1.86600
22	0.2905	0.2909	0.4165	0.3876	0.3898	0.1515	0.3512	0.3538	0.3529	0.2700	0.5750	0.5662	0.1148	0.2847	0.40690
23	0.1790	0.1793	0.3133	0.2886	0.2828	0.0896	0.2456	0.2444	0.2613	0.1700	0.2119	0.2500	-0.1597	0.1880	0.28630
24	1.5028	1.5079	1.4280	1.5990	1.5960	1.7631	1.5741	1.5715	1.5775	1.5200	1.8410	1.8560	1.1340	1.5360	1.60800
25	1.6141	1.7721	1.2480	1.4410	1.6250	0.6848	1.4690	1.6774	1.4862	1.5800	1.1620	1.3170	0.0175	1.6990	1.75500
26	0.0091	-0.0172	0.0642	0.0984	0.0763	-0.3728	0.0798	0.0688	0.0361	-0.0200	0.1277	0.1023	-0.0024	-0.0023	-0.02993
27	-0.0037	-0.0130	0.1030	0.1149	0.1233	-0.4611	0.1084	0.0939	0.0542	0.0300	0.1333	0.1214	-0.1484	-0.0141	0.00452
28	1.5950	1.4398	1.3750	1.8400	1.6170	1.9254	1.7308	1.5291	1.6957	1.6200	1.8420	1.7270	1.1400	1.5780	1.71100
29	1.7402	1.6718	1.3610	1.5480	1.5210	0.9150	1.6092	1.5570	1.7093	1.7000	1.2960	1.2300	0.1630	1.8070	1.65600
30	-0.0307	-0.0273	0.0519	0.0728	0.0783	-0.4063	0.0547	0.0611	0.0115	-0.0400	0.0163	-0.0036	-0.0225	-0.0246	-0.02724
31	-0.0113	-0.0059	0.0902	0.1067	0.1132	-0.4826	0.0831	0.0915	0.0279	0.0000	0.0276	0.0195	-0.1119	-0.0056	0.01554
32	1.4750	1.5222	1.2990	1.6670	1.6900	1.9413	1.6000	1.6198	1.5179	1.5200	1.6080	1.6680	0.8610	1.5470	1.80300
33	1.5874	1.4690	1.1320	1.3540	1.2690	0.9141	1.4170	1.3277	1.4990	1.4900	1.0070	0.7683	0.2800	1.6220	1.59500
34	-0.0522	-0.0482	-0.0150	0.0408	0.0495	-0.4778	-0.0681	-0.0651	-0.1018	-0.2100	-0.1454	-0.2089	-0.0385	-0.0564	-0.03714
35	-0.0223	-0.0161	0.0124	0.0118	0.0232	-0.5294	-0.0554	-0.0509	-0.1046	-0.1900	-0.1513	-0.1916	-0.1116	-0.0407	-0.02322
36	1.5406	1.5563	1.2910	1.7540	1.6980	1.9123	1.6850	1.6399	1.5214	1.6200	1.4190	1.2630	0.8599	1.4700	1.56500
37	1.9761	1.9588	1.4970	1.7720	1.6890	1.2195	1.8967	1.8303	1.8113	1.9700	0.9001	0.6900	0.7309	1.9330	1.92200
38	-0.1141	-0.1123	-0.0402	-0.0669	-0.0671	-0.3023	-0.1499	-0.1522	-0.1293	-0.3600	-0.0831	0.2211	-0.0361	-0.2070	-0.14360
39	-0.2015	-0.1993	-0.0285	-0.0465	-0.0246	-0.2556	-0.1777	-0.1664	-0.1067	-0.4100	-0.0611	0.3027	-0.1029	-0.1907	-0.08105
40	2.2877	2.2811	1.9740	2.3480	2.3740	2.4779	2.2708	2.3052	2.2438	2.1200	1.6460	1.6190	1.6340	2.5570	2.61800
41	0.7071	0.8729	0.6051	0.9618	1.1170	1.3355	0.8714	1.0309	0.8698	0.7600	0.9194	0.9725	0.0000	0.7975	1.02400
42	-0.2273	-0.2410	-0.1313	-0.0665	-0.0887	-0.6057	-0.1253	-0.1392	-0.1679	-0.2100	-0.0718	-0.1018	0.0000	-0.1817	-0.23460
43	-0.0403	-0.0547	0.0643	0.0911	0.0893	-0.5703	0.0990	0.0829	0.0559	0.0000	0.0535	0.0737	-0.1785	0.0158	-0.02776
44	2.0648	1.9486	1.8240	2.3220	2.1950	2.5133	2.2319	2.1017	2.1827	2.0300	2.1090	2.1890	1.4060	2.2430	2.48400
45	0.9345	0.9006	0.7380	1.0250	1.0060	1.5477	0.9778	0.9434	0.9281	0.8500	0.9220	0.8681	0.0000	0.8394	0.71350
46	-0.4091	-0.4155	-0.2840	-0.2782	-0.2812	-0.5764	-0.3283	-0.3208	-0.3497	-0.4600	-0.4703	-0.4690	0.0000	-0.3821	-0.42160
47	-0.2324	-0.2133	-0.0653	-0.0739	-0.0505	-0.4956	-0.1955	-0.1855	-0.1437	-0.2400	-0.4168	-0.3806	-0.0597	-0.1873	-0.14120
48	2.3450	2.3750	2.0370	2.4960	2.5260	2.9043	2.2111	2.2898	2.3281	2.2200	2.1630	2.3020	1.1700	2.6420	2.77400
49	0.6740	0.7438	0.1164	0.2672	0.2681	1.9716	0.9194	0.9144	0.9523	0.7300	1.0600	1.0800	0.0000	0.0219	0.05596
50	-0.0727	-0.0385	-0.0165	0.0893	0.0961	-0.3768	-0.0240	-0.0128	-0.0233	-0.1100	-0.0275	-0.0272	0.0000	-0.0862	-0.02886
51	0.0721	0.0442	0.0543	0.1244	0.0899	-0.2342	0.1539	0.1188	0.0836	0.0100	0.2071	0.1672	-0.0837	0.0097	-0.01422
52	2.1059	2.0238	0.3254	0.4369	0.4042	2.7310	2.1439	2.0576	2.1165	2.0800	2.3750	2.2930	0.3317	0.6856	0.68530

WINTER CONDITION

PRINCIPAL STRESSES "P2" IN THE DAM BODY [MPa]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-0.0335	-0.0380	-0.0265	-0.0528	-0.0523	0.0742	-0.0319	-0.0355	-0.0321	-0.0200	-0.0274	-0.0598	-0.1248	-0.0139	-0.0244
2	-0.0628	-0.0542	-0.0384	-0.0372	-0.0235	0.1609	0.0189	0.0173	0.0184	-0.0700	-0.1217	-0.0956	-0.1839	-0.0552	-0.0459
3	-0.0563	-0.0399	-0.0406	-0.0361	-0.0171	0.2126	-0.0138	-0.0075	-0.0060	-0.0400	-0.0675	-0.1168	-0.1075	0.0087	0.0078
4	-0.0252	-0.0100	-0.0152	-0.0380	-0.0346	0.1294	-0.0353	-0.0381	-0.0367	-0.0300	-0.0613	-0.0555	-0.1354	-0.0432	-0.0154
5	0.4049	0.5497	0.3270	0.3058	0.5779	0.8346	0.3040	0.5601	0.2682	0.3100	0.2861	0.4677	0.3147	0.4615	0.5186
6	-0.5798	-0.5797	-0.4546	-0.4039	-0.4079	-0.4810	-0.4896	-0.5022	-0.4871	-0.5600	-0.6447	-0.5904	-1.1020	-0.5902	-0.5931
7	-0.5355	-0.6441	-0.4050	-0.4411	-0.5495	-0.4794	-0.5589	-0.5992	-0.5565	-0.5800	-0.5948	-0.6581	-0.7141	-0.5403	-0.6075
8	0.0908	0.0174	0.0416	0.0797	0.0752	0.9227	0.0951	0.0340	0.0462	0.0500	0.1379	0.0339	0.1742	0.0700	0.0005
9	0.7913	0.7374	0.6692	0.8333	0.7711	1.0072	0.8272	0.7586	0.7849	0.8000	0.7598	0.6652	0.1586	0.7793	0.7581
10	-0.3684	-0.3554	-0.2549	-0.2989	-0.2080	-0.4352	-0.3579	-0.3234	-0.2022	-0.4100	-0.3397	-0.3518	-0.7604	-0.3384	-0.3689
11	-0.6073	-0.5678	-0.4783	-0.4283	-0.4636	-0.5195	-0.4829	-0.5161	-0.4818	-0.5200	-0.4999	-0.5603	-0.7862	-0.5641	-0.5159
12	0.0103	0.0102	0.0442	0.0769	0.0772	0.8883	0.0399	0.0393	0.0404	0.0000	0.0309	0.0131	0.1968	0.0188	0.0006
13	1.1225	1.0719	0.9501	1.1810	1.1460	1.0624	1.1291	1.1100	1.1093	1.0600	0.9810	0.9277	0.4346	1.0950	1.2070
14	-0.3592	-0.3298	-0.2461	-0.2771	-0.2061	-0.4643	-0.3294	-0.2787	-0.2548	-0.3900	-0.2461	-0.3499	-0.5154	-0.3228	-0.2165
15	-0.5210	-0.4859	-0.4053	-0.2973	-0.3782	-0.5071	-0.3931	-0.4294	-0.4788	-0.4400	-0.4040	-0.4818	-0.6550	-0.5133	-0.4217
16	0.0265	0.0268	0.0643	0.1193	0.1192	0.8079	0.0672	0.0677	0.0648	0.0100	-0.0289	-0.0510	0.1636	-0.0898	0.0011
17	1.0921	1.0913	0.9478	1.1630	1.1570	1.0837	1.1253	1.1264	1.0562	1.0900	1.0400	1.0520	0.7818	1.0400	1.2660
18	-0.2331	-0.2224	-0.1153	-0.1588	-0.1348	-0.3067	-0.2153	-0.2035	-0.2149	-0.3100	-0.1670	-0.1306	-0.3132	-0.2629	-0.0697
19	-0.2916	-0.2939	-0.1582	-0.1535	-0.1496	-0.3095	-0.2742	-0.2701	-0.2879	-0.3500	-0.3252	-0.2242	-0.6001	-0.3167	-0.1664
20	0.0171	0.0178	0.0677	0.1154	0.1175	0.9290	0.0653	0.0655	0.0646	0.0000	-0.0412	-0.0142	0.1402	-0.1041	-0.0027
21	1.3967	1.3722	1.2110	1.6660	1.4320	1.1948	1.6302	1.4374	1.4782	1.5800	1.6300	1.4040	1.0100	1.4050	1.4240
22	-0.0822	-0.0835	0.0224	-0.0432	-0.0259	-0.3053	0.0092	0.0106	-0.0214	0.0100	0.1310	0.1320	-0.1569	-0.0131	-0.0208
23	-0.0338	-0.0338	0.0462	0.0759	0.0801	-0.3250	0.0406	0.0450	0.0129	0.0200	0.0940	0.1074	-0.3366	0.0332	0.0292
24	-0.0575	-0.0570	0.0346	0.0297	0.0369	0.7254	0.0159	0.0187	0.0187	-0.0300	0.1380	0.1536	0.0389	-0.0441	-0.0375
25	0.3624	0.5092	0.1625	0.0197	0.2486	0.1604	0.2035	0.3980	0.1192	0.3200	0.0543	0.1850	0.4488	0.4393	0.4231
26	-0.8154	-0.8934	-0.7180	-0.6795	-0.6489	-0.7495	-0.8167	-0.7903	-0.7949	-0.9000	-0.6731	-0.7105	-1.7440	-0.9263	-0.9377
27	-0.9504	-0.9968	-0.7317	-0.6790	-0.7692	-0.8683	-0.8340	-0.8913	-0.8299	-0.9300	-0.9505	-0.9792	-1.1280	-0.9268	-0.8503
28	0.2672	0.0192	0.1636	0.3129	0.1274	1.8679	0.4394	0.0693	0.3589	0.3200	0.4037	0.0996	0.2662	0.1702	0.0081
29	0.6511	0.5760	0.4305	0.4127	0.3374	0.2103	0.5372	0.4781	0.4819	0.6300	0.3443	0.2375	0.4152	0.5786	0.5420
30	-0.8514	-0.8426	-0.6637	-0.6524	-0.6116	-0.6612	-0.7735	-0.7482	-0.7077	-0.8800	-0.6558	-0.6514	-1.5310	-0.8561	-0.8179
31	-0.9393	-0.9223	-0.7001	-0.6916	-0.6900	-0.8646	-0.8130	-0.8111	-0.8254	-0.9100	-0.8413	-0.8295	-1.2460	-0.9120	-0.7444
32	0.0336	0.2174	0.0889	0.1501	0.2008	1.6683	0.0989	0.3060	0.0779	0.0200	0.1133	0.3132	0.3065	0.0422	0.2169
33	0.8941	0.8902	0.6525	0.7606	0.7798	0.4671	0.8092	0.8212	0.7638	0.8800	0.5383	0.3302	0.2509	0.8782	1.0100
34	-0.9612	-0.9594	-0.7399	-0.8227	-0.8261	-0.7620	-0.8824	-0.8817	-0.9101	-0.9700	-0.7051	-0.3006	-1.2090	-0.9658	-0.6324
35	-0.9144	-0.9064	-0.6801	-0.6807	-0.7186	-0.8441	-0.8082	-0.8307	-0.8744	-0.8900	-0.7039	-0.3949	-1.1390	-0.9313	-0.7121
36	0.0149	0.0148	0.1011	0.1963	0.1964	1.3203	0.1132	0.1130	0.1101	0.0100	-0.0841	-0.1476	0.2824	-0.1009	-0.0059
37	1.1348	1.1191	0.8062	1.0370	1.0100	0.5442	1.0736	1.0524	0.9640	1.1400	0.3089	0.1993	0.6572	1.1200	1.4460
38	-0.2875	-0.2941	-0.1687	-0.2108	-0.1917	-0.5877	-0.3342	-0.3224	-0.3242	-0.4700	-0.3695	-0.4257	-0.8952	-0.3288	-0.2310
39	-0.2985	-0.3033	-0.0461	-0.0835	-0.0610	-0.6349	-0.2966	-0.2681	-0.3285	-0.4600	-0.5650	-0.6055	-0.4785	-0.3227	-0.1749
40	0.7076	0.7347	0.5062	0.5830	0.8601	1.4325	0.6870	0.8344	0.6964	0.6000	-0.0687	0.1027	0.0117	0.7354	0.5967
41	0.6859	0.7599	0.5521	0.8131	0.9205	1.0072	0.8332	0.8896	0.8200	0.7300	0.8067	0.8170	-0.2817	0.6372	0.4777
42	-1.1225	-1.1159	-0.8868	-0.9062	-0.9066	-0.9384	-0.9500	-0.9737	-0.9524	-1.0700	-0.9676	-0.9106	-1.8220	-1.1040	-1.0930
43	-0.9231	-0.9752	-0.6531	-0.6252	-0.7032	-0.9040	-0.7762	-0.8501	-0.7720	-0.9200	-0.9175	-1.0060	-1.2090	-0.8639	-0.6970
44	1.0079	0.7002	0.8513	1.2080	0.7477	2.2423	1.1868	0.7835	1.0811	1.0600	0.9561	0.5452	0.3065	0.8505	0.4365
45	0.3683	0.3102	0.1755	0.3536	0.2700	1.2487	0.6212	0.6377	0.4829	0.3700	0.1957	0.1002	0.0006	0.4011	0.3904
46	-0.7969	-0.8088	-0.6829	-0.6911	-0.6933	-0.7578	-0.8762	-0.8528	-0.7895	-0.9100	-0.7545	-0.6786	-1.7030	-0.8319	-0.8026
47	-0.6710	-0.6524	-0.4269	-0.3923	-0.3773	-0.6115	-0.7094	-0.6689	-0.6146	-0.7700	-0.4986	-0.5093	-0.8054	-0.5673	-0.4769
48	0.3322	0.4920	0.2896	0.3640	0.5636	1.5506	1.0447	1.3099	0.3485	0.4000	0.0899	0.2921	0.1282	0.5949	0.7479
49	0.2763	0.3404	0.0736	0.0746	0.0883	1.5998	0.4546	0.4657	0.5136	0.0800	0.5199	0.6143	-0.8093	-0.1050	0.0120
50	-0.7820	-0.7864	-0.3488	-0.3678	-0.3842	-0.7423	-0.6682	-0.6901	-0.7044	-0.7700	-0.5816	-0.6416	-1.3660	-0.5810	-0.5787
51	-0.3828	-0.3931	-0.1782	-0.1287	-0.1482	-0.2850	-0.2475	-0.2644	-0.2091	-0.3900	-0.1276	-0.1268	-0.8520	-0.1282	-0.0587
52	0.3197	0.3090	-0.0863	-0.0951	-0.1253	1.4989	0.3387	0.3282	0.3289	0.2100	0.4311	0.3435	-0.7221	-0.1922	-0.2254

WINTER CONDITION

PRINCIPAL STRESSES "P3" IN THE DAM BODY
[MPa]

Node	P01_f	P01	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-1.3647	-1.0063	-1.2000	-1.3160	-0.9862	0.0554	-1.1197	-0.9010	-1.1476	-1.1300	-1.3340	-1.1730	-1.3110	-1.2060	-1.0290
2	-1.2320	-0.8434	-1.1000	-1.0670	-0.8560	0.1384	-0.9127	-0.8064	-0.9892	-0.9800	-1.0870	-0.9750	-1.1280	-1.0810	-0.9638
3	-0.9854	-0.7835	-0.8794	-0.8120	-0.7242	0.1586	-0.6450	-0.6558	-0.7646	-0.6900	-0.8303	-0.7745	-0.8263	-0.8396	-0.8186
4	-0.7203	-0.5989	-0.6223	-0.5631	-0.6010	0.0788	-0.3716	-0.4987	-0.5376	-0.3800	-0.5714	-0.7653	-0.5380	-0.5989	-0.6323
5	-0.0153	-0.0139	0.0224	0.0964	0.0518	0.5525	0.0112	0.0082	0.0057	-0.0300	0.0188	0.0009	-0.3308	0.0009	-0.0176
6	-0.6920	-0.6699	-0.5696	-0.6736	-0.6103	-0.5510	-0.7447	-0.6336	-0.7438	-0.7700	-0.8082	-0.6721	-1.1340	-0.6596	-0.6708
7	-0.9036	-0.9872	-0.7797	-0.8099	-0.9024	-0.5239	-0.8461	-0.9214	-0.8545	-0.9000	-0.8023	-0.9515	-1.4760	-0.9343	-0.9695
8	0.0140	-0.0768	0.0052	0.1378	-0.0274	0.5723	0.0324	-0.0431	0.0253	-0.0100	0.0423	0.0037	-0.4776	0.0438	-0.0361
9	-0.0117	-0.0131	0.0217	0.0426	0.0473	0.5655	0.0107	0.0121	0.0147	-0.0200	-0.0168	-0.0153	0.2370	-0.0128	-0.0184
10	-0.6739	-0.6946	-0.5456	-0.5464	-0.5950	-0.4942	-0.5977	-0.6388	-0.6504	-0.6400	-0.6314	-0.6768	-1.1240	-0.6626	-0.6794
11	-1.1136	-1.0587	-0.9711	-1.0070	-0.9628	-0.5551	-1.0343	-0.9966	-1.0772	-1.0900	-1.1110	-1.0080	-1.5730	-1.1130	-1.0470
12	-0.3148	-0.1843	-0.3422	-0.1836	-0.1210	0.5890	-0.2051	-0.1357	-0.3459	-0.2500	-0.1025	-0.1058	-0.7675	-0.3281	-0.1434
13	0.0055	0.0055	0.0391	0.0780	0.0780	0.5763	0.0329	0.0343	0.0318	-0.0200	-0.0313	-0.0391	0.2765	-0.1067	-0.0189
14	-0.6472	-0.6990	-0.5397	-0.5446	-0.5820	-0.4927	-0.6454	-0.6897	-0.6588	-0.6900	-0.5983	-0.7157	-1.1070	-0.6716	-0.6896
15	-1.3533	-1.3167	-1.2460	-1.1770	-1.2500	-0.6460	-1.2426	-1.2916	-1.4355	-1.3000	-1.2680	-1.3180	-1.6700	-1.3720	-1.2630
16	-0.6743	-0.5491	-0.7392	-0.3547	-0.5117	0.6024	-0.4158	-0.4983	-0.8972	-0.4800	-0.2261	-0.5857	-0.9667	-0.7435	-0.4531
17	0.0020	0.0022	0.0379	0.0763	0.0751	0.5915	0.0296	0.0298	0.0278	-0.0300	-0.0564	-0.0445	0.2242	-0.1196	-0.0249
18	-0.4983	-0.5269	-0.3468	-0.2756	-0.3606	-0.5235	-0.3942	-0.4478	-0.4581	-0.4400	-0.4326	-0.4674	-0.9728	-0.5027	-0.5219
19	-1.0118	-1.0526	-0.8472	-1.1040	-0.9460	-0.6236	-1.1336	-0.9773	-1.0114	-1.2200	-1.2920	-0.9655	-1.8240	-1.0620	-1.0960
20	-0.1138	-0.1687	-0.1374	-0.5036	-0.0703	0.6277	-0.4861	-0.0848	-0.2061	-0.5700	-0.8314	-0.0493	-1.2800	-0.2281	-0.2308
21	-0.0379	-0.0376	0.0205	0.0447	0.0455	0.6041	0.0070	0.0081	0.0085	-0.0600	0.1251	0.1336	0.3388	-0.0275	-0.0192
22	-0.6387	-0.6494	-0.4957	-0.3856	-0.4973	-0.5695	-0.5158	-0.5983	-0.5577	-0.5500	-0.3694	-0.5295	-0.9960	-0.6274	-0.6473
23	-1.2709	-1.2822	-1.1290	-1.2290	-1.1850	-0.8119	-1.2893	-1.2498	-1.2413	-1.3400	-1.4870	-1.3980	-1.8970	-1.2940	-1.3280
24	-0.5212	-0.5345	-0.5032	-0.6636	-0.4465	0.6496	-0.6557	-0.4703	-0.5495	-0.6700	-0.6174	-0.2811	-1.3470	-0.5167	-0.5549
25	-0.0839	-0.0790	-0.1267	-0.1431	-0.1879	-0.0444	-0.1728	-0.1750	-0.1847	-0.1200	-0.0434	-0.0568	-0.4711	-0.0758	-0.0772
26	-1.1327	-1.0778	-0.9602	-0.9776	-0.9094	-1.2179	-1.0478	-0.9737	-1.0625	-1.1400	-1.0890	-0.8858	-1.9110	-1.0820	-1.0590
27	-1.5119	-1.6447	-1.2610	-1.3040	-1.4650	-1.0179	-1.3571	-1.5285	-1.3571	-1.4600	-1.4060	-1.5810	-2.4510	-1.5530	-1.6420
28	0.0068	-0.0366	0.0792	0.2906	0.1107	1.1425	0.0544	0.0513	0.0535	-0.0300	0.0884	0.0423	-0.5788	0.0722	-0.0094
29	-0.0751	-0.0763	-0.1166	-0.1953	-0.1836	0.1642	-0.1637	-0.1633	-0.1749	-0.1000	-0.0849	-0.1016	0.1290	-0.0788	-0.0796
30	-1.0685	-1.0947	-0.8578	-0.8911	-0.9277	-1.1026	-0.9692	-1.0049	-0.8933	-1.0500	-0.9820	-0.9771	-1.8990	-1.0730	-1.1160
31	-1.6251	-1.5389	-1.3810	-1.4590	-1.3620	-1.0606	-1.5426	-1.4414	-1.5789	-1.6300	-1.5470	-1.4640	-2.5410	-1.6060	-1.5650
32	0.0092	0.0115	-0.0606	0.1660	0.3080	1.1490	0.0754	0.0762	-0.0761	-0.0100	0.0308	0.0408	-0.9908	0.0301	0.0072
33	-0.0427	-0.0423	-0.0841	-0.1637	-0.1646	0.1692	-0.1206	-0.1200	-0.1439	-0.0900	-0.1939	-0.2784	0.4864	-0.1006	-0.0742
34	-1.2677	-1.3132	-1.0860	-1.0770	-1.1470	-0.9249	-1.1936	-1.2555	-1.2308	-1.2800	-1.0290	-1.1410	-2.1900	-1.2870	-1.4170
35	-2.1501	-2.1107	-1.9020	-1.9360	-1.9650	-1.2025	-2.0228	-2.0377	-2.2196	-2.0900	-1.8550	-1.9610	-2.8940	-2.1590	-2.1770
36	-0.7032	-0.5717	-0.7524	-0.4588	-0.4495	1.1261	-0.5278	-0.4885	-0.9624	-0.5800	-0.4197	-0.5462	-1.4090	-0.7379	-0.6497
37	-0.0870	-0.0793	-0.1010	-0.1958	-0.1912	0.1612	-0.1708	-0.1684	-0.1869	-0.0800	-0.4120	-0.5321	0.4707	-0.0463	-0.0561
38	-1.0386	-1.0671	-0.8051	-0.8896	-0.9289	-0.8979	-1.0299	-1.0478	-1.0777	-1.0900	-0.9105	-0.7781	-1.7690	-1.0600	-0.8423
39	-1.3688	-1.3667	-1.0180	-1.2120	-1.1250	-1.0182	-1.3602	-1.2874	-1.3312	-1.4800	-1.3530	-1.1520	-2.4100	-1.5010	-1.3920
40	-0.1996	-0.2031	0.0451	0.2976	0.1958	1.0886	-0.0592	-0.0638	-0.0784	-0.0600	-0.4215	-0.4674	-0.7426	-0.1852	-0.1018
41	-0.2823	-0.2788	-0.1508	-0.0280	-0.0539	0.4592	-0.1607	-0.1610	-0.1574	-0.2900	-0.2112	-0.2604	-0.9652	-0.2643	-0.2770
42	-1.4723	-1.4244	-1.2190	-1.2490	-1.2340	-1.0677	-1.2967	-1.2864	-1.2506	-1.3800	-1.2370	-1.2770	-2.9940	-1.4260	-1.3320
43	-1.6259	-1.7489	-1.3190	-1.3700	-1.5470	-1.0273	-1.4485	-1.6424	-1.4593	-1.5500	-1.5120	-1.7240	-3.1040	-1.6700	-1.8110
44	-0.0020	-0.0042	0.1391	0.2872	0.3577	1.3870	0.1158	0.1123	0.1133	-0.0100	0.0707	0.0987	-0.5328	0.0697	0.0466
45	-0.3969	-0.3929	-0.2245	-0.0374	-0.0149	0.5467	-0.1569	-0.1592	-0.3168	-0.3500	-0.5342	-0.5512	-1.1640	-0.2821	-0.3062
46	-1.4020	-1.4079	-1.2150	-1.3330	-1.3290	-0.9061	-1.4011	-1.3157	-1.3373	-1.4400	-1.1820	-1.1680	-2.9350	-1.4480	-1.4230
47	-1.6034	-1.5295	-1.2950	-1.4070	-1.3150	-1.3048	-1.5643	-1.3851	-1.5419	-1.6100	-1.3900	-1.3340	-2.9200	-1.5630	-1.5120
48	-0.1410	-0.1319	0.0183	0.3692	0.3495	1.2004	0.1892	0.1941	-0.0218	-0.0700	-0.2447	-0.1681	-1.2940	0.0704	0.0619
49	-1.1779	-0.8838	-0.5345	-0.4756	-0.4274	1.0699	-0.6342	-0.5822	-0.4281	-0.8100	-0.1305	-0.0444	-2.2410	-0.7516	-0.4622
50	-0.9865	-1.0381	-0.8609	-0.7906	-0.8444	-0.8183	-0.8282	-0.9012	-0.8246	-0.9100	-1.2360	-1.3420	-2.7030	-0.9630	-0.9690
51	-1.3414	-1.3681	-1.0590	-1.0210	-1.0830	-1.0387	-1.1405	-1.1948	-1.1116	-1.2100	-1.1320	-1.2760	-2.7860	-0.9662	-1.0150
52	-1.4575	-1.8368	-0.9559	-1.1710	-1.3740	0.9382	-1.4250	-1.8369	-1.5050	-1.4000	-0.5352	-1.0320	-2.4910	-0.9677	-1.2060

Tables for summer condition

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DX" ACROSS JOINT 1 [m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	1.59E-4	-1.86E-6	0.00E+0	-2.46E-3	0.00E+0	0.00E+0	-5.76E-3	0.00E+0	0.00E+0	0.00E+0	3.29E-4	4.62E-6	1.23E-4
2	1.64E-4	1.60E-6	0.00E+0	-2.45E-3	0.00E+0	0.00E+0	-5.74E-3	2.00E-5	1.00E-4	0.00E+0	5.10E-4	1.99E-5	1.37E-4
3	1.67E-4	1.08E-6	0.00E+0	-2.44E-3	0.00E+0	1.00E-6	-5.75E-3	0.00E+0	2.00E-4	0.00E+0	4.99E-4	1.09E-5	1.07E-4
4	1.68E-4	2.53E-6	0.00E+0	-2.43E-3	0.00E+0	0.00E+0	-5.76E-3	0.00E+0	2.00E-4	0.00E+0	4.81E-4	5.81E-6	9.97E-5
5	-1.27E-5	-7.90E-6	0.00E+0	-1.90E-3	0.00E+0	0.00E+0	-4.52E-3	0.00E+0	1.00E-4	0.00E+0	3.00E-4	7.40E-6	1.40E-5
6	-1.20E-5	-9.00E-6	0.00E+0	-1.90E-3	0.00E+0	0.00E+0	-4.50E-3	0.00E+0	2.00E-4	0.00E+0	3.30E-5	1.10E-5	1.50E-5
7	-1.17E-5	-4.90E-6	0.00E+0	-1.90E-3	0.00E+0	1.00E-6	-4.48E-3	0.00E+0	1.00E-4	0.00E+0	3.50E-5	2.00E-6	-8.00E-6
8	-5.03E-6	3.70E-6	0.00E+0	-1.90E-3	0.00E+0	0.00E+0	-4.45E-3	0.00E+0	3.00E-4	0.00E+0	3.30E-5	1.32E-5	-5.00E-6
9	-8.91E-5	-5.44E-5	-2.80E-5	-8.66E-4	0.00E+0	0.00E+0	-2.64E-3	0.00E+0	1.00E-4	0.00E+0	5.94E-4	2.03E-5	-3.00E-5
10	-8.17E-5	-4.73E-5	-2.70E-5	-8.34E-4	0.00E+0	0.00E+0	-2.59E-3	0.00E+0	2.00E-4	0.00E+0	4.85E-4	2.15E-5	-3.00E-5
11	-7.91E-5	-3.55E-5	-3.40E-5	-8.24E-4	0.00E+0	1.00E-6	-2.59E-3	0.00E+0	2.00E-4	0.00E+0	4.97E-4	1.91E-5	-4.10E-5
12	-8.22E-5	-3.15E-5	-4.00E-5	-8.10E-4	0.00E+0	0.00E+0	-2.58E-3	0.00E+0	3.00E-4	0.00E+0	5.03E-4	1.26E-5	-4.80E-5
13	-1.49E-4	-6.27E-5	-5.50E-5	2.48E-4	0.00E+0	1.00E-6	-7.06E-4	0.00E+0	1.00E-4	0.00E+0	1.12E-3	4.30E-6	-6.00E-5
14	-1.46E-4	-6.59E-5	-6.10E-5	2.61E-4	0.00E+0	1.00E-6	-5.89E-4	1.00E-5	2.00E-4	0.00E+0	1.13E-3	6.80E-6	-6.50E-5
15	-1.47E-4	-8.67E-5	-7.30E-5	2.50E-4	0.00E+0	1.00E-6	-7.04E-4	1.00E-5	2.00E-4	0.00E+0	1.14E-3	4.90E-6	-7.30E-5
16	-1.51E-4	-1.07E-4	-8.50E-5	2.44E-4	0.00E+0	0.00E+0	-7.12E-4	0.00E+0	2.00E-4	0.00E+0	1.67E-3	2.50E-6	-8.20E-5
17	-2.09E-4	-1.21E-4	-2.70E-5	1.14E-3	0.00E+0	1.00E-6	6.48E-4	0.00E+0	1.00E-4	0.00E+0	1.62E-3	3.40E-6	-1.33E-4
18	-2.11E-4	-1.21E-4	-5.40E-5	1.14E-3	0.00E+0	1.00E-6	6.55E-4	0.00E+0	2.00E-4	0.00E+0	1.62E-3	5.80E-6	-1.36E-4
19	-2.23E-4	-1.22E-4	-1.35E-4	1.12E-3	0.00E+0	1.00E-6	6.33E-4	0.00E+0	2.00E-4	0.00E+0	1.62E-3	3.30E-6	-1.37E-4
20	-2.37E-4	-1.37E-4	-1.46E-4	1.10E-3	0.00E+0	1.00E-6	6.05E-4	0.00E+0	3.00E-4	0.00E+0	2.15E-3	-2.00E-7	-1.29E-4
21	-2.26E-4	-2.47E-4	1.31E-4	1.54E-3	0.00E+0	0.00E+0	1.30E-3	6.60E-4	2.00E-4	0.00E+0	1.76E-3	2.40E-6	-2.57E-4
22	-2.35E-4	-2.46E-4	1.25E-4	1.53E-3	0.00E+0	0.00E+0	1.29E-3	6.70E-4	2.00E-4	0.00E+0	1.75E-3	5.50E-6	-2.66E-4
23	-2.62E-4	-2.40E-4	1.10E-4	1.51E-3	0.00E+0	1.00E-6	1.27E-3	6.10E-4	1.00E-4	0.00E+0	1.73E-3	4.50E-6	-2.83E-4
24	-2.97E-4	-2.41E-4	9.70E-5	1.48E-3	0.00E+0	1.00E-6	1.23E-3	6.10E-4	3.00E-4	0.00E+0	2.39E-3	1.00E-7	-3.07E-4
25	-1.79E-4	-3.28E-4	1.54E-4	1.47E-3	0.00E+0	0.00E+0	1.35E-3	1.45E-3	2.00E-4	0.00E+0	1.50E-3	3.90E-6	-3.02E-4
26	-1.85E-4	-3.23E-4	1.57E-4	1.46E-3	0.00E+0	1.00E-6	1.35E-3	1.41E-3	2.00E-4	0.00E+0	1.50E-3	7.70E-6	-3.16E-4
27	-2.11E-4	-3.19E-4	1.51E-4	1.43E-3	0.00E+0	1.00E-6	1.33E-3	1.23E-3	2.00E-4	0.00E+0	1.49E-3	3.80E-6	-3.32E-4
28	-2.40E-4	-3.02E-4	1.48E-4	1.41E-3	0.00E+0	1.00E-6	1.30E-3	1.34E-3	3.00E-4	0.00E+0	2.23E-3	5.70E-6	-3.48E-4
29	-1.09E-4	-3.03E-4	9.70E-5	1.06E-3	1.00E-6	0.00E+0	1.03E-3	1.24E-3	1.00E-4	0.00E+0	9.96E-4	9.00E-7	-2.05E-4
30	-1.04E-4	-2.96E-4	1.16E-4	1.07E-3	0.00E+0	1.00E-6	1.04E-3	1.25E-3	1.00E-4	0.00E+0	1.00E-3	1.01E-5	-2.39E-4
31	-1.10E-4	-2.84E-4	1.35E-4	1.07E-3	0.00E+0	1.00E-6	1.04E-3	1.22E-3	2.00E-4	0.00E+0	9.70E-4	1.67E-5	-2.68E-4
32	-1.47E-4	-2.59E-4	1.44E-4	1.04E-3	0.00E+0	1.00E-6	1.02E-3	1.25E-3	3.00E-4	0.00E+0	1.88E-3	1.10E-5	-3.02E-4
33	-4.42E-5	-1.75E-4	2.60E-5	5.16E-4	0.00E+0	1.00E-6	5.68E-4	9.50E-4	1.00E-4	0.00E+0	4.05E-4	2.34E-5	-2.21E-4
34	-1.51E-5	-1.56E-4	5.90E-5	5.34E-4	0.00E+0	1.00E-6	5.84E-4	9.70E-4	2.00E-4	0.00E+0	4.66E-4	2.81E-5	-1.38E-5
35	9.33E-7	-1.72E-4	9.90E-5	5.45E-4	0.00E+0	1.00E-6	6.02E-4	8.30E-4	2.00E-4	0.00E+0	5.70E-4	2.31E-5	-2.00E-5
36	2.66E-6	-1.36E-4	1.41E-4	5.81E-4	-1.00E-6	1.00E-6	6.92E-4	9.00E-4	4.00E-4	0.00E+0	1.29E-3	3.87E-5	-2.11E-5
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DX" ACROSS JOINT 2
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	9.48E-5	-4.00E-6	0.00E+0	1.32E-2	0.00E+0	0.00E+0	1.34E-2	1.00E-5	1.00E-4	0.00E+0	1.21E-2	5.00E-6	-1.00E-5
2	9.99E-5	1.00E-6	0.00E+0	1.32E-2	0.00E+0	1.00E-6	1.34E-2	0.00E+0	1.00E-4	0.00E+0	1.21E-2	1.14E-2	0.00E+0
3	1.03E-4	2.00E-6	0.00E+0	1.32E-2	0.00E+0	0.00E+0	1.34E-2	0.00E+0	1.00E-4	0.00E+0	1.21E-2	1.00E-5	0.00E+0
4	1.04E-4	1.00E-6	0.00E+0	1.32E-2	0.00E+0	0.00E+0	1.34E-2	0.00E+0	1.00E-4	0.00E+0	1.22E-2	7.00E-6	1.00E-5
5	2.75E-5	-2.00E-5	0.00E+0	1.20E-2	0.00E+0	0.00E+0	1.22E-2	0.00E+0	1.00E-4	0.00E+0	1.12E-2	8.00E-6	-3.00E-5
6	2.70E-5	-1.50E-5	0.00E+0	1.20E-2	0.00E+0	0.00E+0	1.22E-2	0.00E+0	1.00E-4	0.00E+0	1.12E-2	6.00E-6	-3.00E-5
7	2.32E-5	-6.00E-6	0.00E+0	1.20E-2	0.00E+0	0.00E+0	1.22E-2	0.00E+0	1.00E-4	0.00E+0	1.12E-2	3.00E-6	-2.00E-5
8	2.02E-5	2.00E-6	0.00E+0	1.20E-2	0.00E+0	0.00E+0	1.22E-2	0.00E+0	1.00E-4	0.00E+0	1.13E-2	0.00E+0	-2.00E-5
9	3.74E-5	-2.10E-5	0.00E+0	1.11E-2	0.00E+0	0.00E+0	1.12E-2	0.00E+0	1.00E-4	0.00E+0	1.04E-2	8.00E-6	-3.00E-5
10	3.45E-5	-1.90E-5	0.00E+0	1.11E-2	0.00E+0	0.00E+0	1.12E-2	0.00E+0	1.00E-4	0.00E+0	1.04E-2	7.00E-6	-3.00E-5
11	2.53E-5	-1.40E-5	0.00E+0	1.10E-2	0.00E+0	1.00E-6	1.12E-2	0.00E+0	1.00E-4	0.00E+0	1.04E-2	5.00E-6	-3.00E-5
12	1.83E-5	1.00E-6	0.00E+0	1.10E-2	0.00E+0	0.00E+0	1.12E-2	0.00E+0	1.00E-4	0.00E+0	1.05E-2	2.00E-6	-4.00E-5
13	6.01E-5	-1.40E-5	0.00E+0	1.01E-2	0.00E+0	0.00E+0	1.02E-2	0.00E+0	1.00E-4	0.00E+0	9.57E-3	6.00E-6	-4.00E-5
14	5.83E-5	-1.50E-5	0.00E+0	1.01E-2	0.00E+0	0.00E+0	1.02E-2	0.00E+0	1.00E-4	0.00E+0	9.57E-3	7.00E-6	-4.00E-5
15	4.49E-5	-1.60E-5	0.00E+0	1.01E-2	0.00E+0	1.00E-6	1.02E-2	0.00E+0	1.00E-4	0.00E+0	9.54E-3	5.00E-6	-5.00E-5
16	3.41E-5	-6.00E-6	0.00E+0	1.01E-2	0.00E+0	1.00E-6	1.02E-2	0.00E+0	1.00E-4	0.00E+0	9.69E-3	0.00E+0	-4.00E-5
17	6.12E-5	-5.00E-6	3.00E-5	9.05E-3	0.00E+0	0.00E+0	9.10E-3	0.00E+0	1.00E-4	0.00E+0	8.55E-3	6.00E-6	-8.00E-5
18	5.72E-5	-7.00E-6	1.00E-5	9.03E-3	0.00E+0	0.00E+0	9.09E-3	0.00E+0	1.00E-4	0.00E+0	8.55E-3	6.00E-6	-8.00E-5
19	4.45E-5	-1.60E-5	0.00E+0	9.01E-3	0.00E+0	0.00E+0	9.07E-3	0.00E+0	1.00E-4	0.00E+0	8.52E-3	3.00E-6	-9.00E-5
20	3.13E-5	-3.30E-5	0.00E+0	9.00E-3	0.00E+0	0.00E+0	9.04E-3	0.00E+0	1.00E-4	0.00E+0	8.69E-3	0.00E+0	-9.00E-5
21	4.12E-5	-1.70E-5	1.00E-5	7.83E-3	0.00E+0	0.00E+0	7.83E-3	0.00E+0	1.00E-4	0.00E+0	7.35E-3	5.00E-6	-1.49E-4
22	3.74E-5	-1.80E-5	0.00E+0	7.82E-3	0.00E+0	0.00E+0	7.82E-3	0.00E+0	1.00E-4	0.00E+0	7.35E-3	6.00E-6	-1.49E-4
23	2.36E-5	-1.90E-5	-1.00E-5	7.80E-3	0.00E+0	0.00E+0	7.80E-3	0.00E+0	1.00E-4	0.00E+0	7.33E-3	4.00E-6	-1.50E-4
24	8.93E-6	-2.60E-5	-2.00E-5	7.79E-3	0.00E+0	1.00E-6	7.78E-3	0.00E+0	1.00E-4	0.00E+0	7.54E-3	-1.00E-6	-1.40E-4
25	9.54E-6	-5.94E-5	-3.00E-5	6.50E-3	0.00E+0	0.00E+0	6.46E-3	0.00E+0	1.00E-4	0.00E+0	6.03E-3	4.00E-6	-2.23E-4
26	8.25E-6	-5.80E-5	-3.00E-5	6.49E-3	0.00E+0	0.00E+0	6.45E-3	0.00E+0	1.00E-4	0.00E+0	6.04E-3	5.00E-6	-2.20E-4
27	-4.59E-6	-5.50E-5	-5.00E-5	6.48E-3	0.00E+0	0.00E+0	6.44E-3	0.00E+0	1.00E-4	0.00E+0	6.02E-3	3.00E-6	-2.29E-4
28	-1.86E-5	-4.90E-5	-6.00E-5	6.47E-3	0.00E+0	0.00E+0	6.43E-3	0.00E+0	1.00E-4	0.00E+0	6.26E-3	0.00E+0	-2.40E-4
29	-2.62E-5	-9.87E-5	-7.00E-5	5.11E-3	0.00E+0	0.00E+0	5.06E-3	0.00E+0	1.00E-4	0.00E+0	4.69E-3	4.00E-6	-2.73E-4
30	-2.31E-5	-9.60E-5	-7.10E-5	5.11E-3	0.00E+0	1.00E-6	5.05E-3	0.00E+0	0.00E+0	0.00E+0	4.68E-3	5.10E-6	-2.66E-4
31	-2.98E-5	-9.15E-5	-7.90E-5	5.09E-3	0.00E+0	1.00E-6	5.05E-3	0.00E+0	1.00E-4	0.00E+0	4.68E-3	5.00E-6	-2.81E-4
32	-4.67E-5	-8.09E-5	-9.90E-5	5.09E-3	0.00E+0	0.00E+0	5.04E-3	0.00E+0	1.00E-4	0.00E+0	4.95E-3	2.30E-6	-3.15E-4
33	-5.34E-5	-1.12E-4	-8.60E-5	3.76E-3	2.00E-6	0.00E+0	3.71E-3	1.00E-5	1.00E-4	0.00E+0	3.38E-3	2.60E-6	-2.59E-4
34	-4.55E-5	-1.06E-4	-8.20E-5	3.75E-3	1.10E-5	0.00E+0	3.70E-3	0.00E+0	1.00E-4	0.00E+0	3.38E-3	6.30E-6	-2.50E-4
35	-4.68E-5	-9.58E-5	-8.30E-5	3.75E-3	2.20E-5	0.00E+0	3.70E-3	0.00E+0	1.00E-4	0.00E+0	3.38E-3	6.40E-6	-2.57E-4
36	-5.23E-5	-5.60E-5	-9.60E-5	3.76E-3	3.00E-6	0.00E+0	3.71E-3	0.00E+0	1.00E-4	0.00E+0	3.68E-3	4.80E-6	-2.75E-4
37	-5.71E-5	-9.73E-5	-7.60E-5	2.51E-3	0.00E+0	0.00E+0	2.47E-3	0.00E+0	1.00E-4	0.00E+0	2.20E-3	1.90E-6	-2.08E-4
38	-4.10E-5	-8.86E-5	-6.80E-5	2.51E-3	0.00E+0	0.00E+0	2.47E-3	0.00E+0	1.00E-4	0.00E+0	2.20E-3	5.80E-6	-1.89E-4
39	-3.66E-5	-7.55E-5	-5.30E-5	2.52E-3	0.00E+0	1.00E-6	2.48E-3	0.00E+0	1.00E-4	0.00E+0	2.21E-3	1.04E-5	-1.77E-4
40	-3.95E-5	-3.81E-5	-5.40E-5	2.53E-3	0.00E+0	0.00E+0	2.50E-3	0.00E+0	1.00E-4	0.00E+0	2.52E-3	1.11E-5	-1.48E-4
41	-4.71E-5	-6.09E-5	-5.70E-5	1.44E-3	0.00E+0	0.00E+0	1.41E-3	0.00E+0	1.00E-4	0.00E+0	1.21E-3	-9.00E-7	-1.27E-4
42	-1.79E-5	-4.99E-5	-4.40E-5	1.44E-3	0.00E+0	0.00E+0	1.41E-3	0.00E+0	0.00E+0	0.00E+0	1.21E-3	2.10E-5	-1.09E-4
43	9.80E-6	-3.76E-5	-2.50E-5	1.45E-3	0.00E+0	0.00E+0	1.43E-3	0.00E+0	1.00E-4	0.00E+0	1.23E-3	2.97E-5	-9.10E-5
44	1.66E-5	6.40E-6	2.90E-5	1.48E-3	0.00E+0	0.00E+0	1.46E-3	0.00E+0	1.00E-4	0.00E+0	1.52E-3	3.40E-6	-8.40E-5
45	-4.91E-5	-2.50E-6	-1.30E-5	5.63E-4	0.00E+0	0.00E+0	5.45E-4	0.00E+0	1.00E-4	0.00E+0	3.92E-4	5.80E-6	-1.46E-4
46	-2.23E-5	-2.30E-6	0.00E+0	5.83E-4	0.00E+0	0.00E+0	5.68E-4	0.00E+0	1.00E-4	0.00E+0	4.04E-4	1.45E-5	-6.29E-5
47	3.25E-5	2.25E-5	1.10E-5	6.43E-4	0.00E+0	1.00E-6	6.31E-4	0.00E+0	1.00E-4	0.00E+0	4.71E-4	3.44E-5	4.10E-6
48	7.00E-5	1.24E-5	6.20E-5	7.15E-4	0.00E+0	0.00E+0	7.08E-4	0.00E+0	1.00E-4	0.00E+0	8.40E-4	4.53E-5	1.65E-5
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DY" ACROSS JOINT 1
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	8.09E-5	-2.00E-7	0.00E+0	-1.25E-3	0.00E+0	0.00E+0	-3.73E-3	0.00E+0	-1.00E-4	0.00E+0	8.84E-4	1.40E-6	-3.00E-6
2	8.34E-5	-1.50E-6	0.00E+0	-1.24E-3	0.00E+0	0.00E+0	-3.73E-3	0.00E+0	-1.00E-4	0.00E+0	1.26E-3	9.20E-6	1.20E-5
3	8.49E-5	-5.00E-7	0.00E+0	-1.24E-3	0.00E+0	-1.00E-6	-3.73E-3	0.00E+0	-2.00E-4	0.00E+0	1.26E-3	4.10E-6	5.40E-5
4	8.56E-5	-1.80E-6	0.00E+0	-1.24E-3	0.00E+0	0.00E+0	-3.73E-3	0.00E+0	-2.00E-4	0.00E+0	1.25E-3	6.00E-7	5.10E-5
5	-9.23E-6	-6.30E-6	0.00E+0	-9.64E-4	0.00E+0	0.00E+0	-2.77E-3	0.00E+0	-1.00E-4	0.00E+0	4.98E-4	2.20E-6	-3.53E-5
6	-8.32E-6	-7.80E-6	0.00E+0	-9.66E-4	0.00E+0	-1.00E-6	-2.83E-3	0.00E+0	-2.00E-4	0.00E+0	-1.70E-5	3.80E-6	-4.00E-5
7	-7.74E-6	-7.50E-6	0.00E+0	-9.67E-4	0.00E+0	-1.00E-6	-2.89E-3	-1.00E-5	-2.00E-4	0.00E+0	-1.90E-5	-1.60E-6	-4.00E-6
8	-4.13E-6	-5.30E-6	0.00E+0	-9.64E-4	0.00E+0	-1.00E-6	-2.95E-3	0.00E+0	-4.00E-4	0.00E+0	-1.70E-5	3.00E-6	-3.00E-6
9	-2.04E-4	1.60E-5	1.26E-5	-7.62E-4	0.00E+0	-1.00E-6	-1.70E-3	-1.00E-5	-2.00E-4	0.00E+0	1.68E-4	-8.48E-6	-6.71E-5
10	-2.08E-4	9.40E-6	7.00E-6	-8.34E-4	0.00E+0	-1.00E-6	-1.81E-3	0.00E+0	-3.00E-4	0.00E+0	-4.60E-5	-1.02E-5	-7.10E-5
11	-2.11E-4	7.00E-7	2.00E-6	-9.08E-4	0.00E+0	-2.00E-6	-1.94E-3	0.00E+0	-4.00E-4	0.00E+0	-3.10E-5	-1.63E-5	-7.34E-5
12	-2.09E-4	-9.00E-6	-4.00E-6	-9.74E-4	0.00E+0	-1.00E-6	-2.05E-3	-1.00E-5	-5.00E-4	0.00E+0	-5.00E-6	-2.02E-5	-7.40E-5
13	-1.40E-4	1.27E-5	3.08E-5	1.64E-5	0.00E+0	-1.00E-6	-4.80E-4	0.00E+0	-2.00E-4	0.00E+0	-4.78E-4	-5.09E-6	-3.98E-5
14	-1.46E-4	1.13E-5	2.44E-5	-4.86E-5	0.00E+0	-1.00E-6	-5.65E-4	0.00E+0	-3.00E-4	0.00E+0	-4.35E-4	-3.90E-6	-4.47E-5
15	-1.52E-4	1.01E-6	1.71E-5	-1.26E-4	0.00E+0	-1.00E-6	-6.64E-4	-1.00E-5	-3.00E-4	0.00E+0	-3.86E-4	-6.22E-6	-4.86E-5
16	-1.62E-4	-1.41E-5	8.60E-6	-2.11E-4	0.00E+0	-1.00E-6	-7.70E-4	0.00E+0	-5.00E-4	0.00E+0	7.07E-4	-1.03E-5	-5.31E-5
17	-1.33E-4	-3.46E-5	6.08E-5	5.83E-4	0.00E+0	0.00E+0	3.18E-4	0.00E+0	-2.00E-4	0.00E+0	-8.33E-4	-3.00E-6	-6.65E-5
18	-1.38E-4	-2.61E-5	3.93E-5	5.47E-4	0.00E+0	-1.00E-6	2.74E-4	-1.00E-5	-3.00E-4	0.00E+0	-8.07E-4	-1.06E-6	-6.46E-5
19	-1.47E-4	-1.68E-5	-1.70E-6	4.97E-4	1.00E-6	-2.00E-6	2.15E-4	0.00E+0	-4.00E-4	0.00E+0	-7.80E-4	-3.24E-6	-6.06E-5
20	-1.57E-4	-1.08E-5	-1.80E-6	4.33E-4	0.00E+0	-1.00E-6	1.45E-4	0.00E+0	-5.00E-4	0.00E+0	3.18E-4	-7.60E-6	-5.43E-5
21	-1.24E-4	-1.25E-4	1.34E-4	8.63E-4	0.00E+0	0.00E+0	7.22E-4	0.00E+0	-2.00E-4	0.00E+0	-9.74E-4	-1.68E-6	-1.33E-4
22	-1.30E-4	-1.15E-4	1.30E-4	8.53E-4	0.00E+0	-1.00E-6	7.07E-4	0.00E+0	-2.00E-4	0.00E+0	-9.71E-4	1.35E-6	-1.33E-4
23	-1.43E-4	-1.04E-4	1.31E-4	8.33E-4	0.00E+0	-1.00E-6	6.82E-4	0.00E+0	-3.00E-4	0.00E+0	-9.59E-4	6.70E-7	-1.33E-4
24	-1.63E-4	-8.64E-5	1.27E-4	8.01E-4	1.00E-6	-1.00E-6	6.45E-4	0.00E+0	-5.00E-4	0.00E+0	3.11E-4	-3.79E-6	-1.31E-4
25	-1.04E-4	-1.98E-4	1.17E-4	8.80E-4	1.00E-6	0.00E+0	8.10E-4	0.00E+0	-2.00E-4	0.00E+0	-8.98E-4	-1.70E-7	-1.76E-4
26	-1.04E-4	-1.88E-4	1.20E-4	8.78E-4	0.00E+0	-1.00E-6	8.09E-4	0.00E+0	-1.00E-4	0.00E+0	-8.93E-4	3.75E-6	-1.78E-4
27	-1.14E-4	-1.82E-4	1.32E-4	8.76E-4	0.00E+0	-1.00E-6	8.01E-4	0.00E+0	-3.00E-4	0.00E+0	-8.97E-4	1.57E-6	-1.82E-4
28	-1.26E-4	-1.65E-4	1.44E-4	8.71E-4	0.00E+0	-2.00E-6	7.88E-4	0.00E+0	-4.00E-4	0.00E+0	4.28E-4	7.20E-7	-1.83E-4
29	-8.67E-5	-2.17E-4	4.99E-5	6.89E-4	0.00E+0	0.00E+0	6.72E-4	0.00E+0	-2.00E-4	0.00E+0	-6.49E-4	-2.46E-6	-1.62E-4
30	-7.78E-5	-2.03E-4	6.07E-5	6.85E-4	0.00E+0	-1.00E-6	6.73E-4	0.00E+0	-1.00E-4	0.00E+0	-6.36E-4	4.83E-6	-1.70E-4
31	-7.34E-5	-1.94E-4	8.73E-5	6.93E-4	0.00E+0	-2.00E-6	6.70E-4	0.00E+0	-2.00E-4	0.00E+0	-6.14E-4	8.22E-6	-1.76E-4
32	-8.74E-5	-1.85E-4	1.10E-4	6.97E-4	1.00E-6	-2.00E-6	6.62E-4	0.00E+0	-4.00E-4	0.00E+0	7.46E-4	2.86E-6	-1.90E-4
33	-1.13E-4	-1.64E-4	-1.30E-5	3.66E-4	0.00E+0	-1.00E-6	3.70E-4	0.00E+0	-1.00E-4	0.00E+0	-3.01E-4	1.01E-5	1.38E-4
34	-1.06E-4	-1.38E-4	6.07E-6	3.46E-4	0.00E+0	-1.00E-6	3.79E-4	0.00E+0	-1.00E-4	0.00E+0	-2.16E-4	8.14E-6	-4.33E-5
35	-1.01E-4	-1.45E-4	4.06E-5	3.50E-4	0.00E+0	-1.00E-6	3.89E-4	0.00E+0	-1.00E-4	0.00E+0	-1.49E-4	2.93E-6	-4.61E-5
36	-8.44E-5	-1.45E-4	8.43E-5	3.85E-4	1.00E-6	-1.00E-6	4.48E-4	0.00E+0	-4.00E-4	0.00E+0	9.01E-4	5.95E-6	-1.57E-5
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DY" ACROSS JOINT 2
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	1.25E-5	-5.94E-6	0.00E+0	1.81E-3	0.00E+0	0.00E+0	1.87E-3	0.00E+0	-5.00E-4	0.00E+0	-1.70E-3	-2.16E-6	-1.30E-6
2	1.34E-5	-7.75E-6	0.00E+0	1.82E-3	0.00E+0	-1.00E-6	1.88E-3	0.00E+0	-4.00E-4	0.00E+0	-1.71E-3	4.19E-4	-7.00E-7
3	1.38E-5	-6.34E-6	0.00E+0	1.82E-3	0.00E+0	0.00E+0	1.89E-3	0.00E+0	-4.00E-4	0.00E+0	-1.72E-3	-1.44E-6	2.00E-7
4	1.41E-5	-5.42E-6	0.00E+0	1.83E-3	0.00E+0	-1.00E-6	1.90E-3	0.00E+0	-3.00E-4	0.00E+0	-1.06E-3	-1.55E-6	7.20E-7
5	-8.40E-6	-6.69E-6	0.00E+0	1.68E-3	0.00E+0	0.00E+0	1.71E-3	0.00E+0	-4.00E-4	0.00E+0	-1.57E-3	-3.72E-6	-3.10E-6
6	-7.80E-6	-6.05E-6	0.00E+0	1.70E-3	0.00E+0	-1.00E-6	1.72E-3	-1.00E-5	-4.00E-4	0.00E+0	-1.58E-3	-3.01E-6	-3.00E-6
7	-7.07E-6	-5.80E-6	0.00E+0	1.71E-3	0.00E+0	-2.00E-6	1.74E-3	0.00E+0	-3.00E-4	0.00E+0	-1.60E-3	-3.07E-6	-2.80E-6
8	-6.04E-6	-6.66E-6	0.00E+0	1.73E-3	0.00E+0	-1.00E-6	1.75E-3	0.00E+0	-4.00E-4	0.00E+0	-7.99E-4	-3.74E-6	-3.20E-6
9	-6.51E-7	-8.00E-6	0.00E+0	1.54E-3	0.00E+0	-1.00E-6	1.56E-3	0.00E+0	-4.00E-4	0.00E+0	-1.45E-3	-4.10E-6	-2.00E-6
10	-1.63E-6	-8.24E-6	0.00E+0	1.55E-3	0.00E+0	-2.00E-6	1.57E-3	-1.00E-5	-4.00E-4	0.00E+0	-1.46E-3	-2.93E-6	-1.20E-6
11	-2.80E-6	-6.48E-6	0.00E+0	1.56E-3	0.00E+0	-2.00E-6	1.58E-3	0.00E+0	-4.00E-4	0.00E+0	-1.47E-3	-2.96E-6	-1.50E-6
12	-4.06E-6	-7.89E-6	0.00E+0	1.58E-3	0.00E+0	-1.00E-6	1.60E-3	-1.00E-5	-4.00E-4	0.00E+0	-5.37E-4	-4.00E-6	-2.90E-6
13	6.52E-6	-7.80E-6	3.00E-6	1.43E-3	1.00E-6	-1.00E-6	1.45E-3	-1.00E-5	-5.00E-4	0.00E+0	-1.35E-3	-4.20E-6	-3.00E-6
14	5.74E-6	-5.49E-6	1.70E-6	1.44E-3	0.00E+0	-2.00E-6	1.46E-3	0.00E+0	-5.00E-4	0.00E+0	-1.37E-3	-2.76E-6	-2.00E-6
15	4.23E-6	-6.18E-6	0.00E+0	1.45E-3	0.00E+0	-2.00E-6	1.47E-3	-1.00E-5	-4.00E-4	0.00E+0	-1.38E-3	-2.79E-6	-2.00E-6
16	2.26E-6	-9.31E-6	0.00E+0	1.47E-3	0.00E+0	-1.00E-6	1.48E-3	0.00E+0	-5.00E-4	0.00E+0	-2.34E-4	-4.23E-6	-2.20E-6
17	9.43E-6	-7.40E-6	8.00E-6	1.32E-3	0.00E+0	-2.00E-6	1.33E-3	0.00E+0	-5.00E-4	0.00E+0	-1.25E-3	-4.10E-6	-1.00E-5
18	9.10E-6	-4.20E-6	7.00E-6	1.34E-3	0.00E+0	-2.00E-6	1.34E-3	0.00E+0	-4.00E-4	0.00E+0	-1.26E-3	-2.40E-6	-9.00E-6
19	8.00E-6	-4.94E-6	4.10E-6	1.35E-3	0.00E+0	-2.00E-6	1.36E-3	0.00E+0	-4.00E-4	0.00E+0	-1.28E-3	-2.36E-6	-8.10E-6
20	6.25E-6	-1.07E-5	2.70E-6	1.37E-3	0.00E+0	-1.00E-6	1.37E-3	0.00E+0	-5.00E-4	0.00E+0	1.10E-5	-4.19E-6	-7.60E-6
21	7.41E-6	-1.12E-5	5.00E-6	1.21E-3	0.00E+0	-1.00E-6	1.21E-3	0.00E+0	-4.00E-4	0.00E+0	-1.14E-3	-3.70E-6	-2.20E-5
22	7.52E-6	-6.50E-6	5.00E-6	1.22E-3	0.00E+0	-3.00E-6	1.22E-3	0.00E+0	-4.00E-4	0.00E+0	-1.14E-3	-1.80E-6	-2.00E-5
23	6.78E-6	-5.39E-6	3.40E-6	1.23E-3	0.00E+0	-2.00E-6	1.23E-3	0.00E+0	-4.00E-4	0.00E+0	-1.16E-3	-1.86E-6	-1.90E-5
24	5.60E-6	-8.54E-6	1.40E-6	1.25E-3	1.00E-6	-1.00E-6	1.24E-3	-1.00E-5	-4.00E-4	0.00E+0	2.57E-4	-4.02E-6	-1.67E-5
25	1.30E-6	-1.98E-5	-5.00E-6	1.08E-3	0.00E+0	-1.00E-6	1.07E-3	-1.00E-5	-5.00E-4	0.00E+0	-1.00E-3	-3.50E-6	-3.80E-5
26	1.98E-6	-1.45E-5	-5.00E-6	1.08E-3	0.00E+0	-2.00E-6	1.07E-3	-1.00E-5	-4.00E-4	0.00E+0	-1.00E-3	-1.35E-6	-3.60E-5
27	1.47E-6	-1.26E-5	-5.40E-6	1.09E-3	0.00E+0	-2.00E-6	1.08E-3	-1.00E-5	-4.00E-4	0.00E+0	-1.01E-3	-1.35E-6	-3.57E-5
28	9.63E-7	-1.40E-5	-7.20E-6	1.10E-3	0.00E+0	-1.00E-6	1.08E-3	0.00E+0	-4.00E-4	0.00E+0	4.84E-4	-3.79E-6	-3.58E-5
29	-8.06E-6	-2.85E-5	-1.40E-5	9.23E-4	0.00E+0	-1.00E-6	9.09E-4	-1.00E-5	-4.00E-4	0.00E+0	-8.45E-4	-3.10E-6	-5.20E-5
30	-6.84E-6	-2.31E-5	-1.45E-5	9.14E-4	0.00E+0	-2.00E-6	9.04E-4	0.00E+0	-3.00E-4	0.00E+0	-8.37E-4	-9.90E-7	-4.99E-5
31	-6.63E-6	-2.13E-5	-1.50E-5	9.11E-4	0.00E+0	-2.00E-6	8.98E-4	0.00E+0	-3.00E-4	0.00E+0	-8.28E-4	-9.00E-7	-5.16E-5
32	-7.41E-6	-2.31E-5	-1.70E-5	9.18E-4	0.00E+0	-1.00E-6	8.95E-4	0.00E+0	-4.00E-4	0.00E+0	6.92E-4	-3.45E-6	-5.55E-5
33	-1.81E-5	-3.34E-5	-1.90E-5	7.43E-4	-1.00E-6	-1.00E-6	7.28E-4	0.00E+0	-4.00E-4	0.00E+0	-6.68E-4	-3.10E-6	-5.65E-5
34	-1.66E-5	-2.72E-5	-1.98E-5	7.20E-4	-1.00E-5	-2.00E-6	7.09E-4	0.00E+0	-2.00E-4	0.00E+0	-6.47E-4	-5.30E-7	-5.44E-5
35	-1.66E-5	-2.40E-5	-1.96E-5	7.04E-4	0.00E+0	-2.00E-6	6.91E-4	0.00E+0	-2.00E-4	0.00E+0	-6.26E-4	-5.90E-7	-5.53E-5
36	-1.56E-5	-2.12E-5	-1.95E-5	7.02E-4	1.00E-6	-1.00E-6	6.76E-4	0.00E+0	-4.00E-4	0.00E+0	8.71E-4	-3.27E-6	-5.67E-5
37	-2.40E-5	-3.27E-5	-1.98E-5	5.41E-4	0.00E+0	-1.00E-6	5.30E-4	0.00E+0	-3.00E-4	0.00E+0	-4.73E-4	2.73E-6	-5.29E-5
38	-2.22E-5	-2.55E-5	-1.89E-5	5.07E-4	0.00E+0	-2.00E-6	4.97E-4	-1.00E-5	-2.00E-4	0.00E+0	-4.42E-4	-3.10E-7	-4.96E-5
39	-2.27E-5	-2.12E-5	-1.63E-5	4.80E-4	0.00E+0	-2.00E-6	4.65E-4	0.00E+0	-2.00E-4	0.00E+0	-4.10E-4	-3.10E-7	-4.73E-5
40	-2.20E-5	-1.79E-5	-1.28E-5	4.67E-4	0.00E+0	-1.00E-6	4.39E-4	0.00E+0	-3.00E-4	0.00E+0	1.02E-3	-3.01E-6	-3.80E-5
41	-2.41E-5	-2.74E-5	-1.53E-5	3.32E-4	0.00E+0	-1.00E-6	3.28E-4	0.00E+0	-3.00E-4	0.00E+0	-2.80E-4	-2.83E-6	-4.00E-5
42	-2.21E-5	-1.71E-5	-1.35E-5	2.92E-4	0.00E+0	-1.00E-6	2.83E-4	0.00E+0	-1.00E-4	0.00E+0	-2.44E-4	7.10E-7	-3.82E-5
43	-2.10E-5	-1.01E-5	-6.26E-6	2.59E-4	0.00E+0	-1.00E-6	2.42E-4	-1.00E-5	-1.00E-4	0.00E+0	-2.06E-4	-1.19E-6	-3.63E-5
44	-1.90E-5	-7.91E-6	-3.72E-6	2.37E-4	0.00E+0	-1.00E-6	2.10E-4	0.00E+0	-3.00E-4	0.00E+0	1.06E-3	-4.97E-6	-2.99E-5
45	-2.15E-5	-2.25E-5	-6.70E-6	1.39E-4	0.00E+0	-1.00E-6	1.35E-4	0.00E+0	-2.00E-4	0.00E+0	-1.00E-4	-3.66E-6	4.11E-4
46	1.77E-7	-6.58E-6	0.00E+0	1.06E-4	0.00E+0	0.00E+0	1.02E-4	0.00E+0	0.00E+0	0.00E+0	-6.80E-5	-4.20E-6	1.06E-4
47	-1.43E-6	-5.80E-6	-1.62E-6	8.45E-5	0.00E+0	-1.00E-6	8.20E-5	0.00E+0	0.00E+0	0.00E+0	-5.00E-5	-7.08E-6	-2.15E-5
48	-1.01E-5	-2.95E-5	-2.10E-6	7.99E-5	0.00E+0	-1.00E-6	8.20E-5	0.00E+0	-3.00E-4	0.00E+0	1.23E-3	9.15E-5	-4.97E-6
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.00E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DZ" ACROSS JOINT 1
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	6.73E-4	-3.10E-6	0.00E+0	2.41E-3	0.00E+0	0.00E+0	3.33E-3	0.00E+0	1.00E-4	7.00E-6	1.72E-3	8.00E-6	2.92E-4
2	6.12E-4	-2.80E-6	0.00E+0	2.61E-3	0.00E+0	0.00E+0	3.80E-3	1.00E-5	1.00E-4	1.00E-6	1.75E-3	7.20E-6	2.51E-4
3	5.49E-4	-1.30E-6	0.00E+0	2.81E-3	0.00E+0	0.00E+0	4.27E-3	0.00E+0	1.00E-4	8.00E-6	1.81E-3	1.08E-5	1.79E-4
4	4.93E-4	-2.50E-6	0.00E+0	2.99E-3	0.00E+0	0.00E+0	4.74E-3	0.00E+0	1.00E-4	7.00E-6	1.90E-3	3.70E-6	1.22E-4
5	7.70E-4	-3.24E-5	0.00E+0	2.35E-3	0.00E+0	1.00E-6	3.29E-3	0.00E+0	2.00E-4	4.00E-6	1.58E-3	6.31E-5	3.38E-4
6	7.07E-4	-3.41E-5	0.00E+0	2.56E-3	0.00E+0	0.00E+0	3.78E-3	0.00E+0	2.00E-4	5.00E-6	1.67E-3	4.96E-5	2.82E-4
7	6.44E-4	-2.23E-5	0.00E+0	2.79E-3	0.00E+0	0.00E+0	4.28E-3	0.00E+0	1.00E-4	4.00E-6	1.79E-3	3.45E-5	2.08E-4
8	5.76E-4	-1.67E-5	0.00E+0	2.99E-3	0.00E+0	0.00E+0	4.75E-3	0.00E+0	1.00E-4	4.00E-6	1.84E-3	1.90E-5	1.50E-4
9	8.49E-4	-1.97E-4	-1.24E-4	1.52E-3	0.00E+0	1.00E-6	2.01E-3	0.00E+0	1.00E-4	8.00E-6	1.05E-3	7.12E-5	2.10E-4
10	6.65E-4	-1.60E-4	-9.65E-5	1.93E-3	0.00E+0	0.00E+0	2.71E-3	0.00E+0	2.00E-4	0.00E+0	1.36E-3	8.02E-5	2.29E-4
11	7.02E-4	-1.11E-4	-8.55E-5	2.32E-3	0.00E+0	0.00E+0	3.37E-3	0.00E+0	1.00E-4	1.00E-6	1.54E-3	9.33E-5	2.17E-4
12	6.99E-4	-7.98E-5	-7.50E-5	2.68E-3	0.00E+0	0.00E+0	4.04E-3	0.00E+0	1.00E-4	1.00E-6	1.74E-3	8.83E-5	2.05E-4
13	3.98E-4	-3.02E-4	-3.33E-4	6.27E-4	0.00E+0	0.00E+0	7.85E-4	0.00E+0	0.00E+0	-9.00E-6	4.78E-4	2.86E-5	5.79E-5
14	4.35E-4	-2.98E-4	-3.16E-4	1.04E-3	0.00E+0	0.00E+0	1.38E-3	0.00E+0	1.00E-4	8.00E-6	7.47E-4	3.02E-5	7.08E-5
15	4.63E-4	-3.07E-4	-3.07E-4	1.43E-3	0.00E+0	0.00E+0	1.97E-3	0.00E+0	0.00E+0	2.00E-6	1.02E-3	3.21E-5	7.01E-5
16	4.95E-4	-3.00E-4	-2.88E-4	1.87E-3	0.00E+0	0.00E+0	2.63E-3	0.00E+0	0.00E+0	6.00E-6	1.07E-3	3.68E-5	6.50E-5
17	1.92E-4	-2.94E-4	-5.55E-4	1.11E-4	0.00E+0	0.00E+0	1.76E-4	0.00E+0	0.00E+0	-4.00E-6	1.14E-4	1.79E-5	-2.76E-5
18	2.10E-4	-3.35E-4	-4.99E-4	3.79E-4	0.00E+0	-1.00E-6	5.55E-4	0.00E+0	0.00E+0	-3.00E-6	2.96E-4	1.53E-5	-5.58E-5
19	2.21E-4	-4.05E-4	-4.89E-4	6.45E-4	0.00E+0	0.00E+0	9.35E-4	0.00E+0	0.00E+0	-2.00E-6	4.41E-4	1.40E-5	-8.59E-5
20	2.22E-4	-5.17E-4	-5.08E-4	9.64E-4	0.00E+0	0.00E+0	1.38E-3	0.00E+0	0.00E+0	-8.00E-6	4.75E-4	1.48E-5	-9.75E-5
21	-2.16E-5	-2.58E-4	-6.67E-4	-8.54E-5	0.00E+0	0.00E+0	-3.30E-5	-1.70E-4	-1.00E-4	-8.00E-6	-7.00E-6	4.09E-6	-1.33E-4
22	-1.02E-5	-3.06E-4	-6.64E-4	-1.43E-5	0.00E+0	0.00E+0	1.04E-4	6.00E-5	0.00E+0	-7.00E-6	-8.00E-6	-2.18E-6	-1.78E-4
23	-2.24E-5	-3.71E-4	-6.80E-4	6.30E-5	0.00E+0	0.00E+0	2.40E-4	9.00E-5	0.00E+0	-5.00E-6	1.00E-6	-1.08E-5	-2.46E-4
24	-2.12E-5	-5.55E-4	-6.44E-4	1.72E-4	0.00E+0	0.00E+0	4.14E-4	-1.20E-4	-1.00E-4	-3.00E-6	-1.53E-4	-1.67E-5	-3.62E-4
25	-1.92E-4	-2.49E-4	-6.45E-4	-1.16E-4	0.00E+0	0.00E+0	-5.00E-5	-7.00E-5	-1.00E-4	-4.00E-6	-1.70E-5	-4.35E-6	-2.95E-4
26	-2.07E-4	-2.74E-4	-6.95E-4	-2.38E-4	0.00E+0	0.00E+0	-1.31E-4	-1.80E-4	0.00E+0	-1.00E-6	-1.99E-4	-2.13E-5	-3.21E-4
27	-2.44E-4	-2.93E-4	-7.50E-4	-3.39E-4	0.00E+0	0.00E+0	-2.09E-4	-3.30E-4	-1.00E-4	-6.00E-6	-4.00E-4	-3.45E-5	-3.25E-4
28	-2.47E-4	-4.23E-4	-7.68E-4	-4.39E-4	0.00E+0	0.00E+0	-2.81E-4	-9.00E-5	-1.00E-4	-4.00E-6	-6.13E-4	-4.44E-5	-3.56E-4
29	-2.95E-4	-2.50E-4	-5.45E-4	-1.10E-4	0.00E+0	0.00E+0	-2.00E-5	-2.40E-4	-1.00E-4	-2.00E-6	2.70E-5	-1.48E-5	-5.26E-4
30	-3.32E-4	-2.36E-4	-6.19E-4	-3.60E-4	0.00E+0	0.00E+0	-2.43E-4	-2.40E-4	-1.00E-4	-4.00E-6	-2.96E-4	-2.27E-5	-5.04E-4
31	-4.15E-4	-2.03E-4	-7.04E-4	-5.95E-4	0.00E+0	0.00E+0	-4.79E-4	-4.80E-4	-2.00E-4	-7.00E-6	-5.78E-4	-5.68E-5	-4.30E-4
32	-4.28E-4	-2.32E-4	-7.27E-4	-8.23E-4	0.00E+0	0.00E+0	-6.98E-4	-4.10E-4	-2.00E-4	0.00E+0	-8.49E-4	-8.33E-5	-3.33E-4
33	-2.70E-4	-1.65E-4	-3.30E-4	-3.88E-5	0.00E+0	0.00E+0	1.20E-4	2.00E-4	0.00E+0	-7.00E-6	1.11E-4	-6.18E-6	-7.03E-4
34	-3.59E-4	-1.58E-4	-3.79E-4	-3.70E-4	0.00E+0	-1.00E-6	-2.17E-4	-2.40E-4	-1.00E-4	-9.00E-6	-2.51E-4	-8.49E-5	-6.50E-4
35	-4.44E-4	-5.47E-5	-4.40E-4	-5.98E-4	0.00E+0	0.00E+0	-4.02E-4	-3.50E-4	-2.00E-4	0.00E+0	-6.16E-4	-1.05E-4	-4.60E-4
36	-4.47E-4	3.15E-5	-4.22E-4	-8.02E-4	0.00E+0	0.00E+0	-5.47E-4	-4.50E-4	-2.00E-4	0.00E+0	-4.06E-4	-7.52E-5	-1.50E-5
37	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-3.00E-6	-3.00E-6	0.00E+0	0.00E+0
38	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-8.00E-6	-3.00E-6	0.00E+0	0.00E+0
39	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-4	-4.00E-6	-4.00E-6	0.00E+0	0.00E+0
40	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-8.00E-6	-5.00E-6	0.00E+0	0.00E+0

SUMMER CONDITION

DIFFERENTIAL DISPLACEMENTS "DZ" ACROSS JOINT 2 [m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f
1	1.72E-4	-1.37E-5	0.00E+0	-1.61E-3	0.00E+0	0.00E+0	-1.67E-3	0.00E+0	0.00E+0	0.00E+0	-1.64E-3	1.34E-5	-2.70E-6
2	1.43E-4	-3.34E-7	0.00E+0	-1.91E-3	0.00E+0	0.00E+0	-1.97E-3	0.00E+0	0.00E+0	2.00E-6	-1.86E-3	1.57E-3	-1.16E-5
3	1.13E-4	2.00E-8	0.00E+0	-2.21E-3	0.00E+0	0.00E+0	-2.28E-3	0.00E+0	0.00E+0	7.00E-6	-2.09E-3	2.36E-6	-1.11E-5
4	8.30E-5	-2.40E-7	0.00E+0	-2.51E-3	0.00E+0	0.00E+0	-2.58E-3	0.00E+0	0.00E+0	6.00E-6	-2.33E-3	-1.15E-6	-1.32E-5
5	1.88E-4	-4.39E-5	0.00E+0	-1.27E-3	0.00E+0	0.00E+0	-1.37E-3	0.00E+0	1.00E-4	-2.00E-6	-1.40E-3	2.86E-5	-1.50E-5
6	1.79E-4	-3.38E-5	0.00E+0	-1.56E-3	0.00E+0	0.00E+0	-1.66E-3	0.00E+0	1.00E-4	-3.00E-6	-1.61E-3	2.32E-5	-9.00E-6
7	1.59E-4	-1.23E-5	0.00E+0	-1.87E-3	0.00E+0	0.00E+0	-1.97E-3	0.00E+0	0.00E+0	-8.00E-6	-1.82E-3	1.63E-5	4.00E-6
8	1.38E-4	1.04E-6	0.00E+0	-2.17E-3	0.00E+0	0.00E+0	-2.28E-3	0.00E+0	0.00E+0	3.00E-6	-2.12E-3	1.07E-5	4.60E-6
9	1.27E-4	-7.40E-5	0.00E+0	-8.93E-4	0.00E+0	0.00E+0	-9.84E-4	0.00E+0	0.00E+0	-3.00E-6	-1.09E-3	2.69E-5	-6.50E-5
10	1.36E-4	-6.19E-5	0.00E+0	-1.19E-3	0.00E+0	0.00E+0	-1.30E-3	0.00E+0	1.00E-4	-7.00E-6	-1.33E-3	2.18E-5	-6.30E-5
11	1.33E-4	-3.86E-5	0.00E+0	-1.51E-3	0.00E+0	0.00E+0	-1.64E-3	0.00E+0	1.00E-4	-1.00E-6	-1.57E-3	1.57E-5	-5.60E-5
12	1.37E-4	1.35E-6	0.00E+0	-1.82E-3	0.00E+0	0.00E+0	-1.96E-3	0.00E+0	0.00E+0	-9.00E-6	-1.88E-3	1.17E-5	-2.80E-5
13	5.04E-5	-1.03E-4	-7.49E-5	-5.50E-4	0.00E+0	0.00E+0	-6.07E-4	0.00E+0	0.00E+0	0.00E+0	-7.41E-4	2.33E-5	-9.34E-5
14	5.64E-5	-9.18E-5	-4.04E-5	-9.11E-4	0.00E+0	0.00E+0	-9.94E-4	0.00E+0	1.00E-4	-1.00E-6	-1.09E-3	1.79E-5	-1.03E-4
15	5.09E-5	-6.71E-5	0.00E+0	-1.30E-3	0.00E+0	0.00E+0	-1.41E-3	0.00E+0	0.00E+0	-6.00E-6	-1.41E-3	1.13E-5	-1.11E-4
16	6.02E-5	-6.10E-6	0.00E+0	-1.64E-3	0.00E+0	0.00E+0	-1.78E-3	0.00E+0	0.00E+0	-6.00E-6	-1.78E-3	7.20E-6	-8.70E-5
17	-1.99E-5	-1.23E-4	-1.32E-4	-1.92E-4	0.00E+0	0.00E+0	-2.20E-4	0.00E+0	0.00E+0	-9.00E-6	-3.43E-4	1.82E-5	-1.05E-4
18	-2.71E-5	-1.25E-4	-1.34E-4	-6.53E-4	0.00E+0	0.00E+0	-7.08E-4	0.00E+0	0.00E+0	-9.00E-6	-8.04E-4	1.17E-5	-1.30E-4
19	-4.79E-5	-1.25E-4	-1.35E-4	-1.14E-3	0.00E+0	0.00E+0	-1.22E-3	0.00E+0	0.00E+0	-8.00E-6	-1.25E-3	3.80E-6	-1.64E-4
20	-4.87E-5	-9.40E-5	-1.05E-4	-1.58E-3	0.00E+0	0.00E+0	-1.70E-3	0.00E+0	0.00E+0	0.00E+0	-1.71E-3	-1.20E-6	-1.55E-4
21	-8.09E-5	-1.16E-4	-1.50E-4	1.57E-4	0.00E+0	0.00E+0	1.47E-4	0.00E+0	1.00E-4	0.00E+0	4.10E-5	1.27E-5	-1.07E-4
22	-1.03E-4	-1.35E-4	-1.77E-4	-4.15E-4	0.00E+0	0.00E+0	-4.47E-4	0.00E+0	0.00E+0	-7.00E-6	-5.29E-4	4.92E-6	-1.50E-4
23	-1.44E-4	-1.63E-4	-2.02E-4	-1.01E-3	0.00E+0	-1.00E-6	-1.07E-3	0.00E+0	0.00E+0	-6.00E-6	-1.11E-3	-4.70E-6	-2.01E-4
24	-1.60E-4	-1.91E-4	-1.88E-4	-1.56E-3	0.00E+0	0.00E+0	-1.65E-3	0.00E+0	0.00E+0	-2.00E-6	-1.68E-3	-1.16E-5	-2.00E-4
25	-1.33E-4	-9.94E-5	-1.43E-4	4.48E-4	0.00E+0	0.00E+0	4.44E-4	0.00E+0	0.00E+0	5.00E-6	3.48E-4	7.61E-6	-1.16E-4
26	-1.72E-4	-1.28E-4	-1.82E-4	-2.21E-4	0.00E+0	0.00E+0	-2.40E-4	0.00E+0	0.00E+0	-1.00E-6	-3.11E-4	-1.68E-6	-1.69E-4
27	-2.30E-4	-1.62E-4	-2.20E-4	-9.08E-4	0.00E+0	-1.00E-6	-9.54E-4	0.00E+0	0.00E+0	-1.00E-6	-9.91E-4	-1.30E-5	-2.32E-4
28	-2.60E-4	-2.26E-4	-2.12E-4	-1.57E-3	0.00E+0	0.00E+0	-1.64E-3	0.00E+0	-1.00E-4	0.00E+0	-1.65E-3	-2.22E-5	-2.80E-4
29	-1.77E-4	-9.34E-5	-1.30E-4	6.37E-4	0.00E+0	0.00E+0	6.34E-4	0.00E+0	0.00E+0	4.00E-6	5.46E-4	3.08E-6	-1.41E-4
30	-2.29E-4	-1.18E-4	-1.67E-4	-1.00E-4	-1.00E-6	0.00E+0	-1.14E-4	0.00E+0	-1.00E-4	-5.00E-6	-1.70E-4	-7.23E-6	-1.92E-4
31	-3.04E-4	-1.42E-4	-2.08E-4	-8.54E-4	-3.00E-6	0.00E+0	-8.90E-4	0.00E+0	-1.00E-4	-7.00E-6	-9.06E-4	-2.08E-5	-2.59E-4
32	-3.47E-4	-1.90E-4	-1.74E-4	-1.59E-3	0.00E+0	0.00E+0	-1.64E-3	0.00E+0	0.00E+0	-5.00E-6	-1.61E-3	-3.27E-5	-3.16E-4
33	-2.12E-4	-9.77E-5	-1.14E-4	7.03E-4	-4.00E-6	0.00E+0	6.96E-4	0.00E+0	0.00E+0	6.00E-6	6.28E-4	-8.30E-7	-1.77E-4
34	-2.70E-4	-1.10E-4	-1.42E-4	-6.60E-5	-4.80E-5	0.00E+0	-7.90E-5	0.00E+0	-1.00E-4	-8.00E-6	-1.15E-4	-1.31E-5	-2.17E-4
35	-3.54E-4	-1.10E-4	-1.79E-4	-8.45E-4	-6.50E-5	0.00E+0	-8.76E-4	0.00E+0	-1.00E-4	0.00E+0	-8.73E-4	-2.76E-5	-2.76E-4
36	-3.98E-4	-1.32E-4	-1.00E-4	-1.60E-3	-9.00E-6	0.00E+0	-1.64E-3	0.00E+0	-1.00E-4	-7.00E-6	-1.56E-3	-4.21E-5	-2.73E-4
37	-2.34E-4	-1.04E-4	-9.15E-5	6.50E-4	0.00E+0	0.00E+0	6.37E-4	0.00E+0	0.00E+0	5.00E-6	5.75E-4	-1.58E-6	-2.00E-4
38	-2.98E-4	-1.02E-4	-1.08E-4	-1.07E-4	0.00E+0	0.00E+0	-1.24E-4	0.00E+0	-1.00E-4	-2.00E-6	-1.30E-4	-1.32E-5	-2.39E-4
39	-3.85E-4	-7.70E-5	-1.44E-4	-8.63E-4	0.00E+0	0.00E+0	-8.90E-4	0.00E+0	0.00E+0	-2.00E-6	-8.53E-4	-3.93E-5	-2.86E-4
40	-4.20E-4	-3.85E-5	-5.80E-5	-1.57E-3	0.00E+0	0.00E+0	-1.61E-3	0.00E+0	-2.00E-4	-4.00E-6	-1.46E-3	-5.57E-5	-2.38E-4
41	-2.29E-4	-1.07E-4	-5.80E-5	5.02E-4	0.00E+0	0.00E+0	4.86E-4	0.00E+0	0.00E+0	2.00E-6	4.53E-4	-7.40E-7	-2.17E-4
42	-3.05E-4	-8.98E-5	-7.33E-5	-1.94E-4	0.00E+0	0.00E+0	-2.11E-4	0.00E+0	0.00E+0	-6.00E-6	-1.88E-4	-5.56E-5	-2.54E-4
43	-4.02E-4	-3.84E-5	-1.90E-5	-8.61E-4	0.00E+0	0.00E+0	-8.90E-4	0.00E+0	-1.00E-4	-9.00E-6	-8.30E-4	-1.29E-4	-2.98E-4
44	-4.10E-4	-5.20E-6	-1.95E-4	-1.44E-3	0.00E+0	0.00E+0	-1.46E-3	0.00E+0	-1.00E-4	-4.00E-6	-1.23E-3	-5.60E-5	-2.23E-4
45	-1.74E-4	-8.53E-5	-6.09E-5	3.23E-4	0.00E+0	0.00E+0	3.17E-4	0.00E+0	0.00E+0	2.00E-6	2.86E-4	1.08E-5	-2.18E-4
46	-2.56E-4	-8.28E-5	0.00E+0	-2.58E-4	0.00E+0	0.00E+0	-2.68E-4	0.00E+0	0.00E+0	0.00E+0	-2.46E-4	-1.17E-4	-2.82E-4
47	-3.45E-4	-8.93E-5	-6.20E-5	-7.48E-4	0.00E+0	-7.00E-6	-7.61E-4	0.00E+0	-2.00E-4	-8.00E-6	-6.15E-4	-1.96E-4	-3.08E-4
48	-3.26E-4	-1.06E-5	-2.15E-4	-1.01E-3	0.00E+0	0.00E+0	-1.00E-3	0.00E+0	-1.00E-4	-6.00E-6	-7.83E-4	-1.18E-4	-1.11E-4
49	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-6	-6.00E-6	0.00E+0	0.00E+0
50	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.00E-6	-6.00E-6	0.00E+0	0.00E+0
51	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-9.00E-6	-2.00E-6	0.00E+0	0.00E+0
52	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.00E-6	-7.00E-6	0.00E+0	0.00E+0

SUMMER CONDITION

NODAL DISPLACEMENTS "DX" IN THE DAM BODY
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	1.40E-2	1.40E-2	1.45E-2	2.24E-2	1.33E-2	1.65E-2	2.52E-2	1.69E-2	1.55E-2	1.26E-2	2.14E-2	1.38E-2	1.35E-2	2.27E-2
2	1.42E-2	1.41E-2	1.46E-2	2.26E-2	1.34E-2	1.66E-2	2.53E-2	1.70E-2	1.57E-2	1.27E-2	2.15E-2	1.39E-2	1.36E-2	2.28E-2
3	1.43E-2	1.42E-2	1.47E-2	2.27E-2	1.35E-2	1.68E-2	2.55E-2	1.72E-2	1.58E-2	1.28E-2	2.16E-2	1.41E-2	1.38E-2	2.30E-2
4	1.44E-2	1.43E-2	1.49E-2	2.28E-2	1.37E-2	1.69E-2	2.56E-2	1.73E-2	1.59E-2	1.29E-2	2.17E-2	1.42E-2	1.39E-2	2.31E-2
5	1.45E-2	1.43E-2	1.47E-2	2.13E-2	1.36E-2	1.61E-2	2.31E-2	1.64E-2	1.55E-2	1.30E-2	2.02E-2	1.43E-2	1.32E-2	2.06E-2
6	1.46E-2	1.44E-2	1.48E-2	2.13E-2	1.37E-2	1.62E-2	2.31E-2	1.65E-2	1.56E-2	1.31E-2	2.03E-2	1.44E-2	1.33E-2	2.06E-2
7	1.47E-2	1.45E-2	1.49E-2	2.14E-2	1.37E-2	1.63E-2	2.32E-2	1.66E-2	1.57E-2	1.32E-2	2.03E-2	1.45E-2	1.34E-2	2.07E-2
8	1.48E-2	1.46E-2	1.50E-2	2.16E-2	1.39E-2	1.64E-2	2.34E-2	1.67E-2	1.58E-2	1.33E-2	2.04E-2	1.46E-2	1.35E-2	2.09E-2
9	9.79E-3	9.74E-3	1.00E-2	8.00E-3	9.13E-3	1.11E-2	9.11E-3	1.15E-2	1.07E-2	8.65E-3	7.79E-3	9.76E-3	8.70E-3	6.40E-3
10	9.99E-3	9.95E-3	1.02E-2	8.16E-3	9.33E-3	1.13E-2	9.29E-3	1.17E-2	1.09E-2	8.85E-3	7.94E-3	9.97E-3	8.90E-3	6.57E-3
11	1.02E-2	1.02E-2	1.05E-2	8.32E-3	9.54E-3	1.15E-2	9.47E-3	1.19E-2	1.11E-2	9.06E-3	8.11E-3	1.02E-2	9.10E-3	6.75E-3
12	1.05E-2	1.04E-2	1.07E-2	8.56E-3	9.81E-3	1.18E-2	9.72E-3	1.22E-2	1.14E-2	9.32E-3	8.28E-3	1.04E-2	9.37E-3	6.99E-3
13	5.78E-3	5.76E-3	6.02E-3	5.27E-3	5.29E-3	6.60E-3	5.78E-3	7.03E-3	6.40E-3	4.97E-3	5.05E-3	5.82E-3	4.93E-3	3.35E-3
14	6.05E-3	6.02E-3	6.28E-3	5.46E-3	5.54E-3	6.90E-3	6.02E-3	7.33E-3	6.70E-3	5.22E-3	5.31E-3	6.08E-3	5.17E-3	3.55E-3
15	6.32E-3	6.29E-3	6.55E-3	5.66E-3	5.81E-3	7.20E-3	6.27E-3	7.64E-3	6.90E-3	5.48E-3	5.61E-3	6.35E-3	5.42E-3	3.77E-3
16	6.66E-3	6.63E-3	6.90E-3	5.94E-3	6.14E-3	7.58E-3	6.58E-3	8.03E-3	7.30E-3	5.80E-3	5.81E-3	6.68E-3	5.74E-3	4.05E-3
17	2.66E-3	2.68E-3	2.70E-3	2.01E-3	2.29E-3	2.84E-3	2.39E-3	2.86E-3	2.80E-3	2.16E-3	1.56E-3	2.66E-3	2.24E-3	1.89E-3
18	2.89E-3	2.91E-3	2.94E-3	2.17E-3	2.51E-3	3.08E-3	2.56E-2	3.11E-3	3.10E-3	2.38E-3	1.66E-3	2.88E-3	2.44E-3	2.04E-3
19	3.14E-3	3.15E-3	3.18E-3	2.33E-3	2.74E-3	3.32E-3	2.73E-3	3.35E-3	3.30E-3	2.60E-3	1.76E-3	3.12E-3	2.63E-3	2.20E-3
20	3.46E-3	3.46E-3	3.49E-3	2.56E-3	3.04E-3	3.63E-3	2.99E-3	3.68E-3	3.60E-3	2.88E-3	2.09E-3	3.43E-3	2.89E-3	2.44E-3
21	1.09E-3	1.08E-3	1.10E-3	1.03E-3	8.88E-4	1.12E-3	1.16E-3	1.10E-3	1.10E-3	8.41E-4	7.95E-4	1.08E-3	9.09E-4	9.42E-4
22	1.21E-3	1.20E-3	1.23E-3	1.11E-3	1.00E-3	1.26E-3	1.27E-3	1.24E-3	1.30E-3	9.79E-4	9.05E-4	1.21E-3	1.03E-3	1.03E-3
23	1.33E-3	1.33E-3	1.35E-3	1.20E-3	1.12E-3	1.40E-3	1.39E-3	1.39E-3	1.40E-3	1.10E-3	9.78E-4	1.33E-3	1.15E-3	1.12E-3
24	1.52E-3	1.52E-3	1.54E-3	1.35E-3	1.29E-3	1.62E-3	1.57E-3	1.60E-3	1.60E-3	1.23E-3	1.11E-3	1.52E-3	1.33E-3	1.28E-3
25	1.12E-2	1.10E-2	1.13E-2	1.56E-2	1.03E-2	1.22E-2	1.66E-2	1.24E-2	1.18E-2	9.84E-3	1.44E-2	1.11E-2	9.53E-3	1.42E-2
26	1.13E-2	1.11E-2	1.14E-2	1.57E-2	1.04E-2	1.22E-2	1.66E-2	1.24E-2	1.19E-2	9.93E-3	1.45E-2	1.12E-2	9.61E-3	1.43E-2
27	1.13E-2	1.11E-2	1.14E-2	1.57E-2	1.04E-2	1.23E-2	1.67E-2	1.25E-2	1.20E-2	9.98E-3	1.45E-2	1.12E-2	9.65E-3	1.43E-2
28	1.15E-2	1.13E-2	1.16E-2	1.59E-2	1.06E-2	1.24E-2	1.68E-2	1.26E-2	1.21E-2	1.02E-2	1.47E-2	1.14E-2	9.81E-3	1.45E-2
29	7.43E-3	7.38E-3	7.54E-3	6.59E-3	6.84E-3	8.11E-3	7.20E-3	8.42E-3	7.90E-3	6.42E-3	6.10E-3	7.46E-3	6.05E-3	5.13E-3
30	7.66E-3	7.61E-3	7.77E-3	6.77E-3	7.06E-3	8.35E-3	7.40E-3	8.65E-3	8.20E-3	6.64E-3	6.26E-3	7.69E-3	6.27E-3	5.32E-3
31	7.84E-3	7.80E-3	7.96E-3	6.91E-3	7.25E-3	8.55E-3	7.55E-3	8.85E-3	8.40E-3	6.83E-3	6.40E-3	7.88E-3	6.46E-3	5.46E-3
32	8.18E-3	8.13E-3	8.29E-3	7.19E-3	7.58E-3	8.90E-3	7.85E-3	9.19E-3	8.70E-3	7.16E-3	6.63E-3	8.21E-3	6.79E-3	5.76E-3
33	4.22E-3	4.11E-3	4.33E-3	4.29E-3	3.82E-3	4.60E-3	4.59E-3	5.18E-3	4.50E-3	3.52E-3	3.73E-3	4.28E-3	2.71E-3	2.51E-3
34	4.51E-3	4.41E-3	4.62E-3	4.61E-3	4.11E-3	4.93E-3	4.84E-3	5.48E-3	4.80E-3	3.80E-3	4.02E-3	4.57E-3	3.00E-3	2.76E-3
35	4.78E-3	4.68E-3	4.88E-3	4.69E-3	4.36E-3	5.23E-3	5.05E-3	5.75E-3	5.10E-3	4.03E-3	4.34E-3	4.84E-3	3.26E-3	2.96E-3
36	5.18E-3	5.09E-3	5.29E-3	5.01E-3	4.76E-3	5.68E-3	5.42E-3	6.17E-3	5.50E-3	4.44E-3	4.63E-3	5.23E-3	3.69E-3	3.33E-3
37	1.88E-3	1.88E-3	1.83E-3	1.65E-3	1.67E-3	1.85E-3	1.65E-3	1.74E-3	1.90E-3	1.48E-3	1.35E-3	1.88E-3	1.17E-3	1.03E-3
38	2.12E-3	2.12E-3	2.06E-3	1.80E-3	1.88E-3	2.08E-3	1.81E-3	1.95E-3	2.10E-3	1.67E-3	1.41E-3	2.11E-3	1.30E-3	1.09E-3
39	2.34E-3	2.35E-3	2.27E-3	1.93E-3	2.08E-3	2.29E-3	1.93E-3	2.12E-3	2.40E-3	1.82E-3	1.45E-3	2.34E-3	1.41E-3	1.15E-3
40	2.68E-3	2.69E-3	2.59E-3	2.17E-3	2.41E-3	2.60E-3	2.16E-3	2.40E-3	2.70E-3	2.25E-3	1.91E-3	2.64E-3	1.61E-3	1.30E-3
41	4.69E-3	4.65E-3	4.73E-3	5.80E-3	4.19E-3	5.00E-3	6.05E-3	5.04E-3	4.90E-3	3.93E-3	5.06E-3	4.75E-3	3.23E-3	4.37E-3
42	4.70E-3	4.66E-3	4.74E-3	5.79E-3	4.21E-3	5.01E-3	6.04E-3	5.04E-3	4.90E-3	3.96E-3	5.07E-3	4.76E-3	3.24E-3	4.36E-3
43	4.62E-3	4.58E-3	4.66E-3	5.71E-3	4.14E-3	4.93E-3	5.95E-3	4.97E-3	4.80E-3	3.88E-3	4.93E-3	4.68E-3	3.16E-3	4.27E-3
44	4.79E-3	4.75E-3	4.83E-3	5.89E-3	4.33E-3	5.09E-3	6.13E-3	5.14E-3	5.00E-3	4.07E-3	5.11E-3	4.85E-3	3.33E-3	4.45E-3
45	2.33E-3	2.34E-3	2.34E-3	2.24E-3	2.10E-3	3.49E-3	3.26E-3	2.47E-3	2.40E-3	1.89E-3	1.91E-3	2.38E-3	1.61E-3	1.55E-3
46	2.50E-3	2.51E-3	2.51E-3	2.39E-3	2.25E-3	3.61E-3	3.37E-3	2.65E-3	2.60E-3	2.05E-3	2.04E-3	2.55E-3	1.74E-3	1.65E-3
47	2.61E-3	2.61E-3	2.62E-3	2.47E-3	2.35E-3	3.63E-3	3.38E-3	2.78E-3	2.70E-3	2.06E-3	2.01E-3	2.66E-3	1.79E-3	1.68E-3
48	2.92E-3	2.93E-3	2.95E-3	2.77E-3	2.70E-3	3.90E-3	3.62E-3	3.10E-3	3.00E-3	2.52E-3	2.43E-3	2.96E-3	2.04E-3	1.90E-3
49	1.54E-3	1.55E-3	1.56E-3	1.64E-3	1.36E-3	1.60E-3	1.67E-3	1.59E-3	1.60E-3	1.27E-3	1.40E-3	1.56E-3	7.26E-4	8.08E-4
50	1.66E-3	1.67E-3	1.67E-3	1.78E-3	1.50E-3	1.73E-3	1.82E-3	1.72E-3	1.70E-3	1.37E-3	1.54E-3	1.71E-3	7.91E-4	8.86E-4
51	1.62E-3	1.62E-3	1.63E-3	1.77E-3	1.47E-3	1.69E-3	1.82E-3	1.70E-3	1.60E-3	1.35E-3	1.52E-3	1.66E-3	7.44E-4	8.75E-4
52	1.55E-3	1.55E-3	1.56E-3	1.70E-3	1.43E-3	1.61E-3	1.74E-3	1.62E-3	1.60E-3	1.34E-3	1.49E-3	1.57E-3	7.96E-4	9.19E-4

SUMMER CONDITION

NODAL DISPLACEMENTS "DY" IN THE DAM BODY
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	6.8E-35	-2.7E-25	8.76E-8	-1.44E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
2	-2.2E-30	-2.0E-25	1.08E-7	-1.31E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
3	-2.0E-30	2.2E-25	1.27E-7	-5.53E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
4	-8.1E-36	4.1E-25	1.47E-7	-1.32E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
5	-3.4E-30	-1.4E-24	1.44E-8	-4.88E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
6	-1.1E-29	-2.3E-24	3.67E-8	-3.51E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
7	-9.5E-30	-1.4E-24	5.98E-8	-3.33E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
8	-2.9E-30	-1.3E-25	8.24E-8	-2.34E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
9	1.66E-3	1.71E-3	1.75E-3	3.81E-4	1.58E-3	2.21E-3	7.90E-4	2.19E-3	-2.10E-3	-1.58E-3	-5.12E-4	1.74E-3	1.81E-3	1.03E-4
10	1.24E-3	1.29E-3	1.33E-3	1.09E-4	1.17E-3	1.75E-3	4.59E-4	1.74E-3	-1.60E-3	-1.18E-3	-2.74E-4	1.32E-3	1.40E-3	-2.13E-4
11	8.05E-4	8.50E-4	8.81E-4	-1.80E-4	7.46E-4	1.26E-3	1.07E-4	1.26E-3	-1.10E-3	-7.64E-4	5.60E-5	8.87E-4	9.71E-4	-5.48E-4
12	3.87E-4	4.32E-4	4.57E-4	-4.50E-4	3.39E-4	7.89E-4	-2.29E-4	8.10E-4	-7.00E-4	-3.69E-4	1.11E-4	4.75E-4	5.69E-4	-8.62E-4
13	1.11E-3	1.16E-3	1.17E-3	2.55E-4	9.92E-4	1.49E-3	4.59E-4	1.52E-3	-1.40E-3	-1.02E-3	-4.84E-4	1.21E-3	1.21E-3	-2.17E-4
14	6.84E-4	7.46E-4	7.49E-4	-8.34E-6	6.00E-4	1.00E-3	1.06E-4	1.04E-3	-9.00E-4	-6.47E-4	-1.27E-4	8.01E-4	8.20E-4	-5.14E-4
15	2.40E-4	3.19E-4	3.09E-4	-2.99E-4	1.93E-4	4.80E-4	-2.88E-4	5.10E-4	-4.00E-4	-2.60E-4	3.00E-4	3.77E-4	4.11E-4	-8.37E-4
16	-1.70E-4	-7.31E-5	-1.02E-4	-5.65E-4	-1.82E-4	-7.00E-6	-6.60E-4	1.00E-5	0.00E+0	9.50E-5	3.66E-4	-1.21E-5	1.97E-5	-1.13E-3
17	-6.11E-6	3.83E-5	-3.33E-5	-7.46E-4	-1.52E-4	4.79E-4	-1.87E-4	5.00E-4	-3.00E-4	3.50E-5	9.46E-4	6.97E-5	3.18E-4	-4.88E-4
18	-2.62E-4	-2.16E-4	-2.88E-4	-8.70E-4	-3.83E-4	2.13E-4	-3.35E-4	2.20E-4	-1.00E-4	2.51E-4	9.45E-4	-1.79E-4	1.15E-4	-6.07E-4
19	-5.31E-4	-4.82E-4	-5.53E-4	-1.00E-3	-6.22E-4	-5.80E-5	-4.89E-4	-6.00E-5	2.00E-4	4.73E-4	9.12E-4	-4.39E-4	-9.43E-5	-7.38E-4
20	-7.51E-4	-7.00E-4	-7.64E-4	-1.09E-3	-8.17E-4	-2.75E-4	-5.88E-4	-3.00E-4	4.00E-4	6.46E-4	1.11E-3	-6.51E-4	-2.52E-4	-8.24E-4
21	-8.65E-4	-8.45E-4	-8.90E-4	-9.99E-4	-9.94E-4	-5.96E-4	-6.65E-4	-6.10E-4	7.00E-4	7.57E-4	9.18E-4	-8.05E-4	-4.17E-4	-7.53E-4
22	-9.13E-4	-8.98E-4	-9.41E-4	-1.00E-3	-1.03E-3	-6.71E-4	-7.05E-4	-6.80E-4	7.00E-4	8.27E-4	9.50E-4	-8.61E-4	-4.71E-4	-7.67E-4
23	-9.69E-4	-9.59E-4	-1.00E-3	-1.02E-3	-1.07E-3	-7.53E-4	-7.53E-4	-7.70E-4	8.00E-4	8.65E-4	9.11E-4	-9.19E-4	-5.27E-4	-7.84E-4
24	-9.66E-4	-9.62E-4	-1.00E-3	-9.71E-4	-1.05E-3	-7.76E-4	-7.40E-4	-7.90E-4	8.00E-4	8.13E-4	8.58E-4	-9.25E-4	-5.33E-4	-7.49E-4
25	-4.4E-30	-2.0E-24	-5.43E-8	-1.79E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
26	-1.4E-29	-3.5E-24	-3.11E-8	-1.44E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
27	-1.1E-29	-2.7E-24	-7.00E-9	-1.03E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
28	-3.6E-30	-7.5E-25	1.58E-8	-6.10E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
29	1.68E-3	1.76E-3	1.82E-3	7.75E-4	1.53E-3	2.13E-3	1.10E-3	2.06E-3	-2.00E-3	-1.55E-3	-7.93E-4	1.75E-3	1.79E-3	5.94E-4
30	1.24E-3	1.31E-3	1.37E-3	4.73E-4	1.11E-3	1.64E-3	7.50E-4	1.59E-3	-1.50E-3	-1.14E-3	-5.57E-4	1.31E-3	1.35E-3	2.64E-4
31	7.63E-4	8.34E-4	8.90E-4	1.47E-4	6.61E-4	1.12E-3	3.74E-4	1.09E-3	-1.00E-3	-7.02E-4	-2.20E-4	8.43E-4	8.79E-4	-8.94E-5
32	3.43E-4	4.10E-4	4.62E-4	-1.28E-4	2.65E-4	6.45E-4	4.70E-5	6.40E-4	-6.00E-4	-3.16E-4	-8.40E-5	4.27E-4	4.61E-4	-3.91E-4
33	1.13E-3	1.18E-3	1.22E-3	5.99E-4	9.13E-4	1.38E-3	7.67E-4	1.29E-3	-1.30E-3	-9.66E-4	-6.68E-4	1.19E-3	1.18E-3	2.81E-4
34	6.91E-4	7.38E-4	7.97E-4	3.18E-4	5.13E-4	8.85E-4	4.19E-4	8.40E-4	-9.00E-4	-5.89E-4	-3.19E-4	7.64E-4	7.22E-4	-6.36E-5
35	2.30E-4	2.71E-4	3.38E-4	5.30E-6	9.30E-5	3.42E-4	3.00E-5	3.50E-4	-3.00E-4	-1.99E-4	1.11E-4	3.10E-4	2.61E-4	-4.08E-4
36	-1.42E-4	-1.10E-4	-3.67E-5	-2.27E-4	-2.43E-4	-1.19E-4	-2.81E-4	-5.00E-5	1.00E-4	1.32E-4	1.88E-4	-5.77E-5	-1.36E-4	-6.84E-4
37	-1.93E-5	1.22E-4	4.67E-5	-5.61E-4	-2.28E-4	2.41E-4	-3.49E-4	2.60E-4	-2.00E-4	1.45E-4	6.46E-4	2.57E-5	1.77E-4	-6.84E-4
38	-2.67E-4	-1.35E-4	-1.89E-4	-6.79E-4	-4.29E-4	-1.00E-5	-4.83E-4	4.00E-5	1.00E-4	2.90E-4	5.94E-4	-2.16E-4	4.49E-5	-7.12E-4
39	-5.42E-4	-4.17E-4	-4.51E-4	-8.23E-4	-6.46E-4	-2.74E-4	-6.29E-4	-2.00E-4	4.00E-4	4.59E-4	5.34E-4	-4.78E-4	-1.13E-4	-7.65E-4
40	-6.99E-4	-5.84E-4	-5.93E-4	-8.58E-4	-7.44E-4	-4.11E-4	-6.58E-4	-3.00E-4	5.00E-4	6.03E-4	6.77E-4	-6.30E-4	-1.34E-4	-6.93E-4
41	-3.2E-30	-1.1E-24	-3.97E-8	-3.12E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
42	-9.5E-30	-1.8E-24	-3.08E-8	-2.53E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
43	-6.9E-30	-1.4E-24	-2.24E-8	-1.83E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
44	-2.6E-30	-1.7E-25	-1.54E-8	-1.37E-8	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
45	4.86E-4	4.99E-4	5.42E-4	2.80E-4	2.46E-4	8.52E-4	5.77E-4	5.90E-4	-6.00E-4	-3.60E-4	-2.77E-4	4.85E-4	5.21E-4	1.50E-4
46	7.35E-5	8.92E-5	1.31E-4	-6.31E-5	-1.16E-4	4.56E-4	2.42E-4	1.50E-4	-2.00E-4	5.10E-5	4.80E-5	7.98E-5	2.38E-4	-7.20E-6
47	-3.35E-4	-3.17E-4	-2.83E-4	-4.12E-4	-4.61E-4	8.80E-5	-6.60E-5	-2.70E-4	3.00E-4	2.87E-4	2.57E-4	-3.30E-4	-5.26E-5	-3.12E-4
48	-6.29E-4	-6.09E-4	-5.83E-4	-6.60E-4	-6.92E-4	-1.62E-4	-2.65E-4	-6.00E-4	6.00E-4	6.26E-4	5.35E-4	-6.28E-4	-2.23E-4	-4.33E-4
49	-1.9E-30	-3.9E-25	-2.37E-8	-5.49E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
50	-2.2E-30	1.6E-26	-2.26E-8	-2.73E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
51	-4.3E-30	-1.9E-25	-1.90E-8	-1.42E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
52	-6.6E-31	5.7E-25	-2.15E-8	-8.87E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

SUMMER CONDITION

NODAL DISPLACEMENTS "DZ" IN THE DAM BODY
[m]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-3.31E-4	-4.22E-4	-4.95E-4	-1.15E-3	-6.98E-4	-6.64E-4	-1.58E-3	-6.20E-4	-5.00E-4	-1.05E-4	-1.19E-3	-2.75E-4	-1.01E-3	-1.78E-3
2	-1.09E-4	-1.96E-4	-2.81E-4	-1.04E-3	-4.74E-4	-5.11E-4	-1.56E-3	-4.90E-4	-3.00E-4	1.39E-4	-1.06E-3	-3.59E-5	-8.45E-4	-1.76E-3
3	8.84E-5	-4.75E-6	-1.02E-4	-9.62E-4	-2.89E-4	-3.92E-4	-1.57E-3	-3.80E-4	-2.00E-4	3.44E-4	-9.50E-4	1.65E-4	-7.26E-4	-1.77E-3
4	2.79E-4	1.75E-4	6.51E-5	-8.95E-4	-1.18E-4	-2.76E-4	-1.58E-3	-2.80E-4	0.00E+0	5.33E-4	-8.65E-4	3.58E-4	-6.15E-4	-1.78E-3
5	-8.21E-4	-8.41E-4	-8.70E-4	-8.60E-4	-1.16E-3	-8.03E-4	-9.03E-4	-7.50E-4	-8.00E-4	-6.12E-4	-8.91E-4	-7.49E-4	-1.15E-3	-1.07E-3
6	-1.06E-3	-1.08E-3	-1.12E-3	-1.33E-3	-1.39E-3	-1.12E-3	-1.48E-3	-1.07E-3	-1.10E-3	-8.33E-4	-1.37E-3	-9.68E-4	-1.44E-3	-1.64E-3
7	-1.23E-3	-1.27E-3	-1.33E-3	-1.76E-3	-1.58E-3	-1.40E-3	-2.02E-3	-1.36E-3	-1.30E-3	-1.01E-3	-1.77E-3	-1.15E-3	-1.70E-3	-2.18E-3
8	-1.39E-3	-1.45E-3	-1.52E-3	-2.15E-3	-1.75E-3	-1.65E-3	-2.52E-3	-1.63E-3	-1.50E-3	-1.17E-3	-2.14E-3	-1.31E-3	-1.94E-3	-2.68E-3
9	-5.32E-4	-5.90E-4	-6.36E-4	-4.99E-4	-9.40E-4	-5.86E-4	-4.74E-4	-5.90E-4	-6.00E-4	-4.19E-4	-3.82E-4	-5.71E-4	-7.12E-4	-6.07E-4
10	-6.54E-4	-7.18E-4	-7.75E-4	-4.73E-4	-1.06E-3	-7.84E-4	-5.10E-4	-7.90E-4	-8.00E-4	-6.34E-4	-4.01E-4	-6.82E-4	-9.05E-4	-5.79E-4
11	-7.38E-4	-8.09E-4	-8.77E-4	-3.98E-4	-1.14E-3	-9.47E-4	-4.97E-4	-9.50E-4	-9.00E-4	-6.04E-4	-3.77E-4	-7.57E-4	-1.07E-3	-5.08E-4
12	-8.09E-4	-8.90E-4	-9.66E-4	-3.11E-4	-1.21E-3	-1.10E-3	-4.71E-4	-1.09E-3	-1.00E-3	-6.64E-4	-3.01E-4	-8.19E-4	-1.22E-3	-4.26E-4
13	-4.01E-4	-5.42E-4	-6.61E-4	-5.80E-4	-7.95E-4	-4.73E-4	-5.59E-4	-5.40E-4	-5.00E-4	-3.12E-4	-4.07E-4	-4.65E-4	-5.68E-4	-6.80E-4
14	-4.16E-4	-5.80E-4	-6.84E-4	-4.28E-4	-8.14E-4	-5.57E-4	-4.26E-4	-5.90E-4	-5.00E-4	-3.31E-4	-3.49E-4	-4.83E-4	-6.89E-4	-5.23E-4
15	-3.96E-4	-5.82E-4	-6.71E-4	-2.25E-4	-7.99E-4	-6.07E-4	-2.34E-4	-6.00E-4	-6.00E-4	-3.14E-4	-2.52E-4	-4.67E-4	-7.82E-4	-3.13E-4
16	-3.71E-4	-5.83E-4	-6.51E-4	-1.02E-5	-7.79E-4	-6.53E-4	-3.10E-5	-6.00E-4	-6.00E-4	-2.90E-4	-9.00E-5	-4.43E-4	-8.68E-4	-9.57E-5
17	-4.02E-4	-3.44E-4	-2.53E-4	-5.51E-4	-7.10E-4	-3.99E-4	-5.29E-4	-3.40E-4	-4.00E-4	-2.83E-4	-4.36E-4	-4.20E-4	-5.06E-4	-4.43E-4
18	-3.37E-4	-2.58E-4	-1.86E-4	-5.04E-4	-6.30E-4	-3.62E-4	-5.77E-4	-3.10E-4	-4.00E-4	-2.13E-4	-3.68E-4	-3.46E-4	-4.94E-4	-4.71E-4
19	-2.42E-4	-1.42E-4	-8.73E-5	-4.35E-4	-5.21E-4	-2.92E-4	-6.14E-4	-2.60E-4	-3.00E-4	-1.15E-4	-2.85E-4	-2.42E-4	-4.55E-4	-4.85E-4
20	-1.47E-4	-2.09E-5	1.04E-5	-3.75E-4	-4.12E-4	-2.23E-4	-6.62E-4	-2.00E-4	-2.00E-4	-1.30E-5	-2.60E-4	-1.37E-4	-4.15E-4	-5.04E-4
21	-4.02E-4	-4.13E-4	-3.88E-4	-4.74E-4	-6.79E-4	-4.06E-4	-4.00E-4	-4.20E-4	-4.00E-4	-3.30E-4	-4.13E-4	-4.32E-4	-5.07E-4	-4.44E-4
22	-2.94E-4	-2.94E-4	-2.69E-4	-3.75E-4	-5.53E-4	-3.20E-4	-3.66E-4	-3.30E-4	-3.00E-4	-2.30E-4	-3.11E-4	-3.19E-4	-4.37E-4	-3.80E-4
23	-1.65E-4	-1.54E-4	-1.29E-4	-2.59E-4	-4.06E-4	-2.14E-4	-3.20E-4	-2.10E-4	-2.00E-4	-1.07E-4	-1.89E-4	-1.87E-4	-3.50E-4	-3.02E-4
24	-4.36E-5	-2.09E-5	3.55E-6	-1.52E-4	-2.66E-4	-1.15E-4	-2.83E-4	-1.10E-4	-1.00E-4	3.00E-5	-6.90E-5	-6.07E-5	-2.71E-4	-2.32E-4
25	3.89E-4	3.78E-4	3.97E-4	1.26E-3	-3.10E-5	6.30E-4	1.45E-3	7.40E-4	6.00E-4	4.78E-4	1.25E-3	4.30E-4	1.91E-4	1.18E-3
26	-3.53E-4	-3.57E-4	-3.60E-4	8.15E-5	-7.43E-4	-2.04E-4	1.68E-4	-1.20E-4	-2.00E-4	-2.14E-4	7.70E-6	-2.90E-4	-5.76E-4	-5.75E-5
27	-1.08E-3	-1.07E-3	-1.10E-3	-1.08E-3	-1.44E-3	-1.03E-3	-1.11E-3	-9.60E-4	-1.00E-3	-8.89E-4	-1.06E-3	-9.92E-4	-1.33E-3	-1.29E-3
28	-1.80E-3	-1.79E-3	-1.84E-3	-2.24E-3	-2.14E-3	-1.84E-3	-2.38E-3	-1.80E-3	-1.80E-3	-1.56E-3	-2.20E-3	-1.69E-3	-2.09E-3	-2.52E-3
29	2.28E-4	1.44E-4	1.60E-4	5.22E-5	-2.75E-4	3.42E-4	2.30E-4	4.40E-4	3.00E-4	2.22E-4	1.89E-4	1.73E-4	2.89E-5	-1.53E-4
30	-3.40E-4	-4.16E-4	-4.25E-4	-3.77E-4	-8.22E-4	-3.18E-4	-2.80E-4	-2.60E-4	-3.00E-4	-3.09E-4	-2.60E-4	-3.91E-4	-5.21E-4	-5.22E-4
31	-8.99E-4	-9.68E-4	-1.00E-3	-7.91E-4	-1.36E-3	-9.73E-4	-7.77E-4	-9.50E-4	-1.00E-3	-8.29E-4	-6.90E-4	-9.46E-4	-1.07E-3	-8.80E-4
32	-1.46E-3	-1.52E-3	-1.58E-3	-1.21E-3	-1.90E-3	-1.63E-3	-1.28E-3	-1.63E-3	-1.60E-3	-1.35E-3	-1.12E-3	-1.50E-3	-1.62E-3	-1.24E-3
33	8.66E-5	-1.42E-4	-1.80E-4	2.16E-4	-4.92E-4	2.20E-5	-1.11E-4	8.00E-5	0.00E+0	-1.40E-5	-9.60E-5	-7.37E-5	-1.67E-4	-4.33E-4
34	-5.08E-4	-5.55E-4	-6.28E-4	-6.05E-4	-8.86E-4	-4.72E-4	-5.47E-4	-4.60E-4	-5.00E-4	-4.04E-4	-4.81E-4	-4.93E-4	-5.94E-4	-7.43E-4
35	-9.24E-4	-9.65E-4	-1.07E-3	-9.81E-4	-1.28E-3	-9.63E-4	-9.69E-4	-1.00E-3	-1.00E-3	-7.77E-4	-8.46E-4	-9.15E-4	-1.01E-3	-1.04E-3
36	-1.34E-3	-1.38E-3	-1.51E-3	-1.36E-3	-1.67E-3	-1.45E-3	-1.40E-3	-1.54E-3	-1.40E-3	-1.16E-3	-1.22E-3	-1.34E-3	-1.43E-3	-1.36E-3
37	-2.52E-4	-2.23E-4	-1.62E-4	-5.79E-4	-7.07E-4	-2.62E-4	-5.59E-4	-2.20E-4	-3.00E-4	-2.80E-4	-5.67E-4	-3.10E-4	-3.20E-4	-4.24E-4
38	-5.12E-4	-5.00E-4	-4.21E-4	-6.94E-4	-9.34E-4	-5.61E-4	-7.25E-4	-5.20E-4	-5.00E-4	-5.16E-4	-6.35E-4	-5.73E-4	-6.03E-4	-6.24E-4
39	-7.83E-4	-7.88E-4	-6.91E-4	-8.26E-4	-1.16E-3	-8.70E-4	-9.07E-4	-8.20E-4	-9.00E-4	-6.96E-4	-6.91E-4	-8.56E-4	-9.05E-4	-8.46E-4
40	-1.04E-3	-1.07E-3	-9.57E-4	-9.47E-4	-1.39E-3	-1.17E-3	-1.07E-3	-1.10E-3	-1.10E-3	-9.32E-4	-7.50E-4	-1.12E-3	-1.20E-3	-1.05E-3
41	9.93E-4	9.75E-4	1.02E-3	1.91E-3	3.91E-4	1.28E-3	2.10E-3	1.35E-3	1.20E-3	8.68E-4	1.69E-3	1.06E-3	6.65E-4	1.63E-3
42	-1.04E-4	-9.49E-5	-8.37E-5	3.57E-4	-6.14E-4	8.20E-5	4.59E-4	1.40E-4	1.00E-4	-8.70E-5	2.90E-4	-2.81E-5	-3.13E-4	1.77E-4
43	-1.18E-3	-1.15E-3	-1.16E-3	-1.16E-3	-1.59E-3	-1.09E-3	-1.15E-3	-1.05E-3	-1.10E-3	-1.05E-3	-1.12E-3	-1.10E-3	-1.27E-3	-1.25E-3
44	-2.19E-3	-2.13E-3	-2.18E-3	-2.57E-3	-2.49E-3	-2.19E-3	-2.64E-3	-2.17E-3	-2.20E-3	-1.89E-3	-2.35E-3	-2.11E-3	-2.14E-3	-2.55E-3
45	2.68E-4	2.25E-4	2.26E-4	1.36E-4	-3.60E-4	7.15E-4	6.62E-4	4.10E-4	4.00E-4	1.06E-4	1.00E-4	2.51E-4	-3.48E-5	-1.18E-4
46	-5.10E-4	-5.54E-4	-5.65E-4	-5.34E-4	-1.06E-3	-2.65E-4	-1.68E-4	-4.60E-4	-5.00E-4	-6.07E-4	-5.51E-4	-5.30E-4	-6.83E-4	-6.59E-4
47	-1.28E-3	-1.32E-3	-1.34E-3	-1.20E-3	-1.73E-3	-1.21E-3	-9.79E-4	-1.32E-3	-1.30E-3	-1.15E-3	-1.04E-3	-1.31E-3	-1.34E-3	-1.21E-3
48	-1.97E-3	-2.01E-3	-2.04E-3	-1.80E-3	-2.33E-3	-2.09E-3	-1.74E-3	-2.09E-3	-2.10E-3	-1.74E-3	-1.59E-3	-2.01E-3	-1.91E-3	-1.70E-3
49	1.37E-4	1.53E-4	1.67E-4	5.28E-4	-5.94E-4	3.05E-4	6.13E-4	3.40E-4	3.00E-4	-6.90E-5	1.82E-4	2.26E-4	-1.86E-4	2.27E-4
50	-7.40E-4	-7.07E-4	-7.16E-4	-6.01E-4	-1.22E-3	-6.27E-4	-5.65E-4	-6.00E-4	-6.00E-4	-6.73E-4	-5.82E-4	-6.61E-4	-8.55E-4	-7.06E-4
51	-1.70E-3	-1.64E-3	-1.67E-3	-1.85E-3	-2.03E-3	-1.65E-3	-1.87E-3	-1.64E-3	-1.70E-3	-1.54E-3	-1.74E-3	-1.62E-3	-1.62E-3	-1.78E-3
52	-2.22E-3	-2.17E-3	-2.21E-3	-2.50E-3	-2.43E-3	-2.23E-3	-2.56E-3	-2.23E-3	-2.30E-3	-1.81E-3	-2.10E-3	-2.19E-3	-1.92E-3	-2.21E-3

SUMMER CONDITION

PRINCIPAL STRESSES "P1" IN THE DAM BODY [MPa]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	0.6514	0.4205	0.8511	0.8565	0.5464	0.8226	0.8965	0.8393	0.1500	0.1283	0.1587	0.0000	0.2530	0.1513
2	0.1934	0.0963	0.1592	0.1790	-0.9795	0.2361	0.2783	0.2599	0.0400	0.0048	-0.0809	0.0047	0.0838	0.1023
3	0.1705	0.0316	0.0063	0.0240	-0.4312	0.2341	0.2686	0.2276	0.0300	0.0416	-0.1770	-0.0013	0.0020	-0.0141
4	0.2061	0.0354	0.0559	0.0598	-0.1411	0.3719	0.4073	0.3573	0.0600	0.2235	-0.0535	0.0000	0.2128	0.0343
5	-0.2036	-0.2246	-0.2230	-0.2232	-0.4082	-0.1614	-0.1637	-0.1620	-0.1700	-0.1453	-0.2923	0.0000	-0.1255	-0.1802
6	-0.1360	-0.1772	-0.2030	-0.2001	0.1264	-0.1365	-0.1384	-0.1353	-0.1100	-0.1238	-0.4242	0.0000	-0.1135	-0.1105
7	0.0703	-0.0636	-0.0459	0.0879	0.1567	-0.0040	0.1303	0.0224	0.0300	0.0172	0.1618	0.0000	-0.0445	0.1487
8	-0.0163	-0.0470	-0.0925	-0.0947	-0.7861	-0.0661	-0.0690	-0.0490	0.0100	-0.0351	-0.2430	0.0000	0.0938	0.0101
9	-0.2084	-0.2291	-0.2605	-0.2623	-0.4235	-0.1949	-0.1965	-0.1943	-0.1700	-0.1513	-0.1929	0.0000	-0.1525	-0.1744
10	-0.1444	-0.1854	-0.2156	-0.2179	0.1268	-0.1624	-0.1614	-0.1564	-0.1200	-0.1307	-0.2054	0.0000	-0.1166	-0.1181
11	-0.0180	-0.0946	-0.1093	-0.1066	0.1536	-0.0547	-0.0297	-0.0363	-0.0200	-0.0115	-0.0893	0.0000	-0.0561	-0.0188
12	-0.0192	-0.0537	-0.0742	-0.0728	-0.8072	-0.0386	-0.0370	-0.0346	0.0100	-0.0444	-0.1262	0.0000	0.0500	0.0050
13	-0.1971	-0.2296	-0.3253	-0.3224	-0.4378	-0.2869	-0.2905	-0.3178	-0.1800	-0.1480	0.0334	0.0000	-0.2733	-0.1745
14	-0.1232	-0.1897	-0.2491	-0.2809	0.1310	-0.2415	-0.2331	-0.1034	-0.1000	-0.1317	0.1520	0.0000	-0.1243	-0.1009
15	0.2335	-0.0505	-0.0219	0.4648	0.1615	-0.0912	0.5590	0.1251	0.0700	-0.0249	0.3642	0.0000	-0.0083	0.5716
16	-0.0243	-0.0551	-0.0545	0.1360	-0.8262	-0.0823	0.4061	0.0332	0.0000	-0.0554	0.3131	0.0000	-0.0886	0.2095
17	-0.2013	-0.2266	-0.3032	-0.3129	-0.4525	-0.2806	-0.2835	-0.2216	-0.1700	-0.1524	0.0322	0.0000	-0.2832	-0.1752
18	-0.1502	-0.1911	-0.2895	-0.2704	0.1378	-0.2208	-0.2620	0.0595	-0.0900	-0.0690	0.2076	0.0000	-0.1300	-0.1363
19	-0.0179	0.0312	-0.0657	-0.2055	0.2525	0.1485	-0.2582	0.4669	0.2100	0.1306	0.3294	0.0000	-0.0125	-0.0971
20	-0.0343	-0.0719	-0.1292	-0.1073	-0.8428	-0.0633	-0.0795	0.0216	-0.0100	-0.0898	0.2907	0.0000	-0.1990	-0.0209
21	-0.2085	-0.2312	-0.3070	-0.3079	-0.4619	-0.2290	-0.2306	-0.2275	-0.1500	-0.2028	-0.1803	0.0000	-0.1901	-0.1901
22	-0.0088	-0.1492	-0.1299	-0.1203	0.1549	-0.1017	0.0183	-0.0877	-0.0600	-0.1198	-0.0366	0.0000	0.0252	0.0525
23	0.1658	0.0641	0.0965	-0.0100	0.2277	0.0976	-0.0215	0.1312	0.1600	-0.1161	-0.0958	0.0000	0.1139	0.0580
24	-0.1335	-0.1133	-0.2109	-0.2080	-0.8563	-0.0852	-0.0879	-0.0785	-0.0100	-0.2804	-0.1919	0.0000	-0.1211	-0.1141
25	-0.3595	-0.4158	-0.3897	-0.3982	-0.9138	-0.3121	-0.3196	-0.3171	-0.3300	-0.2894	-0.3936	0.0000	-0.3326	-0.3515
26	-0.1291	-0.2771	-0.2924	-0.2251	0.2027	-0.1867	-0.0806	-0.1477	-0.1600	-0.1479	-0.3450	0.0000	-0.1266	0.0315
27	0.0472	-0.1331	-0.1316	-0.0228	0.3475	-0.0338	0.0726	-0.0338	0.0000	-0.0351	-0.1060	0.0000	-0.0019	0.1006
28	-0.0220	-0.1078	-0.1722	-0.1732	-1.2049	-0.0938	-0.0961	-0.0920	0.0100	-0.0761	-0.3235	0.0000	0.0349	-0.0088
29	-0.3629	-0.4182	-0.4416	-0.4428	-0.9291	-0.3719	-0.3719	-0.3736	-0.3400	-0.3057	-0.3507	0.0000	-0.3336	-0.3458
30	-0.0646	-0.2477	-0.2720	-0.2860	0.2100	-0.1273	-0.1422	-0.1026	-0.0800	-0.0415	-0.1149	0.0000	-0.0080	-0.0703
31	0.0181	-0.1516	-0.1705	-0.1366	0.3339	-0.0492	-0.0082	-0.0478	0.0100	-0.0084	-0.0517	0.0000	-0.0540	0.0145
32	-0.0108	-0.1088	-0.1366	-0.1393	-1.2258	-0.0756	-0.0780	-0.0830	0.0000	-0.0855	-0.1856	0.0000	0.0126	-0.0067
33	-0.3425	-0.4144	-0.5235	-0.5301	-0.9391	-0.5013	-0.4959	-0.4753	-0.3400	-0.3365	-0.0735	0.0000	-0.3624	-0.2813
34	0.1903	-0.1106	-0.2037	0.0172	0.3100	0.0338	0.1216	0.1332	0.1500	0.0675	0.3336	0.0000	0.5072	0.4098
35	0.1806	-0.1727	-0.2336	0.0199	0.3347	-0.0216	0.1774	0.2016	0.1800	0.1442	0.4665	0.0000	0.0592	0.2103
36	0.0277	-0.0937	-0.1326	-0.1380	-1.2431	-0.1243	-0.1414	-0.1330	0.0200	-0.0075	0.4321	0.0000	-0.0343	-0.0257
37	-0.2773	-0.3697	-0.3933	-0.3269	-0.9314	-0.4358	-0.3799	-0.4124	-0.3300	-0.3676	0.0597	0.0000	-0.3190	-0.1070
38	0.2846	0.2353	0.3312	0.0706	0.5037	0.3342	0.2343	0.4742	0.4100	0.1458	0.2458	0.0000	0.4990	0.5051
39	0.2037	0.0430	-0.0162	-0.3788	0.3217	0.0781	-0.1212	0.2230	0.3200	0.3673	0.7154	0.0000	0.4919	0.3161
40	0.9595	0.2013	0.4634	0.4307	-1.2917	0.5248	0.4942	0.5509	0.3800	0.6205	1.1190	0.0000	0.6770	0.3782
41	-0.5549	-0.6825	-0.7129	-0.6369	-1.2289	-0.5788	-0.4090	-0.5775	-0.5900	-0.4823	-0.2131	0.0000	-0.6523	-0.0019
42	0.2683	0.0447	0.0994	0.4776	0.5449	0.2729	0.6243	0.3181	0.3100	0.4482	0.7672	0.0000	0.3273	0.7362
43	-0.0007	-0.1935	-0.2181	-0.2362	0.4427	-0.0765	-0.1110	-0.0430	-0.0400	-0.0809	-0.0787	0.0000	-0.1434	-0.2159
44	-0.1266	-0.2390	-0.3613	-0.3741	-1.4882	-0.2223	-0.2322	-0.2182	-0.0300	-0.1772	-0.2943	0.0000	-0.0282	-0.0398
45	-0.7695	-0.7107	-1.0980	-1.1410	-0.7609	-0.7568	-0.7633	-0.4632	-0.5600	-0.2217	-0.3690	0.0222	-0.7454	-0.9161
46	0.7284	0.4587	0.6227	0.5718	0.7411	0.3260	0.4127	0.6382	0.8400	0.2019	0.1980	0.0114	0.6376	0.4381
47	0.0107	-0.0974	-0.2944	-0.2281	0.3422	-0.0001	0.1372	0.0706	0.2300	0.3748	0.4723	0.0000	0.2159	0.3509
48	1.0436	0.1238	0.5321	0.5030	-1.6208	-0.3829	-0.3869	0.7851	0.5200	0.4360	0.3969	0.0000	0.7647	0.7284
49	2.9976	1.2860	1.8570	2.5440	0.6012	3.1650	4.6162	3.2793	2.3500	1.0750	2.1920	0.0000	0.9071	1.5750
50	0.7500	0.2750	0.3052	0.2336	1.0563	0.6853	0.6127	0.7382	0.7600	0.6596	0.9988	0.0000	0.1354	0.3579
51	0.1406	-0.0303	-0.0595	-0.1570	0.0676	0.2635	0.1535	0.2428	0.3600	0.0346	0.1766	0.0000	0.0567	0.1849
52	-1.3201	-0.7133	-0.5058	-0.5650	-2.0297	-1.1821	-1.2677	-1.1680	-0.4900	-1.2950	-1.8130	0.0000	-0.5513	-0.6611

SUMMER CONDITION

PRINCIPAL STRESSES "P2" IN THE DAM BODY [MPa]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	0.1957	0.3684	0.9800	1.0290	0.4425	0.3574	0.3575	0.4008	0.0500	0.0506	-0.0827	-0.0607	0.1184	0.0375
2	-0.1120	-0.1371	-0.2238	-0.2099	-1.1405	-0.2019	-0.1947	-0.2249	-0.2000	-0.5215	-0.4522	-0.1071	-0.1660	-0.1542
3	-0.0197	-0.0409	-0.0556	-0.0527	-0.5086	-0.0490	-0.0575	-0.0563	-0.0500	-0.0357	-0.3188	-0.1777	-0.1079	-0.0742
4	-0.0226	-0.0096	-0.0114	-0.0014	-0.1782	0.0078	0.0002	0.0078	0.0000	0.0016	-0.1231	-0.1736	-0.0806	-0.0423
5	-2.0514	-1.8880	-2.1120	-2.3170	-1.6916	-2.0317	-2.2331	-2.0648	-2.0500	-1.9230	-2.4570	-2.1350	-2.0730	-2.1140
6	-0.4407	-0.5594	-0.5307	-0.5695	-0.3565	-0.4805	-0.5069	-0.5034	-0.4600	-0.4110	-0.6970	-0.9653	-0.5484	-0.4280
7	-0.0920	-0.1515	-0.1344	-0.1184	0.0317	-0.1070	-0.0833	-0.1259	-0.0700	-0.0786	-0.4870	-0.5929	-0.1630	-0.0706
8	-0.5167	-0.5743	-0.6494	-0.3212	-1.1872	-0.6644	-0.3223	-0.6510	-0.5800	-0.6179	-0.2990	-1.1110	-0.7911	-0.3309
9	-1.9044	-1.7210	-1.9700	-2.2200	-1.5848	-1.9126	-2.1728	-1.9532	-1.9100	-1.7780	-2.1400	-2.0490	-1.7980	-2.0090
10	-0.4424	-0.5044	-0.5256	-0.6286	-0.2931	-0.4624	-0.5886	-0.4834	-0.4300	-0.3560	-0.5460	-0.9393	-0.4357	-0.4889
11	-0.1433	-0.1905	-0.1903	-0.1518	0.0192	-0.1545	-0.1361	-0.1367	-0.1000	-0.0874	-0.1788	-0.6036	-0.2136	-0.0987
12	-0.7655	-0.7431	-0.8341	-0.6540	-1.2812	-0.8045	-0.5823	-0.7138	-0.7200	-0.7419	-0.5876	-1.2730	-1.0330	-0.6579
13	-1.6224	-1.6860	-1.8070	-2.1430	-1.5192	-1.8575	-2.1281	-1.6260	-1.7800	-1.6560	-1.7690	-2.0570	-1.6870	-1.8050
14	-0.1532	-0.4628	-0.3910	-0.2988	-0.2358	-0.4364	-0.3355	-0.3500	-0.3200	-0.3072	-0.1647	-0.9023	-0.3221	-0.1795
15	-0.0933	-0.2028	-0.1755	-0.1934	0.0234	-0.2515	-0.2063	-0.2075	-0.0700	-0.1031	0.2682	-0.5945	-0.1865	-0.0727
16	-0.5274	-0.7200	-0.7187	-0.0480	-1.3487	-0.9067	-0.0760	-0.6638	-0.7000	-0.8544	-0.0048	-1.4080	-0.9275	0.0072
17	-1.7222	-1.5430	-1.7590	-1.4390	-1.3556	-1.7582	-1.1896	-1.4803	-1.7300	-1.4950	-1.2640	-2.0850	-1.6970	-1.1560
18	-0.3683	-0.2961	-0.3434	-0.3985	-0.0302	-0.2371	-0.3305	-0.2251	-0.1800	-0.1280	-0.1796	-0.7472	-0.3475	-0.2186
19	-0.1861	-0.1401	-0.2081	-0.5260	0.1314	-0.2204	-0.6646	-0.1671	-0.0500	-0.1163	-0.3605	-0.4062	-0.1302	-0.3561
20	-1.0298	-0.6649	-0.8790	-1.7750	-1.2347	-0.6523	-2.1735	-0.4337	-0.6100	-0.7251	-1.6940	-1.2530	-1.0640	-1.6360
21	-1.3939	-1.2890	-1.5010	-1.3640	-1.2081	-1.3730	-1.1443	-1.3491	-1.3800	-1.1610	-1.0650	-2.2160	-1.2090	-1.2090
22	-0.1354	-0.1963	-0.1928	-0.1728	0.0377	-0.1772	-0.1755	-0.1719	-0.1400	-0.1812	-0.0847	-0.5966	-0.1071	-0.1131
23	-0.0098	-0.1204	-0.0798	-0.1345	0.0987	-0.1161	-0.1583	-0.1158	-0.1000	-0.2488	-0.2031	-0.4400	-0.0341	-0.0490
24	-0.9247	-0.7632	-0.8786	-1.2640	-1.4589	-0.9212	-1.4081	-0.8694	-0.8500	-0.8919	-1.1360	-1.3280	-1.0590	-1.2240
25	-2.2133	-2.0450	-2.2970	-2.2080	-2.0679	-2.2366	-2.0625	-2.2202	-2.2300	-2.0490	-2.1830	-3.0530	-2.1080	-1.8310
26	-0.3748	-0.5334	-0.4922	-0.4634	-0.1487	-0.4309	-0.4261	-0.4614	-0.3800	-0.3408	-0.6526	-1.3480	-0.3931	-0.3544
27	-0.3552	-0.5417	-0.4881	-0.4565	-0.1783	-0.4261	-0.4360	-0.4122	-0.3600	-0.3396	-0.6392	-1.2400	-0.4540	-0.4062
28	-2.0703	-2.0680	-2.3200	-2.1140	-2.7148	-2.2496	-2.1476	-2.2550	-2.1400	-2.2610	-2.2060	-3.0920	-2.3900	-2.2380
29	-1.9385	-1.8150	-2.0600	-2.1660	-1.8511	-1.9609	-2.0889	-2.0056	-1.9500	-1.7680	-1.9960	-2.8850	-1.6660	-1.9320
30	-0.3139	-0.4126	-0.3834	-0.3568	-0.0057	-0.3795	-0.3556	-0.4016	-0.3100	-0.3031	-0.3748	-1.1680	-0.2583	-0.2620
31	-0.3212	-0.4410	-0.4133	-0.3587	-0.0899	-0.3728	-0.3306	-0.3595	-0.3000	-0.2627	-0.3423	-1.1470	-0.2814	-0.2483
32	-2.1644	-2.0150	-2.3090	-2.1730	-2.6665	-2.2127	-2.1027	-2.2076	-2.1300	-2.2770	-2.1520	-3.3130	-2.3550	-2.1050
33	-1.6301	-1.5270	-1.9540	-1.8080	-1.5849	-1.7566	-1.9062	-1.8555	-1.7000	-1.5080	-1.4360	-2.6900	-0.8276	-1.0180
34	-0.2818	-0.3779	-0.4426	-0.4393	0.0994	-0.4323	-0.4455	-0.4002	-0.2600	-0.3438	-0.0076	-0.8571	-0.2113	-0.1924
35	-0.3005	-0.4323	-0.5081	-0.4713	-0.0308	-0.4381	-0.4668	-0.4123	-0.2500	-0.1731	-0.3494	-0.8813	-0.3468	-0.3795
36	-2.0412	-2.1690	-2.5310	-2.1600	-2.6931	-2.3148	-2.0826	-1.9813	-2.0800	-2.4290	-1.9000	-3.1480	-2.7830	-2.4640
37	-1.4283	-1.2430	-1.4060	-1.4740	-1.2816	-1.4498	-1.3867	-1.1901	-1.4200	-1.2670	-1.1200	-2.3110	-1.1610	-1.0630
38	-0.3968	-0.4029	-0.4563	-0.4726	0.0990	-0.3751	-0.4065	-0.3097	-0.1800	-0.2854	0.0814	-0.6544	-0.4099	-0.1757
39	-0.5028	-0.5907	-0.7428	-0.6537	-0.0967	-0.5840	-0.5330	-0.5689	-0.1900	0.0794	-0.1116	-0.8310	-0.2425	-0.5481
40	-2.2623	-1.9540	-2.2040	-2.5060	-2.8242	-2.3929	-2.6442	-2.3189	-2.2200	-2.8190	-2.3660	-4.6200	-1.5600	-2.1260
41	-1.3310	-1.2850	-1.4810	-0.7064	-1.4539	-1.2852	-0.5954	-1.1827	-1.2700	-1.1790	-0.6638	-2.9450	-0.9292	-0.6323
42	-0.5311	-0.6956	-0.7593	-0.7572	-0.2128	-0.4818	-0.5042	-0.4692	-0.4500	-0.4181	-0.5485	-1.0590	-0.5640	-0.4840
43	-0.4682	-0.6819	-0.5678	-0.7281	-0.2377	-0.3848	-0.5626	-0.3821	-0.3300	-0.4554	-0.3242	-1.0740	-0.3418	-0.4141
44	-3.2507	-2.9740	-3.3560	-3.7240	-3.6148	-3.1215	-3.4757	-3.0758	-3.0600	-3.4160	-3.3200	-3.4070	-2.7740	-2.9750
45	-1.4443	-0.7924	-0.8348	-1.0310	-1.3146	-1.0867	-1.3077	-1.1117	-1.0900	-0.9648	-0.9772	-2.5380	-1.2450	-1.3260
46	0.1178	0.0323	0.1244	0.0707	0.4114	-0.2908	-0.3012	0.2195	0.2700	-0.0565	-0.0873	-0.2301	0.0250	0.0194
47	-0.1646	-0.3461	-0.2315	-0.1935	0.2385	-0.1578	-0.1532	-0.0732	0.0500	0.1924	0.2139	-0.2715	-0.2216	-0.2285
48	-2.7631	-2.4280	-2.8010	-2.7730	-3.2432	-2.6688	-2.6074	-2.6165	-2.4800	-3.0200	-2.8640	-4.4460	-2.0680	-1.9510
49	-0.0178	0.1556	0.1076	0.4548	-1.1623	-0.1396	0.3314	-0.1191	-0.4600	0.0583	0.6509	-0.1466	0.2892	0.6400
50	0.6743	0.2494	0.2445	0.2347	0.8070	0.5484	0.5948	0.5549	0.7100	0.5449	0.5657	-0.6041	0.0164	0.1764
51	-0.4255	-0.5389	-0.6466	-0.5500	-0.0426	-0.3367	-0.1702	-0.3135	-0.4300	-0.3152	-0.4121	-0.9692	-0.0844	0.0326
52	-4.0362	-0.9922	-1.2370	-1.3980	-3.4727	-3.7852	-4.1495	-3.7654	-3.3900	-3.7040	-3.7870	-1.0380	-1.0430	-1.0690

SUMMER CONDITION

PRINCIPAL STRESSES "P3" IN THE DAM BODY
[MPa]

Node	P01_f	P02_f	P03_f	P03	P04_f	P05_f	P05	P06_f	P07_f	P08_f	P08	P09_f	P10_f	P10
1	-3.1834	-2.7650	-2.5000	-2.6840	-2.2042	-2.7022	-2.9873	-2.6886	-3.0300	-2.3960	-3.3550	-2.9490	-3.1070	-3.2260
2	-3.5833	-3.1990	-3.4940	-3.8690	-3.8701	-3.3367	-3.7534	-3.3379	-3.3300	-3.4000	-4.1280	-3.3080	-3.2670	-3.6350
3	-2.9698	-2.7180	-2.8690	-3.4400	-3.0555	-2.6402	-3.1974	-2.6492	-2.6700	-2.7410	-3.2860	-2.7080	-2.5440	-3.2220
4	-2.4589	-2.3250	-2.2570	-3.0310	-2.5318	-2.0124	-2.7083	-2.0256	-2.1100	-2.1250	-3.1310	-2.1820	-1.9880	-2.8130
5	-4.4893	-4.2820	-4.5000	-4.2550	-4.0831	-4.4501	-4.2202	-4.4173	-4.4300	-4.2500	-4.7270	-4.8610	-4.4970	-4.0860
6	-3.0992	-3.1620	-3.1300	-3.0840	-2.8959	-3.0522	-2.9636	-3.0300	-3.0400	-2.9560	-3.0140	-3.3790	-3.0480	-2.8860
7	-2.8346	-2.9430	-2.8760	-3.0360	-2.7305	-2.7779	-2.8351	-2.7637	-2.7800	-2.7730	-2.3950	-3.1830	-2.7460	-2.8390
8	-3.6453	-3.6440	-3.7110	-4.0790	-4.1229	-3.5787	-3.7797	-3.5735	-3.5900	-3.6650	-3.9590	-4.0530	-3.6090	-3.8450
9	-3.7041	-3.6280	-3.7700	-3.6950	-3.4864	-3.7544	-3.7305	-3.8158	-3.7200	-3.4970	-3.8100	-4.1470	-3.4980	-3.5310
10	-2.6916	-2.8150	-2.7700	-2.7610	-2.5154	-2.6950	-2.6904	-2.7244	-2.6600	-2.5450	-2.6300	-2.9800	-2.5390	-2.5500
11	-2.9174	-3.0380	-2.9920	-3.0460	-2.7694	-2.8689	-2.8968	-2.8764	-2.8200	-2.8100	-2.6400	-3.2310	-2.7990	-2.8230
12	-4.2939	-4.1940	-4.3630	-4.4780	-4.5103	-4.1900	-4.2599	-4.1825	-4.1400	-4.2150	-4.0680	-4.5960	-4.2380	-4.2360
13	-2.8915	-2.7950	-3.1130	-3.1380	-2.7487	-3.1831	-3.4741	-3.8932	-3.0100	-2.6100	-2.8740	-3.2850	-2.4210	-2.8500
14	-2.1339	-2.2770	-2.2780	-2.2590	-1.9985	-2.3176	-2.3368	-2.7961	-2.1200	-2.0560	-2.2640	-2.4440	-1.8950	-1.9900
15	-2.6802	-2.8940	-2.8110	-2.7420	-2.6590	-2.8903	-2.7683	-3.2122	-2.6100	-2.7200	-2.6770	-3.0830	-2.5660	-2.5570
16	-4.4226	-4.4370	-4.5580	-4.4370	-4.7258	-4.7565	-4.5283	-4.8973	-4.3600	-4.5610	-3.5700	-4.8830	-4.1910	-4.3400
17	-1.9993	-2.0500	-2.2790	-2.4670	-2.0609	-2.2166	-2.5500	-2.4677	-2.0700	-1.8420	-2.2080	-2.3850	-1.9390	-2.2310
18	-1.6718	-1.8040	-1.8510	-1.9670	-1.4784	-1.7326	-1.9905	-1.9866	-1.5700	-1.5610	-1.8860	-1.9020	-1.6240	-1.7230
19	-2.7240	-2.7470	-2.8390	-2.8570	-2.4223	-2.6753	-2.9439	-3.0477	-2.4600	-2.5580	-2.7420	-2.8670	-2.4020	-2.6900
20	-5.0433	-4.6190	-5.1420	-5.0640	-4.7323	-4.9512	-5.2944	-5.4264	-4.6400	-4.5550	-3.8780	-5.0420	-4.3550	-4.9850
21	-1.8535	-1.8050	-1.9700	-2.1600	-1.7765	-1.7859	-1.9453	-1.8140	-1.7800	-1.4530	-1.7050	-2.1170	-1.7540	-1.9560
22	-1.2599	-1.3980	-1.3940	-1.4910	-1.1320	-1.1661	-1.3779	-1.1932	-1.1700	-1.4270	-1.6190	-1.5140	-1.0800	-1.2820
23	-2.1468	-2.2920	-2.2770	-2.2190	-2.0421	-2.0998	-2.1745	-2.1124	-2.0800	-2.3760	-2.4830	-2.4220	-1.8580	-2.0080
24	-4.4780	-4.2130	-4.5810	-4.3540	-4.3831	-4.3924	-4.3395	-4.4172	-4.3400	-4.0820	-3.8120	-4.5690	-4.0270	-4.0980
25	-4.3820	-4.1790	-4.4270	-3.9870	-4.0820	-4.3090	-3.9289	-4.2495	-4.3400	-4.1370	-4.4460	-4.9490	-4.3310	-3.8010
26	-2.2899	-2.4950	-2.3960	-2.2030	-2.0474	-2.2415	-2.0640	-2.1902	-2.2500	-2.1830	-2.1320	-2.8180	-2.2010	-1.9820
27	-2.0350	-2.3130	-2.1770	-2.2400	-1.9085	-1.9854	-2.0247	-1.9437	-1.9800	-2.0380	-1.4340	-2.6340	-1.9010	-2.0220
28	-3.8357	-3.8430	-3.9970	-4.3400	-4.4138	-3.7538	-4.0245	-3.7265	-3.7700	-3.9420	-4.0530	-4.4930	-3.7360	-4.1440
29	-3.5128	-3.4120	-3.5860	-3.6220	-3.3644	-3.4993	-3.5349	-3.3460	-3.5100	-3.2720	-3.7550	-4.0610	-3.5800	-3.5400
30	-1.8365	-2.0190	-1.9410	-2.0110	-1.5669	-1.7738	-1.8723	-1.6805	-1.7700	-1.7000	-1.8440	-2.3140	-1.8280	-1.8130
31	-2.1273	-2.2900	-2.2430	-2.2950	-1.8812	-2.0343	-2.1252	-1.9772	-1.9900	-1.9940	-1.7850	-2.6060	-2.0720	-2.0420
32	-4.5636	-4.2920	-4.6490	-4.6490	-4.7608	-4.4275	-4.4624	-4.3936	-4.3800	-4.5090	-4.1710	-4.8860	-4.5500	-4.4180
33	-2.5203	-2.4730	-2.6470	-2.8960	-2.5253	-2.6955	-2.8318	-2.3259	-2.5500	-2.4080	-2.5980	-2.9680	-2.1870	-2.3430
34	-1.2733	-1.5160	-1.4830	-1.6060	-1.0603	-1.2884	-1.4864	-1.0576	-1.1800	-1.2000	-1.3980	-1.8090	-1.3710	-1.3720
35	-2.1092	-2.3530	-2.3810	-2.3450	-1.9469	-2.1169	-2.2346	-2.0242	-1.9400	-1.8420	-2.1520	-2.6500	-2.4470	-2.3070
36	-5.0517	-4.8640	-5.3290	-5.1320	-5.2115	-5.2342	-5.2218	-5.1396	-4.9200	-5.2370	-3.6250	-5.5930	-5.4680	-5.3150
37	-1.5707	-1.4750	-1.6380	-2.2810	-1.8763	-1.7001	-2.1930	-1.7500	-1.6000	-1.7610	-2.1780	-2.2270	-1.4050	-1.4740
38	-0.9423	-0.9585	-0.8828	-1.3360	-0.6338	-0.8484	-1.1766	-0.7480	-0.7400	-0.7870	-1.0210	-0.8627	-0.5988	-0.8848
39	-2.4154	-2.3160	-2.3130	-2.3560	-1.8522	-2.2942	-2.2251	-2.0252	-2.0500	-1.7260	-1.8560	-2.4270	-2.0090	-2.0120
40	-5.4989	-4.9460	-4.9840	-4.7400	-5.3470	-5.1881	-4.7961	-4.7640	-4.9900	-5.1260	-3.7560	-7.7900	-4.9230	-5.1530
41	-2.6022	-2.4120	-2.6960	-2.5380	-2.4309	-2.5727	-2.4721	-2.5104	-2.5600	-2.4300	-2.7470	-3.3070	-2.8810	-2.6400
42	-0.6728	-0.7677	-0.6714	-0.7253	-0.2490	-0.7550	-0.8108	-0.7293	-0.6800	-0.6386	-0.8698	-1.5430	-0.6939	-0.6548
43	-1.0702	-1.2670	-1.2340	-1.4600	-0.8949	-1.1915	-1.4801	-1.1774	-1.0700	-1.1240	-1.6100	-2.3090	-0.9990	-1.2150
44	-4.5234	-4.2060	-4.7610	-5.7180	-4.8642	-4.7750	-5.7870	-4.7639	-4.5400	-4.8710	-5.9260	-6.1830	-4.8830	-5.8320
45	-2.0280	-1.6840	-1.9540	-1.9990	-1.7861	-2.5274	-2.5226	-1.8718	-1.9000	-1.7790	-1.9880	-2.6190	-2.4080	-2.2270
46	-0.9697	-0.8639	-0.8102	-0.8569	-0.3139	-0.8488	-0.8373	-0.8414	-0.8600	-0.9004	-1.0280	-0.7956	-0.6779	-0.6878
47	-2.3218	-2.0400	-2.3330	-2.1820	-1.3467	-1.4130	-1.1502	-2.3387	-1.9300	-1.2250	-1.0500	-3.3590	-1.7720	-1.6450
48	-6.0931	-5.2180	-5.6320	-5.1210	-5.6334	-5.4174	-4.7175	-5.8101	-5.3400	-5.7700	-5.3510	-6.6140	-5.3700	-4.9780
49	-0.4368	0.0065	-0.0317	0.0787	-1.2016	-0.4873	-0.2114	-0.4377	-0.6500	-0.8840	-0.6736	-1.8100	-0.3562	-0.1440
50	-0.3733	-0.4335	-0.4042	-0.1845	0.0705	-0.4954	-0.4810	-0.4564	-0.4800	-0.2500	-0.1284	-2.1050	-0.2179	-0.3769
51	-1.1551	-1.2640	-1.1160	-1.3760	-1.4187	-1.1397	-1.4104	-1.0984	-0.9400	-1.3590	-1.5090	-2.6870	-1.1750	-1.4750
52	-9.2324	-3.6460	-4.7200	-5.4400	-6.3503	-9.2744	-10.7196	-9.3125	-7.9800	-7.1670	-9.1180	-5.3920	-3.5340	-4.2370

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THEME A1

Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam

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NONLINEAR ANALYSIS OF JOINT BEHAVIOUR UNDER THERMAL AND HYDROSTATIC LOADS FOR AN ARCH DAM

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Abstract

The behaviour of the 77 m high double-curvature Talvacchia arch dam, taking into account the nonlinearities of four vertical construction joints, is analyzed using the general-purpose program ADINA. The dam is modelled using three-dimensional solid elements. The vertical joints, which may slide and open, are modelled as three-dimensional contact surfaces available in ADINA. These contact surfaces are formed of 4-node quadrilateral area segments (contact elements). The behaviour of the dam under dead load, hydrostatic pressure and summer and winter temperature conditions is investigated for the following three cases:

- monolithic dam (without joints)
- dam with four vertical frictionless joints
- dam with four vertical friction joints (friction coefficient: 0.75)

The results show that the deformations of the monolithic dam and the dam with friction joints are almost the same, whereas considerable joint movements take place in the case of frictionless joints. Except for the stresses in the vicinity of the joints, the maximum stresses in the jointed dam are very similar to the ones in the monolithic dam. This is true because the stresses are mainly due to dead and water loads. If loads due to imposed deformations (such as, winter temperature) or earthquake would be considered alone, larger differences could be expected because of the tensile stresses caused by these actions.

Introduction

In the context of the Third Benchmark Workshop on Numerical Analysis of Dams, the 77 m high double-curvature Talvacchia arch dam in Italy has been investigated. In engineering practice, the effect of contraction joints is not considered in the analysis of arch dams, except for the evaluation of the dead load stresses, where it is assumed that the vertical construction joints are ungrouted. For the other major loads, i.e. water, temperature and earthquake loads, the joints are neglected. Under earthquake loads, however, especially under the effect of the so-called maximum credible earthquake, dynamic tensile stresses may occur which exceed the tensile and shear strengths of the grouted joints. For the prediction of the behaviour of the jointed dam, reliable joint models and powerful numerical methods must be available before such effects can be studied analytically. At the moment, different models and procedures exist with which the nonlinear behaviour of a jointed dam could be analyzed. However, because of the very small joint movements under static loads, the calibration of the models is very difficult. Moreover, there is a lack of information on the actual strength properties of grouted contraction joints. Often the joints are provided with interlocking shear keys, which make the situation even more complicated.

Joint modelling of arch dams is still in the research and development phase. Three-dimensional arch dam models with joints between every monolith would require computational efforts which are about two magnitudes higher than for a monolithic dam. Especially for earthquake investigations in the time domain, the computational effort would still be considered to be prohibitive, since parameter studies (sensitivity analyses) would have to be carried out because of the material uncertainties of the joints.

To the authors' knowledge, only few studies have been carried out which are concerned with the effect of vertical contraction joints on arch dams under earthquake loading (Mays and Roehm, 1993; Fenves et al., 1989 and 1992; Weber et al., 1990; Hohberg, 1992). However, for static loads, numerous references already exist mainly in the field of rock mechanics. The applicability of joint models for static loading conditions would be the first step in solving dynamic earthquake problems, where joint models would be really meaningful.

Structural Model

The finite element model of the dam-foundation system is shown in Figs. 1 and 2. The dam and the foundation consist of 726 and 544 twenty-node solid elements (total 1270 elements) respectively. Three element layers exist across the dam thickness. At the four vertical joints, 480 four-node quadrilateral contact elements are provided. Contact elements are provided on each face of a joint. The boundary of the foundation rock is assumed to be fixed. The complete finite element model with contact surfaces comprises 6644 nodes with 18603 degrees of freedom.

The modulus of elasticity and the Poisson's ratio of mass concrete are 36 GPa and 0.20 respectively, and those of rock are 12 GPa and 0.16 respectively. Nonlinearities are confined to the four vertical contraction joints. The coefficient of thermal expansion of concrete is taken as $0.7 \times 10^{-5}/°C$, the mass density of concrete as 2400 kg/m^3 and the friction coefficient of the joint faces as 0.75.

The following three structural systems are investigated:

- monolithic dam (without joints)
- dam with four vertical frictionless joints
- dam with four vertical friction joints (friction coefficient: 0.75)

Although the dam and the applied loads are symmetrical with respect to the crown cantilever, the complete dam-foundation model has been analyzed.

Joint Modelling

The contact surfaces provided in the computer program ADINA are used to model the behaviour of the vertical contraction joints (ADINA R&D Inc,. 1987; Bathe and Chaudhary, 1984 and 1985). Contact surfaces are specified in ADINA to model contact behaviour between structural or solid elements.

The contact conditions are assumed to be very general:

- the points of contact are assumed not known a priori;
- both sticking and frictionless or frictional sliding can be modelled;
- repeated contact and separation are permitted in any sequence.

Contact surfaces are defined as surfaces that are initially in contact or are anticipated to come into contact during the response solution.

Contact surfaces may be two- or three-dimensional. In the present analysis, three-dimensional contact surfaces are used. A contact surface needs to be defined only over that part of the body boundary which is initially in contact with other bodies or which is expected to come into contact with other bodies.

Two friction models are available in ADINA:

- frictionless ($\mu = 0$)
- Coulomb friction ($\mu > 0$)

where μ is the coefficient of friction. The friction law is satisfied in a global sense over each individual contact area segment or element.

The conditions of tension release, sliding or sticking for every segment in the contact region are determined during each equilibrium iteration.

The following criteria are used:

- The segment experiences tension release if the total normal contact force (integration of the normal traction) over the segment is tensile. Both normal and tangential contact forces over the segment are then updated to zero.

- The segment experiences sliding contact if the ratio of the total tangential segment contact force to the total normal segment contact force exceeds the coefficient of friction. The tangential force is then updated to equal the segment frictional capacity (which is zero for the frictionless model).
- The segment experiences sticking contact if the total tangential segment contact force is less than the segment frictional capacity. The segment tractions satisfy the friction law and both normal and tangential tractions are resisted by contact (no updating of the segment normal and tangential tractions is performed).

Loading Conditions

The following loads are considered:

(i) Gravity load + "summer" thermal distribution + water level 507 m.a.s.l.

(ii) Gravity load + "winter" thermal distribution + water level 471 m.a.s.l.

For both conditions, calculations are performed under the assumption of the presence or absence of friction on joint faces.

The gravity load of rock foundation is neglected. The gravity load of the dam is applied in a single step with joints considered to be working in the case of the jointed dam. For the homogeneous monolithic dam, gravity load is also applied in a single step.

The temperature distribution in winter is related to a water level of 471 m.a.s.l. and in summer to a water level of 507 m.a.s.l. (Fig. 3). The reference temperature (grouting temperature of joints) is assumed to be 0°C, i.e. no thermal stresses exist at this stage. Joints are assumed to be in contact, with no stress transmitted, in this thermal condition and with neither the gravity load nor the hydrostatic load applied.

Structural Analysis and Computational Aspects

All analyses have been carried out with ADINA Version 6.1.3 (1994) on a workstation Sun SPARC system 10 Model 51 (50 MHz SuperSPARC processor). The CPU times for the different analyses are shown in Table 1. For the two load cases analyzed, we can notice that the computational effort for the dam with frictionless joints is about 14 times larger than that for the monolithic dam, and that the analysis of the dam with friction joints needs 3.1 to 4.3 times as much effort as for the frictionless joint analysis. These differences are quite remarkable.

In the nonlinear analysis with the jointed dam model, the sequence of load application plays an important role. In particular, the problem with the friction joints is path dependent. Accordingly, the loads are applied as follows:

(i) Gravity load (load applied in one step), followed by

(ii) Hydrostatic pressure (load applied in three steps), followed by

(iii) Temperature load (load applied in three steps).

Path dependence makes the behaviour of the dam dependent on the complete load time history. Also in any structural analysis, the sequence of load application must be defined; otherwise comparison of any results will become difficult. In the present analysis, among the three systems analyzed, only the one with friction joints will exhibit path dependence.

In the iterative solution procedure, two convergence criteria were specified:

(i)	Norm of contact force vector	:	5%, and
(ii)	Energy convergence criterion	:	0.1%

With these criteria the following numbers of iterations per load were required for the frictionless joint model:

(i)	Gravity load:	6 iterations	(16)
(ii)	Hydrostatic pressure, summer:	11 iterations	(9)
(iii)	Temperature load, summer:	9 iterations	(6)
(iv)	Hydrostatic pressure, winter:	12 iterations	(9)
(v)	Temperature load, winter:	11 iterations	(32)

The values in brackets given above indicate the numbers of iterations for the case of the friction-joint model. We can note that the convergence of the friction-joint model in winter requires the largest number of iterations.

As can be seen from Table 1, although the number of iterations in summer for the frictionless model is higher than for the friction-joint model, the computational effort is smaller, i.e. a single iteration of the friction-joint model needs considerably more computer time than one of the frictionless model.

Discussion of Results

The results of the finite element analysis are shown in Figs. 4 to 8. In all these Figures, a comparison is made between the following models:

(i) Monolithic dam (without joints)

(ii) Dam with frictionless joints

(iii) Dam with friction joints ($\mu = 0.75$)

From Figs. 4, 7 and 8, we can notice that joint friction greatly restrains independent movement of the individual monoliths, i.e. a conventional, monolithic dam model is sufficient to predict the deformations in a jointed dam.

Figures 5 and 6 show the contour plots of the extreme principal stresses for summer and winter respectively. Because of symmetry only one half of the up- and downstream dam faces are shown for the three structural systems listed above. It can be clearly seen that the presence of joints does not alter the minimum principal stress (compressive) patterns in summer dramatically, especially when we compare systems (i) and (iii) where the deformations are also very similar. The maximum principal stress (tensile) patterns in winter (Fig. 6, downstream face) clearly show the stress redistribution due to joint opening under tension. In the far-field of the joints, the peak stresses approach those of the monolithic dam. Thus, it can be assumed that in a real dam with joint spacing of some 15 m, tensile stresses on both faces of the dam will decrease considerably except for the dam-foundation contact zone. Hence, as expected, joints in tension zones have a beneficial effect on the maximum tensile stresses in a dam.

In the compression zone, a frictionless joint (Fig. 5) can even lead to higher compressive stresses (dam-foundation contact zone) under certain loading conditions as compared to a monolithic dam or a dam with friction joints. The largest values of the principal stresses for summer and winter are given in Table 2 for the three systems studied. Joints do not necessarily lead to smaller stresses!

As far as joint movements are concerned, we can distinguish between joint opening and joint sliding. Relative joint sliding is visible from Figs. 7 and 8 and Table 3. Significant sliding occurs only in the case of frictionless joints. In practical situations ($\mu = 0.75$), sliding is very small. Joint opening, however, takes place in winter for the system analyzed. As shown in Fig. 9, large portions of the joints open in winter. The lower portion of Joint 1 is completely open and only a small zone near the crest remains under compression. The unusual behaviour of Joint 1 is also due to the fact that the water level in winter is below this cantilever. Thus, almost no compressive arch stresses are effective on this joint. In summer, all joints are closed. For frictionless joints, the joint openings are essentially the same as for joints with friction.

Conclusions

Based on the results of the static analysis of Talvacchia arch dam, taking into account the non-linear behaviour of joints, the following conclusions can be drawn:

(i) The computer program ADINA allows the realistic modelling of joints in arch dams.

(ii) The computational effort for the analysis of a jointed dam with and without friction is 15 to 60 times larger than for a monolithic dam (accuracy of contact force: 5%).

(iii) Joint opening due to tensile forces occurs in winter only.

(iv) Displacements (winter and summer) of a dam can be predicted accurately by a conventional monolithic dam model.

(v) Relative joint movements are significant for frictionless joints; however, this is not the case for arch dams with grouted contraction joints.

(vi) Behaviour of a dam with friction joints is path dependent.

(vii) Joint movements are a minor problem under static load conditions; however, under the effect of the maximum credible earthquake, the modelling of joint movements may be of greater importance.

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Table 1 Computation times in CPU-hours on Sun SPARC system 10

Case	No joints	Joints without friction	Joints with friction (μ=0.75)
Summer	1.49	20.32	63.70
Winter	1.49	22.20	95.04

Table 2 Largest values of maximum and minimum principal stresses in dam body under gravity load, hydrostatic pressure and temperature in summer and winter

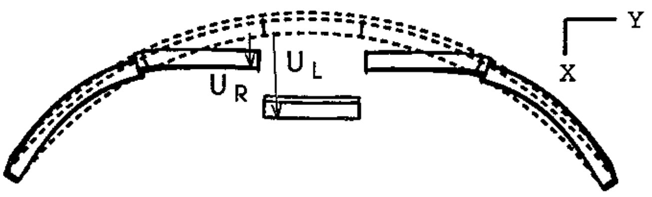
	No joints		Joints without friction		Joints with friction (μ=0.75)	
Case	σ_1 (MPa)	σ_3 (MPa)	σ_1 (MPa)	σ_3 (MPa)	σ_1 (MPa)	σ_3 (MPa)
Summer	1.86	-7.60	2.54	-10.35	2.13	-7.61
Winter	3.05	-1.89	2.72	-3.29	2.74	-3.15

Note: σ_1 and σ_3 are the largest values of the maximum and minimum principal stresses, respectively.

Table 3 Comparison of displacements at crest and midheight of crown cantilever and joints under gravity load, hydrostatic pressure and temperature in summer and winter

		No joints	Joints without friction			Joints with friction (μ=0.75)		
Location	Case	U	U_R	U_L	$U_L - U_R$	U_R	U_L	$U_L - U_R$
Crest at Joint 1	Summer	-0.40	-0.77	-3.23	-2.46	-0.30	-0.30	0.00
	Winter	8.06	6.12	9.38	3.27	8.04	7.78	-0.26
Crest at Joint 2	Summer	12.10	8.09	21.24	13.15	12.85	12.85	0.00
	Winter	12.54	11.59	17.16	5.57	13.12	13.12	0.00
Crest at crown	Summer	13.66	22.41	--	--	14.48	--	--
	Winter	13.25	17.62	--	--	13.88	--	--
Midheight at Joint 1	Summer	2.88	2.29	3.35	1.06	2.85	2.94	0.10
	Winter	0.97	0.79	0.59	-0.20	0.83	0.61	-0.22
Midheight at Joint 2	Summer	9.97	8.38	14.88	6.50	10.21	10.18	-0.03
	Winter	3.93	3.33	5.06	1.73	3.89	3.83	-0.06
Midheight at crown	Summer	10.95	15.57	--	--	11.26	--	--
	Winter	4.36	5.26	--	--	4.17	--	--

Notes: U is the displacement in mm along x-axis, i.e. in the downstream direction. Subscripts R and L respectively refer to the right and left sides (looking at the dam from upstream) of a joint.



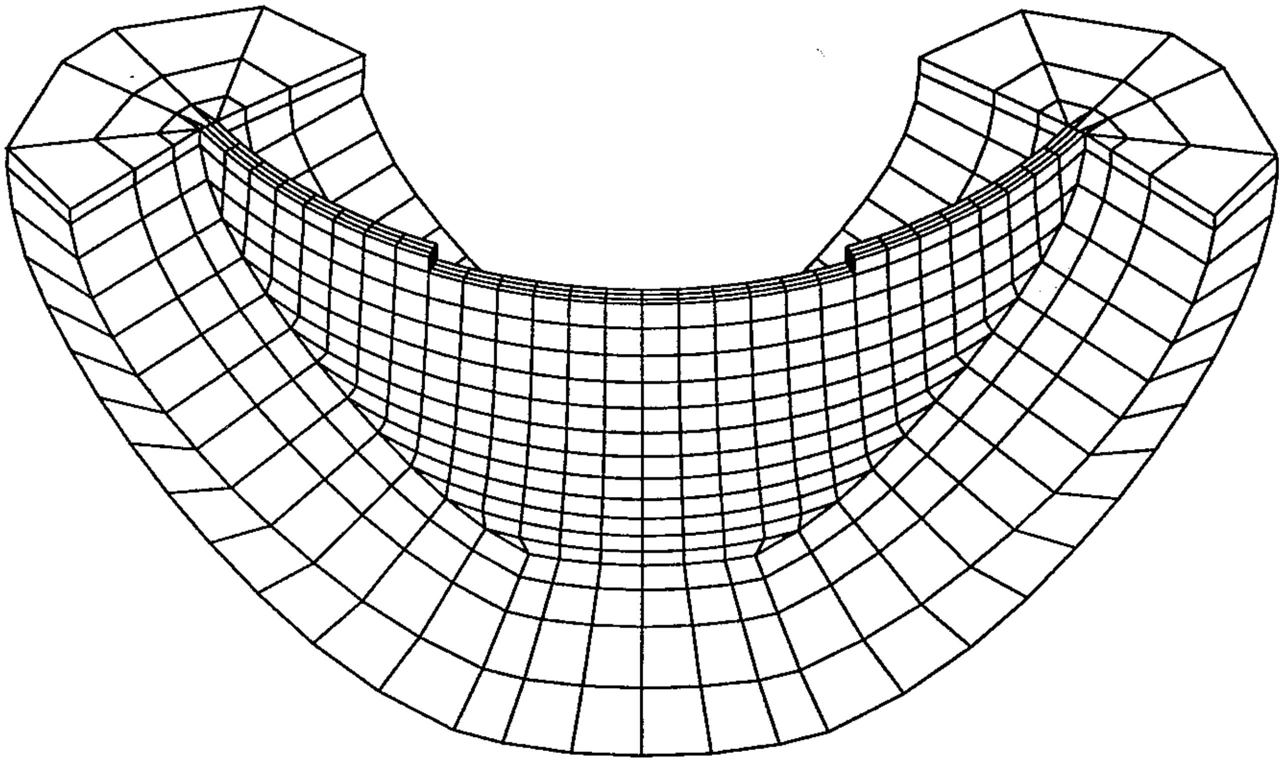


Fig. 1 Three-dimensional finite element model of dam-foundation system

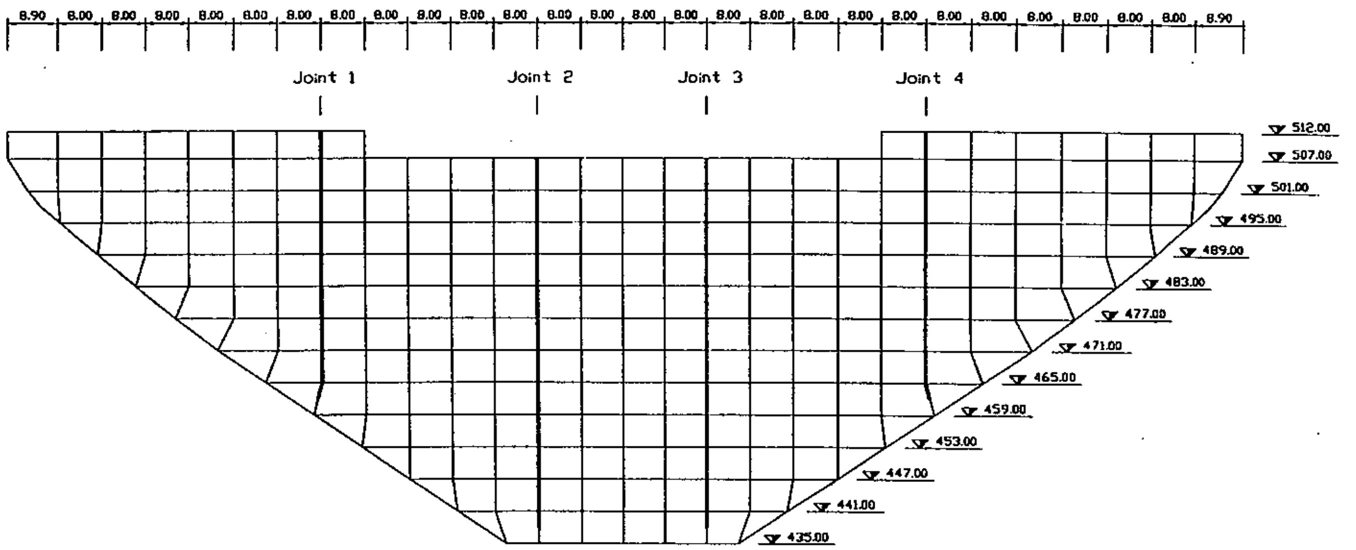


Fig. 2 Downstream view of finite element model of dam with locations of vertical contraction joints (Joints 1 to 4)

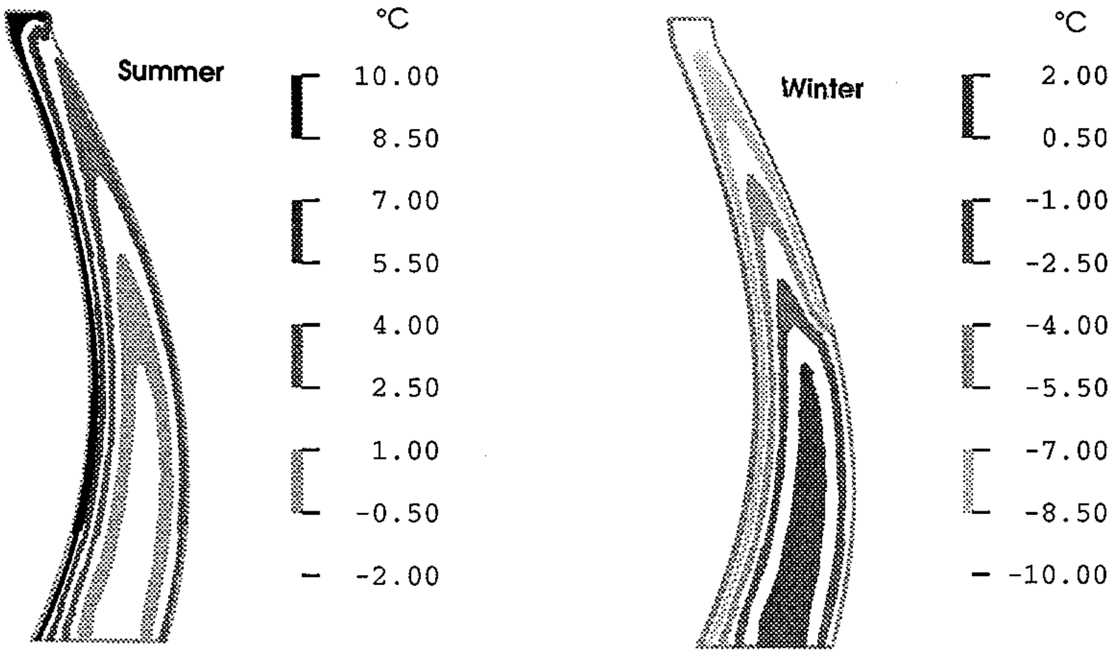


Fig. 3 Temperature distributions at crown cantilever in summer and winter

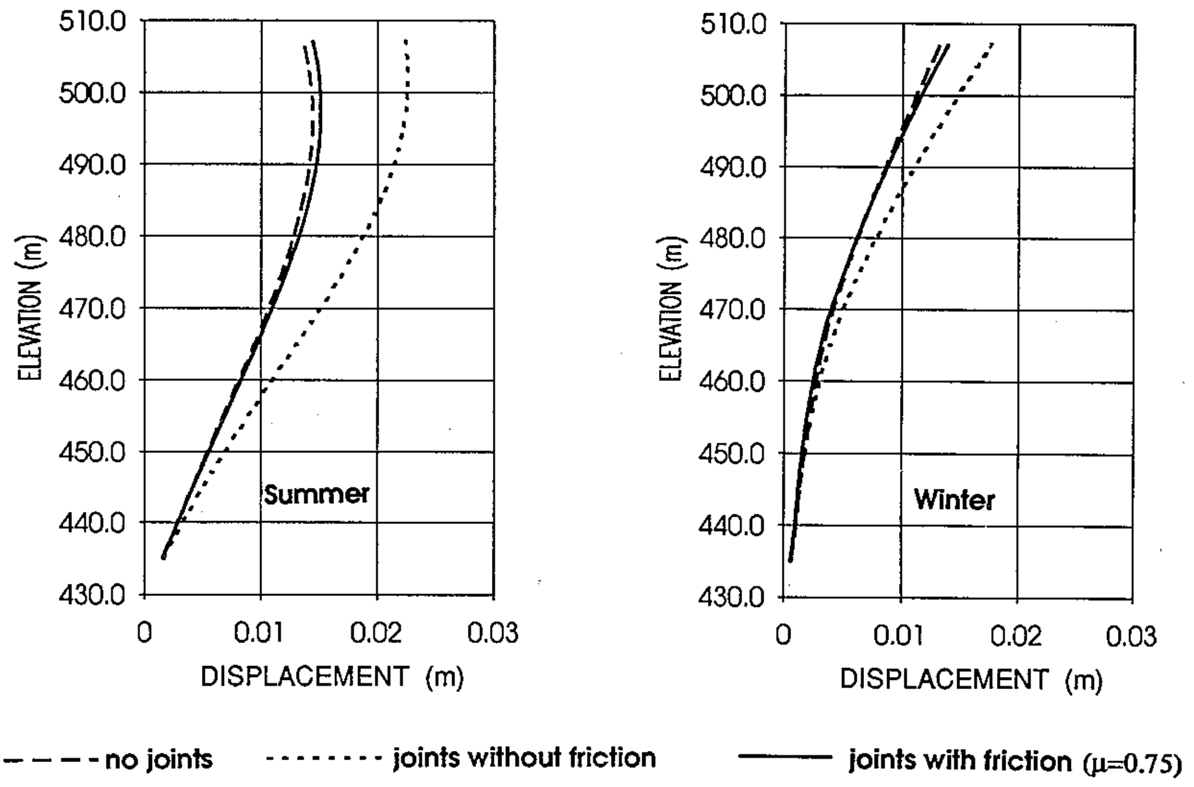


Fig. 4 Comparison of radial deflection of crown cantilever in summer and winter calculated with three different joint models under gravity load, hydrostatic pressure and temperature

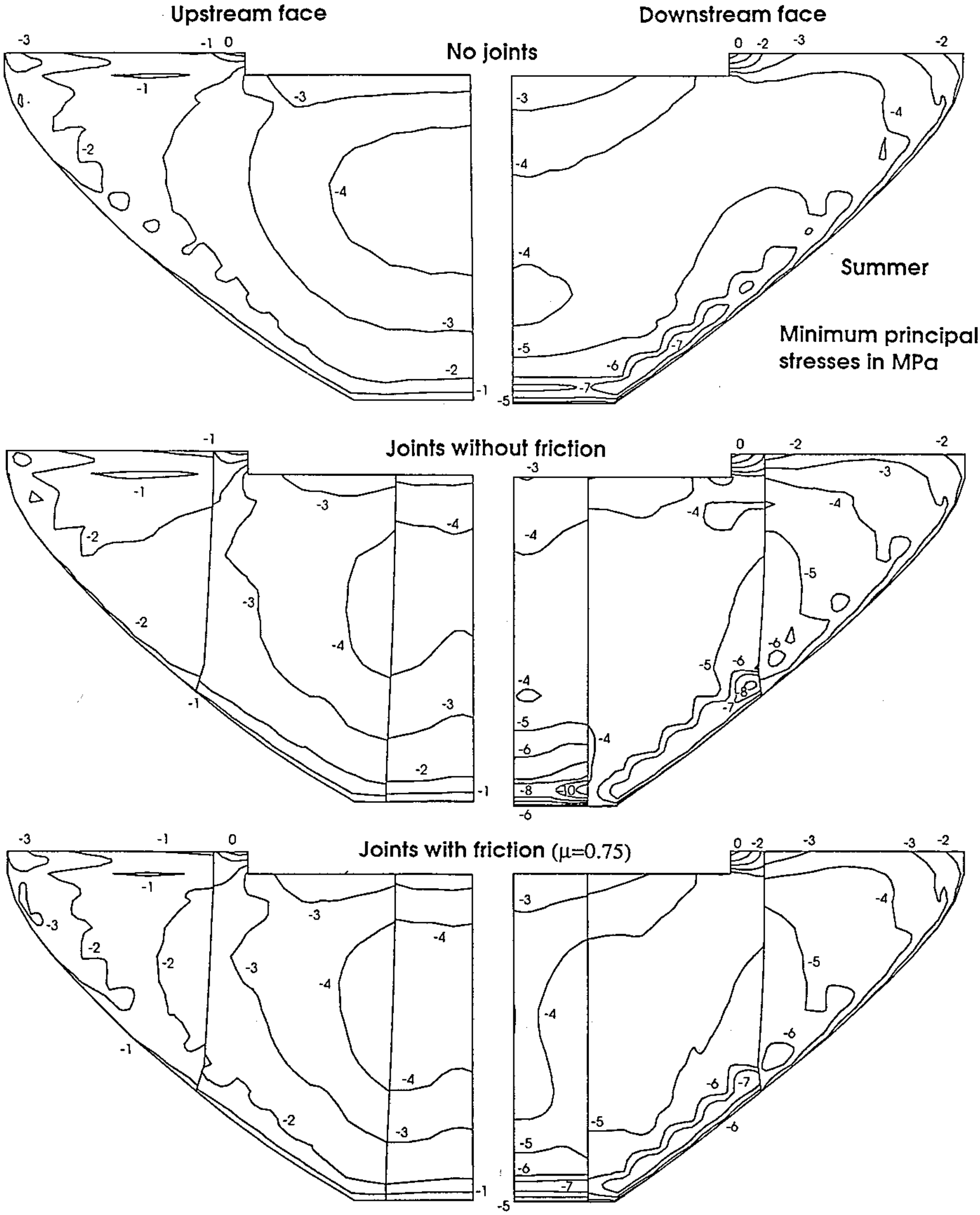


Fig. 5 Comparison of minimum principal stress contours in summer obtained with three different models under gravity load, hydrostatic pressure and temperature

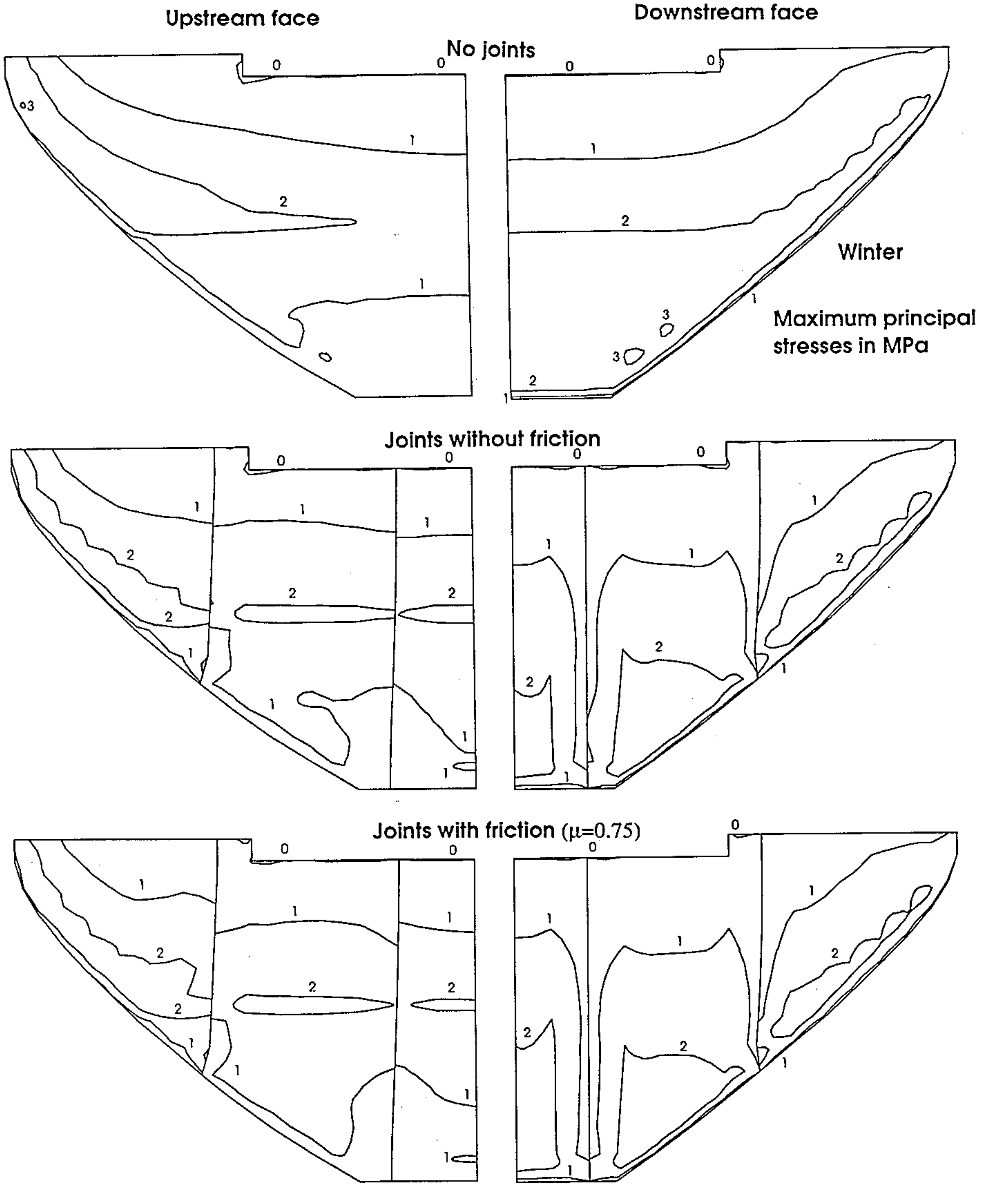


Fig. 6 Comparison of maximum principal stress contours in winter obtained with three different models under gravity load, hydrostatic pressure and temperature

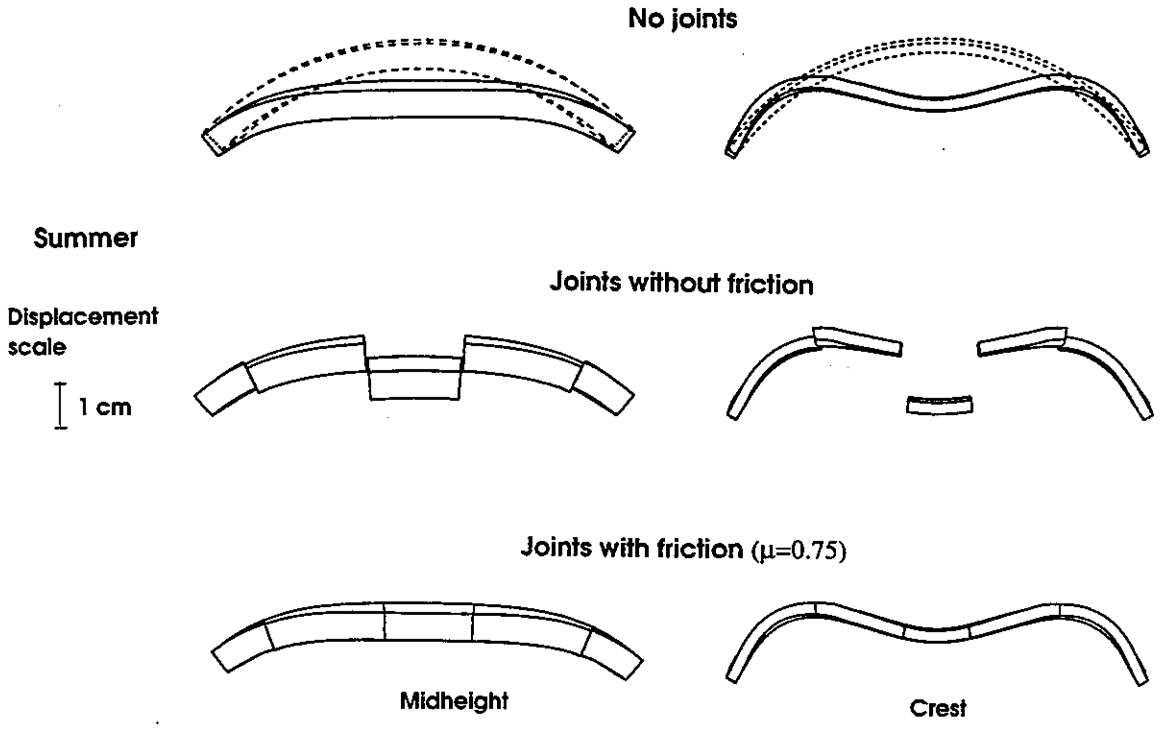


Fig. 7 Comparison of displaced positions of crest and midheight in summer computed using three different models under gravity load, hydrostatic pressure and temperature

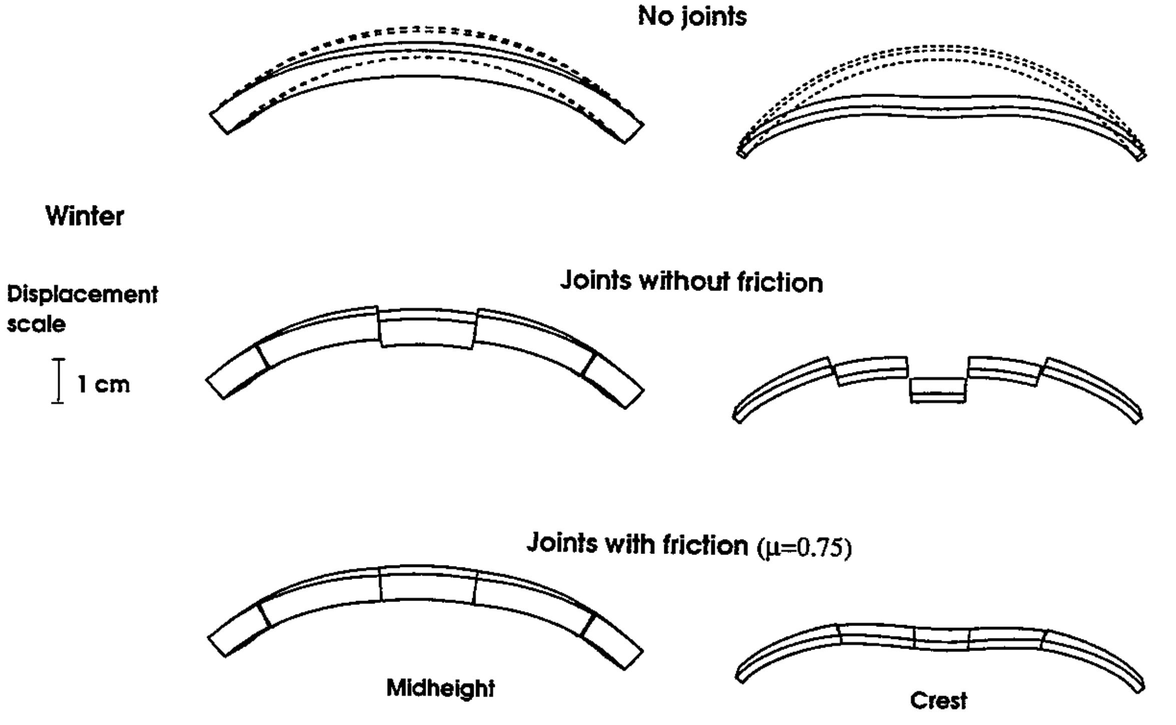


Fig. 8 Comparison of displaced positions of crest and midheight in winter computed using three different models under gravity load, hydrostatic pressure and temperature

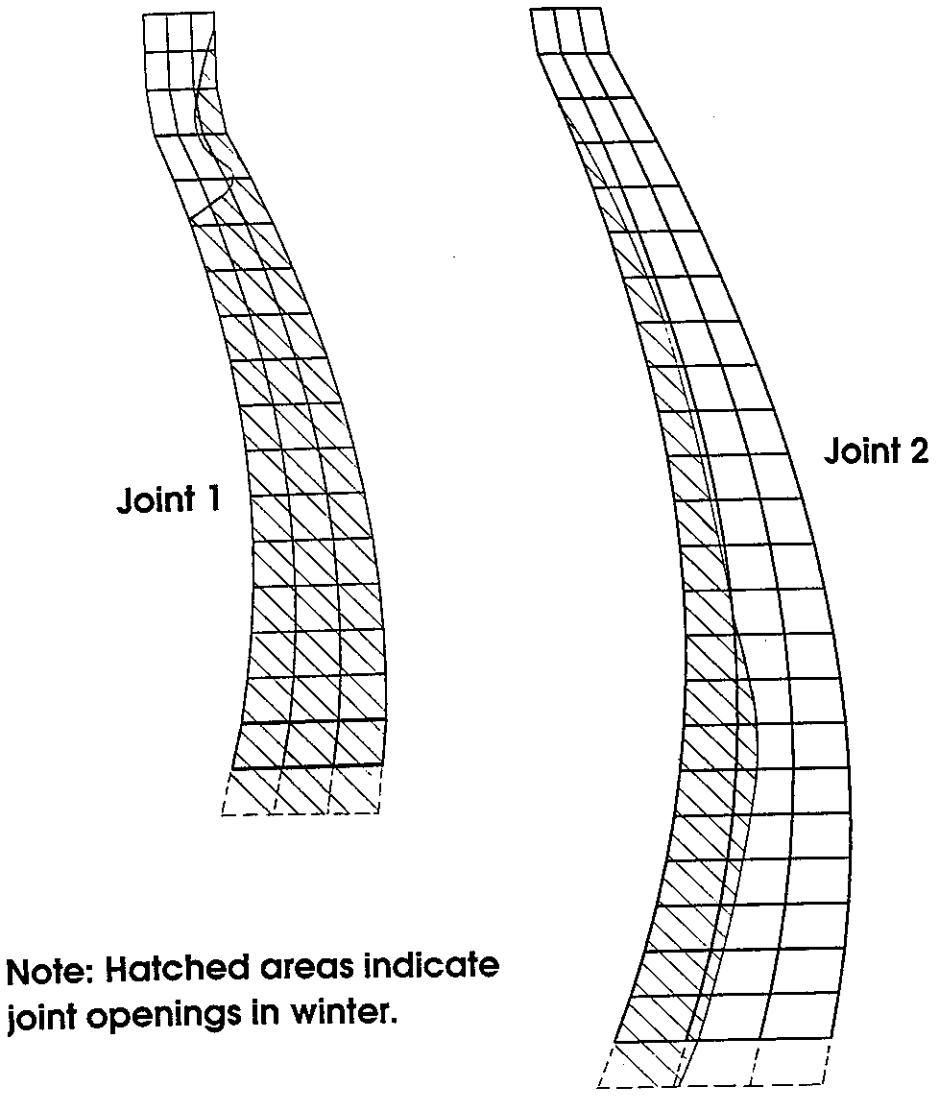


Fig. 9 Open areas of Joint 1 and Joint 2 in winter based on model with friction ($\mu = 0.75$) in joints under gravity load, hydrostatic pressure and temperature

STATIC ARCH DAM ANALYSIS CONSIDERING NONLINEAR BLOCK JOINT BEHAVIOUR

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Abstract

It is often necessary to introduce discontinuities within an analysis to provide for the overall system behaviour which effects the bearing capacity of a structure. Local joints may lead to some stress concentrations and local failure but don't influence the global system safety.

The static analysis of Talvacchia Dam with nonlinear block joint behaviour is considered. Two different loading cases for summer and winter conditions including dead weight, temperature distribution and water loading are analysed. Three calculations are carried out with monolithic arch, closed but sliding joints and with frictional joints. The solution for the described problem is found with an implicit solution procedure. The general purpose program Abaqus is employed to solve the numerical problem. The results calculated either for frictional or fully coupled joint behaviour are nearly the same, due to the high friction factor and the geometrical relation between height and curvature. The arch stresses keep the joints closed. Sliding joints, normally used to evaluate dead weight loading conditions only, lead to larger displacements and different stress distribution, due to a change in the bearing behaviour. The bending of concrete columns is increased and horizontal stresses are reduced.

In some cases it is necessary to introduce discrete joints to model separation and/or frictional sliding. However, due to the nonlinear behaviour it's necessary to take care of the appropriate loading sequence. Two different numerical possibilities for the contact algorithm are prescribed. Numerically calculated results are compared with the solution by applying the conventional calculation procedure.

Introduction

For Talvacchia double curvature arch dam the influence of acting construction joints is to investigate. The provided geometry for the dam is used and has to be slightly modified within the joint. The numerical procedure needs isoparametric joint elements with a midsurface point, this leads to a subsequent change of 20 node brick elements to 27 variable node brick elements with midsurface nodes too. This is done for all elements in the vicinity of the joints. The symmetric nature of the problem is utilized.

The elastic parameters for concrete and rock are as follows:

- $E_c = 36GPa$, $\nu_c = 0.2$, $\alpha_t = 0.7 * 10^{-5}$, $\gamma_c = 24kN/m^3$
- $E_r = 12GPa$, $\nu_r = 0.16$, $\gamma_r \approx 0$

The friction factor during compression acting in the surface normal direction is assumed to be

- $\mu = 0.75$,

no postfailure behaviour is introduced.

The loading conditions are modelled in a step by step sequence by applying

- dead weight,
- temperature loading and
- water loading

in a subsequent manner. Within the further context "summer loading" and "winter loading" stands for full loading condition in summer and winter respectively. Normally the dead weight is applied, depending on joint grouting, for each concrete column separately. For any further loading the "joint closing temperature" is introduced to define the starting state of the dam to act as arched structure and joints are tied together. For the benchmark the dead weight is activated for all arch dam elements with initially closed joints and leads to some initial sliding and joint opening in discrete joints. The summer temperature distribution will lead to some additional prestressing. This configuration is the initial condition for applying full water load. The results of stress/strain distribution within the structure are slightly different compared with an analysis without joints in operation.

The initial dead weight loading, winter temperature distribution and partially water loading lead to partially open joints. They are not fully closed due to water loading. The high amount of maximum principal tensile stresses for winter temperature distribution is recognized. The joint opening leads to a reduction of these tensile stresses at the location in the vicinity of the joints but not within a concrete block (between discrete joints).

Numerical Procedure

This part contents the questions of discretization, surface contact conditions and the way to prescribe the frictional interface.

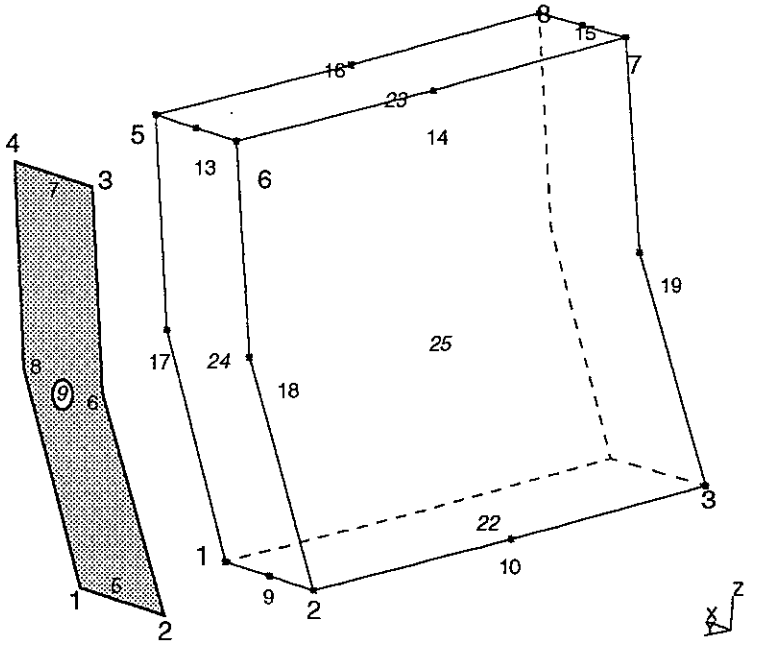
Discretization

Two different main procedures are available within Abaqus to model contact

- explicit (dynamic analysis)
- implicit (static and dynamic analysis).

The explicit procedure, assuming a master and slaved surface (prescribed during the input without defining an element), is used in conjunction with dynamic nonlinear earthquake calculations.

To model implicit contact analysis for general nonlinear static analysis within Abaqus, it is necessary to define contact elements. Quadratic isoparametric interface elements are appropriate in conjunction with the given dam layout with quadratic solid elements. Due to convergence problems during initial calculations it was necessary to use nine noded interface elements with 27 variable noded bricks with additional midsurface nodes. Convergence problems



27 variable node element with 9-nodes per face "interface" element

occurred due to partially contact within some elements. Nine noded quadratic interface elements seem to be sufficient to prescribe this contact condition. Some work were done to investigate the influence of integration procedure on convergence behaviour [2],[3]. The influence of the opposite direction of nodal forces equivalent to constant stress state in an element has to be mentioned.

Frictional Behaviour

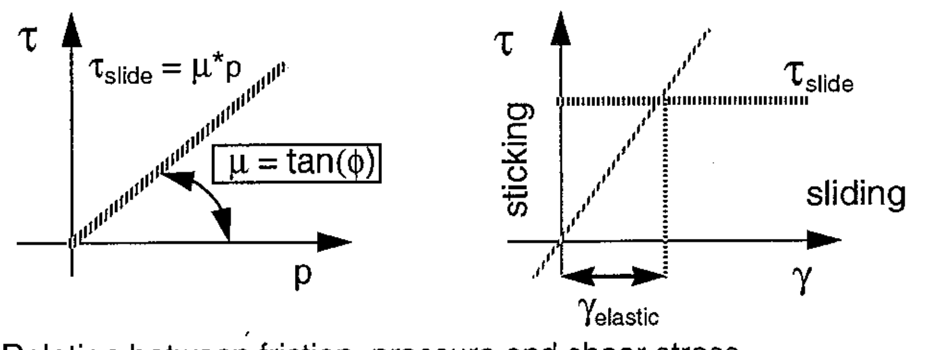
Different criteria may be chosen to satisfy numerical convergence within a reasonable time. Following procedures are possible and compared during execution of the analysis:

- Penalty parameters, Elastic Slip (defined in the input deck) and
- Lagrange method.

During initial state of contact (no sliding should occur) with some pressure stress "p" acting, the allowable shear stress transmitted within the contact surface is calculated with

$\tau_{max} < \mu^*p$ sticking state

If the current shear stress τ equals τ_{max}, the sticking state changes to sliding. The procedure may model the behaviour rigorous and "accurate" by introducing Lagrange multiplier, but may cause convergence problems during iteration. A weaker, but more time effective formulation is the introduction of penalty parameters. This gives some additional sliding during sticking state. This sliding can be controlled with some allowable $\gamma_{elastic}$ value and gives the program the value to choose the penalty parameter.



Relation between friction, pressure and shear stress

The penalty parameter for this mode is found iteratively from an allowable sliding during sticking from:

$$K_p < \mu^*p/\gamma$$

Sudden changes of the penalty value may lead to convergence problems; therefore some amount of elastic sliding improves convergence performance. The sensitiveness of the solution, depending on the elastic slip is shown and in this special situation not significant at all. A smaller sliding value increases the computation time.

Surface Contact

The opening and closing behaviour can be predicted with a hard contact option. This means a transmission of any pressure stress if the nodes are in contact and no pressure stress transmission if the joints are separated. The amount of separation and/or possible tensile stress transmission can be input. It is possible, for reasons of better convergence to apply some softened contact condition with an exponential increasing amount of pressure during contact, starting with a small amount of opening and resulting in an amount of overclosure if the pressure reaches a certain value. The values are scalable and lead to improved convergence but less accuracy.

The question of rigorousness

To find an appropriate contact condition the procedure leads to a nonlinear iterative solution procedure, which is sketched as follows:

- each equilibrium iteration is started with an estimate of contact situation - "open" or "closed"
- equilibrium iteration is performed - full Newton method
- if a point was thought to be closed (pressure $p > 0$) or if point was thought to be open (opening $h > 0$)
- at the end of iteration it is known if guess was correct or not
- iteration is performed until all contact conditions fulfilled
  - contact at interface points
  - criteria for equilibrium tolerance

It is possible to apply some error bounds for the convergence of the solution and values to fulfill sliding and surface contact.

All scalable values mentioned above to find an appropriate solution should be found within a process of engineering decision. Which amount of accuracy is necessary to prescribe the overall behaviour and which numerical method must be introduced to meet the mechanical situation. However, a benchmark should give the possibility to study the behaviour in detail, but also within a reasonable time. Therefore some meaningful assumptions within an engineering standpoint of view are introduced to calculate the results. These are shown in table [1]. It was not possible to find a convergent solution with the Lagrangian method for sticking behaviour. However, due to some disretization assumptions at the tip of the block joints (this can clearly be seen on stress contour plots), the gradient on contact stresses leads to oscillating contact conditions, therefore the iteration procedure was assumed to be convergent though in five contact points the contact condition is violated - 0.3MPa tensile stresses might occur and 3mm of relative elastic slip - to a greater amount than generally assumed (table [1]).

Numerical Parameters for Contact [Table1]

mode	p	τ	slip
sticking	$p < 0$	$\tau < \mu^* p$	1mm
sliding	$p < 0$	$\tau = \mu^* p$	any value
open	$p = 0$	$\tau = 0$	any value

During "softened contact" the amount of joint opening which allows to transmit zero pressure is assumed to be 0.1mm and leads to overclosure of about 0.1mm for a stress level of -7MPa.

Calculation time on DEC Alpha AXP 7000 [Table 2] :

problem description		iterations (steps)	computation time
closed joints fully coupled analysis 5 loading cases		- (5)	8:00 min
sliding joints no friction - fully coupled		- (5)	8:00 min
frictional joint behaviour	Case [a]	110 (3)	3h 12 min

a. Elastic slip 1mm; softened contact; winter loading only

Numerical Calculation

To compare the calculated results a general overview is sketched, showing the gained results in pictures of radial deflection curve, vertical and horizontal stress distribution. The detailed results that are of numerical interest can also be found in the appendix. The results are compared and separated into:

- Coupled joints, full arch behaviour
- Coupled but sliding joints - without frictional behaviour
- Sliding joints with friction - joints are coupled or open

It has to be mentioned, that some assumptions in relation to the kind of analysis are introduced. Due to discretization the discontinuity at the rock base - joint connection leads to some high stress concentration and would need some mesh refinement. The postprozessing task is reduced to a minimum - for the global behaviour - detailed results are provided for joints only. The stress diagram lines show (at the dam base line) a mean stress value, which would normally show higher gradients.

Coupled joints

The arch dam is investigated with the provided geometry, the related nodal pairs in the block joints are kept closed during loading. The results for dead weight and water loading are compared with results provided from the first benchmark Workshop [7] and further results are detailed in the appendix.

Sliding joints

By introducing sliding joints without friction within the calculation the results are significantly affected. Radial deflections are increasing by about 100%. The bending behaviour of highest concrete blocks increases and arch stresses are reduced. The influence of joint opening at the dam base in relation to the water pressure should be investigated [6].

Frictional joints

The overall behaviour of the structure is only slightly influenced by introducing sliding, frictional joints, as it can be seen from the radial deflection curve and vertical and horizontal stress distribution. This is true for summer and winter loading conditions.

The monitoring of joints 1(4) and 2 (3) (in selected points and diagram lines) shows for

- hard and
- soft contact condition

the opening, closing and related nodal pressures. It can be seen from pages *A-19-* and *A-20-* that some nodes are labeled "open" in joint 2 and some nodal pairs are open in joint 1 during dead weight and temperature loading. Applying of the water loading results in a joint closing and linear increase of contact pressure. The influence on introducing some engineering "meaningful" softer contact conditions doesn't influence the results too much, but reduces computation time and stress concentrations within the contact surface.

In the vicinity of discontinuities the local stress distribution is different compared with coupled joints, but thermal induced tensile stresses are significantly reduced. The global dam performance recognizes some higher bending stresses due to sliding within the joints. The influence of the artificial "elastic slip" during sticking was investigated (value from 1mm to 0.1mm), but isn't significant at all.

Conclusion

Numerical calculations should be able to "predict", dependent on the provided input data of interest, the overall system performance and will give local stressing, leading to local and global system safety estimation.

Finite element procedures are an appropriate tool to investigate the mechanical structural behaviour and give with some additional numerical tasks the possibility to incorporate discontinuities. The numerical procedure is highlighted and shows some procedures for contact formulation for which two are carried out and assumptions on convergence criteria are mentioned.

The benchmark results show:

- for frictional joint behaviour no significant global changes, due to the height of the dam, but some small changes of the relation of bending and arch stresses
- for sliding joints an increase in deflections and due to the bending of conrete columns higher tensile stresses at the dams upstream side.

From an engineering standpoint of view it seems to be appropriate to include joint behaviour for dead weight loading. Due to joint grouting these joints are normally closed during water loading and will transmit arch stresses - otherwise the dam would not act as arched structure. Some influence of frictional joints might be seen from results and due to uncertainties may happen in "reality". Joint behaviour is necessary to be investigated if tensile stresses may open the joints and changes the system behaviour.

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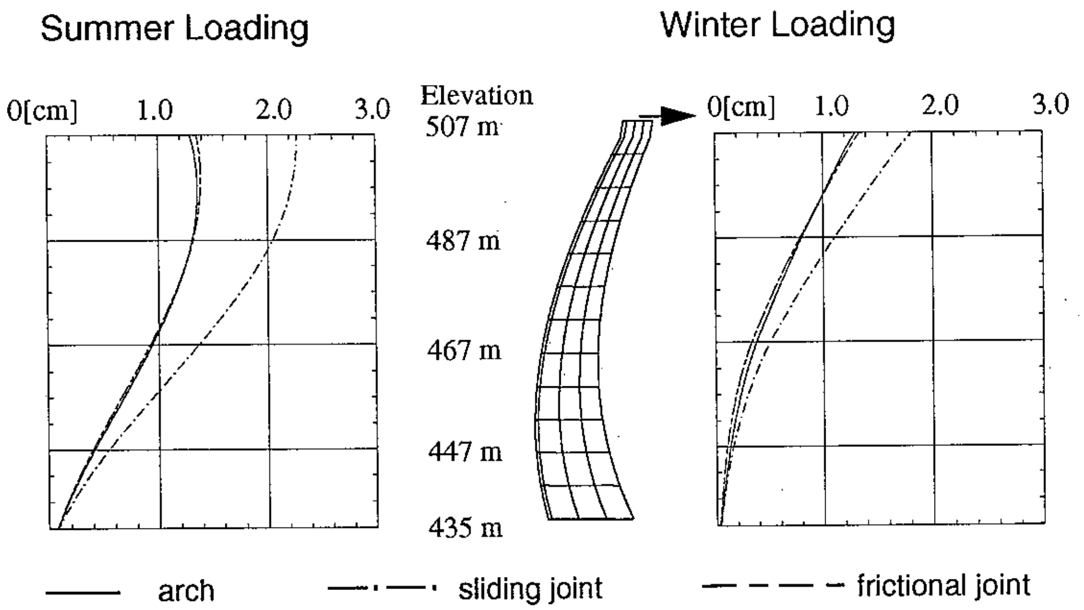
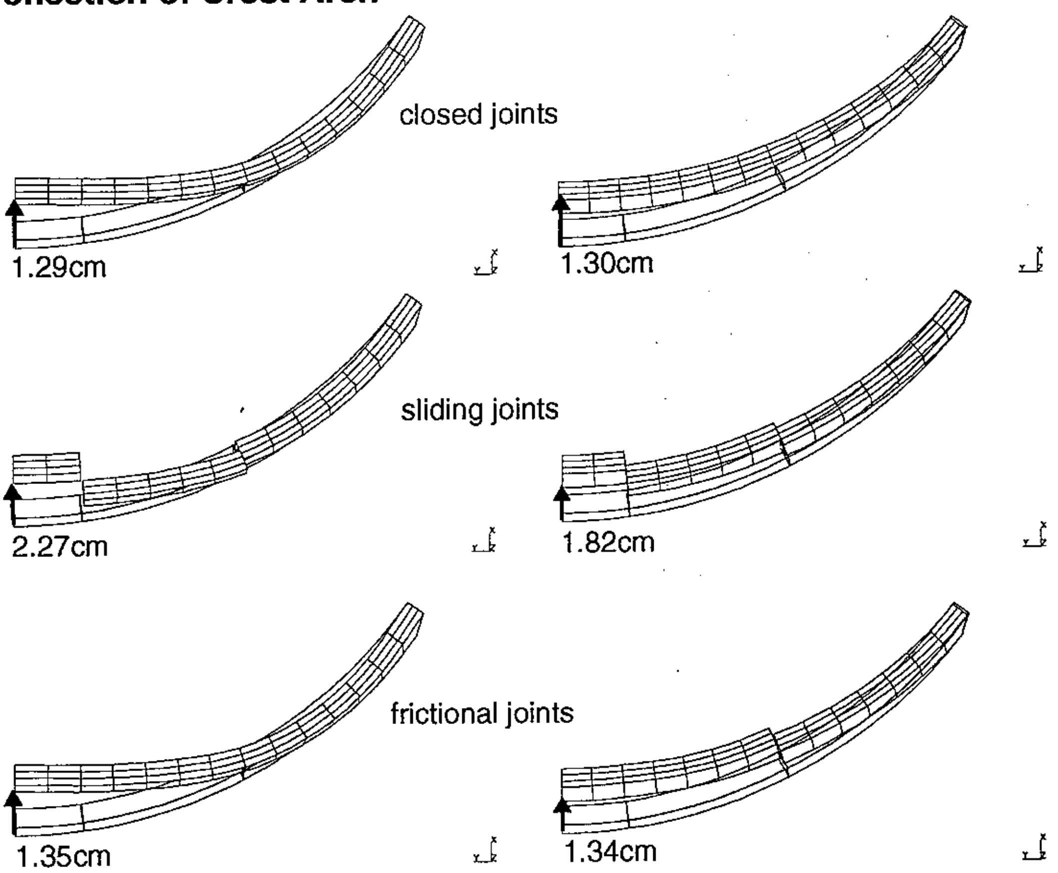
APPENDIX

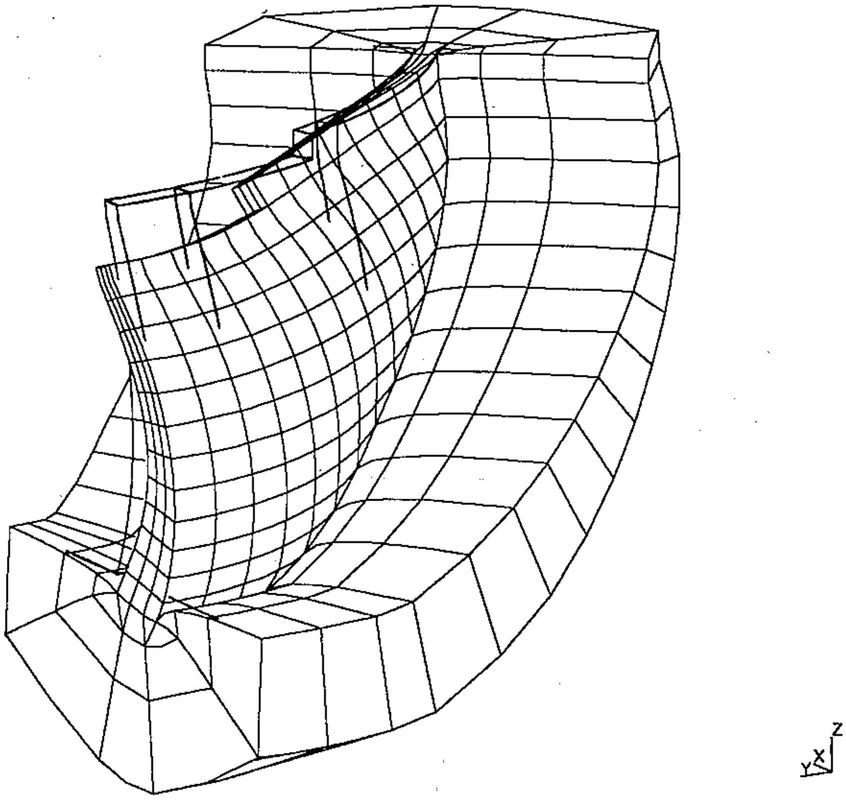
Radial Deflection

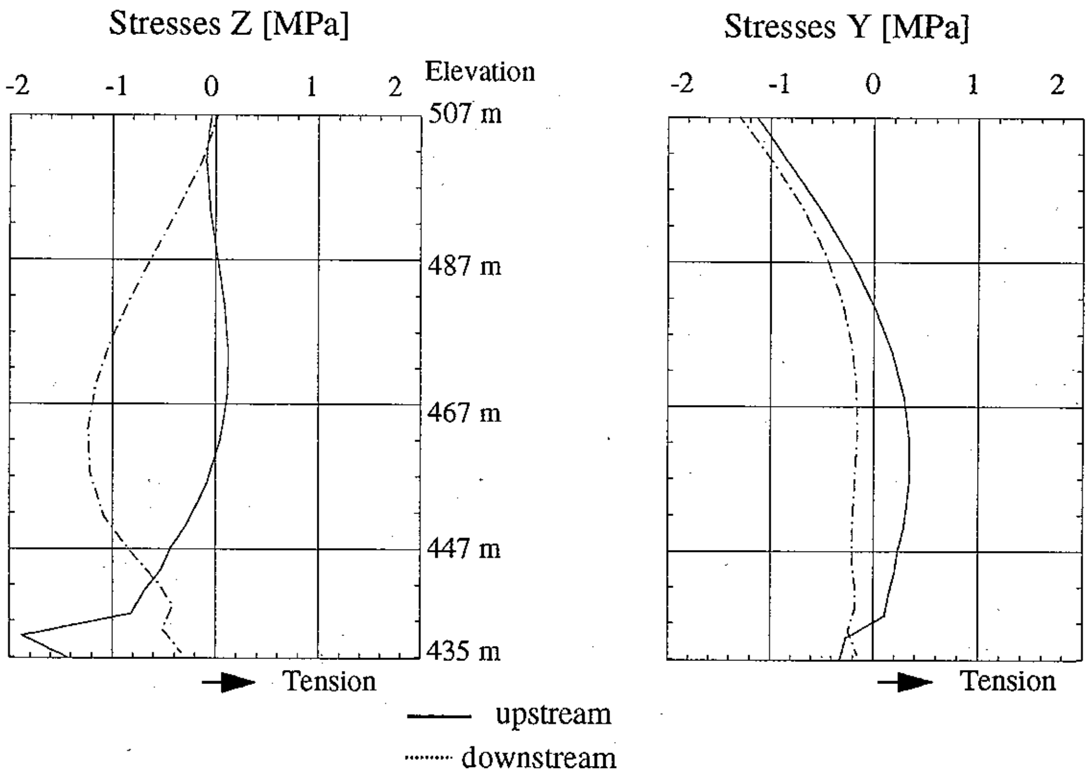


Deflection of Crest Arch



Dead Weight (only) - Initial Structure (No discrete Joint's)

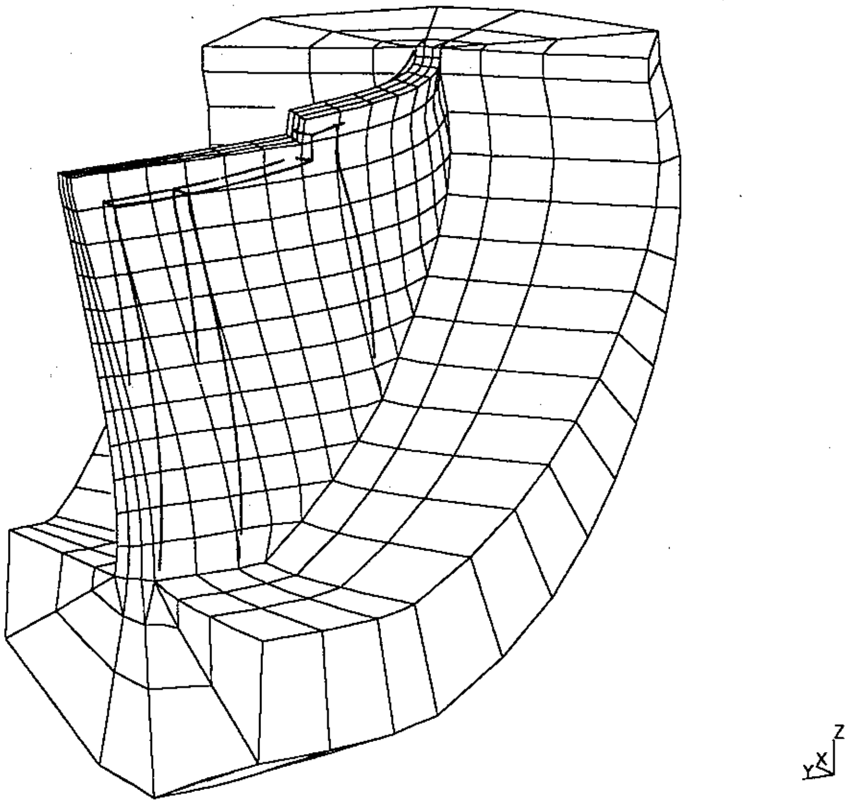


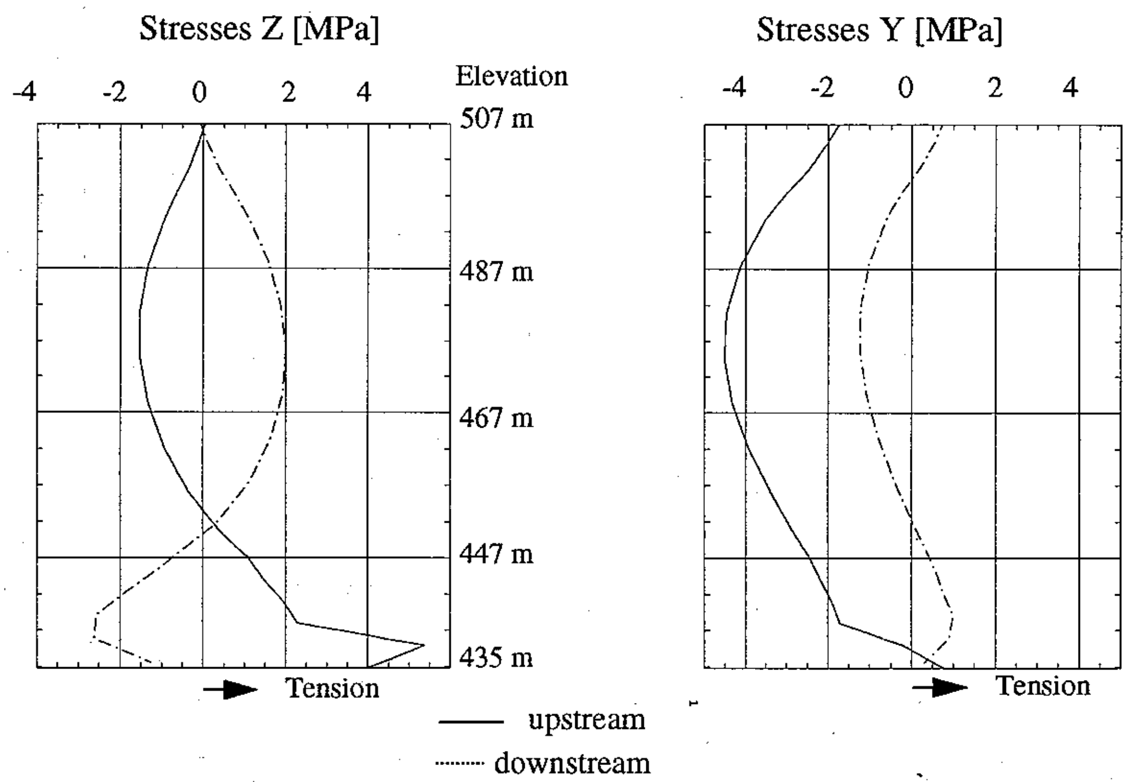


Dead Weight - Joints are closed [Table1]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	7.667E-04	0.000E+00	-2.919E-03	1.011E-01	4.456E-02	-1.040E-01
2	377	7.770E-04	0.000E+00	-3.057E-03	3.110E-02	-1.741E-01	-1.157E+00
3	463	7.876E-04	0.000E+00	-3.202E-03	1.557E-03	-8.206E-02	-1.318E+00
4	549	7.978E-04	0.000E+00	-3.342E-03	6.834E-02	-1.479E-02	-1.570E+00
5	1550	-7.755E-04	0.000E+00	-2.298E-03	2.660E-03	-5.024E-03	-4.728E-01
6	1624	-7.712E-04	0.000E+00	-2.444E-03	4.268E-01	2.577E-01	-2.813E-02
7	1698	-7.639E-04	0.000E+00	-2.602E-03	1.413E-02	-2.264E-01	-3.412E-01
8	1772	-7.550E-04	0.000E+00	-2.766E-03	1.390E-03	-1.672E+00	-2.205E+00
9	1542	-5.257E-04	2.168E-04	-1.965E-03	3.132E-03	-2.915E-02	-4.905E-01
10	1616	-5.310E-04	2.445E-04	-2.109E-03	4.812E-01	2.265E-01	-2.683E-02
11	1690	-5.331E-04	2.747E-04	-2.267E-03	1.730E-05	-2.169E-01	-3.068E-01
12	1764	-5.323E-04	3.047E-04	-2.433E-03	3.366E-04	-1.814E+00	-2.108E+00
13	1538	-2.672E-04	3.467E-04	-1.611E-03	5.514E-03	-1.512E-01	-5.061E-01
14	1612	-2.779E-04	3.728E-04	-1.750E-03	4.709E-01	2.103E-01	-2.165E-02
15	1686	-2.851E-04	4.018E-04	-1.905E-03	-2.127E-02	-1.531E-01	-3.276E-01
16	1760	-2.883E-04	4.312E-04	-2.069E-03	-2.211E-03	-1.939E+00	-2.026E+00
17	1534	-9.476E-05	4.400E-04	-1.181E-03	5.923E-03	-2.334E-01	-5.592E-01
18	1608	-1.005E-04	4.465E-04	-1.309E-03	4.378E-01	2.274E-01	-1.984E-02
19	1682	-1.021E-04	4.557E-04	-1.450E-03	-2.925E-02	-1.076E-01	-3.291E-01
20	1756	-9.908E-05	4.673E-04	-1.598E-03	-1.244E-02	-1.854E+00	-2.172E+00
21	1530	-6.557E-05	4.051E-04	-7.595E-04	1.859E-03	-4.079E-01	-7.763E-01
22	1604	-5.744E-05	3.907E-04	-8.606E-04	3.614E-01	1.796E-01	-1.739E-02
23	1678	-4.465E-05	3.782E-04	-9.708E-04	-8.693E-03	-5.037E-02	-3.733E-01
24	1752	-2.813E-05	3.699E-04	-1.082E-03	-4.015E-02	-1.725E+00	-2.254E+00
25	2567	-1.416E-03	0.000E+00	-2.111E-03	7.901E-03	-1.557E-01	-8.833E-01
26	2623	-1.418E-03	0.000E+00	-2.116E-03	1.016E+00	4.179E-01	-2.836E-02
27	2679	-1.413E-03	0.000E+00	-2.128E-03	2.593E-01	-5.548E-02	-2.312E-01
28	2735	-1.399E-03	0.000E+00	-2.148E-03	-1.290E-02	-2.625E+00	-2.970E+00
29	2559	-9.718E-04	-1.744E-04	-1.846E-03	1.155E-02	-3.128E-01	-1.151E+00
30	2615	-9.944E-04	-1.145E-04	-1.833E-03	9.548E-01	2.766E-01	-2.933E-02
31	2671	-1.011E-03	-5.130E-05	-1.825E-03	2.975E-01	-9.222E-02	-2.357E-01
32	2727	-1.018E-03	1.536E-05	-1.815E-03	-7.811E-03	-2.507E+00	-2.922E+00
33	2555	-4.992E-04	-1.025E-04	-1.554E-03	3.332E-02	-7.241E-01	-1.471E+00
34	2611	-5.344E-04	-3.476E-05	-1.519E-03	7.788E-01	1.933E-01	-1.270E-01
35	2667	-5.647E-04	3.447E-05	-1.487E-03	4.253E-01	-9.883E-02	-2.400E-01
36	2723	-5.929E-04	1.098E-04	-1.442E-03	5.099E-02	-2.111E+00	-2.709E+00
37	2551	-1.816E-04	4.095E-05	-1.144E-03	2.985E-01	-9.074E-01	-1.695E+00
38	2607	-2.008E-04	6.640E-05	-1.104E-03	5.612E-01	2.327E-01	-2.965E-01
39	2663	-2.117E-04	1.008E-04	-1.062E-03	3.939E-01	4.779E-02	-3.062E-01
40	2719	-2.251E-04	1.289E-04	-1.005E-03	2.213E-01	-1.653E+00	-2.716E+00
41	3503	-6.365E-04	0.000E+00	-2.007E-03	2.739E-02	-7.247E-01	-1.840E+00
42	3535	-6.219E-04	0.000E+00	-1.780E-03	7.466E-01	2.070E-01	-2.580E-01
43	3567	-5.969E-04	0.000E+00	-1.551E-03	2.583E-01	1.787E-01	-3.539E-01
44	3599	-5.789E-04	0.000E+00	-1.297E-03	-8.756E-02	-2.742E+00	-2.991E+00
45	3495	-1.736E-04	-1.301E-04	-1.522E-03	4.989E-01	-9.765E-01	-2.441E+00
46	3527	-1.963E-04	-5.107E-05	-1.364E-03	5.377E-01	3.637E-02	-8.147E-01
47	3559	-2.135E-04	2.025E-05	-1.211E-03	4.098E-01	-1.029E-01	-3.797E-01
48	3591	-2.356E-04	8.520E-05	-1.044E-03	1.516E-01	-1.975E+00	-3.045E+00
49	3791	5.341E-05	0.000E+00	-1.451E-03	-6.008E-01	-6.647E-01	-2.007E+00
50	3811	1.747E-06	0.000E+00	-1.365E-03	2.561E-01	-1.571E-01	-5.925E-01
51	3831	-3.435E-06	0.000E+00	-1.150E-03	-1.363E-01	-1.928E-01	-5.070E-01
52	3851	-3.287E-05	0.000E+00	-8.737E-04	-4.454E-02	-9.328E-01	-1.048E+00

Water Loading (only) - Initial Structure (No discrete Joint's)

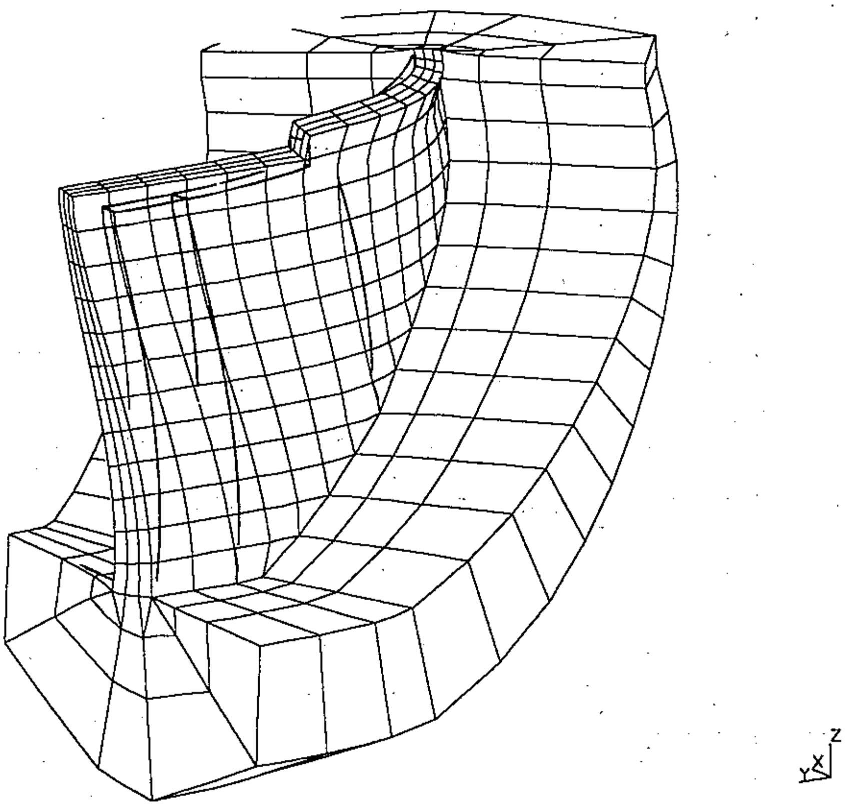


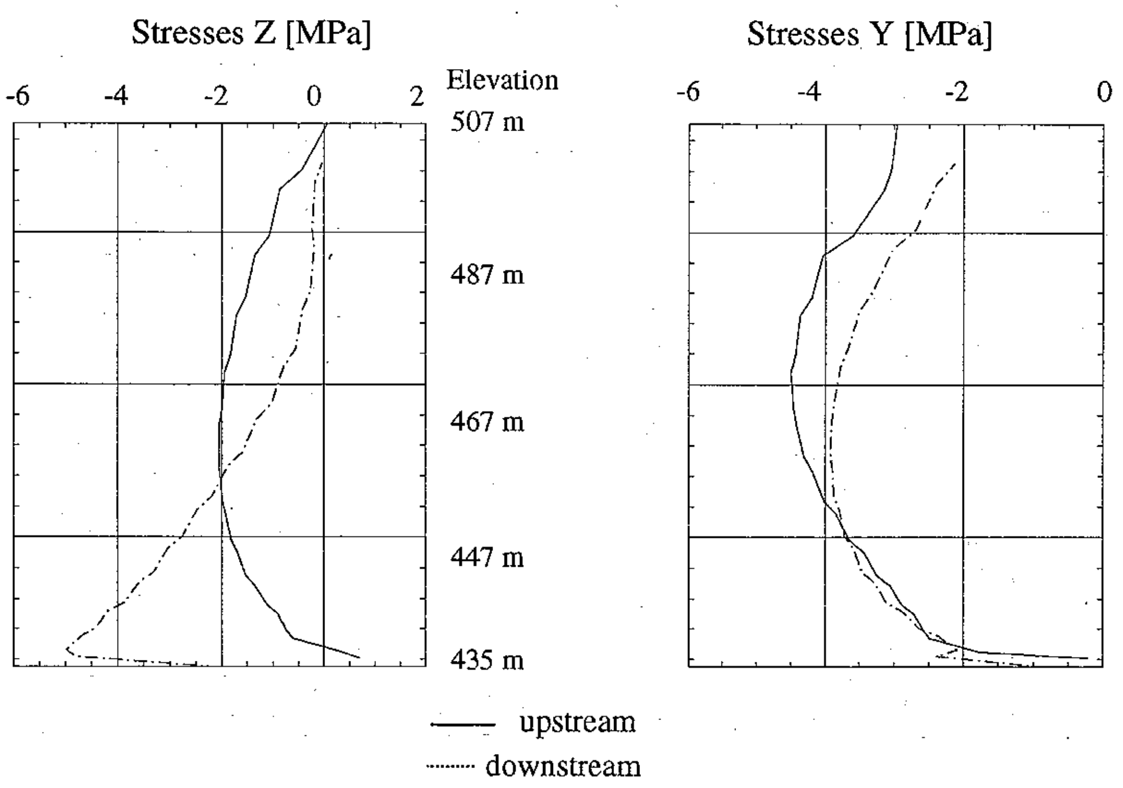


Water Loading only - Joints are closed [Table2]

LABEL	NODE	Displacements [m]			Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	2.085E-02	0.000E+00	2.256E-03	7.074E-02	3.515E-03	-1.727E+00
2	377	2.086E-02	0.000E+00	2.193E-03	4.962E-02	1.147E-02	-9.266E-01
3	463	2.087E-02	0.000E+00	2.124E-03	8.421E-03	-8.714E-03	-1.030E-01
4	549	2.087E-02	0.000E+00	2.054E-03	7.299E-01	2.063E-03	-9.319E-02
5	1550	1.961E-02	0.000E+00	2.910E-03	-1.763E-01	-1.550E+00	-4.137E+00
6	1624	1.964E-02	0.000E+00	2.558E-03	-6.321E-02	-5.072E-01	-3.149E+00
7	1698	1.967E-02	0.000E+00	2.237E-03	6.327E-01	-3.497E-02	-2.088E+00
8	1772	1.967E-02	0.000E+00	1.969E-03	1.711E+00	5.219E-03	-1.006E+00
9	1542	1.351E-02	2.238E-03	2.661E-03	-1.777E-01	-1.382E+00	-3.506E+00
10	1616	1.371E-02	1.645E-03	2.425E-03	-6.389E-02	-3.994E-01	-2.911E+00
11	1690	1.391E-02	1.027E-03	2.222E-03	7.410E-01	-3.112E-02	-2.325E+00
12	1764	1.410E-02	4.124E-04	2.066E-03	1.887E+00	5.585E-03	-1.756E+00
13	1538	8.086E-03	1.509E-03	2.311E-03	-1.794E-01	-1.317E+00	-2.388E+00
14	1612	8.362E-03	9.385E-04	2.159E-03	-8.270E-02	-3.149E-01	-2.354E+00
15	1686	8.646E-03	3.445E-04	2.044E-03	9.245E-01	-2.061E-02	-2.442E+00
16	1760	8.921E-03	-2.446E-04	1.969E-03	2.274E+00	8.073E-03	-2.553E+00
17	1534	3.974E-03	1.654E-04	1.621E-03	-1.826E-01	-1.173E+00	-1.860E+00
18	1608	4.203E-03	-1.709E-04	1.603E-03	-7.886E-02	-2.121E-01	-1.928E+00
19	1682	4.440E-03	-5.246E-04	1.617E-03	1.131E+00	2.034E-03	-2.248E+00
20	1756	4.670E-03	-8.788E-04	1.658E-03	2.638E+00	3.863E-03	-2.589E+00
21	1530	1.712E-03	-7.395E-04	8.366E-04	-1.803E-01	-1.031E+00	-1.353E+00
22	1604	1.839E-03	-8.728E-04	9.151E-04	-4.479E-02	-1.071E-01	-1.588E+00
23	1678	1.971E-03	-1.009E-03	1.016E-03	1.009E+00	3.358E-02	-1.872E+00
24	1752	2.096E-03	-1.152E-03	1.120E-03	2.379E+00	-3.424E-02	-2.222E+00
25	2567	1.495E-02	0.000E+00	4.816E-03	-3.544E-01	-1.381E+00	-4.322E+00
26	2623	1.500E-02	0.000E+00	3.764E-03	-1.543E-01	-4.392E-01	-3.334E+00
27	2679	1.504E-02	0.000E+00	2.715E-03	6.984E-01	-4.212E-02	-2.243E+00
28	2735	1.505E-02	0.000E+00	1.705E-03	1.942E+00	1.099E-02	-1.078E+00
29	2559	9.690E-03	2.500E-03	3.920E-03	-3.571E-01	-5.801E-01	-3.518E+00
30	2615	9.961E-03	1.811E-03	3.077E-03	1.101E-01	-2.668E-01	-2.843E+00
31	2671	1.023E-02	1.105E-03	2.225E-03	8.262E-01	-5.909E-02	-2.191E+00
32	2727	1.048E-02	3.942E-04	1.385E-03	1.750E+00	3.413E-03	-1.520E+00
33	2555	4.593E-03	1.597E-03	3.132E-03	6.867E-01	-3.275E-01	-1.311E+00
34	2611	4.985E-03	8.636E-04	2.404E-03	8.719E-01	-1.928E-01	-2.048E+00
35	2667	5.386E-03	1.557E-04	1.672E-03	9.445E-01	-1.790E-01	-2.697E+00
36	2723	5.816E-03	-5.619E-04	9.166E-04	9.135E-01	-8.380E-02	-3.169E+00
37	2551	1.724E-03	-1.858E-04	1.959E-03	1.087E+00	-3.570E-01	-9.220E-01
38	2607	1.875E-03	-4.155E-04	1.434E-03	1.273E+00	-4.969E-01	-9.313E-01
39	2663	2.047E-03	-6.578E-04	8.970E-04	1.269E+00	-6.256E-01	-2.232E+00
40	2719	2.193E-03	-8.254E-04	3.421E-04	1.094E+00	7.825E-02	-3.610E+00
41	3503	5.184E-03	0.000E+00	5.266E-03	1.458E+00	-6.616E-01	-2.193E+00
42	3535	5.113E-03	0.000E+00	3.588E-03	1.386E+00	-8.251E-01	-1.266E+00
43	3567	5.030E-03	0.000E+00	1.945E-03	7.702E-01	-4.161E-01	-8.780E-01
44	3599	5.004E-03	0.000E+00	3.167E-04	5.617E-01	8.428E-02	-1.216E+00
45	3495	2.185E-03	7.395E-04	3.232E-03	2.732E+00	-1.346E+00	-2.015E+00
46	3527	2.337E-03	2.262E-04	2.125E-03	2.529E+00	-8.740E-02	-8.648E-01
47	3559	2.475E-03	-2.347E-04	1.058E-03	9.476E-01	1.479E-01	-1.800E+00
48	3591	2.617E-03	-6.123E-04	4.127E-05	1.374E+00	5.587E-01	-3.075E+00
49	3791	6.821E-04	0.000E+00	3.105E-03	4.536E+00	1.527E+00	7.687E-01
50	3811	8.706E-04	0.000E+00	2.072E-03	1.136E+00	3.822E-01	1.264E-01
51	3831	9.017E-04	0.000E+00	8.145E-04	5.968E-01	4.350E-01	-3.734E-01
52	3851	8.170E-04	0.000E+00	-9.053E-06	3.062E-01	-4.681E-01	-2.075E+00

Summer Loading (Joints are closed)

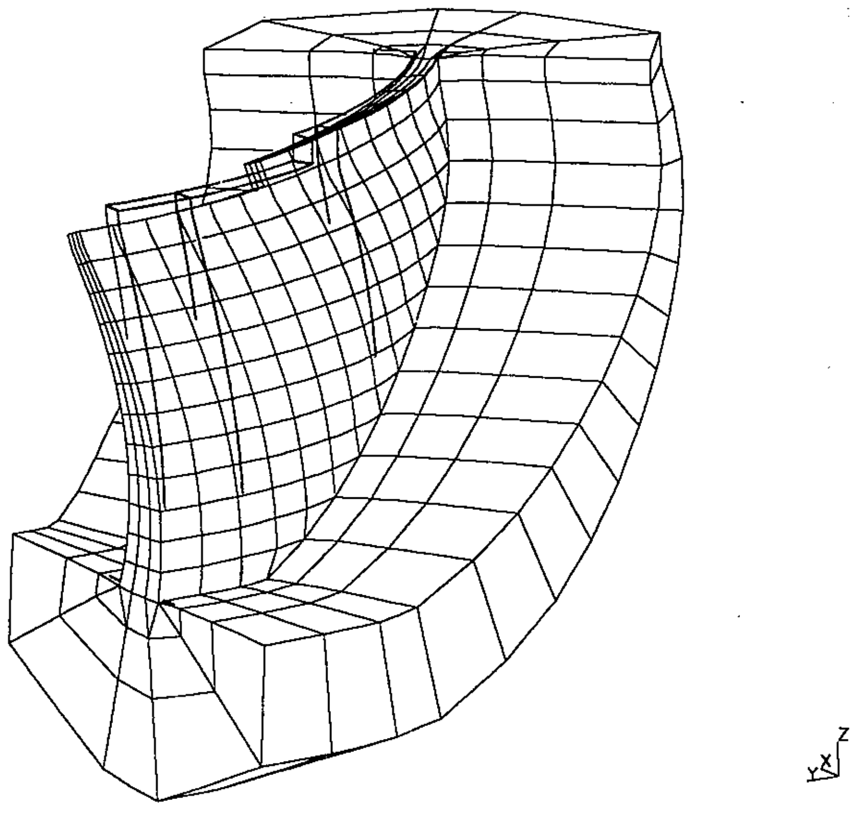


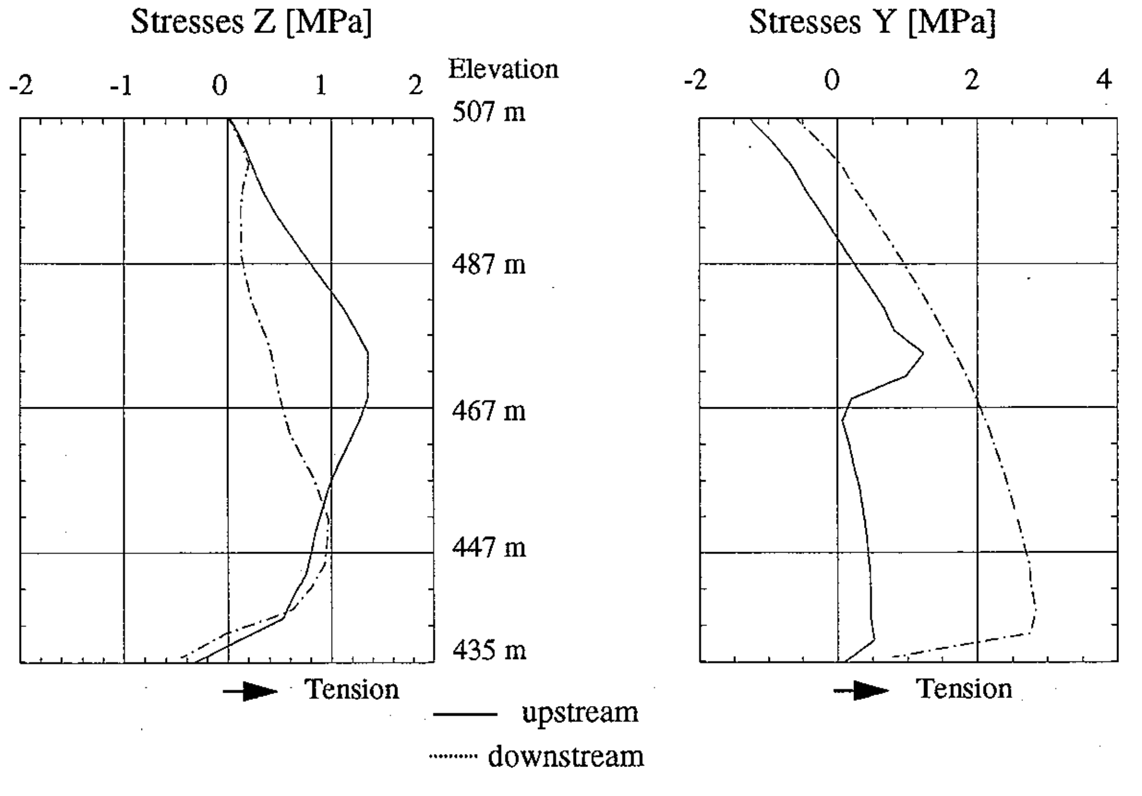


Summer Loading - Joints are closed [Table3]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	1.291E-02	0.000E+00	-5.266E-04	1.560E-01	3.188E-02	-2.960E+00
2	377	1.304E-02	0.000E+00	-3.093E-04	8.431E-02	-1.670E-01	-3.265E+00
3	463	1.316E-02	0.000E+00	-1.331E-04	-9.885E-03	-6.963E-02	-2.662E+00
4	549	1.329E-02	0.000E+00	3.698E-05	3.385E-02	-4.839E-02	-2.138E+00
5	1550	1.313E-02	0.000E+00	-8.809E-04	-1.742E-01	-1.999E+00	-4.361E+00
6	1624	1.321E-02	0.000E+00	-1.130E-03	-1.140E-01	-4.412E-01	-3.022E+00
7	1698	1.329E-02	0.000E+00	-1.342E-03	2.388E-02	-8.116E-02	-2.812E+00
8	1772	1.344E-02	0.000E+00	-1.534E-03	7.125E-03	-6.095E-01	-3.673E+00
9	1542	8.553E-03	1.641E-03	-6.593E-04	-1.752E-01	-1.800E+00	-3.546E+00
10	1616	8.754E-03	1.217E-03	-8.000E-04	-1.205E-01	-3.602E-01	-2.571E+00
11	1690	8.959E-03	7.747E-04	-9.071E-04	-1.599E-03	-9.374E-02	-2.824E+00
12	1764	9.233E-03	3.556E-04	-1.002E-03	5.665E-03	-7.597E-01	-4.217E+00
13	1538	4.690E-03	1.012E-03	-4.879E-04	-1.734E-01	-1.699E+00	-2.412E+00
14	1612	4.933E-03	6.300E-04	-5.566E-04	-1.251E-01	-2.789E-01	-1.916E+00
15	1686	5.185E-03	2.334E-04	-5.926E-04	5.950E-02	-1.134E-01	-2.709E+00
16	1760	5.507E-03	-1.275E-04	-6.229E-04	4.780E-03	-7.724E-01	-4.686E+00
17	1534	2.026E-03	-3.220E-05	-4.723E-04	-1.777E-01	-1.562E+00	-1.844E+00
18	1608	2.214E-03	-2.176E-04	-4.352E-04	-9.160E-02	-1.331E-01	-1.442E+00
19	1682	2.407E-03	-4.142E-04	-3.692E-04	2.524E-01	-8.147E-02	-2.387E+00
20	1756	2.670E-03	-5.655E-04	-3.035E-04	-1.576E-02	-5.895E-01	-4.588E+00
21	1530	8.521E-04	-6.641E-04	-5.022E-04	-1.896E-01	-1.320E+00	-1.840E+00
22	1604	9.555E-04	-6.972E-04	-4.033E-04	-3.002E-02	-1.083E-01	-1.110E+00
23	1678	1.060E-03	-7.320E-04	-2.853E-04	1.223E-01	-3.478E-02	-1.870E+00
24	1752	1.226E-03	-7.158E-04	-1.743E-04	-1.105E-01	-9.509E-01	-4.017E+00
25	2567	9.713E-03	0.000E+00	3.631E-04	-3.479E-01	-2.144E+00	-4.186E+00
26	2623	9.794E-03	0.000E+00	-3.804E-04	-1.361E-01	-3.610E-01	-2.168E+00
27	2679	9.828E-03	0.000E+00	-1.109E-03	9.740E-03	-3.717E-01	-1.988E+00
28	2735	1.000E-02	0.000E+00	-1.837E-03	-3.702E-03	-2.206E+00	-3.870E+00
29	2559	6.151E-03	1.643E-03	4.079E-05	-3.457E-01	-1.743E+00	-3.521E+00
30	2615	6.378E-03	1.191E-03	-4.994E-04	-1.222E-02	-2.692E-01	-1.724E+00
31	2671	6.563E-03	7.130E-04	-1.035E-03	-4.489E-03	-2.680E-01	-1.937E+00
32	2727	6.896E-03	2.855E-04	-1.572E-03	-3.688E-03	-2.180E+00	-4.347E+00
33	2555	2.766E-03	9.592E-04	-1.087E-04	-2.828E-01	-8.400E-01	-2.000E+00
34	2611	3.069E-03	4.896E-04	-5.338E-04	4.836E-01	-1.351E-01	-1.235E+00
35	2667	3.338E-03	2.151E-05	-9.577E-04	8.144E-02	-3.444E-01	-2.271E+00
36	2723	3.776E-03	-3.731E-04	-1.387E-03	-1.420E-02	-2.724E+00	-5.376E+00
37	2551	1.087E-03	-2.940E-04	-3.545E-04	-1.651E-01	-8.658E-01	-1.335E+00
38	2607	1.195E-03	-3.899E-04	-6.382E-04	5.305E-01	-2.178E-01	-5.960E-01
39	2663	1.302E-03	-5.147E-04	-9.411E-04	4.066E-01	-6.568E-01	-1.969E+00
40	2719	1.495E-03	-5.003E-04	-1.229E-03	3.972E-01	-2.127E+00	-5.357E+00
41	3503	3.394E-03	0.000E+00	8.669E-04	-6.280E-01	-9.148E-01	-2.712E+00
42	3535	3.400E-03	0.000E+00	-1.456E-04	3.809E-01	-4.459E-01	-6.002E-01
43	3567	3.316E-03	0.000E+00	-1.145E-03	-1.528E-01	-2.345E-01	-9.150E-01
44	3599	3.489E-03	0.000E+00	-2.050E-03	-3.234E-02	-2.636E+00	-4.744E+00
45	3495	1.666E-03	3.645E-04	1.884E-05	-7.257E-01	-1.208E+00	-2.252E+00
46	3527	1.789E-03	7.963E-05	-6.434E-04	5.555E-01	1.009E-01	-6.749E-01
47	3559	1.842E-03	-2.201E-04	-1.313E-03	3.655E-01	-2.625E-01	-1.828E+00
48	3591	2.084E-03	-3.904E-04	-1.896E-03	7.603E-01	-1.924E+00	-5.458E+00
49	3791	7.690E-04	0.000E+00	-2.645E-05	1.068E+00	3.654E-01	-2.213E-01
50	3811	8.382E-04	0.000E+00	-7.253E-04	2.845E-01	7.129E-02	-2.117E-01
51	3831	7.859E-04	0.000E+00	-1.527E-03	2.663E-01	-7.344E-02	-1.189E+00
52	3851	8.259E-04	0.000E+00	-1.863E-03	-5.748E-01	-8.977E-01	-3.579E+00

Winter Loading (Joints are closed)

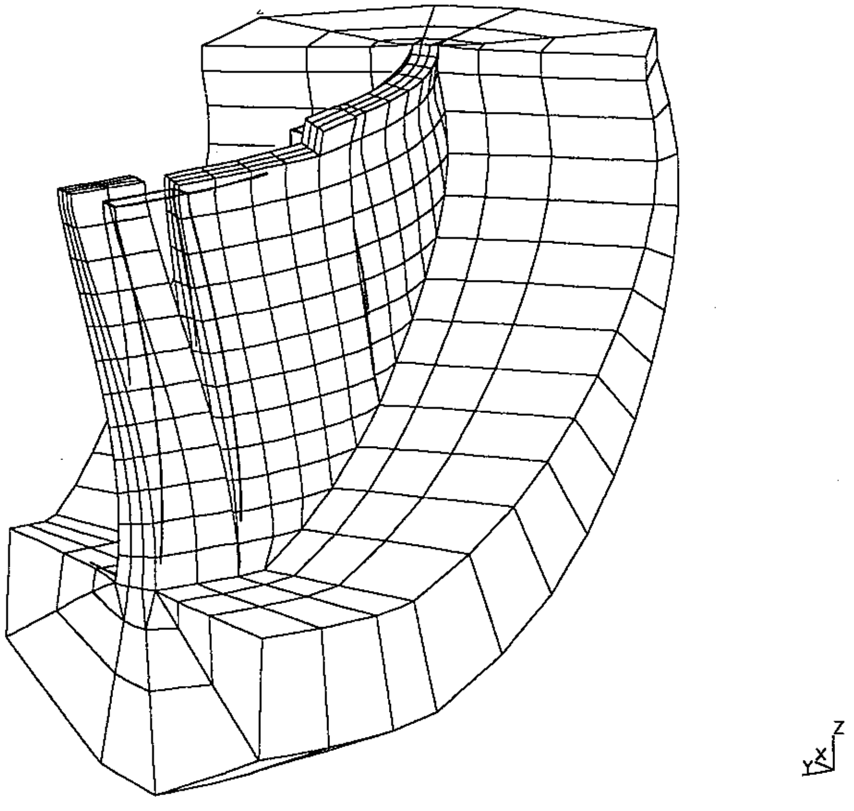


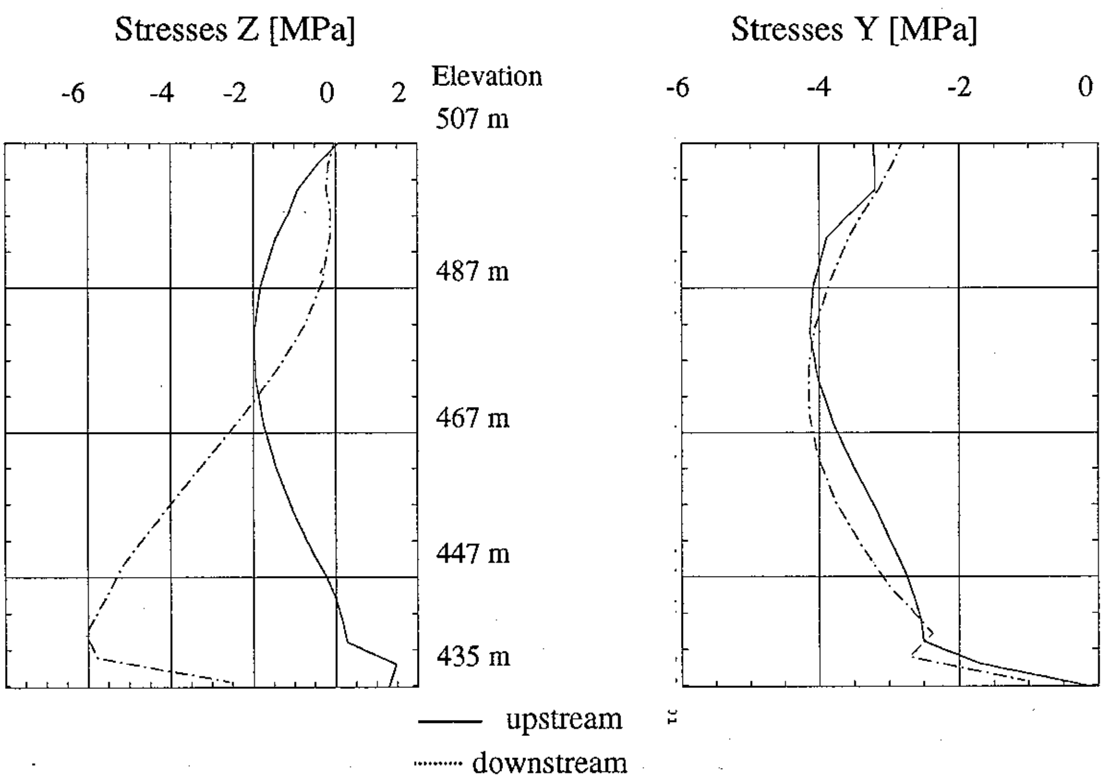


Winter Loading - Joints are Closed [Table4]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	1.303E-02	0.000E+00	-6.493E-03	2.219E-02	-1.809E-02	-1.270E+00
2	377	1.293E-02	0.000E+00	-6.969E-03	8.501E-02	-5.831E-02	-1.133E+00
3	463	1.284E-02	0.000E+00	-7.461E-03	6.374E-02	2.638E-03	-8.702E-01
4	549	1.274E-02	0.000E+00	-7.943E-03	2.160E-02	-2.474E-02	-6.004E-01
5	1550	8.086E-03	0.000E+00	-3.229E-03	9.343E-01	2.201E-01	-1.677E-02
6	1624	7.974E-03	0.000E+00	-3.802E-03	1.552E-02	-6.185E-01	-8.367E-01
7	1698	7.903E-03	0.000E+00	-4.414E-03	1.674E-02	-6.273E-01	-8.908E-01
8	1772	7.787E-03	0.000E+00	-5.004E-03	8.926E-01	1.389E-01	1.753E-03
9	1542	6.061E-03	1.792E-03	-2.709E-03	1.183E+00	7.124E-01	-1.797E-02
10	1616	6.004E-03	1.566E-03	-3.243E-03	1.275E-02	-4.128E-01	-6.813E-01
11	1690	5.993E-03	1.346E-03	-3.818E-03	1.285E-02	-4.567E-01	-1.039E+00
12	1764	5.940E-03	1.117E-03	-4.376E-03	9.035E-01	1.479E-03	-1.017E-01
13	1538	4.199E-03	1.989E-03	-2.186E-03	1.472E+00	1.185E+00	-1.942E-02
14	1612	4.177E-03	1.736E-03	-2.680E-03	1.628E-02	-9.504E-02	-6.162E-01
15	1686	4.205E-03	1.497E-03	-3.215E-03	4.978E-03	-2.375E-01	-1.180E+00
16	1760	4.195E-03	1.244E-03	-3.737E-03	1.027E+00	2.156E-03	-3.695E-01
17	1534	2.468E-03	1.776E-03	-1.657E-03	1.715E+00	1.541E+00	-2.438E-02
18	1608	2.464E-03	1.538E-03	-2.075E-03	2.170E-01	-8.340E-03	-5.588E-01
19	1682	2.514E-03	1.324E-03	-2.528E-03	7.218E-02	-5.162E-03	-1.323E+00
20	1756	2.528E-03	1.089E-03	-2.973E-03	1.391E+00	-5.705E-03	-6.623E-01
21	1530	9.973E-04	1.294E-03	-1.157E-03	2.039E+00	1.719E+00	-1.893E-02
22	1604	1.010E-03	1.066E-03	-1.463E-03	5.545E-01	-2.490E-02	-5.518E-01
23	1678	1.072E-03	8.715E-04	-1.791E-03	4.331E-01	2.466E-02	-1.435E+00
24	1752	1.103E-03	6.545E-04	-2.111E-03	1.754E+00	-4.941E-02	-9.112E-01
25	2567	4.011E-03	0.000E+00	-1.156E-03	1.435E+00	2.052E-01	-7.604E-02
26	2623	3.955E-03	0.000E+00	-1.750E-03	-1.713E-02	-1.004E+00	-1.145E+00
27	2679	3.968E-03	0.000E+00	-2.358E-03	2.054E-02	-7.896E-01	-1.435E+00
28	2735	3.852E-03	0.000E+00	-2.925E-03	1.933E+00	4.892E-01	8.183E-03
29	2559	2.548E-03	8.805E-04	-1.077E-03	1.613E+00	5.806E-01	-7.855E-02
30	2615	2.552E-03	6.742E-04	-1.577E-03	-2.813E-02	-7.862E-01	-1.107E+00
31	2671	2.631E-03	4.896E-04	-2.079E-03	1.448E-02	-6.078E-01	-1.607E+00
32	2727	2.588E-03	2.643E-04	-2.543E-03	1.995E+00	1.715E-01	8.258E-03
33	2555	1.228E-03	7.087E-04	-9.511E-04	1.851E+00	1.095E+00	-7.284E-02
34	2611	1.264E-03	4.914E-04	-1.368E-03	-2.296E-02	-4.684E-01	-1.101E+00
35	2667	1.378E-03	3.171E-04	-1.765E-03	6.848E-04	-5.010E-01	-1.780E+00
36	2723	1.376E-03	8.327E-05	-2.127E-03	1.864E+00	-3.680E-03	-1.732E-01
37	2551	3.990E-04	2.784E-04	-8.129E-04	1.866E+00	1.530E+00	-2.823E-03
38	2607	3.999E-04	1.547E-04	-1.113E-03	-1.295E-01	-3.333E-01	-1.150E+00
39	2663	4.684E-04	8.720E-05	-1.371E-03	-2.373E-01	-2.617E-01	-1.962E+00
40	2719	4.200E-04	-4.411E-05	-1.594E-03	2.356E+00	1.488E-01	-3.584E-01
41	3503	1.078E-03	0.000E+00	-8.329E-04	7.659E-01	4.648E-01	-2.785E-01
42	3535	1.030E-03	0.000E+00	-1.132E-03	-2.187E-01	-1.028E+00	-1.331E+00
43	3567	1.088E-03	0.000E+00	-1.405E-03	-8.779E-03	-5.449E-01	-1.538E+00
44	3599	9.367E-04	0.000E+00	-1.679E-03	2.740E+00	9.899E-01	5.604E-02
45	3495	5.212E-04	1.730E-04	-9.303E-04	7.243E-01	5.069E-01	-3.211E-01
46	3527	5.103E-04	6.965E-05	-1.108E-03	-4.191E-01	-7.755E-01	-1.348E+00
47	3559	5.678E-04	2.386E-05	-1.250E-03	-1.552E-01	-4.191E-01	-1.589E+00
48	3591	4.302E-04	-7.023E-05	-1.375E-03	2.835E+00	5.773E-01	5.983E-02
49	3791	3.421E-04	0.000E+00	-7.747E-04	9.376E-02	1.978E-02	-3.989E-01
50	3811	3.458E-04	0.000E+00	-1.091E-03	-2.450E-02	-5.180E-01	-8.665E-01
51	3831	4.082E-04	0.000E+00	-1.153E-03	4.317E-02	2.807E-03	-9.078E-01
52	3851	1.510E-04	0.000E+00	-9.657E-04	7.841E-01	-1.857E-01	-9.376E-01

Summer Loading (Sliding Joints)

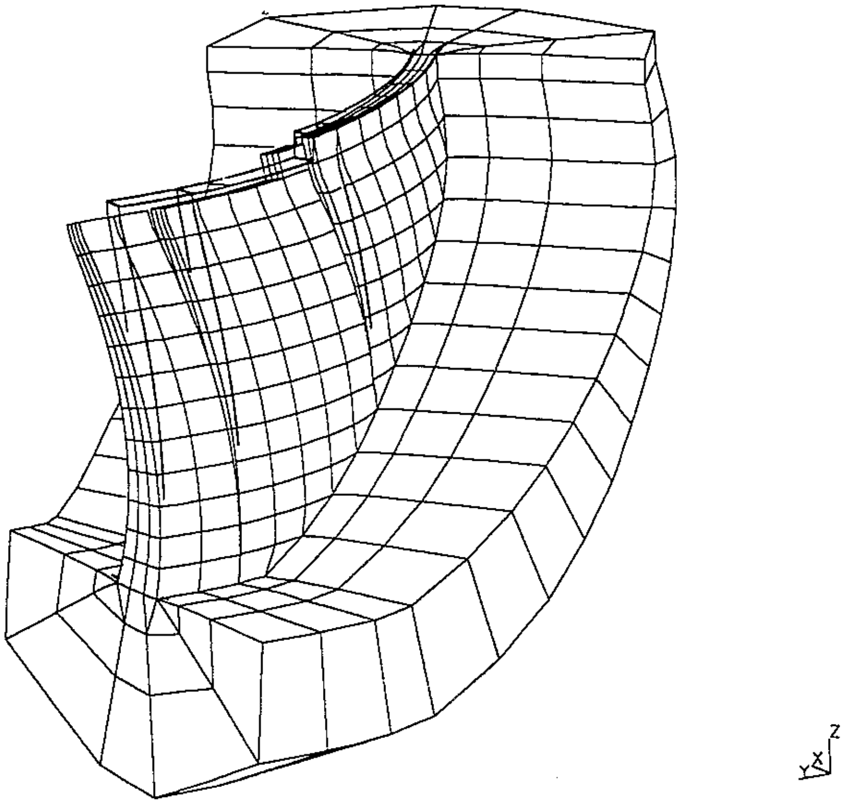


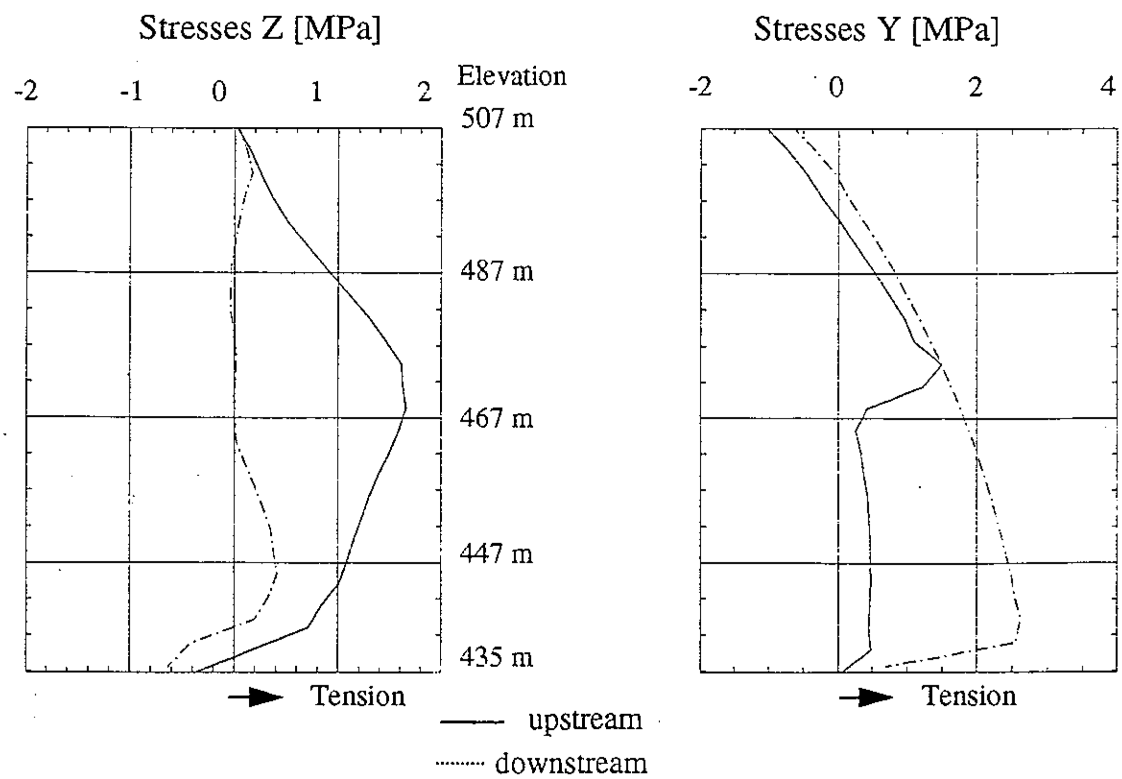


Summer Loading - Joints are Sliding [Table5]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	2.269E-02	0.000E+00	-1.783E-03	1.513E-01	3.750E-02	-3.226E+00
2	377	2.282E-02	0.000E+00	-1.750E-03	1.023E-01	-1.542E-01	-3.635E+00
3	463	2.295E-02	0.000E+00	-1.767E-03	-1.410E-02	-7.416E-02	-3.222E+00
4	549	2.309E-02	0.000E+00	-1.783E-03	3.428E-02	-4.225E-02	-2.813E+00
5	1550	2.055E-02	0.000E+00	-1.074E-03	-1.802E-01	-2.114E+00	-4.086E+00
6	1624	2.064E-02	0.000E+00	-1.644E-03	-1.105E-01	-4.280E-01	-2.886E+00
7	1698	2.072E-02	0.000E+00	-2.180E-03	1.487E-01	-7.061E-02	-2.839E+00
8	1772	2.086E-02	0.000E+00	-2.683E-03	1.009E-02	-3.309E-01	-3.845E+00
9	1542	6.404E-03	1.032E-04	-6.065E-04	-1.744E-01	-2.009E+00	-3.531E+00
10	1616	6.574E-03	-2.128E-04	-5.788E-04	-1.181E-01	-4.889E-01	-2.550E+00
11	1690	6.749E-03	-5.477E-04	-5.080E-04	-1.875E-02	-9.872E-02	-2.823E+00
12	1764	6.994E-03	-8.618E-04	-4.258E-04	5.019E-03	-6.579E-01	-4.236E+00
13	1538	3.346E-03	-2.166E-04	-6.801E-04	-1.745E-01	-1.805E+00	-2.850E+00
14	1612	3.554E-03	-5.143E-04	-5.226E-04	-1.009E-01	-1.795E-01	-1.990E+00
15	1686	3.769E-03	-8.372E-04	-3.131E-04	5.716E-01	-7.268E-02	-2.557E+00
16	1760	4.049E-03	-1.133E-03	-9.569E-05	2.095E-01	7.189E-03	-4.340E+00
17	1534	1.892E-03	-4.880E-04	-4.426E-04	-1.752E-01	-1.156E+00	-2.231E+00
18	1608	2.040E-03	-6.067E-04	-4.706E-04	-1.363E-01	-2.186E-01	-1.723E+00
19	1682	2.201E-03	-7.382E-04	-4.850E-04	-9.710E-02	-3.561E-01	-2.690E+00
20	1756	2.440E-03	-8.236E-04	-5.042E-04	-2.092E-02	-1.636E+00	-4.985E+00
21	1530	9.417E-04	-7.528E-04	-4.443E-04	-1.901E-01	-1.209E+00	-1.956E+00
22	1604	1.030E-03	-7.669E-04	-3.798E-04	5.246E-02	-1.131E-01	-1.292E+00
23	1678	1.121E-03	-7.837E-04	-3.020E-04	5.798E-02	-4.900E-02	-2.008E+00
24	1752	1.277E-03	-7.486E-04	-2.317E-04	-1.141E-01	-1.224E+00	-4.098E+00
25	2567	1.418E-02	0.000E+00	1.177E-03	-3.515E-01	-1.831E+00	-3.801E+00
26	2623	1.425E-02	0.000E+00	-5.747E-05	3.150E-02	-3.544E-01	-1.982E+00
27	2679	1.428E-02	0.000E+00	-1.291E-03	1.006E-01	-4.062E-01	-2.022E+00
28	2735	1.446E-02	0.000E+00	-2.518E-03	-8.797E-03	-2.238E+00	-4.144E+00
29	2559	5.131E-03	5.944E-04	-1.534E-04	-3.458E-01	-1.932E+00	-3.540E+00
30	2615	5.319E-03	2.641E-04	-5.221E-04	-7.028E-02	-2.620E-01	-1.813E+00
31	2671	5.464E-03	-8.936E-05	-8.795E-04	1.451E-02	-2.483E-01	-2.042E+00
32	2727	5.755E-03	-3.914E-04	-1.241E-03	-6.676E-03	-2.105E+00	-4.418E+00
33	2555	2.512E-03	2.807E-04	-4.330E-04	-2.813E-01	-1.018E+00	-2.343E+00
34	2611	2.755E-03	-6.364E-05	-7.432E-04	4.098E-01	-1.924E-01	-1.372E+00
35	2667	2.959E-03	-4.082E-04	-1.040E-03	2.103E-01	-3.795E-01	-2.307E+00
36	2723	3.325E-03	-6.844E-04	-1.359E-03	-2.572E-02	-2.464E+00	-5.315E+00
37	2551	1.033E-03	-6.841E-04	-4.238E-04	-1.070E-01	-1.063E+00	-1.474E+00
38	2607	1.093E-03	-7.117E-04	-6.240E-04	5.051E-01	-1.757E-01	-8.848E-01
39	2663	1.152E-03	-7.648E-04	-8.456E-04	3.161E-01	-5.481E-01	-2.012E+00
40	2719	1.302E-03	-6.927E-04	-1.046E-03	3.782E-01	-2.126E+00	-5.153E+00
41	3503	4.371E-03	0.000E+00	1.634E-03	-1.865E-03	-6.323E-01	-2.640E+00
42	3535	4.357E-03	0.000E+00	1.768E-04	7.362E-01	-4.840E-01	-6.548E-01
43	3567	4.267E-03	0.000E+00	-1.253E-03	-2.159E-01	-4.141E-01	-1.215E+00
44	3599	4.451E-03	0.000E+00	-2.546E-03	-3.978E-02	-2.975E+00	-5.832E+00
45	3495	1.553E-03	1.501E-04	-1.177E-04	-9.161E-01	-1.326E+00	-2.227E+00
46	3527	1.653E-03	-7.196E-05	-6.585E-04	4.381E-01	1.941E-02	-6.878E-01
47	3559	1.680E-03	-3.119E-04	-1.210E-03	3.509E-01	-2.285E-01	-1.645E+00
48	3591	1.898E-03	-4.325E-04	-1.695E-03	7.284E-01	-1.951E+00	-4.978E+00
49	3791	8.082E-04	0.000E+00	2.271E-04	1.575E+00	6.400E-01	-1.440E-01
50	3811	8.947E-04	0.000E+00	-7.064E-04	3.579E-01	1.754E-01	-3.769E-01
51	3831	8.753E-04	0.000E+00	-1.775E-03	1.849E-01	3.255E-02	-1.475E+00
52	3851	9.188E-04	0.000E+00	-2.205E-03	-6.611E-01	-1.069E+00	-4.237E+00

Winter Loading (Sliding Joints)

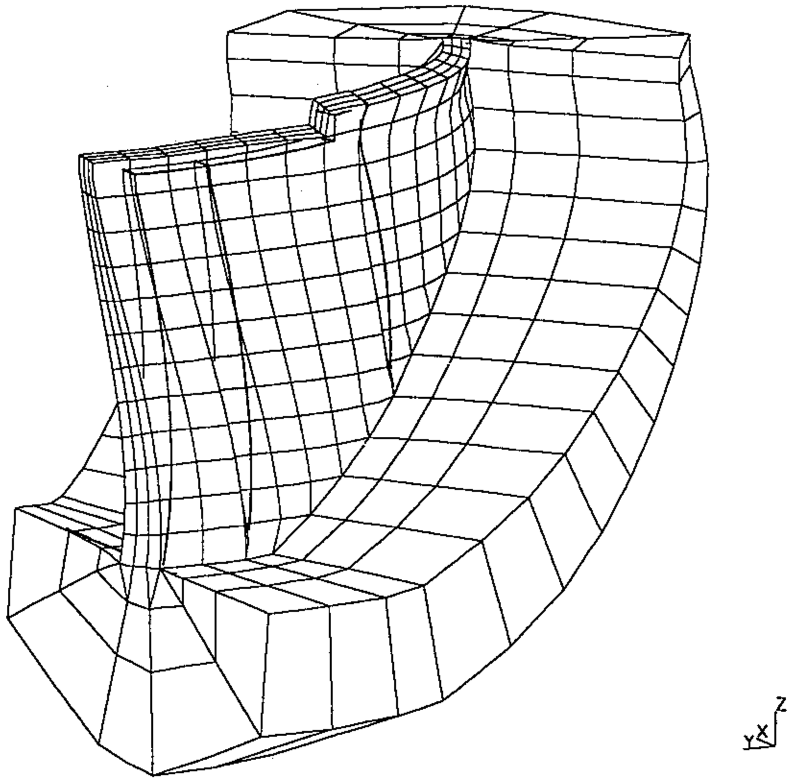


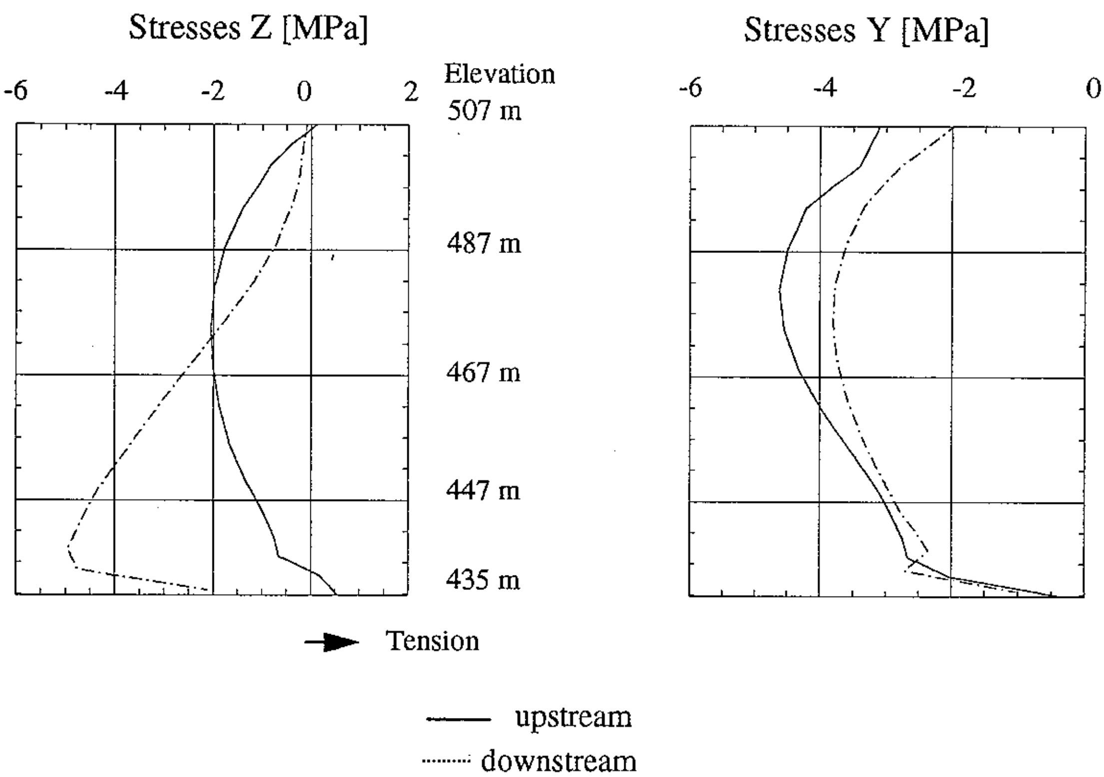


Winter Loading - Joints are Sliding [Table6]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	1.816E-02	0.000E+00	-7.852E-03	2.322E-02	-2.443E-02	-1.029E+00
2	377	1.806E-02	0.000E+00	-8.501E-03	9.123E-02	-4.587E-02	-9.638E-01
3	463	1.797E-02	0.000E+00	-9.174E-03	6.719E-02	7.813E-03	-8.186E-01
4	549	1.787E-02	0.000E+00	-9.829E-03	3.945E-02	-1.542E-02	-6.323E-01
5	1550	1.117E-02	0.000E+00	-3.714E-03	1.076E+00	5.186E-01	-1.761E-02
6	1624	1.106E-02	0.000E+00	-4.515E-03	2.059E-02	-5.931E-01	-6.708E-01
7	1698	1.099E-02	0.000E+00	-5.368E-03	1.228E-02	-6.075E-01	-9.695E-01
8	1772	1.087E-02	0.000E+00	-6.195E-03	7.711E-01	5.398E-04	-3.611E-02
9	1542	5.631E-03	1.133E-03	-2.713E-03	1.286E+00	7.581E-01	-1.837E-02
10	1616	5.557E-03	9.607E-04	-3.232E-03	1.331E-02	-3.689E-01	-6.794E-01
11	1690	5.530E-03	7.996E-04	-3.795E-03	9.675E-03	-5.159E-01	-1.047E+00
12	1764	5.461E-03	6.294E-04	-4.343E-03	7.649E-01	5.621E-04	-1.434E-01
13	1538	4.305E-03	1.484E-03	-2.659E-03	1.327E+00	1.207E+00	-1.885E-02
14	1612	4.248E-03	1.308E-03	-3.173E-03	1.757E-02	-2.165E-01	-6.896E-01
15	1686	4.243E-03	1.151E-03	-3.727E-03	2.630E-03	-4.217E-01	-1.263E+00
16	1760	4.200E-03	9.803E-04	-4.268E-03	7.795E-01	1.075E-03	-4.531E-01
17	1534	2.195E-03	9.547E-04	-1.272E-03	1.506E+00	1.266E+00	-2.487E-02
18	1608	2.168E-03	7.635E-04	-1.573E-03	-1.192E-02	-6.969E-02	-5.219E-01
19	1682	2.191E-03	5.955E-04	-1.904E-03	9.420E-04	-1.664E-01	-1.096E+00
20	1756	2.175E-03	4.066E-04	-2.225E-03	1.197E+00	-2.719E-03	-2.308E-01
21	1530	9.461E-04	7.991E-04	-1.116E-03	1.866E+00	1.424E+00	-1.919E-02
22	1604	9.349E-04	6.069E-04	-1.340E-03	4.069E-01	-2.081E-02	-6.473E-01
23	1678	9.701E-04	4.483E-04	-1.582E-03	2.863E-01	2.922E-02	-1.328E+00
24	1752	9.729E-04	2.651E-04	-1.817E-03	1.608E+00	-3.748E-02	-5.549E-01
25	2567	5.387E-03	0.000E+00	-1.150E-03	1.755E+00	4.231E-01	-7.720E-02
26	2623	5.327E-03	0.000E+00	-1.962E-03	-2.993E-02	-9.377E-01	-1.059E+00
27	2679	5.341E-03	0.000E+00	-2.801E-03	4.516E-03	-8.503E-01	-1.642E+00
28	2735	5.233E-03	0.000E+00	-3.599E-03	1.711E+00	8.128E-03	-9.423E-03
29	2559	2.211E-03	5.574E-04	-1.155E-03	1.656E+00	5.420E-01	-7.961E-02
30	2615	2.202E-03	3.888E-04	-1.610E-03	-2.724E-02	-8.179E-01	-1.116E+00
31	2671	2.267E-03	2.458E-04	-2.067E-03	1.554E-02	-7.444E-01	-1.565E+00
32	2727	2.212E-03	6.168E-05	-2.487E-03	1.803E+00	2.169E-01	7.240E-03
33	2555	1.136E-03	5.117E-04	-1.264E-03	1.595E+00	1.010E+00	-7.421E-02
34	2611	1.151E-03	3.437E-04	-1.677E-03	-3.714E-02	-6.324E-01	-1.417E+00
35	2667	1.245E-03	2.240E-04	-2.060E-03	-2.322E-02	-7.121E-01	-2.177E+00
36	2723	1.223E-03	4.734E-05	-2.403E-03	1.565E+00	-5.945E-03	-6.497E-01
37	2551	3.943E-04	2.143E-04	-5.060E-04	1.922E+00	1.446E+00	-5.605E-02
38	2607	3.851E-04	1.028E-04	-7.491E-04	-1.436E-01	-2.310E-01	-8.423E-01
39	2663	4.354E-04	4.594E-05	-9.564E-04	-8.105E-02	-1.749E-01	-1.392E+00
40	2719	3.680E-04	-7.934E-05	-1.145E-03	2.618E+00	5.967E-01	-1.018E-01
41	3503	1.264E-03	0.000E+00	-8.761E-04	1.024E+00	4.777E-01	-2.770E-01
42	3535	1.212E-03	0.000E+00	-1.284E-03	-2.348E-01	-1.093E+00	-1.332E+00
43	3567	1.276E-03	0.000E+00	-1.663E-03	-2.776E-02	-6.970E-01	-1.811E+00
44	3599	1.135E-03	0.000E+00	-2.019E-03	2.484E+00	4.365E-01	4.661E-02
45	3495	4.533E-04	1.650E-04	-1.015E-03	7.135E-01	3.904E-01	-3.062E-01
46	3527	4.369E-04	7.995E-05	-1.151E-03	-4.216E-01	-8.026E-01	-1.423E+00
47	3559	4.880E-04	5.220E-05	-1.250E-03	-1.412E-01	-4.769E-01	-1.512E+00
48	3591	3.447E-04	-2.834E-05	-1.339E-03	2.774E+00	7.479E-01	6.185E-02
49	3791	3.512E-04	0.000E+00	-9.003E-04	5.596E-02	1.203E-02	-4.622E-01
50	3811	3.522E-04	0.000E+00	-1.274E-03	-2.886E-02	-5.787E-01	-9.690E-01
51	3831	4.267E-04	0.000E+00	-1.386E-03	-1.422E-02	-5.870E-02	-1.015E+00
52	3851	1.694E-04	0.000E+00	-1.185E-03	6.853E-01	-2.254E-01	-1.206E+00

Summer Loading (Frictional Joints)

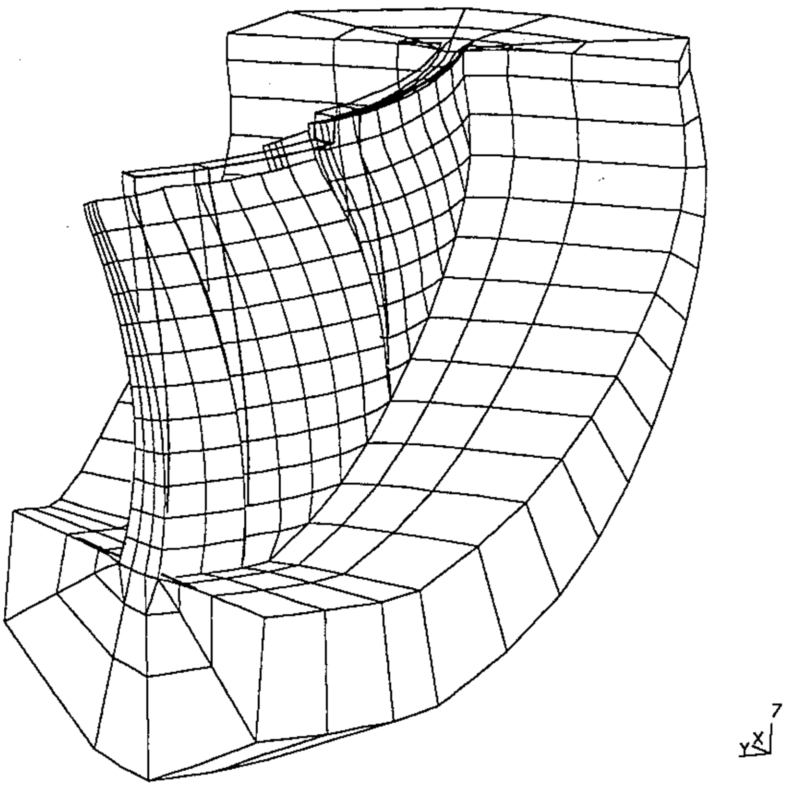


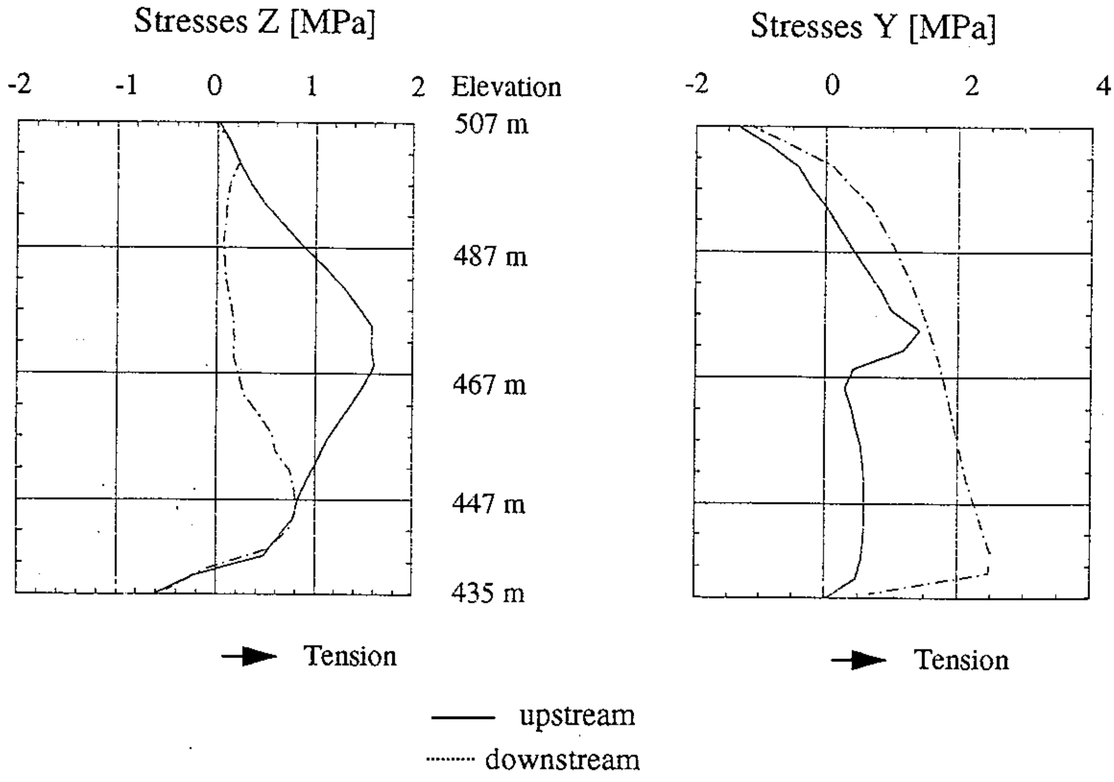


Summer Loading - Frictional Joints [Table 7]

LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp	Prin-Maximum	Prin-Middle	Prin-Minimum
1	291	1.350E-02	0.000E+00	-1.014E-03	2.530E-01	1.184E-01	-3.107E+00
2	377	1.363E-02	0.000E+00	-8.454E-04	8.375E-02	-1.660E-01	-3.267E+00
3	463	1.375E-02	0.000E+00	-7.261E-04	1.953E-03	-1.079E-01	-2.544E+00
4	549	1.387E-02	0.000E+00	-6.149E-04	2.128E-01	-8.064E-02	-1.988E+00
5	1550	1.321E-02	0.000E+00	-1.148E-03	-1.255E-01	-2.073E+00	-4.497E+00
6	1624	1.329E-02	0.000E+00	-1.443E-03	-1.135E-01	-5.484E-01	-3.048E+00
7	1698	1.337E-02	0.000E+00	-1.704E-03	-4.453E-02	-1.630E-01	-2.746E+00
8	1772	1.351E-02	0.000E+00	-1.942E-03	9.375E-02	-7.911E-01	-3.609E+00
9	1542	8.704E-03	1.805E-03	-7.124E-04	-1.525E-01	-1.798E+00	-3.498E+00
10	1616	8.901E-03	1.395E-03	-9.054E-04	-1.166E-01	-4.357E-01	-2.539E+00
11	1690	9.101E-03	9.705E-04	-1.069E-03	-5.613E-02	-2.136E-01	-2.799E+00
12	1764	9.367E-03	5.692E-04	-1.223E-03	4.995E-02	-1.033E+00	-4.238E+00
13	1538	4.927E-03	1.207E-03	-5.678E-04	-2.733E-01	-1.687E+00	-2.421E+00
14	1612	5.167E-03	8.200E-04	-6.892E-04	-1.243E-01	-3.221E-01	-1.895E+00
15	1686	5.420E-03	4.108E-04	-7.818E-04	-8.279E-03	-1.865E-01	-2.566E+00
16	1760	5.736E-03	1.966E-05	-8.679E-04	-8.862E-02	-9.275E-01	-4.191E+00
17	1534	2.244E-03	3.182E-04	-5.055E-04	-2.832E-01	-1.697E+00	-1.939E+00
18	1608	2.436E-03	1.150E-04	-4.936E-04	-1.300E-01	-3.475E-01	-1.524E+00
19	1682	2.634E-03	-9.429E-05	-4.545E-04	-1.250E-02	-1.302E-01	-2.402E+00
20	1756	2.888E-03	-2.524E-04	-4.147E-04	-1.990E-01	-1.064E+00	-4.355E+00
21	1530	9.090E-04	-4.169E-04	-5.070E-04	-1.901E-01	-1.209E+00	-1.754E+00
22	1604	1.028E-03	-4.713E-04	-4.368E-04	2.520E-02	-1.071E-01	-1.080E+00
23	1678	1.150E-03	-5.272E-04	-3.499E-04	1.139E-01	-3.411E-02	-1.858E+00
24	1752	1.332E-03	-5.330E-04	-2.710E-04	-1.211E-01	-1.059E+00	-4.027E+00
25	2567	9.526E-03	0.000E+00	1.909E-04	-3.326E-01	-2.108E+00	-4.331E+00
26	2623	9.607E-03	0.000E+00	-5.760E-04	-1.266E-01	-3.931E-01	-2.201E+00
27	2679	9.645E-03	0.000E+00	-1.331E-03	-1.881E-03	-4.540E-01	-1.901E+00
28	2735	9.813E-03	0.000E+00	-2.085E-03	3.485E-02	-2.390E+00	-3.736E+00
29	2559	6.049E-03	1.794E-03	2.888E-05	-3.336E-01	-1.666E+00	-3.580E+00
30	2615	6.272E-03	1.347E-03	-5.208E-04	-7.958E-03	-2.583E-01	-1.828E+00
31	2671	6.459E-03	8.794E-04	-1.069E-03	-5.403E-02	-2.814E-01	-2.072E+00
32	2727	6.788E-03	4.609E-04	-1.618E-03	1.261E-02	-2.355E+00	-4.550E+00
33	2555	2.714E-03	1.181E-03	-1.667E-04	-3.624E-01	-8.276E-01	-2.187E+00
34	2611	2.999E-03	7.215E-04	-5.944E-04	5.072E-01	-2.113E-01	-1.371E+00
35	2667	3.260E-03	2.612E-04	-1.009E-03	5.915E-02	-3.468E-01	-2.447E+00
36	2723	3.685E-03	-1.362E-04	-1.430E-03	-3.431E-02	-2.783E+00	-5.468E+00
37	2551	1.168E-03	1.769E-04	-3.196E-04	-3.190E-01	-1.161E+00	-1.405E+00
38	2607	1.298E-03	4.493E-05	-6.033E-04	4.990E-01	-4.099E-01	-5.988E-01
39	2663	1.414E-03	-1.134E-04	-9.048E-04	4.919E-01	-2.425E-01	-2.009E+00
40	2719	1.613E-03	-1.338E-04	-1.198E-03	6.770E-01	-1.560E+00	-4.923E+00
41	3503	3.227E-03	0.000E+00	6.649E-04	-6.523E-01	-9.292E-01	-2.881E+00
42	3535	3.235E-03	0.000E+00	-3.129E-04	3.273E-01	-5.640E-01	-5.939E-01
43	3567	3.164E-03	0.000E+00	-1.272E-03	-1.434E-01	-3.418E-01	-9.990E-01
44	3599	3.330E-03	0.000E+00	-2.137E-03	-2.817E-02	-2.774E+00	-4.883E+00
45	3495	1.612E-03	5.211E-04	-3.477E-05	-7.454E-01	1.245E+00	-2.408E+00
46	3527	1.738E-03	2.379E-04	-6.833E-04	5.378E-01	2.503E-02	-6.779E-01
47	3559	1.794E-03	-5.256E-05	-1.340E-03	2.159E-01	-2.216E-01	-1.772E+00
48	3591	2.035E-03	-2.230E-04	-1.910E-03	7.647E-01	-2.068E+00	-5.370E+00
49	3791	7.260E-04	0.000E+00	-1.857E-04	9.071E-01	2.892E-01	-3.562E-01
50	3811	7.905E-04	0.000E+00	-8.552E-04	1.354E-01	1.644E-02	-2.179E-01
51	3831	7.437E-04	0.000E+00	-1.616E-03	5.673E-02	-8.441E-02	-1.175E+00
52	3851	7.955E-04	0.000E+00	-1.919E-03	-5.513E-01	-1.043E+00	-3.534E+00

Winter Loading (Frictional Joints)



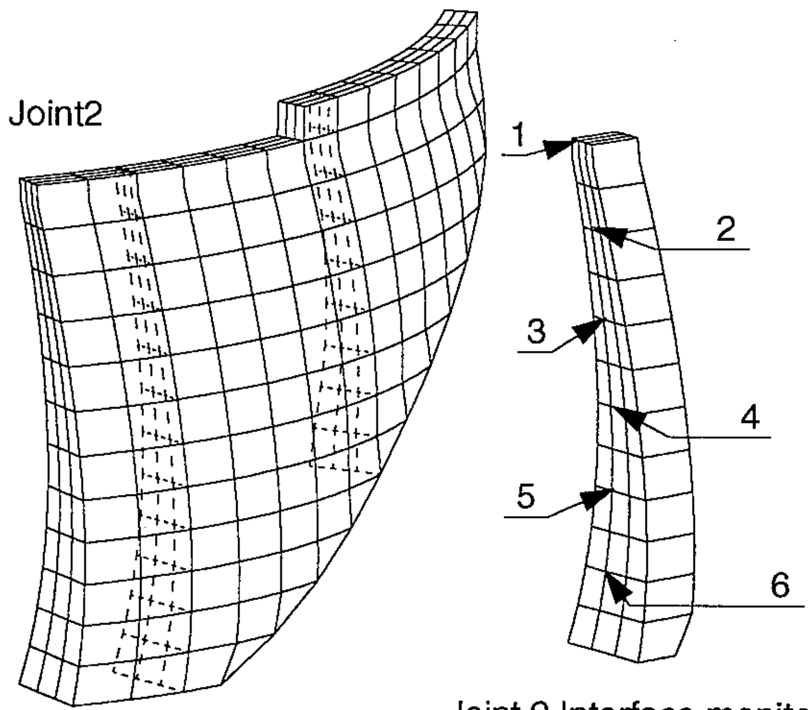


Winter Loading - Frictional Joints [Table8]

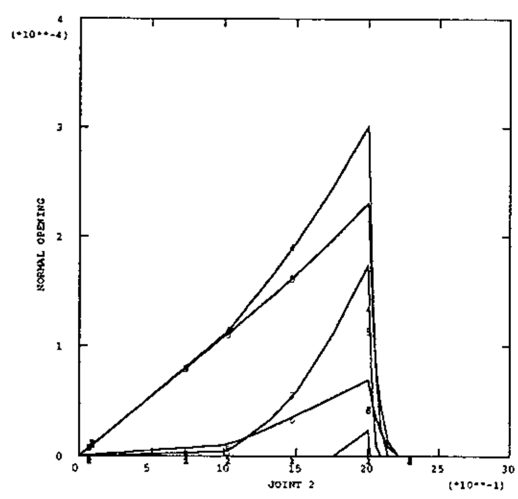
LABEL	NODE	Displacement [m]			Principal Stresses [MPa]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Prin - Maximum	Prin - Middle	Prin - Minimum
1	291	1.341E-02	0.000E+00	-7.074E-03	1.548E-02	-1.391E-02	-1.206E+00
2	377	1.332E-02	0.000E+00	-7.594E-03	8.467E-02	-5.517E-02	-1.081E+00
3	463	1.322E-02	0.000E+00	-8.133E-03	5.200E-02	8.673E-03	-8.396E-01
4	549	1.313E-02	0.000E+00	-8.662E-03	2.029E-02	-4.322E-02	-5.989E-01
5	1550	7.955E-03	0.000E+00	-3.586E-03	1.046E+00	4.615E-01	8.902E-04
6	1624	7.839E-03	0.000E+00	-4.210E-03	1.614E-02	-5.902E-01	-6.596E-01
7	1698	7.768E-03	0.000E+00	-4.879E-03	-2.404E-02	-5.403E-01	-9.343E-01
8	1772	7.652E-03	0.000E+00	-5.526E-03	8.909E-01	7.003E-02	4.380E-02
9	1542	5.973E-03	1.698E-03	-2.749E-03	1.474E+00	7.793E-01	-1.281E-02
10	1616	5.912E-03	1.480E-03	-3.338E-03	1.886E-02	-3.384E-01	-6.626E-01
11	1690	5.899E-03	1.272E-03	-3.977E-03	-5.885E-03	-5.641E-01	-1.113E+00
12	1764	5.845E-03	1.056E-03	-4.604E-03	6.640E-01	1.880E-02	-3.281E-01
13	1538	4.262E-03	1.967E-03	-2.559E-03	1.487E+00	1.095E+00	-1.067E-01
14	1612	4.232E-03	1.739E-03	-3.139E-03	6.534E-02	-3.228E-01	-6.716E-01
15	1686	4.254E-03	1.524E-03	-3.768E-03	5.756E-02	-5.133E-01	-1.372E+00
16	1760	4.235E-03	1.298E-03	-4.387E-03	7.315E-01	-8.979E-02	-7.435E-01
17	1534	2.120E-03	6.426E-04	-1.239E-03	1.503E+00	1.040E+00	-1.196E-01
18	1608	2.069E-03	4.941E-04	-1.534E-03	5.740E-02	-2.629E-01	-5.027E-01
19	1682	2.064E-03	3.716E-04	-1.860E-03	6.030E-02	-3.167E-01	-1.062E+00
20	1756	2.019E-03	2.263E-04	-2.178E-03	1.177E+00	-1.041E-01	-2.281E-01
21	1530	9.915E-04	6.964E-04	-1.083E-03	1.742E+00	1.405E+00	-2.754E-02
22	1604	9.720E-04	5.161E-04	-1.306E-03	2.847E-01	-1.312E-02	-6.274E-01
23	1678	9.987E-04	3.696E-04	-1.546E-03	1.880E-01	3.321E-02	-1.294E+00
24	1752	9.929E-04	1.972E-04	-1.780E-03	1.536E+00	-4.405E-02	-5.167E-01
25	2567	3.562E-03	0.000E+00	-1.483E-03	1.699E+00	4.393E-01	-7.579E-02
26	2623	3.501E-03	0.000E+00	-2.084E-03	-2.325E-03	-9.263E-01	-1.082E+00
27	2679	3.515E-03	0.000E+00	-2.703E-03	-1.409E-02	-9.268E-01	-1.553E+00
28	2735	3.407E-03	0.000E+00	-3.287E-03	1.578E+00	1.702E-01	7.217E-02
29	2559	2.228E-03	8.662E-04	-1.183E-03	1.807E+00	5.786E-01	-7.884E-02
30	2615	2.232E-03	6.573E-04	-1.664E-03	-2.464E-02	-8.561E-01	-1.073E+00
31	2671	2.313E-03	4.698E-04	-2.152E-03	-5.575E-03	-9.120E-01	-1.606E+00
32	2727	2.278E-03	2.450E-04	-2.604E-03	1.547E+00	4.219E-02	3.014E-02
33	2555	9.388E-04	7.814E-04	-1.237E-03	1.622E+00	8.782E-01	-1.006E-01
34	2611	9.754E-04	5.883E-04	-1.641E-03	-5.639E-02	-9.668E-01	-1.287E+00
35	2667	1.084E-03	4.336E-04	-2.025E-03	-4.072E-02	-9.313E-01	-2.159E+00
36	2723	1.079E-03	2.193E-04	-2.370E-03	1.470E+00	-1.009E-01	-7.379E-01
37	2551	4.671E-04	-3.407E-05	-5.363E-04	1.933E+00	1.120E+00	-4.632E-02
38	2607	4.397E-04	-1.112E-04	-7.374E-04	-2.070E-01	-3.288E-01	-1.060E+00
39	2663	4.614E-04	-1.367E-04	-9.051E-04	-1.907E-01	-3.227E-01	-1.501E+00
40	2719	3.682E-04	-2.341E-04	-1.060E-03	2.557E+00	7.354E-01	-1.852E-01
41	3503	8.201E-04	0.000E+00	-1.212E-03	7.975E-01	6.372E-01	-2.643E-01
42	3535	7.734E-04	0.000E+00	-1.454E-03	-1.817E-01	-1.104E+00	-1.426E+00
43	3567	8.399E-04	0.000E+00	-1.675E-03	1.577E-02	-8.639E-01	-1.670E+00
44	3599	6.993E-04	0.000E+00	-1.886E-03	2.243E+00	8.505E-01	6.971E-02
45	3495	4.358E-04	1.958E-04	-1.044E-03	8.394E-01	4.011E-01	-2.821E-01
46	3527	4.281E-04	8.762E-05	-1.192E-03	-3.821E-01	-8.319E-01	-1.448E+00
47	3559	4.930E-04	3.297E-05	-1.308E-03	-1.873E-01	-5.673E-01	-1.563E+00
48	3591	3.615E-04	-6.625E-05	-1.407E-03	2.642E+00	5.949E-01	7.035E-02
49	3791	2.889E-04	0.000E+00	-1.050E-03	2.190E-02	-1.050E-01	-7.516E-01
50	3811	2.756E-04	0.000E+00	-1.335E-03	-8.815E-02	-5.810E-01	-9.630E-01
51	3831	3.424E-04	0.000E+00	-1.350E-03	9.749E-03	-1.282E-01	-9.662E-01
52	3851	9.614E-05	0.000E+00	-1.099E-03	6.856E-01	-1.922E-01	-9.677E-01

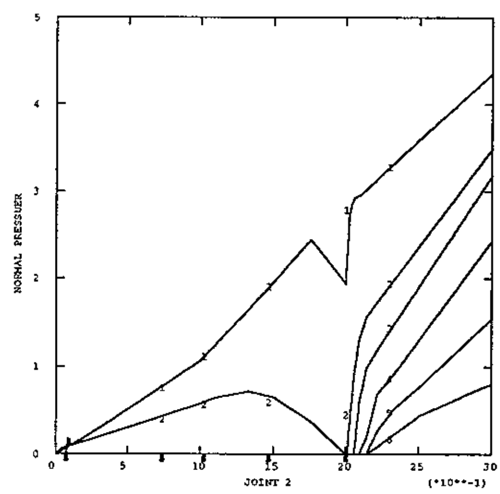
Summer loading

Joint 2 opening (μ=0.75) - Hard Contact condition



Joint 2 Interface monitoring points

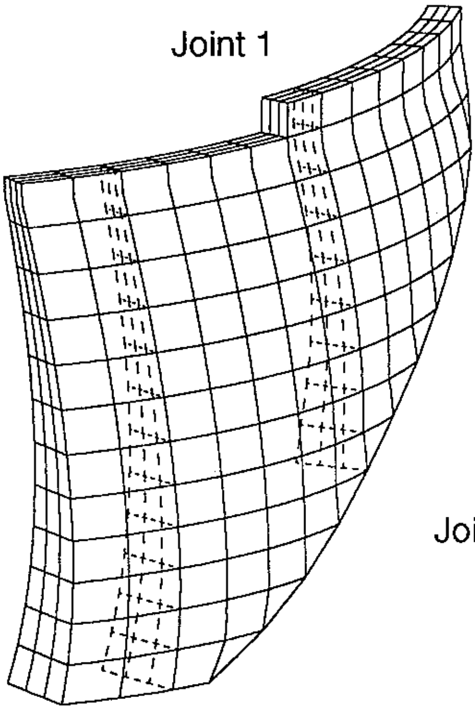


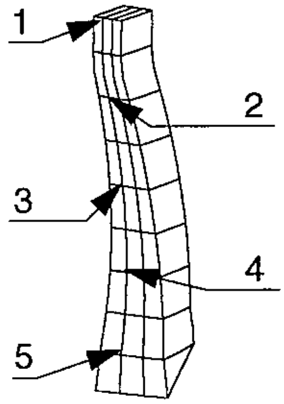


10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

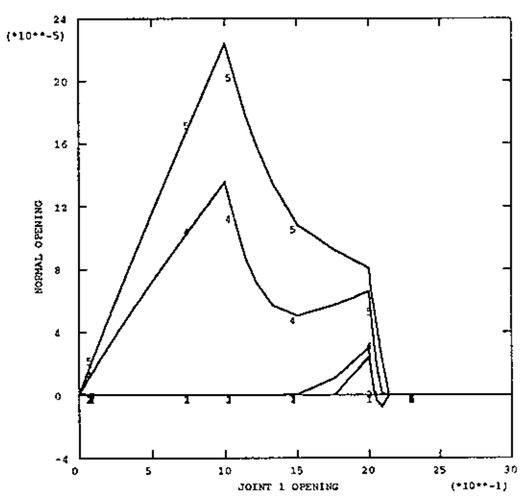
Summer loading

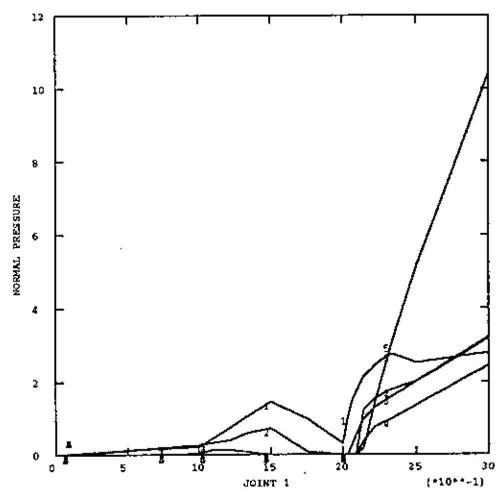
Joint 1 opening (μ=0.75) - Hard Contact condition





Joint 1 Interface monitoring points

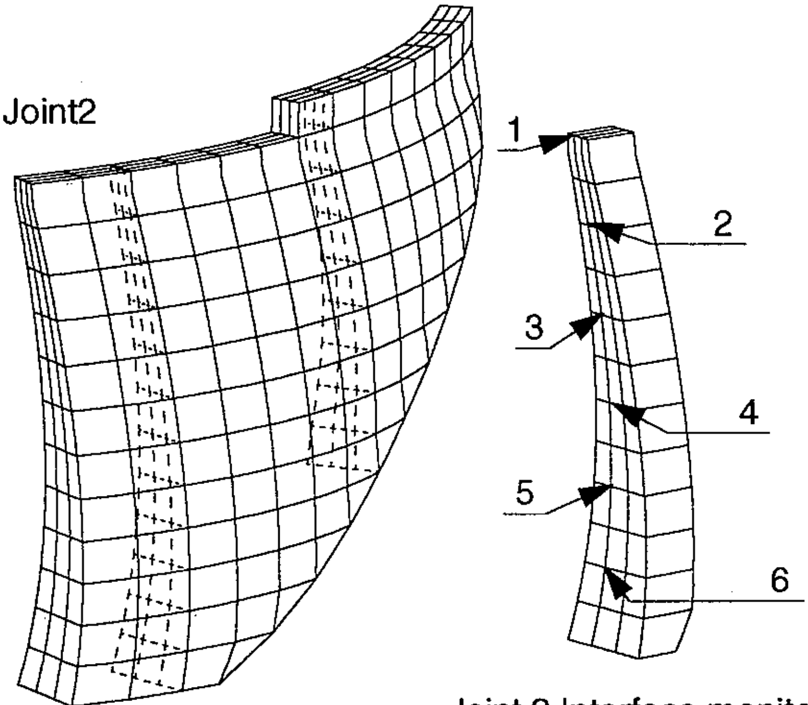




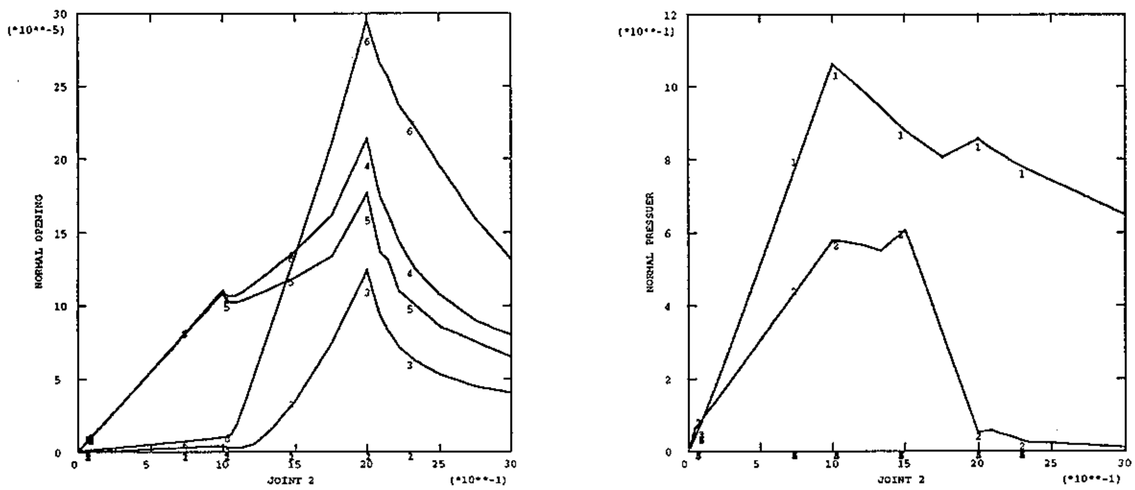
10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

Winter Loading

Joint 2 opening (μ=0.75) - Hard Contact condition



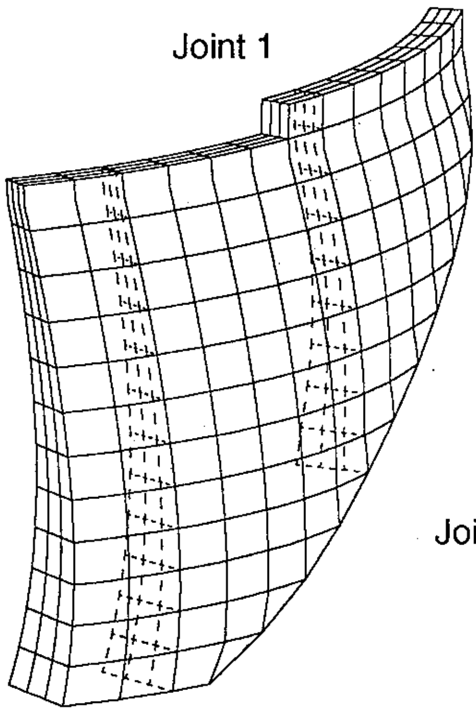
Joint 2 Interface monitoring points

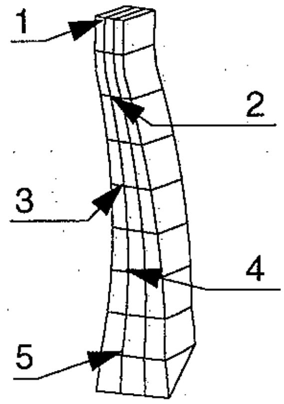


10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

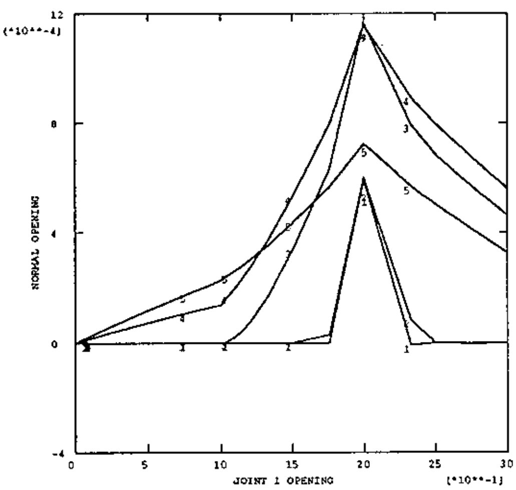
Winter Loading

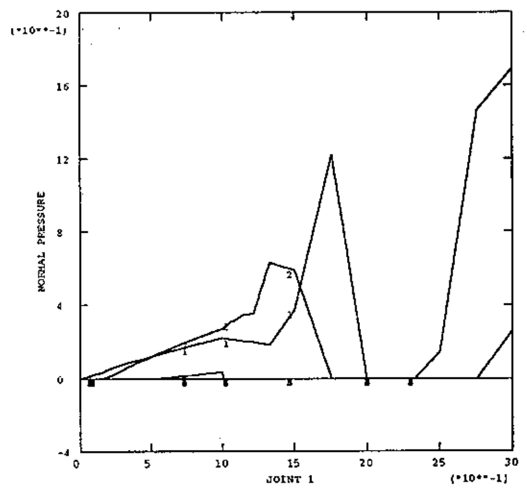
Joint 1 opening (μ=0.75) - Hard Contact condition





Joint 1 Interface monitoring points

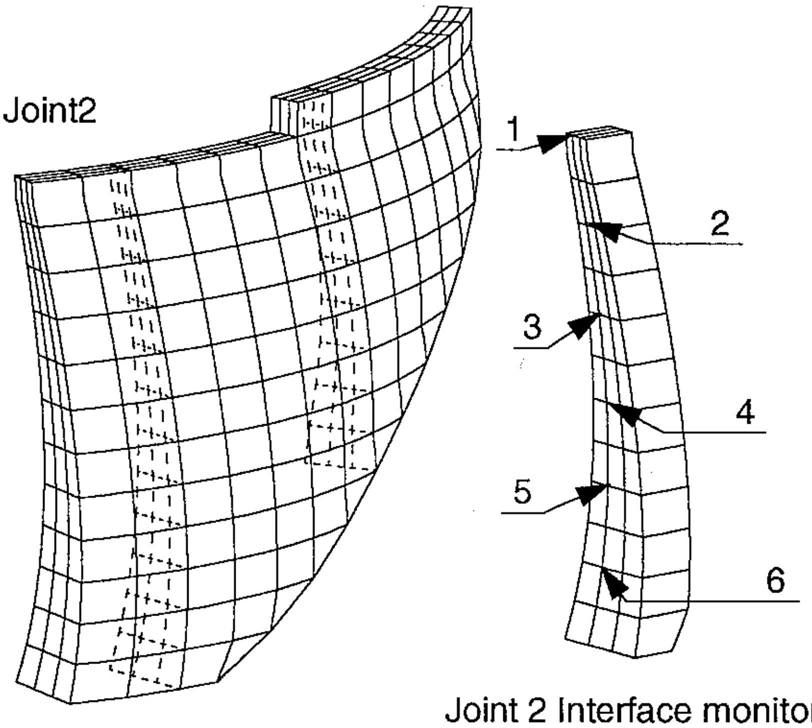




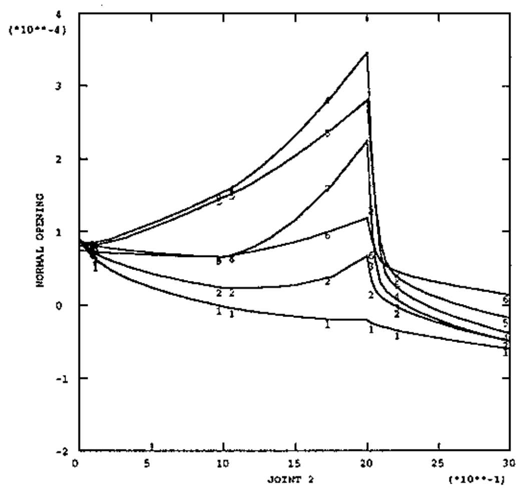
10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

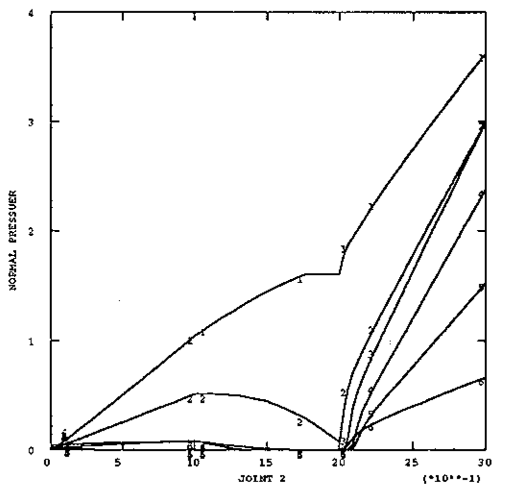
Summer Loading

Joint 2 opening (μ=0.75) - Soft Contact condition



Joint 2 Interface monitoring points

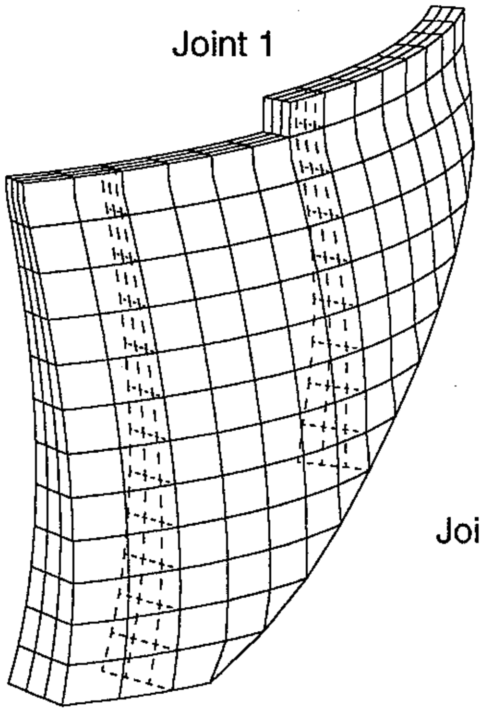


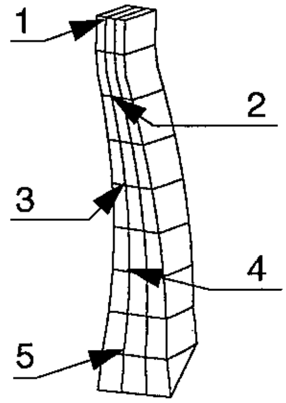


10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

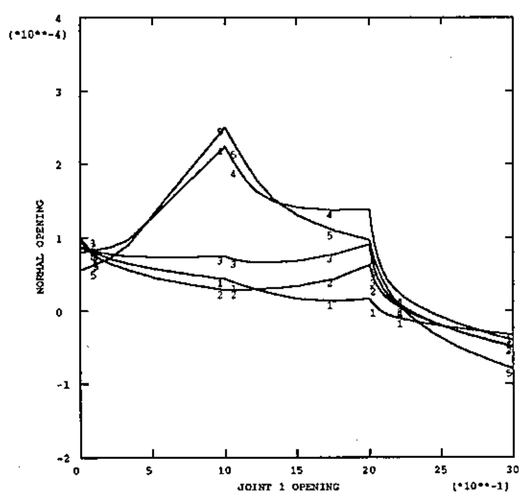
Summer Loading

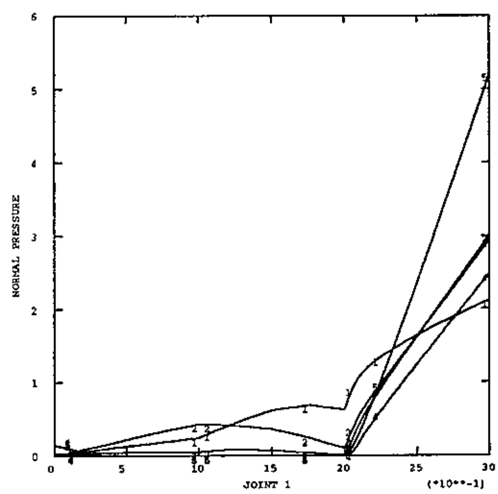
Joint 1 opening (μ=0.75) - Soft Contact condition





Joint 1 Interface monitoring points

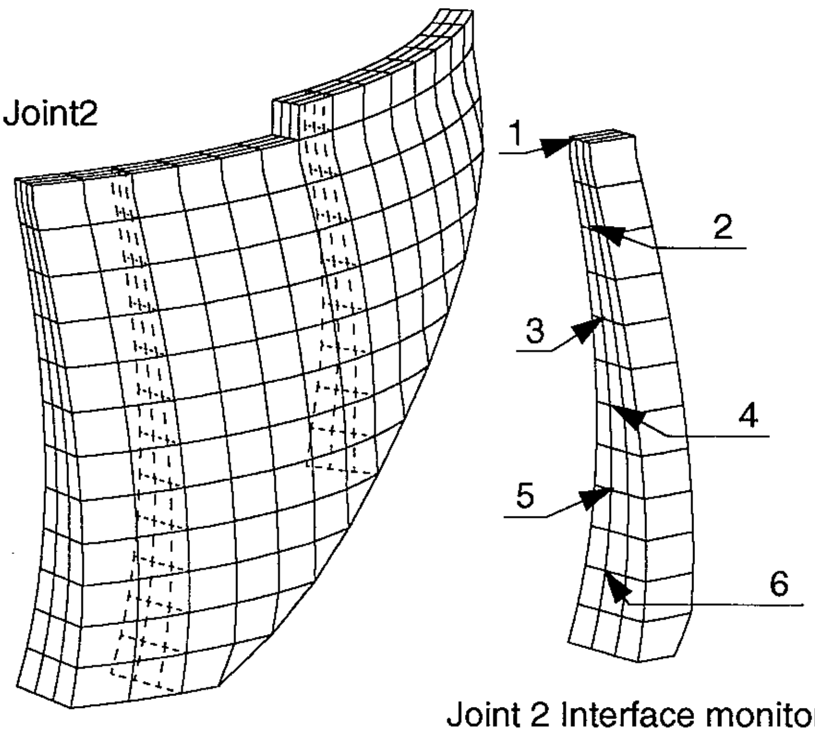




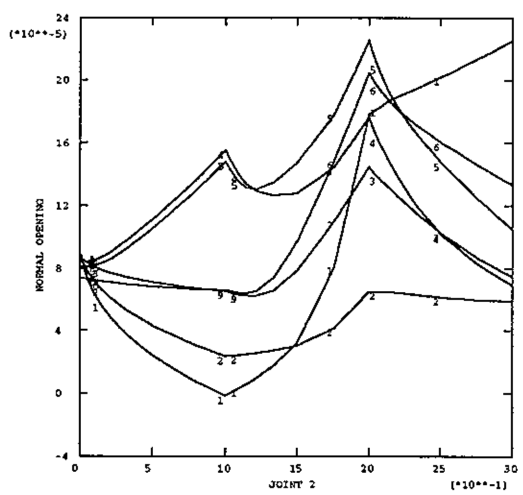
10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

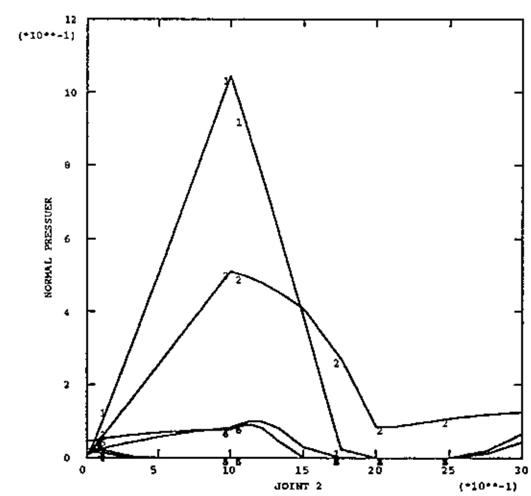
Winter Loading

Joint 2 opening (μ=0.75) - Soft Contact condition



Joint 2 Interface monitoring points

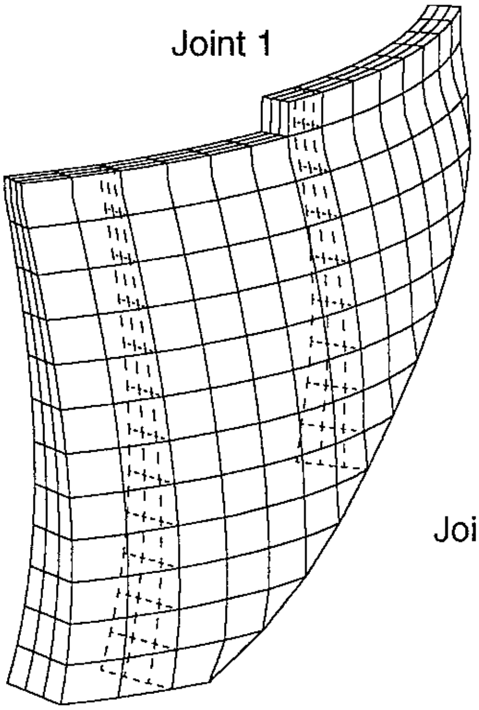


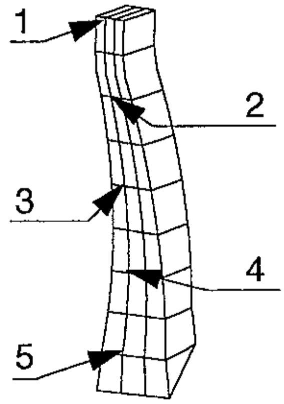


10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

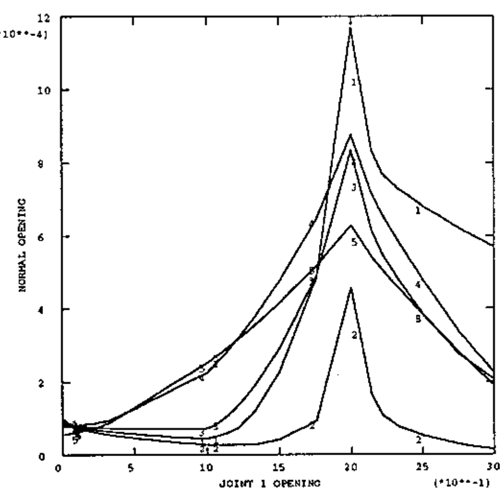
Winter Loading

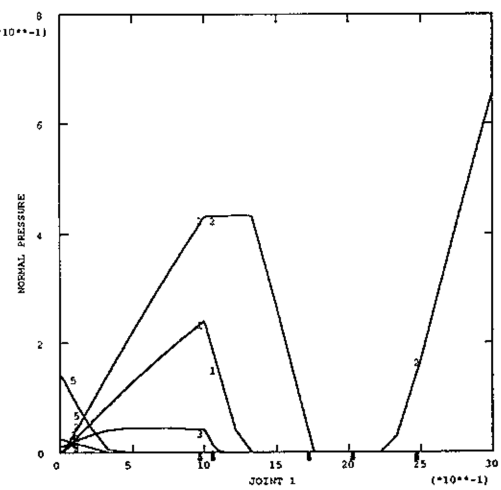
Joint 1 opening (μ=0.75) - Soft Contact condition





Joint 1 Interface monitoring points





10 - indicates dead weight loading
20 - indicates dead weight and temperature loading
30 - indicates full loading

Summer Loading - Frictional Joint 1 Opening [Table9]

LABEL	NODE	Displacement Joint 1 Right [m]			NODE	Displacement Joint 1 Left [m]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Label	X-Comp	Y-Comp	Z-Comp.
1	15	-1.521E-04	-1.251E-03	2.019E-04	6183	-2.942E-05	-1.254E-03	4.936E-04
2	67	1.255E-04	-1.520E-03	7.112E-04	6185	2.628E-04	-1.508E-03	9.624E-04
3	119	4.051E-04	-1.812E-03	1.183E-03	6187	5.116E-04	-1.758E-03	1.362E-03
4	171	7.029E-04	-2.065E-03	1.575E-03	6189	8.026E-04	-2.014E-03	1.697E-03
5	277	1.331E-03	-8.621E-04	1.003E-04	6194	1.345E-03	-8.974E-04	4.379E-04
6	363	1.537E-03	-1.132E-03	5.212E-04	6196	1.552E-03	-1.172E-03	8.031E-04
7	449	1.766E-03	-1.429E-03	9.575E-04	6198	1.758E-03	-1.433E-03	1.165E-03
8	535	2.033E-03	-1.674E-03	1.384E-03	6200	2.028E-03	-1.677E-03	1.534E-03
9	708	2.620E-03	-1.859E-04	-3.141E-04	6205	2.590E-03	-2.530E-04	-1.037E-04
10	794	2.826E-03	-4.613E-04	-6.389E-05	6207	2.796E-03	-5.323E-04	1.652E-04
11	880	3.047E-03	-7.502E-04	2.407E-04	6209	3.006E-03	-8.236E-04	4.581E-04
12	966	3.325E-03	-1.009E-03	5.488E-04	6211	3.277E-03	-1.083E-03	7.542E-04
13	1137	3.288E-03	4.241E-04	-5.410E-04	6216	3.228E-03	3.843E-04	-4.831E-04
14	1217	3.509E-03	1.361E-04	-4.450E-04	6218	3.444E-03	9.142E-05	-3.742E-04
15	1297	3.736E-03	-1.694E-04	-3.026E-04	6220	3.663E-03	-2.180E-04	-2.325E-04
16	1377	4.034E-03	-4.394E-04	-1.472E-04	6222	3.952E-03	-4.925E-04	-8.220E-05
17	1536	3.441E-03	7.919E-04	-4.947E-04	6227	3.308E-03	7.254E-04	-5.223E-04
18	1610	3.672E-03	4.851E-04	-5.372E-04	6229	3.536E-03	4.205E-04	-5.930E-04
19	1684	3.895E-03	1.607E-04	-5.463E-04	6231	3.758E-03	1.001E-04	-6.322E-04
20	1758	4.196E-03	-1.138E-04	-5.596E-04	6233	4.067E-03	-1.681E-04	-6.571E-04
21	1905	3.188E-03	9.445E-04	-3.028E-04	6238	2.931E-03	8.117E-04	-4.361E-04
22	1973	3.428E-03	6.278E-04	-4.804E-04	6240	3.162E-03	4.947E-04	-6.582E-04
23	2041	3.660E-03	2.905E-04	-6.246E-04	6242	3.377E-03	1.573E-04	-8.705E-04
24	2109	3.998E-03	1.165E-05	-7.481E-04	6244	3.691E-03	-1.196E-04	-1.110E-03
25	2244	2.590E-03	8.821E-04	-7.278E-05	6249	2.288E-03	7.061E-04	-3.676E-04
26	2306	2.828E-03	5.724E-04	-3.717E-04	6251	2.512E-03	3.942E-04	-6.930E-04
27	2368	3.051E-03	2.403E-04	-6.746E-04	6253	2.719E-03	5.849E-05	-1.000E-03
28	2430	3.390E-03	-1.777E-05	-9.693E-04	6255	3.042E-03	-2.009E-04	-1.325E-03
29	2553	1.730E-03	6.513E-04	1.401E-04	6260	1.525E-03	4.895E-04	-3.859E-04
30	2609	1.949E-03	3.685E-04	-2.761E-04	6262	1.710E-03	1.982E-04	-7.798E-04
31	2665	2.150E-03	6.347E-05	-6.869E-04	6264	1.882E-03	-1.124E-04	-1.117E-03
32	2721	2.508E-03	-1.336E-04	-1.132E-03	6266	2.206E-03	-3.238E-04	-1.465E-03
33	2832	5.875E-04	1.727E-04	2.104E-04	6271	3.666E-04	3.110E-04	-4.923E-04
34	2882	6.465E-04	8.822E-05	-2.723E-04	6273	6.327E-04	4.494E-05	-9.218E-04
35	2932	7.313E-04	-7.855E-05	-6.973E-04	6275	7.113E-04	-1.246E-04	-1.157E-03
36	2982	9.590E-04	-1.363E-04	-1.298E-03	6277	9.379E-04	-1.520E-04	-1.313E-03
37	3081	3.811E-05	-1.069E-04	-4.968E-04	3081	3.811E-05	-1.069E-04	-4.968E-04
38	3125	-2.184E-05	-1.881E-04	-6.492E-04	3125	-2.184E-05	-1.881E-04	-6.492E-04
39	3169	3.651E-05	-3.428E-04	-1.027E-03	3169	3.651E-05	-3.428E-04	-1.027E-03
40	3213	3.076E-04	-3.557E-04	-1.109E-03	3213	3.076E-04	-3.557E-04	-1.109E-03

Winter Loading - Frictional Joint 1 Opening [Table10]

LABEL	NODE	Displacement Joint 1 Right [m]			NODE	Displacement Joint 1 Left [m]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Label	X-Comp	Y-Comp	Z-Comp.
1	15	6.399E-03	2.609E-03	-3.196E-03	6183	9.281E-03	4.339E-03	-5.136E-03
2	67	6.373E-03	2.405E-03	-3.562E-03	6185	9.216E-03	4.206E-03	-5.706E-03
3	119	6.372E-03	2.200E-03	-3.880E-03	6187	9.170E-03	4.086E-03	-6.235E-03
4	171	6.349E-03	1.984E-03	-4.137E-03	6189	9.097E-03	3.964E-03	-6.700E-03
5	277	5.473E-03	2.084E-03	-3.088E-03	6194	7.823E-03	3.412E-03	-5.053E-03
6	363	5.464E-03	1.898E-03	-3.420E-03	6196	7.777E-03	3.283E-03	-5.584E-03
7	449	5.490E-03	1.711E-03	-3.752E-03	6198	7.754E-03	3.178E-03	-6.121E-03
8	535	5.483E-03	1.500E-03	-4.073E-03	6200	7.690E-03	3.066E-03	-6.644E-03
9	708	4.428E-03	1.409E-03	-2.354E-03	6205	6.003E-03	2.662E-03	-4.210E-03
10	794	4.400E-03	1.274E-03	-2.729E-03	6207	5.983E-03	2.494E-03	-4.757E-03
11	880	4.426E-03	1.127E-03	-3.117E-03	6209	5.986E-03	2.357E-03	-5.334E-03
12	966	4.434E-03	9.186E-04	-3.498E-03	6211	5.936E-03	2.243E-03	-5.881E-03
13	1137	3.352E-03	8.411E-04	-1.534E-03	6216	4.268E-03	2.091E-03	-3.171E-03
14	1217	3.300E-03	7.565E-04	-1.900E-03	6218	4.282E-03	1.857E-03	-3.742E-03
15	1297	3.323E-03	6.534E-04	-2.287E-03	6220	4.328E-03	1.677E-03	-4.345E-03
16	1377	3.309E-03	4.919E-04	-2.690E-03	6222	4.310E-03	1.508E-03	-4.933E-03
17	1536	2.411E-03	3.854E-04	-1.003E-03	6227	2.778E-03	1.616E-03	-2.439E-03
18	1610	2.334E-03	3.505E-04	-1.317E-03	6229	2.831E-03	1.325E-03	-2.972E-03
19	1684	2.356E-03	2.962E-04	-1.657E-03	6231	2.928E-03	1.111E-03	-3.545E-03
20	1758	2.336E-03	1.577E-04	-2.007E-03	6233	2.937E-03	9.181E-04	-4.094E-03
21	1905	1.668E-03	6.385E-05	-6.737E-04	6238	1.604E-03	1.226E-03	-1.950E-03
22	1973	1.572E-03	7.033E-05	-9.335E-04	6240	1.693E-03	9.000E-04	-2.415E-03
23	2041	1.606E-03	5.204E-05	-1.214E-03	6242	1.836E-03	6.845E-04	-2.920E-03
24	2109	1.594E-03	-8.191E-05	-1.497E-03	6244	1.862E-03	5.015E-04	-3.386E-03
25	2244	1.091E-03	-1.399E-04	-4.729E-04	6249	7.524E-04	8.957E-04	-1.625E-03
26	2306	9.791E-04	-9.150E-05	-6.879E-04	6251	8.767E-04	5.616E-04	-2.001E-03
27	2368	1.029E-03	-8.110E-05	-9.161E-04	6253	1.051E-03	3.768E-04	-2.421E-03
28	2430	1.043E-03	-2.273E-04	-1.140E-03	6255	1.079E-03	2.488E-04	-2.781E-03
29	2553	5.468E-04	-1.656E-04	-3.880E-04	6260	2.153E-04	5.005E-04	-1.401E-03
30	2609	4.965E-04	-1.188E-04	-5.756E-04	6262	3.635E-04	2.684E-04	-1.694E-03
31	2665	5.718E-04	-1.188E-04	-7.510E-04	6264	5.417E-04	1.793E-04	-2.010E-03
32	2721	5.895E-04	-2.882E-04	-9.107E-04	6266	5.254E-04	1.208E-04	-2.242E-03
33	2832	2.161E-04	-2.034E-04	-4.880E-04	6271	-1.141E-04	2.931E-04	-1.276E-03
34	2882	1.345E-04	-1.250E-04	-6.094E-04	6273	3.992E-05	1.217E-04	-1.387E-03
35	2932	1.924E-04	-1.052E-04	-7.116E-04	6275	1.965E-04	1.354E-04	-1.578E-03
36	2982	2.134E-04	-2.973E-04	-8.560E-04	6277	1.440E-04	2.503E-04	-1.744E-03
37	3081	4.682E-05	1.212E-05	-7.063E-04	3081	4.682E-05	1.212E-05	-7.063E-04
38	3125	1.596E-05	-5.391E-05	-8.239E-04	3125	1.596E-05	-5.391E-05	-8.239E-04
39	3169	4.847E-05	-2.715E-05	-8.435E-04	3169	4.847E-05	-2.715E-05	-8.435E-04
40	3213	-7.763E-05	-5.463E-05	-7.603E-04	3213	-7.763E-05	-5.463E-05	-7.603E-04

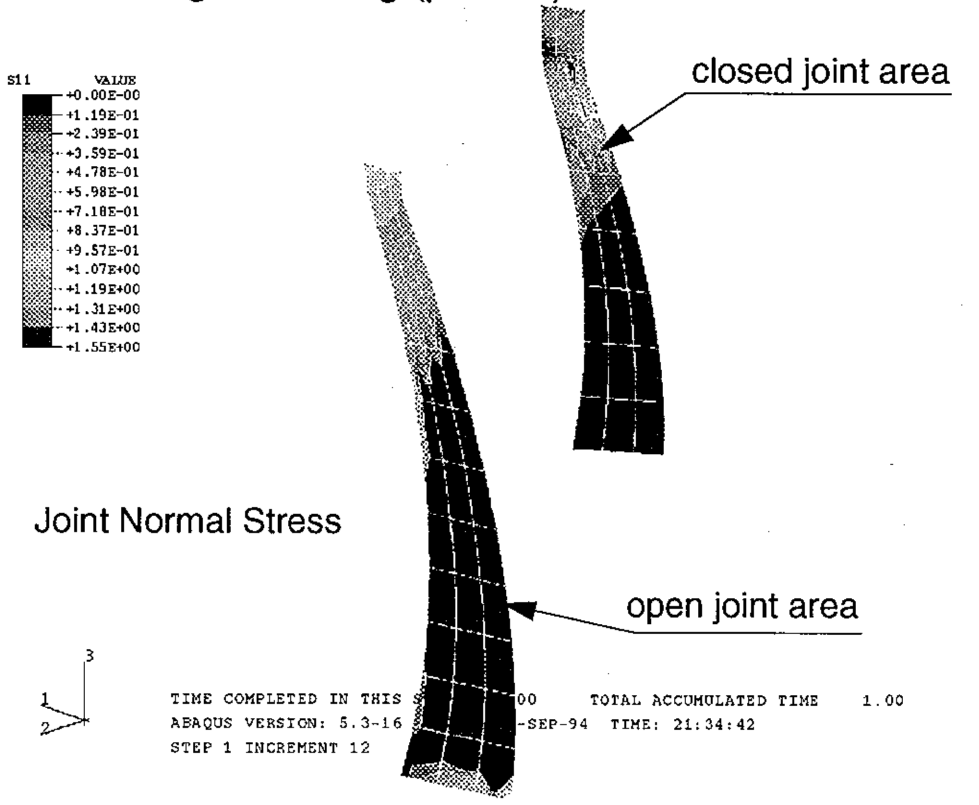
Summer Loading - Frictional Joint 2 Opening [Table11]

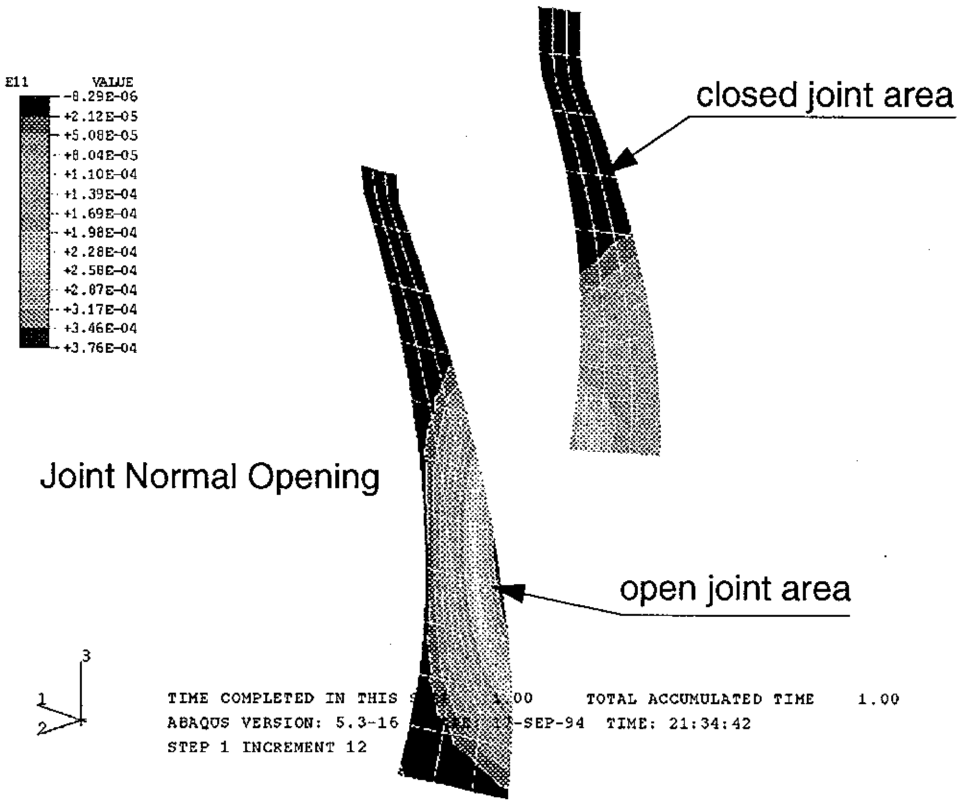
LABEL	NODE	Displacement Joint 2 Right [m]			NODE	Displacement Joint 2 Left [m]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Label	X-Comp	Y-Comp	Z-Comp.
1	287	1.174E-02	7.548E-04	-9.739E-04	6282	1.173E-02	7.535E-04	-9.766E-04
2	373	1.190E-02	5.162E-04	-7.309E-04	6284	1.190E-02	5.155E-04	-7.425E-04
3	459	1.207E-02	2.775E-04	-5.919E-04	6286	1.207E-02	2.777E-04	-6.030E-04
4	545	1.226E-02	4.540E-05	-4.992E-04	6288	1.227E-02	4.612E-05	-5.124E-04
5	718	1.230E-02	9.359E-04	-1.146E-03	6293	1.227E-02	9.328E-04	-1.161E-03
6	804	1.241E-02	6.841E-04	-1.109E-03	6295	1.238E-02	6.811E-04	-1.118E-03
7	890	1.251E-02	4.224E-04	-1.035E-03	6297	1.249E-02	4.196E-04	-1.031E-03
8	976	1.267E-02	1.686E-04	-9.527E-04	6299	1.265E-02	1.654E-04	-9.481E-04
9	1147	1.232E-02	1.161E-03	-1.172E-03	6304	1.229E-02	1.159E-03	-1.237E-03
10	1227	1.243E-02	8.971E-04	-1.260E-03	6306	1.240E-02	8.959E-04	-1.323E-03
11	1307	1.253E-02	6.225E-04	-1.317E-03	6308	1.250E-02	6.210E-04	-1.373E-03
12	1387	1.271E-02	3.574E-04	-1.369E-03	6310	1.267E-02	3.545E-04	-1.397E-03
13	1546	1.189E-02	1.295E-03	-9.426E-04	6315	1.185E-02	1.292E-03	-1.036E-03
14	1620	1.201E-02	1.022E-03	-1.197E-03	6317	1.197E-02	1.020E-03	-1.300E-03
15	1694	1.211E-02	7.376E-04	-1.415E-03	6319	1.206E-02	7.356E-04	-1.526E-03
16	1768	1.229E-02	4.647E-04	-1.630E-03	6321	1.225E-02	4.625E-04	-1.717E-03
17	1915	1.108E-02	1.353E-03	-5.693E-04	6326	1.100E-02	1.343E-03	-6.738E-04
18	1983	1.120E-02	1.072E-03	-9.814E-04	6328	1.112E-02	1.063E-03	-1.111E-03
19	2051	1.130E-02	7.789E-04	-1.361E-03	6330	1.121E-02	7.708E-04	-1.525E-03
20	2119	1.149E-02	4.994E-04	-1.746E-03	6332	1.140E-02	4.918E-04	-1.901E-03
21	2254	9.978E-03	1.344E-03	-1.481E-04	6337	9.829E-03	1.322E-03	-2.549E-04
22	2316	1.010E-02	1.059E-03	-7.010E-04	6339	9.951E-03	1.039E-03	-8.512E-04
23	2378	1.018E-02	7.605E-04	-1.232E-03	6341	1.003E-02	7.415E-04	-1.433E-03
24	2440	1.038E-02	4.813E-04	-1.779E-03	6343	1.024E-02	4.646E-04	-1.979E-03
25	2563	8.673E-03	1.278E-03	2.455E-04	6348	8.450E-03	1.240E-03	1.300E-04
26	2619	8.788E-03	9.931E-04	-4.290E-04	6350	8.568E-03	9.571E-04	-5.979E-04
27	2675	8.865E-03	6.965E-04	-1.091E-03	6352	8.636E-03	6.608E-04	-1.323E-03
28	2731	9.079E-03	4.183E-04	-1.755E-03	6354	8.839E-03	3.825E-04	-2.035E-03
29	2842	7.234E-03	1.153E-03	5.607E-04	6359	6.961E-03	1.101E-03	4.201E-04
30	2892	7.339E-03	8.777E-04	-2.180E-04	6361	7.073E-03	8.278E-04	-4.098E-04
31	2942	7.403E-03	5.932E-04	-9.889E-04	6363	7.122E-03	5.416E-04	-1.248E-03
32	2992	7.633E-03	3.254E-04	-1.760E-03	6365	7.318E-03	2.699E-04	-2.076E-03
33	3091	5.710E-03	9.691E-04	7.617E-04	6370	5.451E-03	9.126E-04	5.846E-04
34	3135	5.796E-03	7.136E-04	-1.041E-04	6372	5.546E-03	6.592E-04	-3.208E-04
35	3179	5.835E-03	4.517E-04	-9.600E-04	6374	5.578E-03	3.964E-04	-1.236E-03
36	3223	6.052E-03	2.213E-04	-1.840E-03	6376	5.777E-03	1.646E-04	-2.113E-03
37	3310	4.157E-03	7.432E-04	8.134E-04	6381	3.949E-03	6.903E-04	6.134E-04
38	3348	4.212E-03	5.143E-04	-1.070E-04	6383	4.023E-03	4.647E-04	-3.455E-04
39	3386	4.209E-03	2.824E-04	-1.015E-03	6385	4.032E-03	2.351E-04	-1.301E-03
40	3424	4.384E-03	1.067E-04	-1.953E-03	6387	4.236E-03	6.874E-05	-2.191E-03
41	3499	2.641E-03	4.948E-04	7.337E-04	6392	2.514E-03	4.548E-04	5.169E-04
42	3531	2.640E-03	2.991E-04	-2.452E-04	6394	2.531E-03	2.609E-04	-4.996E-04
43	3563	2.581E-03	1.079E-04	-1.142E-03	6396	2.490E-03	7.156E-05	-1.440E-03
44	3595	2.752E-03	-1.381E-05	-2.069E-03	6398	2.668E-03	-4.369E-05	-2.292E-03
45	3658	8.885E-04	-3.148E-05	5.083E-04	6403	7.425E-04	3.791E-04	2.901E-04
46	3684	8.736E-04	1.677E-05	-4.900E-04	6405	8.107E-04	1.232E-04	-7.722E-04
47	3710	7.843E-04	-1.503E-05	-1.275E-03	6407	7.884E-04	-3.651E-05	-1.583E-03
48	3736	8.937E-04	-4.198E-05	-2.072E-03	6409	9.102E-04	-4.695E-05	-2.183E-03
49	3787	-9.812E-05	-2.721E-05	-2.828E-04	3787	-9.812E-05	-2.721E-05	-2.828E-04
50	3807	-2.321E-04	-9.524E-05	-8.017E-04	3807	-2.321E-04	-9.524E-05	-8.017E-04
51	3827	-2.435E-04	-1.493E-04	-1.661E-03	3827	-2.435E-04	-1.493E-04	-1.661E-03
52	3847	1.056E-04	-1.069E-04	-1.757E-03	3847	1.056E-04	-1.069E-04	-1.757E-03

Winter Loading - Frictional Joint 2 Opening [Table12]

LABEL	NODE	Displacement Joint 2 Right [m]			NODE	Displacement Joint 2 Left [m]		
Data	Label	X-Comp	Y-Comp	Z-Comp.	Label	X-Comp	Y-Comp	Z-Comp.
1	287	1.192E-02	1.409E-03	-5.639E-03	6282	1.182E-02	1.505E-03	-5.885E-03
2	373	1.182E-02	1.280E-03	-6.210E-03	6284	1.171E-02	1.426E-03	-6.456E-03
3	459	1.173E-02	1.145E-03	-6.709E-03	6286	1.162E-02	1.350E-03	-6.960E-03
4	545	1.163E-02	1.001E-03	-7.148E-03	6288	1.150E-02	1.283E-03	-7.404E-03
5	718	1.005E-02	1.188E-03	-4.911E-03	6293	9.953E-03	1.194E-03	-5.206E-03
6	804	9.960E-03	1.076E-03	-5.410E-03	6295	9.868E-03	1.082E-03	-5.693E-03
7	890	9.906E-03	9.569E-04	-5.945E-03	6297	9.810E-03	9.820E-04	-6.225E-03
8	976	9.816E-03	8.234E-04	-6.447E-03	6299	9.713E-03	8.917E-04	-6.723E-03
9	1147	8.336E-03	9.994E-04	-3.768E-03	6304	8.263E-03	1.041E-03	-4.142E-03
10	1227	8.254E-03	8.886E-04	-4.326E-03	6306	8.180E-03	9.112E-04	-4.684E-03
11	1307	8.228E-03	7.589E-04	-4.919E-03	6308	8.145E-03	8.087E-04	-5.269E-03
12	1387	8.153E-03	5.956E-04	-5.491E-03	6310	8.052E-03	7.250E-04	-5.823E-03
13	1546	6.736E-03	8.050E-04	-2.800E-03	6315	6.703E-03	9.132E-04	-3.257E-03
14	1620	6.661E-03	7.176E-04	-3.370E-03	6317	6.627E-03	7.633E-04	-3.803E-03
15	1694	6.660E-03	5.932E-04	-3.975E-03	6319	6.615E-03	6.586E-04	-4.407E-03
16	1768	6.596E-03	4.129E-04	-4.565E-03	6321	6.526E-03	5.858E-04	-4.980E-03
17	1915	5.316E-03	6.398E-04	-2.055E-03	6326	5.306E-03	7.983E-04	-2.543E-03
18	1983	5.245E-03	5.798E-04	-2.594E-03	6328	5.245E-03	6.259E-04	-3.090E-03
19	2051	5.277E-03	4.630E-04	-3.179E-03	6330	5.261E-03	5.252E-04	-3.689E-03
20	2119	5.230E-03	2.614E-04	-3.750E-03	6332	5.179E-03	4.811E-04	-4.256E-03
21	2254	4.115E-03	5.075E-04	-1.525E-03	6337	4.068E-03	6.991E-04	-1.981E-03
22	2316	4.046E-03	4.810E-04	-2.019E-03	6339	4.024E-03	4.986E-04	-2.518E-03
23	2378	4.106E-03	3.691E-04	-2.560E-03	6341	4.076E-03	4.100E-04	-3.106E-03
24	2440	4.076E-03	1.396E-04	-3.083E-03	6343	4.008E-03	4.083E-04	-3.656E-03
25	2563	3.067E-03	4.946E-04	-1.188E-03	6348	2.976E-03	4.984E-04	-1.598E-03
26	2619	3.064E-03	3.981E-04	-1.639E-03	6350	2.979E-03	3.856E-04	-2.106E-03
27	2675	3.147E-03	2.908E-04	-2.121E-03	6352	3.063E-03	3.092E-04	-2.649E-03
28	2731	3.139E-03	2.182E-05	-2.578E-03	6354	3.004E-03	3.591E-04	-3.152E-03
29	2842	2.281E-03	4.227E-04	-1.071E-03	6359	2.131E-03	3.943E-04	-1.452E-03
30	2892	2.286E-03	3.236E-04	-1.433E-03	6361	2.140E-03	2.925E-04	-1.860E-03
31	2942	2.389E-03	2.206E-04	-1.821E-03	6363	2.253E-03	2.357E-04	-2.310E-03
32	2992	2.403E-03	-8.614E-05	-2.189E-03	6365	2.201E-03	3.430E-04	-2.725E-03
33	3091	1.672E-03	3.396E-04	-1.000E-03	6370	1.508E-03	3.145E-04	-1.363E-03
34	3135	1.678E-03	2.583E-04	-1.307E-03	6372	1.522E-03	2.170E-04	-1.693E-03
35	3179	1.797E-03	1.642E-04	-1.610E-03	6374	1.649E-03	1.836E-04	-2.049E-03
36	3223	1.826E-03	-1.678E-04	-1.899E-03	6376	1.596E-03	3.449E-04	-2.373E-03
37	3310	1.174E-03	2.460E-04	-9.506E-04	6381	1.029E-03	2.473E-04	-1.287E-03
38	3348	1.176E-03	1.935E-04	-1.217E-03	6383	1.047E-03	1.513E-04	-1.558E-03
39	3386	1.298E-03	1.163E-04	-1.451E-03	6385	1.178E-03	1.377E-04	-1.831E-03
40	3424	1.336E-03	-2.197E-04	-1.681E-03	6387	1.123E-03	3.409E-04	-2.083E-03
41	3499	7.409E-04	1.151E-04	-9.108E-04	6392	6.251E-04	2.109E-04	-1.209E-03
42	3531	7.242E-04	1.214E-04	-1.157E-03	6394	6.439E-04	8.753E-05	-1.439E-03
43	3563	8.342E-04	7.081E-05	-1.328E-03	6396	7.722E-04	8.890E-05	-1.634E-03
44	3595	8.446E-04	-2.341E-04	-1.518E-03	6398	6.947E-04	2.943E-04	-1.835E-03
45	3658	2.407E-04	-1.308E-04	-8.620E-04	6403	1.207E-04	2.434E-04	-1.112E-03
46	3684	2.160E-04	3.463E-05	-1.102E-03	6405	1.937E-04	1.890E-05	-1.309E-03
47	3710	2.939E-04	2.992E-05	-1.226E-03	6407	3.041E-04	2.335E-05	-1.444E-03
48	3736	2.370E-04	-1.880E-04	-1.408E-03	6409	2.098E-04	2.059E-04	-1.608E-03
49	3787	3.176E-05	-1.582E-05	-9.185E-04	3787	3.176E-05	-1.582E-05	-9.185E-04
50	3807	-3.125E-05	-5.561E-05	-1.181E-03	3807	-3.125E-05	-5.561E-05	-1.181E-03
51	3827	7.020E-05	-3.261E-05	-1.175E-03	3827	7.020E-05	-3.261E-05	-1.175E-03
52	3847	-5.323E-05	-2.954E-05	-9.116E-04	3847	-5.323E-05	-2.954E-05	-9.116E-04

Dead Weight Loading (μ=0.75) - Hard Contact





THIRD BENCHMARK WORKSHOP
ON NUMERICAL ANALYSIS OF DAMS

"NON-LINEAR ANALYSIS OF JOINT BEHAVIOUR UNDER THERMAL AND HYDROSTATIC LOADS FOR AN ARCH DAM"

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1.0 INTRODUCTION

One of the most critical points in the f.e. analysis of arch dams is the assessment of maximum stresses developed in the dam body due to the thermal loads. For example, in a typical winter condition the temperature field determines a generalized contraction which cannot be withstood by the structure without the presence of contraction joints. For this reason the f.e. analysis of a monolitic linear model provides very often unacceptable results. On the other hand the numerical representation of contraction joints introduces in the f.e. model a strong concentrated non-linearity which must be treated with care to guarantee the correctness of results. For this reason it would be worth assessing the reliability of different f.e. codes through the direct comparison of results obtained for a single test problem.

This report summarizes the analyses carried out for an arch dam model with four vertical joints (reported in Fig.1) subjected to static and thermal loads. Geometrical, physical and mechanical parameters supplied for the benchmark will not be repeated here. It is assumed that the benchmark requirements are well known to the reader.

2.0 LOADING CONDITIONS

The analyses have been carried out considering two loading conditions: a "summer" thermal condition with a corresponding reservoir level of 507 m a.s.l. and a "winter" thermal condition with a corresponding reservoir level of 471 m a.s.l.; for both these conditions the selfweight has been applied to the concrete only.

3.0 SOFTWARE USED AND COMPUTATIONAL METHODS SELECTED

The analyses have been carried out using two different codes: a static p-version finite element code (FIESTA by ISMES) and a general purpose finite element code (ABAQUS by Hibbitt, Karlsson and Sorensen).

3.1 ANALYSES WITH FIESTA CODE

With the FIESTA code both the "winter" and the "summer" conditions have been examined assuming a zero friction coefficient. Joints have been reproduced by means of "gap" elements connecting the double nodes belonging to faced surfaces. For each "gap" element the director cosines of the normal to the contact surface have been externally computed and supplied to the code.

3.2 ANALYSES WITH ABAQUS CODE

With the ABAQUS code the "winter" and the "summer" conditions have been examined considering the friction coefficient supplied by the Workshop committee (0.75).

Moreover, an analysis with a zero friction coefficient has been carried out for the "winter" condition to compare results obtained from the two codes with the same input data.

Joints have been reproduced by means of 18 nodes interface elements; the director cosines of the local normal are automatically computed by the code. Loads have been applied one at a time following the sequence: weight-thermal load-hydrostatic load.

3.3 COMPUTATIONAL METHODS

For both the codes the contact behaviour has been taken into account by means of Lagrange Multipliers Technique (LMT); this method respects rigorously the constraints, avoiding penetration between faced nodes.

The unilateral contact constraints can be described using the relationship:

$$[B]^T\{u\} \geq \{\gamma\} \qquad (1)$$

where [B] is the matrix which describes the required coupling between components of the displacements vector {u} and $\{\gamma\}$ is the initial opening vector between the nodes. At each step, the code verifies the existence of penetrations and, when it recognizes at least one, imposes the respect of constraints by means of the relation:

$$[B]^T\{u\} = \{\gamma\} \qquad (2)$$

for degrees of freedom subjected to penetration.

The respect of these constraints can be achieved using the LMT which requires updating the order of solution vector, adding an unknown (a Lagrange multiplier) for each violated constraint.

The solution of the static problem can be obtained minimizing the expression of total potential energy plus the Lagrange constraints:

$$\Pi = \frac{1}{2}\{u\}^T[K]\{u\} - \{F\}\{u\} + \{\lambda\}^T\left([B]^T\{u\} - \{\gamma\}\right) \qquad (3)$$

where $\{\lambda\}$ is the Lagrange multipliers vector. Imposing the minimum condition we obtain the following set of linear equations:

$$\begin{bmatrix} K & B \\ B^T & 0 \end{bmatrix} \begin{Bmatrix} u \\ \lambda \end{Bmatrix} = \begin{Bmatrix} F \\ \gamma \end{Bmatrix} \qquad (4)$$

where {F} is the nodal forces vector and [K] is the stiffness matrix relevant to the structure when all the double nodes pertaining to the joints are disconnected. The linear set of equations describes a mixed problem; i.e. the unknowns are displacements {u} and Lagrange multipliers {λ} which represent the constraint forces.

The friction effect (reproduced in the ABAQUS runs only) has been taken into account using a "penalty" method which does not impose the respect of the Coulomb law strictly. This method substitutes the stick contact, existing until the tranversal load does not exceed the limit slip value, with a large but finite stiffness called "stiffness in stick".

The shear force vector {S} is given by:

$$\{S\} = [\alpha]\left([B]^T \{u\}\right) \qquad (5)$$

Where [B] is now the matrix which operates the extraction of relative tangential displacements and [α] is the stiffness matrix related to these displacements. The total potential energy expression relevant to the new added stiffness is:

$$\frac{1}{2}\{u\}^T [B][\alpha][B]^T \{u\} \qquad (6)$$

Minimizing the total potential energy expression for the whole system including (6), we obtain a system of linear equations with the same order of the original stiffness matrix [K]:

$$\left([K]+[B][\alpha][B]^T\right)\cdot\{u\} = \{F\} \qquad (7)$$

Where [α] is the "stiffness in stick" diagonal matrix. As the magnitude of [α] terms increases, the constraints violation decreases. On the other hand, too large values of [α] elements can generate a bad conditioning of the resultant stiffness matrix; [α] must be chosen taking into account these two opposite requirements.

When the shear force between two faced nodes overcomes the slip value, the code updates [α], erasing the related shear stiffness to simulate the slip behaviour, and introducing the corresponding friction forces.

4.0 RESULTS FROM THE ABAQUS CODE

In the following, the principal results for the ABAQUS analyses of "summer" and "winter" conditions (both considering the friction effect) are presented. For the sake of brevity, the complete set of results for the different analyses cannot be reported here.

"Summer" condition

The deformed shape of the dam under the summer loads is reported in Fig.2 (displacements are shown with an amplification factor equal to 1500); joints are totally closed, except some point near the crest. Displacements and principal stresses for selected points indicated by the Workshop specifications are shown in Tabels 1-2-3.

"Winter" condition

The deformed shape of the dam under the winter loads is reported in Fig.3; joint 1 is almost totally opened, while joint 2 is closed, except the downstream side near the base. Displacements and principal stresses for selected points indicated by the Workshop specifications are shown in Tabels 4-5-6.

5.0 COMPARISON BETWEEN RESULTS FROM THE DIFFERENT ANALYSES

The two loading conditions suggested by the Workshop Committee have been applied to the same model and analysed by means of two different f.e. codes which use different elements to reproduce the unilateral contact behaviour. Moreover, the "winter" loading condition has been analysed with the ABAQUS code considering both the "no friction" option and a friction coefficient equal to 0.75 as suggested by the Workshop. The availability of results obtained from different analyses allows us to get information about their "sensitivity" to different techniques adopted and to the friction. Comparisons between joints opening, computed for positions indicated by the Workshop specifications and obtained from different analyses, are set out in Fig. 4 for the "winter" condition, which is of course much more significant for this kind of results. It appears quite evident that the general behaviour is the same for the three analyses.

A significant difference exists between results from the ABAQUS analysis considering friction and the others; the openings computed considering friction are always greater than or equal to those obtained from the FIESTA and ABAQUS analysis without friction, except for joint 2 in the upstream zone. However, from a engineering point of view, the results associated with the ABAQUS and FIESTA analyses without friction can be considered equivalent, and also the friction effect seems to be negligible.

A comparison between cantilever stresses computed in the central cantilever using the two codes is shown in Fig. 5 and 6 for both the loading conditions. Although the central cantilever is not directly interested by any joint, the influence of different joint representations is appreciable; stresses computed from different analyses show differences locally greater than 0.5 MPa.

6.0 CONCLUSIONS

A set of non-linear static analyses has been carried out with different codes and hypoteses for the contact behaviour. The good general agreement between results makes us quite confident about the correctness and robustness of computational methods employed. Further comparisons with other Workshop results would be useful to asses the reliability of employed methods.

7.0 REFERENCE

[1] ABAQUS User's Manual Version 5.2, by Hibbit, Karlsson & Sorensen, Inc.

[2] FIESTA User's Manual Version 2., by ISMES S.p.a.

[3] "A Joint Element for the Nonlinear Dynamic Analysis of Arch Dams"; Thesis by Jörg-Martin Hohberg, also appeared as IBK Report 186 with Birkhäuser Publishers, 1992.

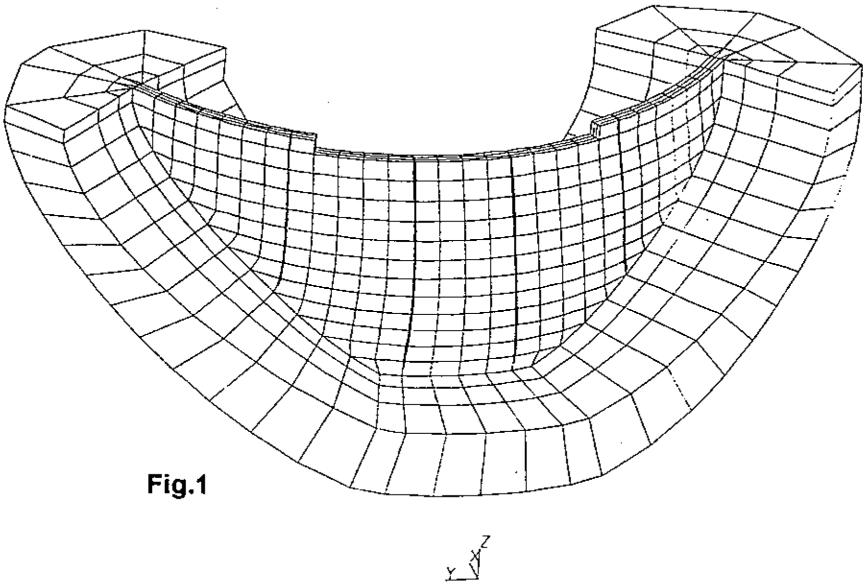


Fig.1

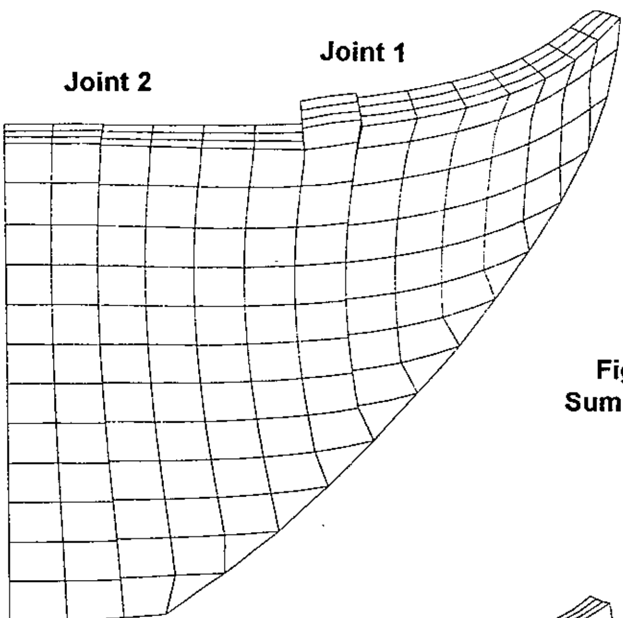


Fig.2
Summer condition

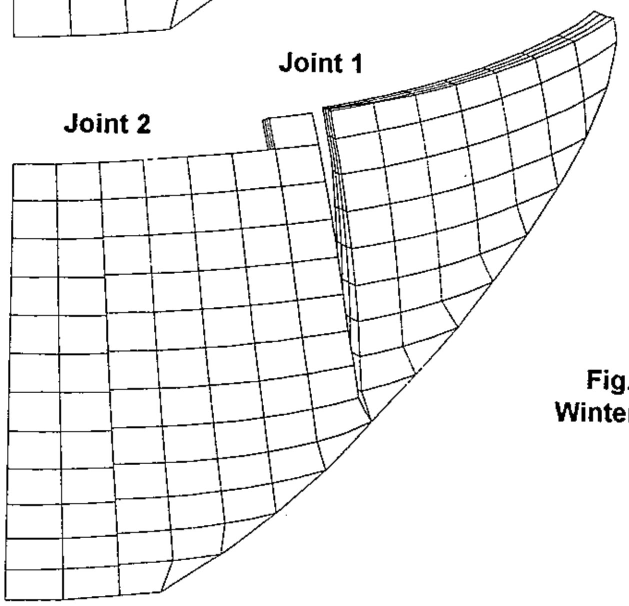


Fig.3
Winter condition

JOINTS OPENING FOR THE WINTER CONDITION

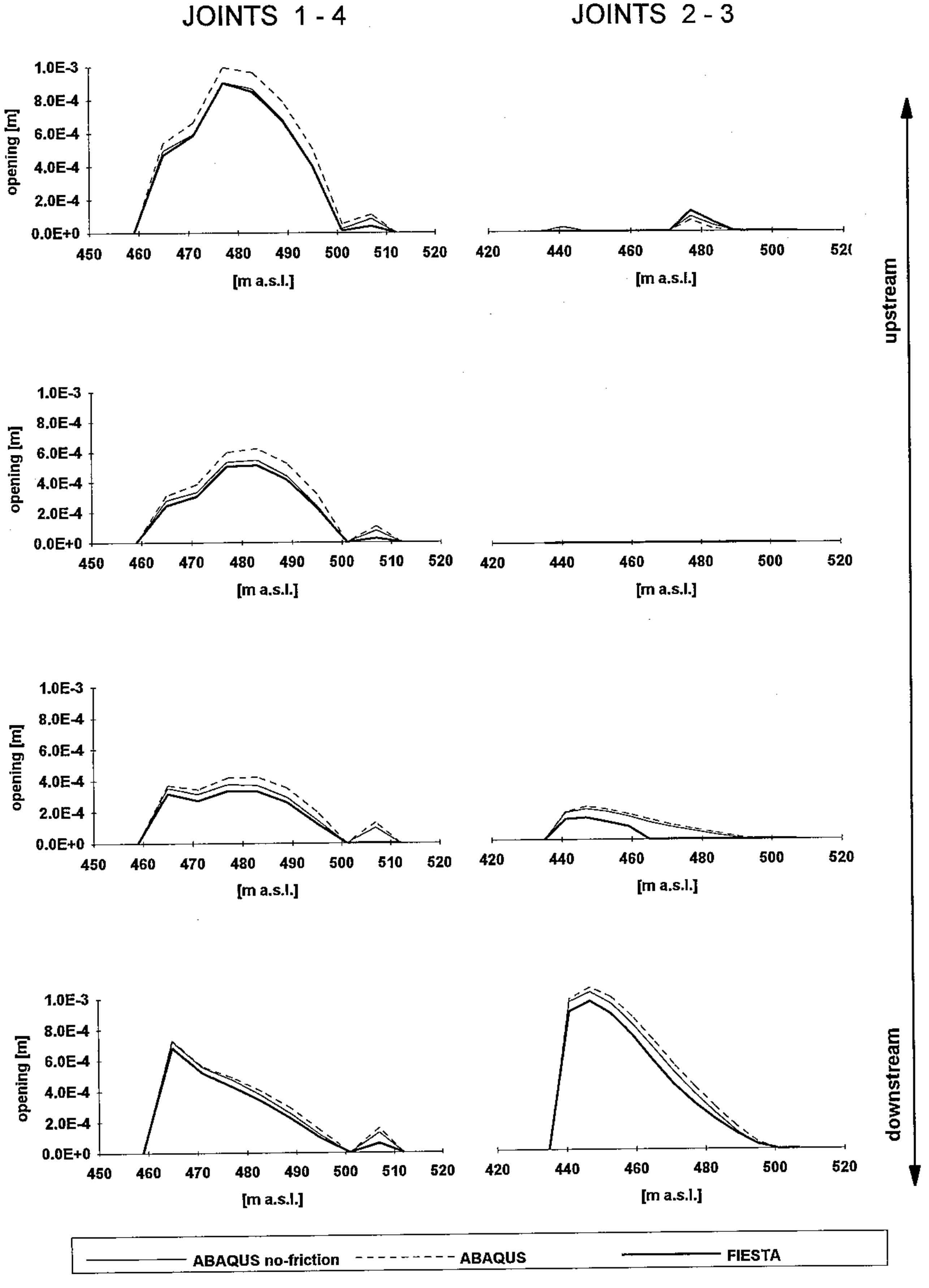


Fig. 4

SUMMER CONDITION

CANTILEVER STRESSES ON CENTRAL CANTILEVER

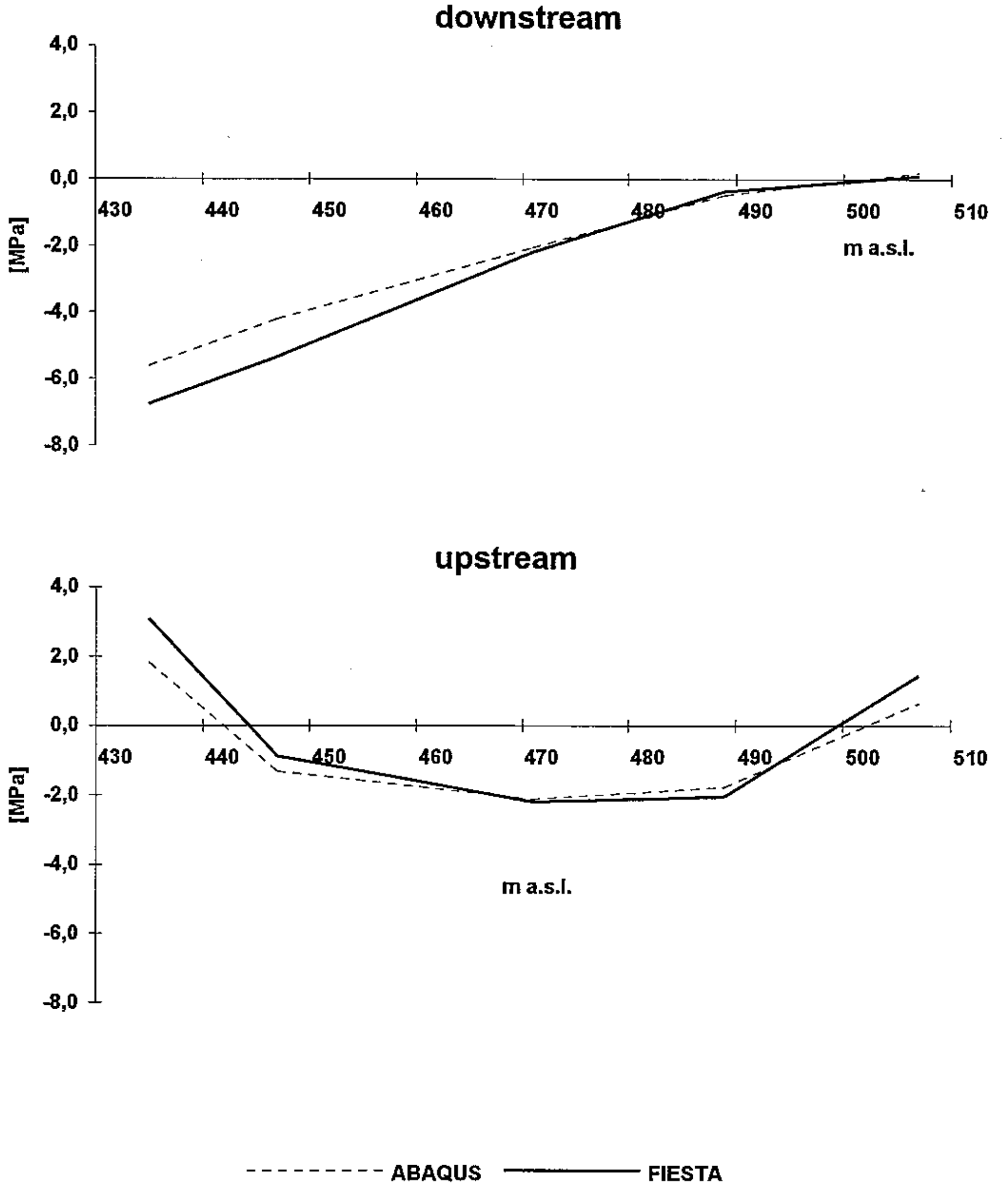


Fig. 5

WINTER CONDITION

CANTILEVER STRESSES ON CENTRAL CANTILEVER

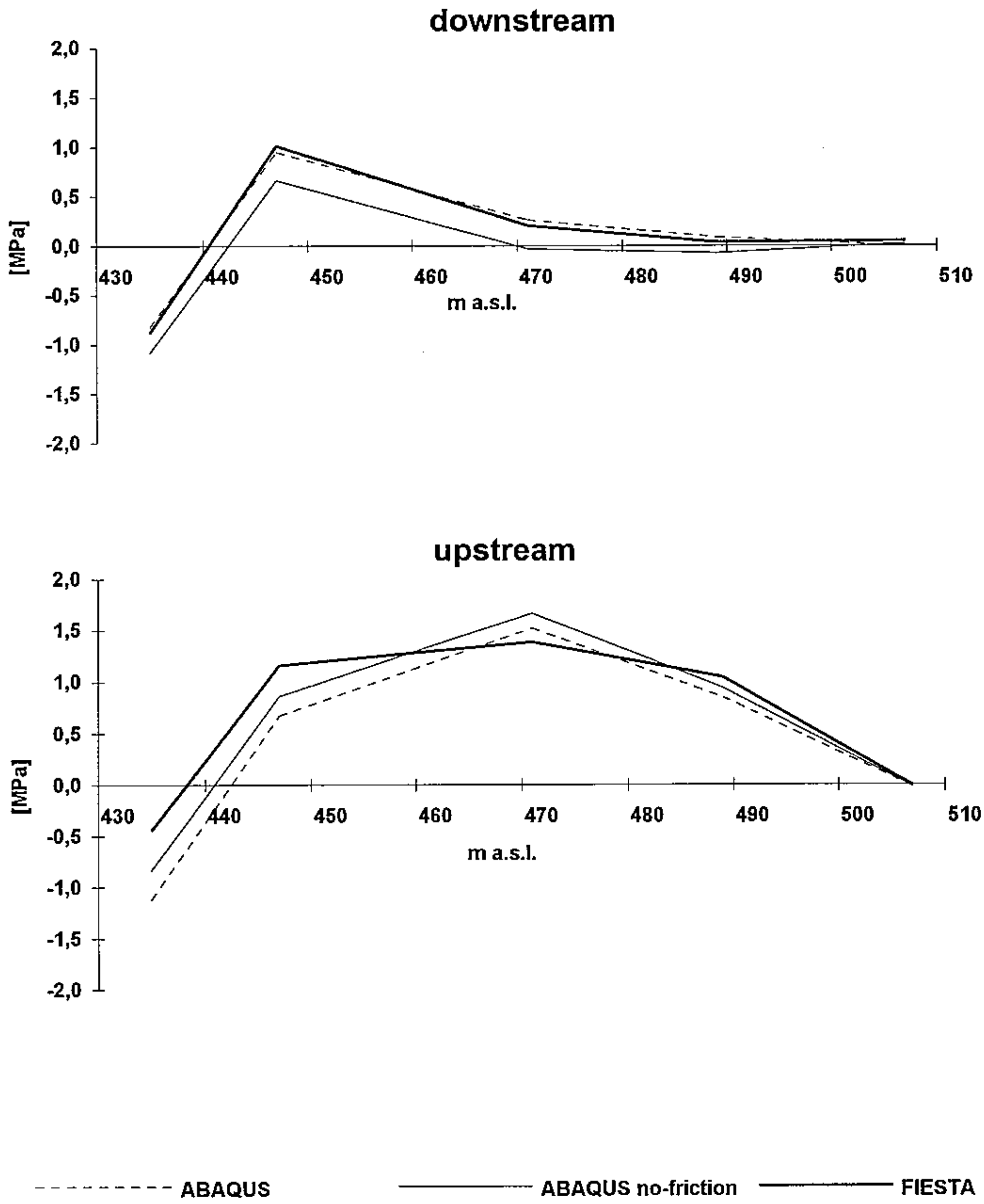


Fig. 6

SUMMER CONDITION
Nodal displacements and stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	1,40E-02	6,79E-35	-3,31E-04	6,51E-01	1,96E-01	-3,18E+00
2	1,42E-02	-2,21E-30	-1,09E-04	1,93E-01	-1,12E-01	-3,58E+00
3	1,43E-02	-2,03E-30	8,84E-05	1,71E-01	-1,97E-02	-2,97E+00
4	1,44E-02	-8,14E-36	2,79E-04	2,06E-01	-2,26E-02	-2,46E+00
5	1,45E-02	-3,43E-30	-8,21E-04	-2,04E-01	-2,05E+00	-4,49E+00
6	1,46E-02	-1,14E-29	-1,05E-03	-1,36E-01	-4,41E-01	-3,10E+00
7	1,47E-02	-9,51E-30	-1,23E-03	7,03E-02	-9,20E-02	-2,83E+00
8	1,48E-02	-2,89E-30	-1,39E-03	-1,63E-02	-5,17E-01	-3,65E+00
9	9,79E-03	1,66E-03	-5,32E-04	-2,08E-01	-1,90E+00	-3,70E+00
10	9,99E-03	1,24E-03	-6,54E-04	-1,44E-01	-4,42E-01	-2,69E+00
11	1,02E-02	8,05E-04	-7,38E-04	-1,80E-02	-1,43E-01	-2,92E+00
12	1,05E-02	3,87E-04	-8,09E-04	-1,92E-02	-7,65E-01	-4,29E+00
13	5,78E-03	1,11E-03	-4,01E-04	-1,97E-01	-1,62E+00	-2,89E+00
14	6,05E-03	6,84E-04	-4,16E-04	-1,23E-01	-1,53E-01	-2,13E+00
15	6,32E-03	2,40E-04	-3,96E-04	2,33E-01	-9,33E-02	-2,68E+00
16	6,66E-03	-1,70E-04	-3,71E-04	-2,43E-02	-5,27E-01	-4,42E+00
17	2,66E-03	-6,11E-06	-4,02E-04	-2,01E-01	-1,72E+00	-2,00E+00
18	2,89E-03	-2,62E-04	-3,37E-04	-1,50E-01	-3,68E-01	-1,67E+00
19	3,14E-03	-5,31E-04	-2,42E-04	-1,79E-02	-1,86E-01	-2,72E+00
20	3,46E-03	-7,51E-04	-1,47E-04	-3,43E-02	-1,03E+00	-5,04E+00
21	1,09E-03	-8,65E-04	-4,02E-04	-2,09E-01	-1,39E+00	-1,85E+00
22	1,21E-03	-9,13E-04	-2,94E-04	-8,80E-03	-1,35E-01	-1,26E+00
23	1,33E-03	-9,69E-04	-1,65E-04	1,66E-01	-9,77E-03	-2,15E+00
24	1,52E-03	-9,66E-04	-4,36E-05	-1,34E-01	-9,25E-01	-4,48E+00
25	1,12E-02	-4,43E-30	3,89E-04	-3,59E-01	-2,21E+00	-4,38E+00
26	1,13E-02	-1,40E-29	-3,53E-04	-1,29E-01	-3,75E-01	-2,29E+00
27	1,13E-02	-1,10E-29	-1,08E-03	4,72E-02	-3,55E-01	-2,04E+00
28	1,15E-02	-3,65E-30	-1,80E-03	-2,20E-02	-2,07E+00	-3,84E+00
29	7,43E-03	1,68E-03	2,28E-04	-3,63E-01	-1,94E+00	-3,51E+00
30	7,66E-03	1,24E-03	-3,40E-04	-6,48E-02	-3,14E-01	-1,84E+00
31	7,84E-03	7,63E-04	-8,99E-04	1,81E-02	-3,21E-01	-2,13E+00
32	8,18E-03	3,43E-04	-1,46E-03	-1,08E-02	-2,16E+00	-4,56E+00
33	4,22E-03	1,13E-03	-8,66E-05	-3,43E-01	-1,63E+00	-2,52E+00
34	4,51E-03	6,91E-04	-5,08E-04	1,90E-01	-2,82E-01	-1,27E+00
35	4,78E-03	2,30E-04	-9,24E-04	1,81E-01	-3,00E-01	-2,11E+00
36	5,18E-03	-1,42E-04	-1,34E-03	2,77E-02	-2,04E+00	-5,05E+00
37	1,88E-03	-1,93E-05	-2,52E-04	-2,77E-01	-1,43E+00	-1,57E+00
38	2,12E-03	-2,67E-04	-5,12E-04	2,95E-01	-3,97E-01	-9,42E-01
39	2,34E-03	-5,42E-04	-7,83E-04	2,04E-01	-5,03E-01	-2,42E+00
40	2,68E-03	-6,99E-04	-1,04E-03	9,59E-01	-2,26E+00	-5,50E+00
41	4,69E-03	-3,20E-30	9,93E-04	-5,55E-01	-1,33E+00	-2,60E+00
42	4,70E-03	-9,50E-30	-1,04E-04	2,88E-01	-5,31E-01	-6,73E-01
43	4,62E-03	-6,88E-30	-1,18E-03	-7,17E-04	-4,68E-01	-1,07E+00
44	4,79E-03	-2,55E-30	-2,19E-03	-1,27E-01	-3,25E+00	-4,52E+00
45	2,33E-03	4,86E-04	2,68E-04	-7,70E-01	-1,44E+00	-2,03E+00
46	2,50E-03	7,35E-05	-5,10E-04	7,28E-01	1,18E-01	-9,90E-01
47	2,61E-03	-3,35E-04	-1,28E-03	1,07E-02	-1,65E-01	-2,32E+00
48	2,92E-03	-6,29E-04	-1,97E-03	1,04E+00	-2,76E+00	-6,09E+00
49	1,54E-03	-1,92E-30	1,37E-04	3,00E+00	-1,78E-02	-4,37E-01
50	1,66E-03	-2,20E-30	-7,40E-04	7,50E-01	6,74E-01	-3,73E-01
51	1,62E-03	-4,28E-30	-1,70E-03	1,41E-01	-4,26E-01	-1,16E+00
52	1,55E-03	-6,63E-31	-2,22E-03	-1,32E+00	-4,04E+00	-9,23E+00

Tab. 1

SUMMER CONDITION
Displacements at Joints 1 and 4

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	-4,63E-04	-3,04E-04	-2,00E-03	-1,92E-03	8,54E-04	1,53E-03
2	-1,90E-04	-2,61E-05	-2,28E-03	-2,20E-03	1,41E-03	2,02E-03
3	8,45E-05	2,52E-04	-2,56E-03	-2,47E-03	1,97E-03	2,52E-03
4	3,58E-04	5,26E-04	-2,83E-03	-2,75E-03	2,52E-03	3,01E-03
5	1,29E-03	1,28E-03	-1,45E-03	-1,46E-03	5,44E-04	1,31E-03
6	1,51E-03	1,50E-03	-1,74E-03	-1,75E-03	1,06E-03	1,77E-03
7	1,75E-03	1,74E-03	-2,03E-03	-2,04E-03	1,58E-03	2,22E-03
8	2,02E-03	2,01E-03	-2,30E-03	-2,31E-03	2,09E-03	2,66E-03
9	2,85E-03	2,76E-03	-5,40E-04	-7,44E-04	-8,03E-05	5,69E-04
10	3,07E-03	2,99E-03	-8,54E-04	-1,06E-03	2,50E-04	9,35E-04
11	3,32E-03	3,24E-03	-1,17E-03	-1,38E-03	6,25E-04	1,33E-03
12	3,61E-03	3,52E-03	-1,47E-03	-1,68E-03	1,02E-03	1,72E-03
13	3,75E-03	3,60E-03	1,89E-04	4,87E-05	-4,37E-04	-3,85E-05
14	4,00E-03	3,86E-03	-1,52E-04	-2,98E-04	-2,71E-04	1,63E-04
15	4,27E-03	4,13E-03	-4,98E-04	-6,51E-04	-6,14E-05	4,02E-04
16	4,60E-03	4,45E-03	-8,15E-04	-9,77E-04	1,56E-04	6,50E-04
17	4,12E-03	3,91E-03	6,67E-04	5,34E-04	-4,66E-04	-2,74E-04
18	4,40E-03	4,19E-03	2,98E-04	1,60E-04	-4,48E-04	-2,38E-04
19	4,69E-03	4,46E-03	-7,77E-05	-2,24E-04	-3,93E-04	-1,73E-04
20	5,05E-03	4,81E-03	-4,16E-04	-5,73E-04	-3,32E-04	-1,10E-04
21	4,04E-03	3,81E-03	8,71E-04	7,47E-04	-3,11E-04	-3,33E-04
22	4,33E-03	4,10E-03	4,91E-04	3,61E-04	-4,36E-04	-4,46E-04
23	4,63E-03	4,37E-03	9,97E-05	-4,35E-05	-5,25E-04	-5,47E-04
24	5,04E-03	4,74E-03	-2,44E-04	-4,07E-04	-6,24E-04	-6,45E-04
25	3,60E-03	3,42E-03	8,36E-04	7,32E-04	-1,25E-04	-3,17E-04
26	3,90E-03	3,72E-03	4,57E-04	3,53E-04	-3,59E-04	-5,66E-04
27	4,20E-03	3,99E-03	6,51E-05	-4,86E-05	-5,74E-04	-8,17E-04
28	4,61E-03	4,37E-03	-2,60E-04	-3,86E-04	-8,08E-04	-1,06E-03
29	2,92E-03	2,82E-03	6,19E-04	5,32E-04	-1,62E-06	-2,97E-04
30	3,22E-03	3,11E-03	2,56E-04	1,78E-04	-3,27E-04	-6,59E-04
31	3,48E-03	3,37E-03	-1,21E-04	-1,94E-04	-6,19E-04	-1,03E-03
32	3,92E-03	3,77E-03	-3,98E-04	-4,85E-04	-9,45E-04	-1,37E-03
33	2,13E-03	2,09E-03	3,03E-04	1,91E-04	-3,40E-05	-3,04E-04
34	2,39E-03	2,38E-03	-3,10E-05	-1,37E-04	-3,84E-04	-7,44E-04
35	2,62E-03	2,62E-03	-3,82E-04	-4,82E-04	-7,44E-04	-1,19E-03
36	3,00E-03	3,00E-03	-6,11E-04	-6,95E-04	-1,15E-03	-1,59E-03
37	8,37E-03	8,37E-03	2,03E-04	2,03E-04	-1,56E-03	-1,56E-03
38	7,24E-03	7,24E-03	8,33E-04	8,33E-04	5,57E-04	5,57E-04
39	7,30E-03	7,30E-03	5,41E-04	5,41E-04	-3,00E-04	-3,00E-04
40	7,41E-03	7,41E-03	2,63E-04	2,63E-04	-1,16E-03	-1,16E-03

Tab. 2

SUMMER CONDITION
Displacements at Joints 2 and 3

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	1,24E-02	1,24E-02	5,91E-04	6,03E-04	-1,90E-04	-1,86E-05
2	1,25E-02	1,26E-02	3,35E-04	3,48E-04	7,73E-05	2,20E-04
3	1,27E-02	1,28E-02	7,82E-05	9,20E-05	3,17E-04	4,30E-04
4	1,28E-02	1,29E-02	-1,75E-04	-1,61E-04	5,47E-04	6,30E-04
5	1,31E-02	1,32E-02	8,30E-04	8,22E-04	-6,90E-04	-5,03E-04
6	1,32E-02	1,33E-02	5,61E-04	5,53E-04	-5,41E-04	-3,63E-04
7	1,34E-02	1,34E-02	2,85E-04	2,78E-04	-3,66E-04	-2,08E-04
8	1,35E-02	1,36E-02	1,57E-05	9,69E-06	-1,81E-04	-4,26E-05
9	1,34E-02	1,34E-02	1,08E-03	1,08E-03	-8,63E-04	-7,36E-04
10	1,35E-02	1,35E-02	8,12E-04	8,10E-04	-8,86E-04	-7,50E-04
11	1,36E-02	1,36E-02	5,29E-04	5,26E-04	-8,66E-04	-7,33E-04
12	1,38E-02	1,38E-02	2,52E-04	2,48E-04	-8,31E-04	-6,93E-04
13	1,31E-02	1,32E-02	1,23E-03	1,24E-03	-7,20E-04	-6,70E-04
14	1,32E-02	1,33E-02	9,54E-04	9,60E-04	-9,23E-04	-8,67E-04
15	1,34E-02	1,34E-02	6,65E-04	6,69E-04	-1,08E-03	-1,03E-03
16	1,36E-02	1,36E-02	3,83E-04	3,85E-04	-1,23E-03	-1,17E-03
17	1,24E-02	1,25E-02	1,30E-03	1,31E-03	-3,81E-04	-4,01E-04
18	1,25E-02	1,26E-02	1,01E-03	1,02E-03	-7,59E-04	-7,86E-04
19	1,27E-02	1,27E-02	7,16E-04	7,24E-04	-1,09E-03	-1,14E-03
20	1,29E-02	1,29E-02	4,31E-04	4,38E-04	-1,43E-03	-1,48E-03
21	1,14E-02	1,14E-02	1,29E-03	1,30E-03	4,19E-05	-3,90E-05
22	1,15E-02	1,16E-02	1,00E-03	1,01E-03	-4,94E-04	-5,97E-04
23	1,16E-02	1,17E-02	7,03E-04	7,09E-04	-9,95E-04	-1,14E-03
24	1,19E-02	1,19E-02	4,16E-04	4,22E-04	-1,50E-03	-1,66E-03
25	1,01E-02	1,01E-02	1,23E-03	1,23E-03	4,55E-04	3,22E-04
26	1,02E-02	1,03E-02	9,40E-04	9,42E-04	-2,16E-04	-3,88E-04
27	1,03E-02	1,03E-02	6,37E-04	6,39E-04	-8,62E-04	-1,09E-03
28	1,06E-02	1,06E-02	3,55E-04	3,56E-04	-1,52E-03	-1,78E-03
29	8,68E-03	8,65E-03	1,12E-03	1,11E-03	7,91E-04	6,14E-04
30	8,81E-03	8,78E-03	8,33E-04	8,26E-04	8,18E-06	-2,21E-04
31	8,89E-03	8,86E-03	5,32E-04	5,26E-04	-7,58E-04	-1,06E-03
32	9,14E-03	9,09E-03	2,60E-04	2,52E-04	-1,54E-03	-1,88E-03
33	7,16E-03	7,10E-03	9,72E-04	9,54E-04	1,00E-03	7,91E-04
34	7,27E-03	7,23E-03	6,89E-04	6,72E-04	1,31E-04	-1,39E-04
35	7,33E-03	7,28E-03	3,96E-04	3,80E-04	-7,31E-04	-1,09E-03
36	7,58E-03	7,53E-03	1,41E-04	1,26E-04	-1,60E-03	-2,00E-03
37	5,60E-03	5,55E-03	7,85E-04	7,61E-04	1,06E-03	8,25E-04
38	5,70E-03	5,66E-03	5,14E-04	4,92E-04	1,27E-04	-1,71E-04
39	5,72E-03	5,69E-03	2,37E-04	2,14E-04	-7,96E-04	-1,18E-03
40	5,97E-03	5,93E-03	1,08E-05	-1,13E-05	-1,71E-03	-2,13E-03
41	4,09E-03	4,04E-03	5,70E-04	5,46E-04	9,44E-04	7,15E-04
42	4,15E-03	4,13E-03	3,20E-04	2,98E-04	-1,61E-05	-3,21E-04
43	4,12E-03	4,13E-03	6,75E-05	4,66E-05	-9,49E-04	-1,35E-03
44	4,35E-03	4,37E-03	-1,08E-04	-1,27E-04	-1,85E-03	-2,26E-03
45	2,67E-03	2,62E-03	3,37E-04	3,15E-04	6,27E-04	4,53E-04
46	2,70E-03	2,67E-03	1,11E-04	1,11E-04	-3,22E-04	-5,78E-04
47	2,61E-03	2,65E-03	-9,58E-05	-9,72E-05	-1,18E-03	-1,53E-03
48	2,77E-03	2,84E-03	-1,96E-04	-2,06E-04	-1,96E-03	-2,29E-03
49	2,12E-03	2,12E-03	-2,37E-04	-2,37E-04	-2,05E-03	-2,05E-03
50	1,54E-03	1,54E-03	-1,92E-30	-1,92E-30	1,37E-04	1,37E-04
51	1,66E-03	1,66E-03	-2,20E-30	-2,20E-30	-7,40E-04	-7,40E-04
52	1,62E-03	1,62E-03	-4,28E-30	-4,28E-30	-1,70E-03	-1,70E-03

Tab. 3

WINTER CONDITION
Nodal displacements and stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	1,37E-02	1,14E-35	-6,88E-03	-7,94E-03	-3,35E-02	-1,36E+00
2	1,36E-02	-1,44E-30	-7,40E-03	7,33E-02	-6,28E-02	-1,23E+00
3	1,35E-02	-1,55E-30	-7,93E-03	6,66E-02	-5,63E-02	-9,85E-01
4	1,34E-02	-8,59E-37	-8,44E-03	1,19E-02	-2,52E-02	-7,20E-01
5	8,38E-03	-9,83E-31	-3,46E-03	1,01E+00	4,05E-01	-1,53E-02
6	8,27E-03	-6,69E-31	-4,07E-03	2,22E-02	-5,80E-01	-6,92E-01
7	8,19E-03	-1,93E-30	-4,72E-03	5,56E-03	-5,35E-01	-9,04E-01
8	8,08E-03	-9,68E-32	-5,35E-03	9,40E-01	9,08E-02	1,40E-02
9	6,22E-03	1,71E-03	-2,74E-03	1,43E+00	7,91E-01	-1,17E-02
10	6,16E-03	1,48E-03	-3,32E-03	1,99E-02	-3,68E-01	-6,74E-01
11	6,15E-03	1,27E-03	-3,96E-03	-8,86E-05	-6,07E-01	-1,11E+00
12	6,10E-03	1,04E-03	-4,58E-03	6,10E-01	1,03E-02	-3,15E-01
13	4,47E-03	1,96E-03	-2,53E-03	1,47E+00	1,12E+00	5,53E-03
14	4,45E-03	1,73E-03	-3,10E-03	4,24E-02	-3,59E-01	-6,47E-01
15	4,47E-03	1,52E-03	-3,72E-03	3,18E-02	-5,21E-01	-1,35E+00
16	4,45E-03	1,29E-03	-4,33E-03	7,97E-01	2,65E-02	-6,74E-01
17	2,16E-03	7,28E-04	-1,20E-03	1,55E+00	1,09E+00	1,99E-03
18	2,12E-03	5,62E-04	-1,49E-03	3,11E-02	-2,33E-01	-4,98E-01
19	2,13E-03	4,22E-04	-1,81E-03	3,26E-02	-2,92E-01	-1,01E+00
20	2,10E-03	2,58E-04	-2,12E-03	1,22E+00	1,71E-02	-1,14E-01
21	9,60E-04	7,04E-04	-1,03E-03	1,76E+00	1,40E+00	-3,79E-02
22	9,43E-04	5,17E-04	-1,25E-03	2,90E-01	-8,22E-02	-6,39E-01
23	9,73E-04	3,67E-04	-1,48E-03	1,79E-01	-3,38E-02	-1,27E+00
24	9,71E-04	1,91E-04	-1,71E-03	1,50E+00	-5,75E-02	-5,21E-01
25	4,05E-03	-6,16E-32	-1,35E-03	1,61E+00	3,62E-01	-8,39E-02
26	4,00E-03	-1,54E-30	-1,96E-03	-9,12E-03	-9,15E-01	-1,13E+00
27	4,01E-03	-3,96E-30	-2,58E-03	-3,72E-03	-9,50E-01	-1,51E+00
28	3,90E-03	-2,58E-33	-3,16E-03	1,60E+00	2,67E-01	6,76E-03
29	2,49E-03	8,71E-04	-1,15E-03	1,74E+00	6,31E-01	-7,51E-02
30	2,50E-03	6,46E-04	-1,64E-03	-3,07E-02	-8,51E-01	-1,07E+00
31	2,59E-03	4,44E-04	-2,13E-03	-1,13E-02	-9,39E-01	-1,63E+00
32	2,56E-03	2,04E-04	-2,59E-03	1,48E+00	3,36E-02	9,17E-03
33	1,19E-03	7,43E-04	-1,20E-03	1,59E+00	8,94E-01	-4,27E-02
34	1,22E-03	5,56E-04	-1,60E-03	-5,22E-02	-9,61E-01	-1,27E+00
35	1,33E-03	4,08E-04	-1,99E-03	-2,23E-02	-9,14E-01	-2,15E+00
36	1,33E-03	2,05E-04	-2,35E-03	1,54E+00	1,49E-02	-7,03E-01
37	5,19E-04	5,54E-05	-5,10E-04	1,98E+00	1,13E+00	-8,70E-02
38	5,10E-04	-5,53E-05	-7,08E-04	-1,14E-01	-2,87E-01	-1,04E+00
39	5,57E-04	-1,10E-04	-8,73E-04	-2,02E-01	-2,99E-01	-1,37E+00
40	4,96E-04	-2,33E-04	-1,03E-03	2,29E+00	7,08E-01	-2,00E-01
41	1,24E-03	-2,03E-30	-1,07E-03	7,07E-01	6,86E-01	-2,82E-01
42	1,20E-03	-2,95E-30	-1,33E-03	-2,27E-01	-1,12E+00	-1,47E+00
43	1,26E-03	-4,03E-30	-1,57E-03	-4,03E-02	-9,23E-01	-1,63E+00
44	1,13E-03	2,97E-31	-1,80E-03	2,06E+00	1,01E+00	-2,02E-03
45	5,99E-04	2,16E-04	-9,97E-04	9,34E-01	3,68E-01	-3,97E-01
46	6,10E-04	5,94E-05	-1,16E-03	-4,09E-01	-7,97E-01	-1,40E+00
47	6,90E-04	-4,34E-05	-1,28E-03	-2,32E-01	-6,71E-01	-1,60E+00
48	5,86E-04	-1,90E-04	-1,39E-03	2,35E+00	3,32E-01	-1,41E-01
49	5,49E-04	-1,48E-30	-8,81E-04	6,74E-01	2,76E-01	-1,18E+00
50	5,67E-04	-2,88E-30	-1,24E-03	-7,27E-02	-7,82E-01	-9,86E-01
51	6,15E-04	1,33E-30	-1,30E-03	7,21E-02	-3,83E-01	-1,34E+00
52	3,86E-04	1,51E-30	-1,07E-03	2,11E+00	3,20E-01	-1,46E+00

Tab. 4

WINTER CONDITION
Displacements at Joints 1 and 4

Node	D'x [m]	D"x	D'y	D"y	D'z	D"z
1	6,34E-03	1,04E-02	2,60E-03	4,67E-03	-3,78E-03	-6,17E-03
2	6,32E-03	1,04E-02	2,42E-03	4,49E-03	-4,09E-03	-6,72E-03
3	6,29E-03	1,04E-02	2,24E-03	4,31E-03	-4,41E-03	-7,29E-03
4	6,26E-03	1,03E-02	2,07E-03	4,14E-03	-4,72E-03	-7,84E-03
5	5,48E-03	8,80E-03	2,02E-03	3,85E-03	-3,48E-03	-5,85E-03
6	5,46E-03	8,78E-03	1,86E-03	3,67E-03	-3,79E-03	-6,40E-03
7	5,45E-03	8,77E-03	1,68E-03	3,52E-03	-4,12E-03	-6,98E-03
8	5,43E-03	8,73E-03	1,50E-03	3,37E-03	-4,42E-03	-7,53E-03
9	4,57E-03	6,92E-03	1,41E-03	3,16E-03	-2,61E-03	-4,69E-03
10	4,55E-03	6,89E-03	1,24E-03	2,99E-03	-2,97E-03	-5,30E-03
11	4,56E-03	6,86E-03	1,05E-03	2,84E-03	-3,33E-03	-5,94E-03
12	4,56E-03	6,83E-03	8,62E-04	2,69E-03	-3,71E-03	-6,56E-03
13	3,60E-03	5,13E-03	9,19E-04	2,55E-03	-1,75E-03	-3,45E-03
14	3,54E-03	5,13E-03	8,05E-04	2,30E-03	-2,09E-03	-4,07E-03
15	3,53E-03	5,15E-03	6,69E-04	2,10E-03	-2,46E-03	-4,73E-03
16	3,51E-03	5,13E-03	4,92E-04	1,91E-03	-2,84E-03	-5,37E-03
17	2,74E-03	3,54E-03	5,21E-04	2,01E-03	-1,14E-03	-2,55E-03
18	2,66E-03	3,57E-03	4,34E-04	1,72E-03	-1,45E-03	-3,14E-03
19	2,66E-03	3,62E-03	3,23E-04	1,49E-03	-1,78E-03	-3,77E-03
20	2,64E-03	3,61E-03	1,40E-04	1,30E-03	-2,12E-03	-4,38E-03
21	2,03E-03	2,25E-03	2,31E-04	1,55E-03	-7,33E-04	-1,94E-03
22	1,93E-03	2,30E-03	1,75E-04	1,22E-03	-9,94E-04	-2,47E-03
23	1,95E-03	2,40E-03	8,89E-05	9,94E-04	-1,28E-03	-3,03E-03
24	1,94E-03	2,40E-03	-1,10E-04	8,18E-04	-1,57E-03	-3,56E-03
25	1,44E-03	1,29E-03	4,93E-05	1,13E-03	-4,46E-04	-1,52E-03
26	1,32E-03	1,37E-03	2,43E-05	7,90E-04	-6,79E-04	-1,96E-03
27	1,37E-03	1,50E-03	-4,13E-05	6,01E-04	-9,29E-04	-2,45E-03
28	1,39E-03	1,48E-03	-2,68E-04	4,76E-04	-1,17E-03	-2,87E-03
29	8,38E-04	6,30E-04	3,07E-05	6,36E-04	-3,16E-04	-1,24E-03
30	7,94E-04	7,45E-04	1,41E-06	3,98E-04	-5,26E-04	-1,61E-03
31	8,91E-04	8,84E-04	-8,46E-05	3,15E-04	-7,24E-04	-1,98E-03
32	9,36E-04	8,29E-04	-3,52E-04	2,78E-04	-9,05E-04	-2,28E-03
33	4,60E-04	2,41E-04	1,82E-05	3,31E-04	-4,24E-04	-1,13E-03
34	4,27E-04	3,72E-04	-1,90E-06	1,56E-04	-5,67E-04	-1,29E-03
35	5,30E-04	5,01E-04	-8,30E-05	1,67E-04	-6,58E-04	-1,50E-03
36	5,88E-04	3,94E-04	-3,58E-04	2,31E-04	-7,47E-04	-1,68E-03
37	2,71E-03	2,71E-03	-2,37E-04	-2,37E-04	-2,09E-03	-2,09E-03
38	2,27E-03	2,27E-03	3,85E-04	3,85E-04	-1,13E-03	-1,13E-03
39	2,36E-03	2,36E-03	2,76E-04	2,76E-04	-1,47E-03	-1,47E-03
40	2,46E-03	2,46E-03	-6,17E-05	-6,17E-05	-1,78E-03	-1,78E-03

Tab. 5

WINTER CONDITION
Displacements at Joints 2 and 3

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	1,31E-02	1,31E-02	1,72E-03	1,72E-03	-6,58E-03	-6,60E-03
2	1,30E-02	1,30E-02	1,61E-03	1,61E-03	-7,10E-03	-7,11E-03
3	1,29E-02	1,29E-02	1,50E-03	1,50E-03	-7,64E-03	-7,65E-03
4	1,28E-02	1,28E-02	1,39E-03	1,39E-03	-8,15E-03	-8,17E-03
5	1,12E-02	1,12E-02	1,42E-03	1,42E-03	-5,52E-03	-5,55E-03
6	1,11E-02	1,11E-02	1,29E-03	1,29E-03	-6,07E-03	-6,11E-03
7	1,11E-02	1,11E-02	1,17E-03	1,17E-03	-6,65E-03	-6,68E-03
8	1,10E-02	1,10E-02	1,04E-03	1,04E-03	-7,20E-03	-7,24E-03
9	9,48E-03	9,47E-03	1,22E-03	1,22E-03	-4,21E-03	-4,37E-03
10	9,39E-03	9,38E-03	1,08E-03	1,08E-03	-4,82E-03	-4,93E-03
11	9,33E-03	9,31E-03	9,35E-04	9,38E-04	-5,43E-03	-5,56E-03
12	9,24E-03	9,20E-03	7,70E-04	8,14E-04	-6,04E-03	-6,16E-03
13	7,80E-03	7,88E-03	1,02E-03	1,04E-03	-3,06E-03	-3,42E-03
14	7,72E-03	7,78E-03	8,80E-04	9,01E-04	-3,68E-03	-3,99E-03
15	7,68E-03	7,72E-03	7,33E-04	7,69E-04	-4,33E-03	-4,63E-03
16	7,60E-03	7,61E-03	5,26E-04	6,79E-04	-4,97E-03	-5,22E-03
17	6,29E-03	6,43E-03	8,50E-04	8,93E-04	-2,21E-03	-2,60E-03
18	6,20E-03	6,33E-03	7,21E-04	7,52E-04	-2,78E-03	-3,19E-03
19	6,18E-03	6,30E-03	5,71E-04	6,41E-04	-3,42E-03	-3,84E-03
20	6,11E-03	6,19E-03	3,28E-04	6,03E-04	-4,04E-03	-4,44E-03
21	5,00E-03	5,07E-03	7,05E-04	7,81E-04	-1,59E-03	-1,92E-03
22	4,90E-03	4,98E-03	5,95E-04	6,14E-04	-2,13E-03	-2,52E-03
23	4,92E-03	4,99E-03	4,37E-04	5,20E-04	-2,72E-03	-3,17E-03
24	4,87E-03	4,88E-03	1,46E-04	5,34E-04	-3,29E-03	-3,78E-03
25	3,83E-03	3,79E-03	6,25E-04	6,17E-04	-1,17E-03	-1,44E-03
26	3,81E-03	3,77E-03	4,89E-04	4,83E-04	-1,68E-03	-2,03E-03
27	3,88E-03	3,83E-03	3,23E-04	4,06E-04	-2,22E-03	-2,64E-03
28	3,84E-03	3,73E-03	-2,39E-05	4,72E-04	-2,72E-03	-3,21E-03
29	2,95E-03	2,79E-03	5,36E-04	5,04E-04	-1,05E-03	-1,29E-03
30	2,95E-03	2,79E-03	4,01E-04	3,69E-04	-1,45E-03	-1,75E-03
31	3,05E-03	2,90E-03	2,29E-04	3,16E-04	-1,87E-03	-2,26E-03
32	3,04E-03	2,80E-03	-1,73E-04	4,41E-04	-2,27E-03	-2,73E-03
33	2,29E-03	2,10E-03	4,54E-04	4,08E-04	-9,69E-04	-1,21E-03
34	2,30E-03	2,10E-03	3,27E-04	2,81E-04	-1,30E-03	-1,57E-03
35	2,43E-03	2,23E-03	1,53E-04	2,59E-04	-1,63E-03	-1,98E-03
36	2,42E-03	2,12E-03	-2,91E-04	4,46E-04	-1,94E-03	-2,34E-03
37	1,78E-03	1,60E-03	3,71E-04	3,22E-04	-9,08E-04	-1,14E-03
38	1,77E-03	1,60E-03	2,56E-04	2,10E-04	-1,19E-03	-1,43E-03
39	1,92E-03	1,74E-03	9,01E-05	2,21E-04	-1,43E-03	-1,74E-03
40	1,92E-03	1,61E-03	-3,78E-04	4,65E-04	-1,67E-03	-2,02E-03
41	1,35E-03	1,22E-03	2,84E-04	2,43E-04	-8,61E-04	-1,07E-03
42	1,33E-03	1,20E-03	1,84E-04	1,46E-04	-1,11E-03	-1,29E-03
43	1,47E-03	1,35E-03	3,24E-05	1,85E-04	-1,27E-03	-1,52E-03
44	1,46E-03	1,20E-03	-4,38E-04	4,70E-04	-1,46E-03	-1,75E-03
45	9,75E-04	9,01E-04	1,72E-04	1,69E-04	-8,09E-04	-9,64E-04
46	9,40E-04	8,80E-04	1,02E-04	8,25E-05	-1,05E-03	-1,16E-03
47	1,03E-03	9,76E-04	-1,46E-05	1,26E-04	-1,14E-03	-1,31E-03
48	9,73E-04	7,94E-04	-4,37E-04	4,23E-04	-1,24E-03	-1,43E-03
49	6,73E-04	6,73E-04	-3,44E-04	-3,44E-04	-1,11E-03	-1,11E-03
50	5,49E-04	5,49E-04	-1,48E-30	-1,48E-30	-8,81E-04	-8,81E-04
51	5,67E-04	5,67E-04	-2,88E-30	-2,88E-30	-1,24E-03	-1,24E-03
52	6,15E-04	6,15E-04	1,33E-30	1,33E-30	-1,30E-03	-1,30E-03

Tab. 6

NOTES

NOTES

THIRD BENCHMARK WARKSHOP ON NUMERICAL ANALYSIS OF DAMS

THEME A1 : Arch dam

RAPPORT D'ETUDE

"Non-linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam"

(Modifications for RAPPORT of 1 JUILLET 1994)

Date : 28 october 1994

Auteur : Dr Ing. Lucian ILIE,
Dr Ing. Axel SCHALLER
Ing. Luc VADEZ

1 Juillet 1994

SOMMAIRE

1 Juillet 1994

1 OBJET ET HYPOTHESES GENERALES

L'objet de cette étude est de déterminer le comportement des joints verticaux d'un barrage voute soumis à des variations climatiques de température et de niveau du lac.

Voir les spécifications techniques de l'étude dans le document ICOLD définissant le thème A2.

2 METHODOLOGIE

La modélisation et les calculs sont effectués par la méthode des éléments finis en utilisant le progiciel ANSYS version 5.0A en statique non-linéaire (éléments de contact) et petits déplacements.

Les matériaux du barrage et de la fondation sont élastiques linéaires et isotropes.

Le système d'unité utilisé est le suivant :

- m pour les distances,
- Newton pour les efforts,
- Pascal (N/m2) pour les contraintes,
- kg/m3 pour la densité,
- m/s2 pour l'accélération.

2-1 Modélisation

Le modèle fourni par ICOLD a été converti au format ANSYS. Le barrage et la fondation sont entièrement représentés en éléments tridimensionnels à 20 noeuds (SOLID95).

La liaison au niveau du joint est assurée par des éléments de contacts à 2 noeuds (CONTAC52) orientés perpandiculairement à l'axe de la vallée et reliant les seuls noeuds sommets des éléments volumiques.

Le joint est étudié dans 2 configurations :
- coefficient de frottement nul,
- coefficient de frottement = 0,75.

Chaque modèle correspond à un demi-barrage (conditions de symétrie dans le plan vertical).

Le modèle compte 635 éléments solides et 84 éléments de contact.

Voir dans la figure A suivante une vue du modèle du barrage.

2-2 *Calculs*

Les chargements de température et de pression sont ceux donnés par ICOLD pour l'été "summer" et l'hiver "winter".

Les calculs non-linéaires ont étés réalisés en utilisant la méthode FULL NEWTON-RAPHSON et en découpant le chargement en 10 pas.

La convergence du calcul est basée sur un critère en effort (charge résiduelle).

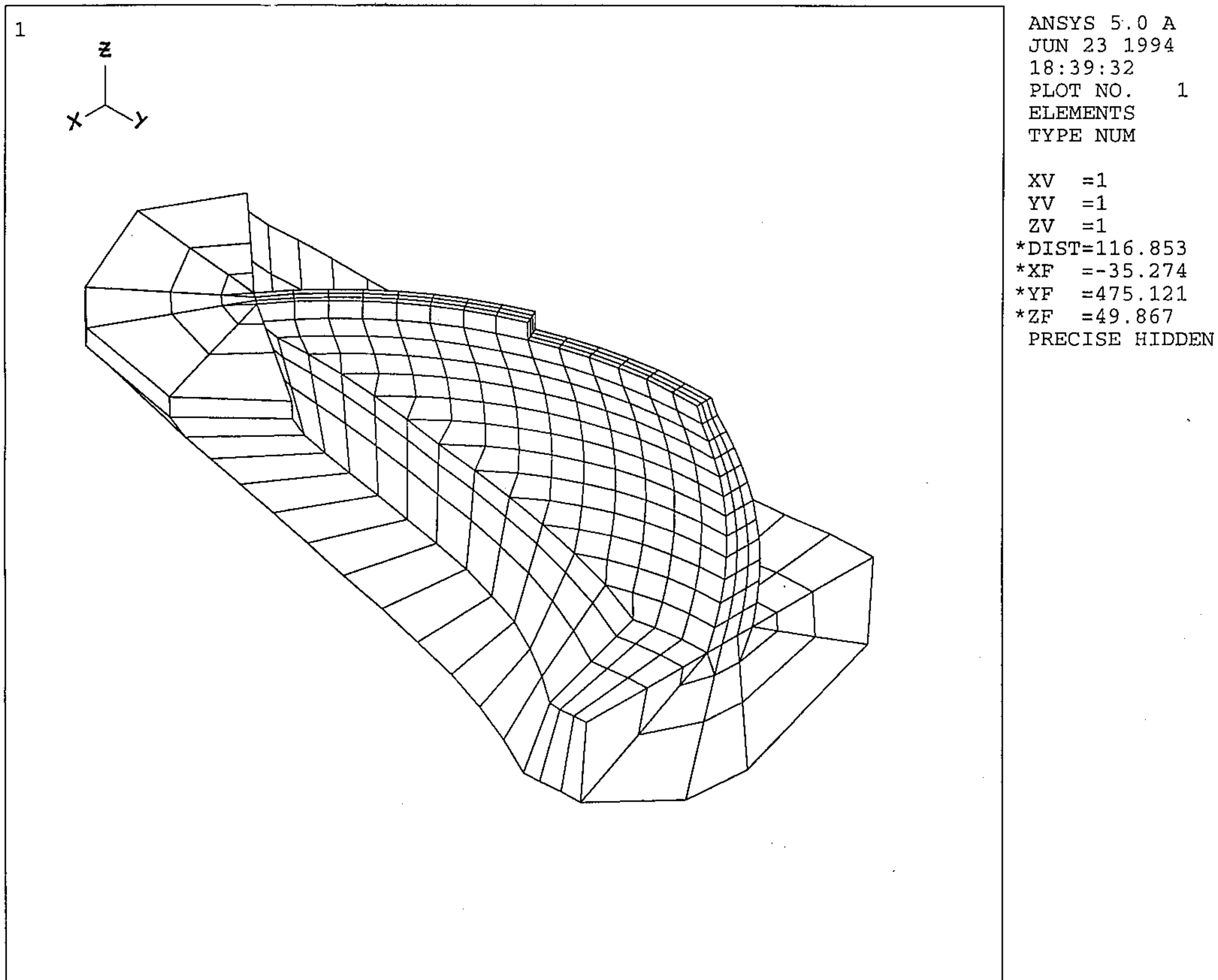
Les temps d'exécution, sur COMPAQ486 Pentium, des calculs pour les 2 cas de charges et les 2 conditions de frottement sont les suivants :

saison	coefficient de frottement	nombre d'éléments	temps CPU
"summer"	0	719	6186
"summer"	0,75	719	20600
"winter"	0	719	7212
"winter"	0,75	719	18301

2-2 *Résultats*

Voir dans les figures 4 à 8 suivantes les résultats demandés.

Voir en plus dans les figures 9 à 16 des vues complémentaires donnant les ouvertures des joints et les états des éléments de contacts pour les différents cas de charges.



ARCH DAM -dead weight + "SUMMER"- Mu=.75 (ADDL 1994)

Fig. 4.

FIGURE 4

(SUMMER MU=.00)

node	dx(m)	dy(m)	dz(m)	P1(MPa)	P2(MPa)	P3(MPa)
1.	0.025210	0.000000	-0.001579	0.896457	0.357466	-2.987335
2.	0.025322	0.000000	-0.001557	0.278252	-0.194711	-3.753383
3.	0.025453	0.000000	-0.001571	0.268626	-0.057474	-3.197381
4.	0.025577	0.000000	-0.001584	0.407288	0.000249	-2.708283
5.	0.023053	0.000000	-0.000903	-0.163722	-2.233082	-4.220196
6.	0.023136	0.000000	-0.001478	-0.138426	-0.506936	-2.963636
7.	0.023217	0.000000	-0.002015	0.130267	-0.083334	-2.835074
8.	0.023360	0.000000	-0.002517	-0.068969	-0.322310	-3.779668
9.	0.009113	0.000790	-0.000474	-0.196489	-2.172843	-3.730533
10.	0.009291	0.000459	-0.000510	-0.161379	-0.588601	-2.690405
11.	0.009472	0.000107	-0.000497	-0.029680	-0.136126	-2.896779
12.	0.009722	-0.000229	-0.000471	-0.037022	-0.582338	-4.259852
13.	0.005783	0.000459	-0.000559	-0.290538	-2.128139	-3.474051
14.	0.006022	0.000105	-0.000425	-0.233082	-0.335486	-2.336829
15.	0.006266	-0.000288	-0.000234	0.559019	-0.206330	-2.768341
16.	0.006584	-0.000660	-0.000031	0.406147	-0.075998	-4.528285
17.	0.002387	-0.000187	-0.000529	-0.283522	-1.189550	-2.549956
18.	0.002558	-0.000335	-0.000577	-0.262028	-0.330500	-1.990547
19.	0.002730	-0.000489	-0.000614	-0.258243	-0.664642	-2.943923
20.	0.002985	-0.000588	-0.000662	-0.079528	-2.173544	-5.294445
21.	0.001160	-0.000665	-0.000400	-0.230593	-1.144271	-1.945255
22.	0.001273	-0.000705	-0.000366	0.018314	-0.175501	-1.377854
23.	0.001387	-0.000753	-0.000320	-0.021522	-0.158336	-2.174509
24.	0.001572	-0.000740	-0.000283	-0.087866	-1.408063	-4.339530
25.	0.016552	0.000000	0.001454	-0.319638	-2.062511	-3.928857
26.	0.016630	0.000000	0.000168	-0.080645	-0.426078	-2.063966
27.	0.016665	0.000000	-0.001114	0.072628	-0.436048	-2.024690
28.	0.016839	0.000000	-0.002383	-0.096109	-2.147637	-4.024452
29.	0.007201	0.001101	0.000230	-0.371898	-2.088906	-3.534854
30.	0.007397	0.000750	-0.000280	-0.142193	-0.355592	-1.872327
31.	0.007553	0.000374	-0.000777	-0.008173	-0.330635	-2.125242
32.	0.007851	0.000047	-0.001275	-0.078009	-2.102721	-4.462409
33.	0.004585	0.000767	-0.000111	-0.496871	-1.906213	-2.831814
34.	0.004837	0.000419	-0.000547	0.121598	-0.445481	-1.486370
35.	0.005054	0.000030	-0.000969	0.177403	-0.466801	-2.234563
36.	0.005420	-0.000281	-0.001396	-0.141390	-2.082575	-5.221791
37.	0.001650	-0.000349	-0.000559	-0.379886	-1.386667	-2.193017
38.	0.001805	-0.000483	-0.000725	0.234269	-0.406535	-1.176563
39.	0.001931	-0.000629	-0.000907	-0.121184	-0.533048	-2.225141
40.	0.002160	-0.000658	-0.001069	0.494160	-2.644222	-4.796066
41.	0.006054	0.000000	0.002102	-0.408990	-0.595367	-2.472140
42.	0.006042	0.000000	0.000459	0.624287	-0.504184	-0.810778
43.	0.005953	0.000000	-0.001149	-0.110965	-0.562554	-1.480055
44.	0.006131	0.000000	-0.002641	-0.232221	-3.475709	-5.786963
45.	0.003262	0.000577	0.000662	-0.763332	-1.307685	-2.522613
46.	0.003365	0.000242	-0.000168	0.412675	-0.301214	-0.837301
47.	0.003375	-0.000066	-0.000979	0.137160	-0.153210	-1.150227
48.	0.003618	-0.000265	-0.001738	-0.386879	-2.607359	-4.717469
49.	0.001672	0.000000	0.000613	4.616233	0.331368	-0.211367
50.	0.001824	0.000000	-0.000565	0.612699	0.594788	-0.481003
51.	0.001820	0.000000	-0.001873	0.153510	-0.170213	-1.410371
52.	0.001740	0.000000	-0.002555	-1.267653	-4.149487	-10.719629

FIGURE 6

(SUMMER MU=.00)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.023607	0.010224	0.001010	-0.000861	-0.001189	0.000476
2.	0.023754	0.010374	0.000797	-0.001085	-0.001092	0.000876
3.	0.023915	0.010537	0.000581	-0.001312	-0.001041	0.001239
4.	0.024074	0.010700	0.000368	-0.001536	-0.001003	0.001580
5.	0.023599	0.011361	0.001155	-0.000552	-0.001572	-0.000204
6.	0.023719	0.011485	0.000928	-0.000793	-0.001641	0.000015
7.	0.023840	0.011618	0.000694	-0.001041	-0.001699	0.000272
8.	0.024008	0.011798	0.000463	-0.001287	-0.001727	0.000552
9.	0.023081	0.011840	0.001338	-0.000222	-0.001428	-0.000444
10.	0.023203	0.011972	0.001122	-0.000450	-0.001707	-0.000409
11.	0.023323	0.012111	0.000895	-0.000689	-0.001960	-0.000316
12.	0.023505	0.012311	0.000670	-0.000927	-0.002176	-0.000216
13.	0.021978	0.011751	0.001434	-0.000011	-0.000975	-0.000368
14.	0.022111	0.011894	0.001233	-0.000223	-0.001506	-0.000512
15.	0.022225	0.012030	0.001019	-0.000450	-0.002005	-0.000596
16.	0.022422	0.012248	0.000810	-0.000671	-0.002460	-0.000676
17.	0.020314	0.011218	0.001457	0.000125	-0.000302	-0.000082
18.	0.020452	0.011366	0.001267	-0.000077	-0.001104	-0.000396
19.	0.020555	0.011489	0.001062	-0.000295	-0.001877	-0.000654
20.	0.020768	0.011724	0.000869	-0.000499	-0.002611	-0.000916
21.	0.018179	0.010353	0.001423	0.000213	0.000436	0.000289
22.	0.018322	0.010505	0.001236	0.000017	-0.000620	-0.000173
23.	0.018409	0.010608	0.001031	-0.000198	-0.001656	-0.000587
24.	0.018640	0.010857	0.000849	-0.000391	-0.002665	-0.001012
25.	0.015716	0.009258	0.001343	0.000273	0.001099	0.000655
26.	0.015860	0.009411	0.001150	0.000077	-0.000171	0.000069
27.	0.015928	0.009489	0.000936	-0.000142	-0.001436	-0.000482
28.	0.016178	0.009751	0.000756	-0.000328	-0.002683	-0.001043
29.	0.013073	0.008014	0.001223	0.000314	0.001586	0.000952
30.	0.013213	0.008163	0.001018	0.000114	0.000151	0.000265
31.	0.013260	0.008214	0.000786	-0.000112	-0.001292	-0.000402
32.	0.013528	0.008484	0.000600	-0.000295	-0.002717	-0.001074
33.	0.010387	0.006682	0.001068	0.000340	0.001833	0.001137
34.	0.010517	0.006818	0.000844	0.000135	0.000289	0.000368
35.	0.010538	0.006838	0.000591	-0.000100	-0.001270	-0.000394
36.	0.010819	0.007109	0.000395	-0.000281	-0.002793	-0.001149
37.	0.007781	0.005314	0.000880	0.000350	0.001817	0.001180
38.	0.007891	0.005425	0.000636	0.000139	0.000225	0.000349
39.	0.007881	0.005405	0.000365	-0.000100	-0.001375	-0.000485
40.	0.008162	0.005665	0.000162	-0.000277	-0.002900	-0.001295
41.	0.005367	0.003961	0.000663	0.000335	0.001546	0.001060
42.	0.005442	0.004029	0.000405	0.000122	-0.000029	0.000182
43.	0.005388	0.003957	0.000130	-0.000112	-0.001577	-0.000687
44.	0.005647	0.004187	-0.000060	-0.000270	-0.002970	-0.001507
45.	0.003209	0.002664	0.000420	0.000285	0.001079	0.000762
46.	0.003253	0.002685	0.000172	0.000070	-0.000407	-0.000139
47.	0.003185	0.002554	-0.000070	-0.000152	-0.001774	-0.001013
48.	0.003428	0.002720	-0.000179	-0.000261	-0.002827	-0.001823
49.	0.001351	0.001351	0.000103	0.000103	0.000261	0.000261
50.	0.001484	0.001484	-0.000104	-0.000104	-0.000630	-0.000630
51.	0.001490	0.001490	-0.000345	-0.000345	-0.001657	-0.001657
52.	0.001464	0.001464	-0.000340	-0.000340	-0.002204	-0.002204

FIGURE 8

(SUMMER MU=.00)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	-0.004271	0.001490	-0.003080	0.000647	0.002924	-0.000405
2.	-0.003960	0.001781	-0.003437	0.000290	0.003675	-0.000124
3.	-0.003664	0.002086	-0.003797	-0.000065	0.004455	0.000184
4.	-0.003360	0.002397	-0.004148	-0.000414	0.005214	0.000472
5.	-0.001840	0.002680	-0.002572	0.000200	0.002637	-0.000657
6.	-0.001570	0.002930	-0.002955	-0.000122	0.003360	-0.000420
7.	-0.001270	0.003205	-0.003340	-0.000447	0.004102	-0.000181
8.	-0.000938	0.003508	-0.003691	-0.000746	0.004804	0.000050
9.	0.000796	0.003431	-0.001572	0.000130	0.001264	-0.000746
10.	0.001068	0.003662	-0.001972	-0.000160	0.001966	-0.000741
11.	0.001342	0.003933	-0.002393	-0.000458	0.002679	-0.000688
12.	0.001684	0.004259	-0.002805	-0.000754	0.003396	-0.000641
13.	0.002853	0.003559	-0.000475	0.000005	0.000043	-0.000742
14.	0.003100	0.003789	-0.000807	-0.000242	0.000556	-0.000824
15.	0.003348	0.004052	-0.001165	-0.000501	0.001101	-0.000867
16.	0.003679	0.004391	-0.001515	-0.000745	0.001685	-0.000943
17.	0.004062	0.003414	0.000206	-0.000112	-0.000472	-0.000648
18.	0.004290	0.003635	-0.000061	-0.000335	-0.000215	-0.000770
19.	0.004505	0.003872	-0.000357	-0.000572	0.000077	-0.000858
20.	0.004815	0.004210	-0.000622	-0.000767	0.000402	-0.000981
21.	0.004441	0.003144	0.000536	-0.000186	-0.000575	-0.000542
22.	0.004655	0.003362	0.000309	-0.000398	-0.000581	-0.000685
23.	0.004844	0.003573	0.000051	-0.000631	-0.000560	-0.000800
24.	0.005148	0.003917	-0.000148	-0.000793	-0.000524	-0.000938
25.	0.004144	0.002791	0.000596	-0.000214	-0.000498	-0.000448
26.	0.004356	0.003010	0.000381	-0.000428	-0.000738	-0.000607
27.	0.004533	0.003205	0.000130	-0.000671	-0.000962	-0.000753
28.	0.004851	0.003552	-0.000027	-0.000815	-0.001184	-0.000903
29.	0.003389	0.002357	0.000452	-0.000220	-0.000406	-0.000386
30.	0.003608	0.002571	0.000231	-0.000442	-0.000819	-0.000576
31.	0.003780	0.002745	-0.000025	-0.000695	-0.001229	-0.000750
32.	0.004122	0.003099	-0.000161	-0.000823	-0.001624	-0.000926
33.	0.002415	0.001847	0.000132	-0.000238	-0.000340	-0.000460
34.	0.002635	0.002051	-0.000101	-0.000480	-0.000864	-0.000647
35.	0.002812	0.002210	-0.000373	-0.000762	-0.001328	-0.000926
36.	0.003201	0.002509	-0.000447	-0.000895	-0.001758	-0.001211
37.	0.001235	0.001235	-0.000388	-0.000388	-0.000561	-0.000561
38.	0.001480	0.001480	-0.000665	-0.000665	-0.000877	-0.000877
39.	0.001650	0.001650	-0.000970	-0.000970	-0.001269	-0.001269
40.	0.001735	0.001735	-0.001079	-0.001079	-0.001532	-0.001532

FIGURE 4

(SUMMER MU=.75)

node	dx(m)	dy(m)	dz(m)	P1(MPa)	P2(MPa)	P3(MPa)
1.	0.016536	0.000000	-0.000664	0.822640	0.357351	-2.702185
2.	0.016646	0.000000	-0.000511	0.236110	-0.201913	-3.336706
3.	0.016774	0.000000	-0.000392	0.234106	-0.048958	-2.640247
4.	0.016893	0.000000	-0.000276	0.371938	0.007784	-2.012420
5.	0.016105	0.000000	-0.000803	-0.161399	-2.031728	-4.450095
6.	0.016190	0.000000	-0.001118	-0.138494	-0.480478	-3.052159
7.	0.016272	0.000000	-0.001396	-0.004001	-0.106958	-2.777923
8.	0.016416	0.000000	-0.001654	-0.066051	-0.664351	-3.578683
9.	0.011055	0.002214	-0.000586	-0.194934	-1.912600	-3.754376
10.	0.011271	0.001747	-0.000784	-0.162423	-0.462361	-2.695023
11.	0.011490	0.001258	-0.000947	-0.054703	-0.154450	-2.868919
12.	0.011778	0.000789	-0.001096	-0.038601	-0.804521	-4.190034
13.	0.006602	0.001488	-0.000473	-0.286929	-1.857507	-3.183075
14.	0.006898	0.001000	-0.000557	-0.241487	-0.436416	-2.317563
15.	0.007202	0.000480	-0.000607	-0.091212	-0.251547	-2.890310
16.	0.007582	-0.000007	-0.000653	-0.082335	-0.906658	-4.756461
17.	0.002841	0.000479	-0.000399	-0.280591	-1.758226	-2.216576
18.	0.003083	0.000213	-0.000362	-0.220770	-0.237112	-1.732570
19.	0.003321	-0.000058	-0.000292	0.148494	-0.220410	-2.675309
20.	0.003633	-0.000275	-0.000223	-0.063291	-0.652264	-4.951193
21.	0.001120	-0.000596	-0.000406	-0.228987	-1.372989	-1.785893
22.	0.001263	-0.000671	-0.000320	-0.101726	-0.177153	-1.186102
23.	0.001404	-0.000753	-0.000214	0.097552	-0.116119	-2.099823
24.	0.001615	-0.000776	-0.000115	-0.085241	-0.921172	-4.392425
25.	0.012155	0.000000	0.000630	-0.312091	-2.236583	-4.309010
26.	0.012238	0.000000	-0.000204	-0.196734	-0.430866	-2.241475
27.	0.012275	0.000000	-0.001025	-0.033834	-0.426091	-1.985422
28.	0.012449	0.000000	-0.001841	-0.093806	-2.249634	-3.753759
29.	0.008107	0.002129	0.000342	-0.371899	-1.960891	-3.499267
30.	0.008348	0.001638	-0.000318	-0.127298	-0.379561	-1.773803
31.	0.008552	0.001118	-0.000973	-0.049234	-0.372802	-2.034332
32.	0.008900	0.000645	-0.001625	-0.075563	-2.212678	-4.427457
33.	0.004600	0.001383	0.000022	-0.501309	-1.756586	-2.695474
34.	0.004927	0.000885	-0.000472	0.033759	-0.432319	-1.288398
35.	0.005227	0.000342	-0.000963	-0.021585	-0.438061	-2.116906
36.	0.005678	-0.000119	-0.001450	-0.124280	-2.314829	-5.234236
37.	0.001848	0.000241	-0.000262	-0.435829	-1.449817	-1.700081
38.	0.002084	-0.000010	-0.000561	0.334168	-0.375062	-0.848355
39.	0.002290	-0.000274	-0.000870	0.078135	-0.584007	-2.294242
40.	0.002597	-0.000411	-0.001165	0.524841	-2.392897	-5.188119
41.	0.005001	0.000000	0.001275	-0.578840	-1.285198	-2.572650
42.	0.005007	0.000000	0.000082	0.272944	-0.481883	-0.754953
43.	0.004925	0.000000	-0.001088	-0.076505	-0.384788	-1.191465
44.	0.005092	0.000000	-0.002186	-0.222268	-3.121523	-4.775046
45.	0.003488	0.000852	0.000715	-0.755801	-1.086701	-2.527417
46.	0.003606	0.000456	-0.000265	0.325045	-0.290812	-0.848790
47.	0.003634	0.000088	-0.001212	-0.000136	-0.157756	-1.412954
48.	0.003898	-0.000162	-0.002086	-0.382900	-2.668846	-5.417430
49.	0.001596	0.000000	0.000305	3.164960	-0.139567	-0.487339
50.	0.001726	0.000000	-0.000627	0.685298	0.548388	-0.495370
51.	0.001690	0.000000	-0.001653	0.263495	-0.336743	-1.139682
52.	0.001612	0.000000	-0.002232	-1.182112	-3.785190	-9.274428

FIGURE 6

(SUMMER MU=.75)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.014607	0.014607	0.000846	0.000846	-0.000309	-0.000309
2.	0.014764	0.014763	0.000569	0.000570	-0.000072	-0.000072
3.	0.014931	0.014931	0.000294	0.000294	0.000121	0.000121
4.	0.015098	0.015098	0.000018	0.000019	0.000298	0.000298
5.	0.015153	0.015153	0.001083	0.001083	-0.000831	-0.000831
6.	0.015281	0.015281	0.000804	0.000805	-0.000755	-0.000755
7.	0.015413	0.015413	0.000513	0.000515	-0.000656	-0.000656
8.	0.015589	0.015589	0.000228	0.000229	-0.000534	-0.000534
9.	0.015161	0.015161	0.001364	0.001365	-0.000914	-0.000914
10.	0.015298	0.015298	0.001078	0.001080	-0.001015	-0.001015
11.	0.015436	0.015435	0.000781	0.000783	-0.001077	-0.001077
12.	0.015632	0.015632	0.000492	0.000493	-0.001121	-0.001121
13.	0.014665	0.014665	0.001523	0.001524	-0.000726	-0.000726
14.	0.014817	0.014817	0.001233	0.001235	-0.001013	-0.001013
15.	0.014954	0.014953	0.000928	0.000930	-0.001257	-0.001257
16.	0.015170	0.015169	0.000635	0.000636	-0.001484	-0.001484
17.	0.013743	0.013743	0.001583	0.001585	-0.000349	-0.000349
18.	0.013904	0.013904	0.001288	0.001290	-0.000824	-0.000824
19.	0.014032	0.014032	0.000977	0.000979	-0.001259	-0.001259
20.	0.014267	0.014267	0.000681	0.000682	-0.001683	-0.001683
21.	0.012485	0.012485	0.001560	0.001561	0.000100	0.000100
22.	0.012653	0.012653	0.001262	0.001265	-0.000546	-0.000546
23.	0.012764	0.012764	0.000946	0.000948	-0.001161	-0.001160
24.	0.013017	0.013016	0.000651	0.000652	-0.001771	-0.001771
25.	0.010993	0.010993	0.001466	0.001467	0.000527	0.000527
26.	0.011162	0.011162	0.001170	0.001172	-0.000266	-0.000266
27.	0.011251	0.011251	0.000852	0.000854	-0.001039	-0.001038
28.	0.011518	0.011518	0.000563	0.000564	-0.001810	-0.001810
29.	0.009355	0.009355	0.001316	0.001317	0.000863	0.000863
30.	0.009520	0.009519	0.001024	0.001026	-0.000049	-0.000049
31.	0.009583	0.009582	0.000708	0.000710	-0.000954	-0.000954
32.	0.009859	0.009859	0.000432	0.000433	-0.001853	-0.001853
33.	0.007650	0.007650	0.001121	0.001122	0.001062	0.001062
34.	0.007801	0.007801	0.000836	0.000838	0.000059	0.000059
35.	0.007833	0.007833	0.000527	0.000529	-0.000946	-0.000946
36.	0.008111	0.008111	0.000271	0.000272	-0.001932	-0.001932
37.	0.005945	0.005945	0.000891	0.000892	0.001099	0.001099
38.	0.006071	0.006071	0.000617	0.000619	0.000036	0.000036
39.	0.006064	0.006063	0.000322	0.000324	-0.001030	-0.001030
40.	0.006332	0.006332	0.000096	0.000097	-0.002053	-0.002053
41.	0.004308	0.004308	0.000635	0.000636	0.000960	0.000960
42.	0.004391	0.004391	0.000379	0.000380	-0.000127	-0.000127
43.	0.004334	0.004334	0.000108	0.000109	-0.001199	-0.001199
44.	0.004574	0.004574	-0.000074	-0.000073	-0.002182	-0.002182
45.	0.002784	0.002784	0.000362	0.000363	0.000655	0.000655
46.	0.002823	0.002823	0.000138	0.000138	-0.000414	-0.000414
47.	0.002724	0.002723	-0.000097	-0.000096	-0.001423	-0.001416
48.	0.002925	0.002925	-0.000220	-0.000219	-0.002257	-0.002257
49.	0.001341	0.001341	0.000067	0.000067	0.000098	0.000098
50.	0.001461	0.001461	-0.000096	-0.000096	-0.000712	-0.000712
51.	0.001447	0.001447	-0.000290	-0.000290	-0.001642	-0.001642
52.	0.001419	0.001419	-0.000307	-0.000307	-0.002140	-0.002140

FIGURE 8

(SUMMER MU=.75)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.000322	0.000322	-0.001694	-0.001694	0.001110	0.001110
2.	0.000631	0.000631	-0.002046	-0.002046	0.001620	0.001620
3.	0.000936	0.000935	-0.002394	-0.002393	0.002149	0.002149
4.	0.001248	0.001248	-0.002738	-0.002738	0.002656	0.002656
5.	0.001911	0.001911	-0.001231	-0.001231	0.000773	0.000772
6.	0.002164	0.002164	-0.001578	-0.001577	0.001246	0.001246
7.	0.002446	0.002445	-0.001923	-0.001922	0.001725	0.001725
8.	0.002761	0.002761	-0.002241	-0.002240	0.002184	0.002184
9.	0.003363	0.003363	-0.000374	-0.000373	0.000125	0.000124
10.	0.003618	0.003618	-0.000724	-0.000723	0.000449	0.000449
11.	0.003893	0.003892	-0.001084	-0.001082	0.000807	0.000807
12.	0.004223	0.004223	-0.001417	-0.001416	0.001176	0.001176
13.	0.004158	0.004157	0.000460	0.000461	-0.000314	-0.000314
14.	0.004436	0.004435	0.000088	0.000089	-0.000163	-0.000163
15.	0.004729	0.004728	-0.000297	-0.000296	0.000029	0.000029
16.	0.005091	0.005091	-0.000649	-0.000648	0.000230	0.000230
17.	0.004388	0.004387	0.000942	0.000942	-0.000403	-0.000403
18.	0.004685	0.004684	0.000551	0.000552	-0.000422	-0.000421
19.	0.004984	0.004983	0.000143	0.000145	-0.000405	-0.000405
20.	0.005374	0.005373	-0.000215	-0.000214	-0.000388	-0.000388
21.	0.004178	0.004178	0.001117	0.001117	-0.000330	-0.000330
22.	0.004489	0.004489	0.000717	0.000718	-0.000501	-0.000501
23.	0.004786	0.004785	0.000294	0.000295	-0.000648	-0.000648
24.	0.005203	0.005202	-0.000058	-0.000057	-0.000799	-0.000799
25.	0.003654	0.003654	0.001038	0.001038	-0.000223	-0.000223
26.	0.003972	0.003971	0.000638	0.000639	-0.000520	-0.000520
27.	0.004259	0.004258	0.000211	0.000212	-0.000807	-0.000807
28.	0.004695	0.004694	-0.000117	-0.000115	-0.001097	-0.001097
29.	0.002936	0.002936	0.000759	0.000759	-0.000167	-0.000167
30.	0.003245	0.003244	0.000372	0.000373	-0.000561	-0.000561
31.	0.003508	0.003507	-0.000038	-0.000036	-0.000950	-0.000950
32.	0.003949	0.003948	-0.000320	-0.000318	-0.001332	-0.001332
33.	0.002129	0.002128	0.000337	0.000338	-0.000211	-0.000211
34.	0.002416	0.002415	-0.000016	-0.000015	-0.000654	-0.000653
35.	0.002653	0.002652	-0.000403	-0.000402	-0.001118	-0.001118
36.	0.003080	0.003079	-0.000628	-0.000627	-0.001549	-0.001549
37.	0.001195	0.001195	-0.000267	-0.000267	-0.000423	-0.000423
38.	0.001456	0.001456	-0.000569	-0.000569	-0.000801	-0.000801
39.	0.001662	0.001662	-0.000916	-0.000916	-0.001279	-0.001279
40.	0.001776	0.001776	-0.001048	-0.001048	-0.001583	-0.001583

FIGURE 4

(WINTER MU=.00)

node	dx (m)	dy (m)	dz (m)	P1 (MPa)	P2 (MPa)	P3 (MPa)
1.	0.017793	0.000000	-0.007639	0.106031	-0.035507	-0.900952
2.	0.017694	0.000000	-0.008286	0.115631	0.017268	-0.806405
3.	0.017593	0.000000	-0.008951	0.117109	-0.007544	-0.655781
4.	0.017491	0.000000	-0.009593	0.104646	-0.038121	-0.498671
5.	0.010912	0.000000	-0.003579	1.196543	0.560088	0.008209
6.	0.010798	0.000000	-0.004356	0.069054	-0.502223	-0.633574
7.	0.010726	0.000000	-0.005184	0.052607	-0.599154	-0.921358
8.	0.010613	0.000000	-0.005990	0.730099	0.034033	-0.043096
9.	0.005622	0.001266	-0.002656	1.382911	0.758575	0.012108
10.	0.005557	0.001068	-0.003171	0.062080	-0.323361	-0.638771
11.	0.005537	0.000882	-0.003731	0.054695	-0.516050	-0.996636
12.	0.005476	0.000687	-0.004277	0.734424	0.039264	-0.135711
13.	0.004052	0.001592	-0.002545	1.412416	1.110009	0.034312
14.	0.004017	0.001379	-0.003052	0.036266	-0.278670	-0.689745
15.	0.004034	0.001182	-0.003600	0.033541	-0.429420	-1.291609
16.	0.004009	0.000973	-0.004136	0.928746	0.067739	-0.498335
17.	0.002114	0.000688	-0.001213	1.592652	1.126377	0.029835
18.	0.002069	0.000531	-0.001498	0.015237	-0.203453	-0.447806
19.	0.002075	0.000400	-0.001812	0.034362	-0.270070	-0.977299
20.	0.002039	0.000244	-0.002118	1.260256	0.065507	-0.084825
21.	0.000952	0.000699	-0.001040	1.794772	1.437421	0.008101
22.	0.000933	0.000513	-0.001258	0.353768	0.010589	-0.598290
23.	0.000961	0.000365	-0.001491	0.244448	0.045003	-1.249813
24.	0.000956	0.000191	-0.001718	1.571518	0.018702	-0.470304
25.	0.005372	0.000000	-0.001138	1.677371	0.397963	-0.175028
26.	0.005315	0.000000	-0.001900	0.068840	-0.790263	-0.973653
27.	0.005327	0.000000	-0.002690	0.093875	-0.891328	-1.528474
28.	0.005222	0.000000	-0.003441	1.529067	0.069333	0.051296
29.	0.002279	0.000660	-0.001154	1.556986	0.478142	-0.163341
30.	0.002286	0.000462	-0.001592	0.061128	-0.748211	-1.004944
31.	0.002360	0.000287	-0.002034	0.091519	-0.811135	-1.441423
32.	0.002319	0.000074	-0.002440	1.619815	0.305950	0.076151
33.	0.001101	0.000597	-0.001246	1.327743	0.821192	-0.119960
34.	0.001130	0.000430	-0.001615	-0.065103	-0.881742	-1.255463
35.	0.001229	0.000301	-0.001965	-0.050892	-0.830682	-2.037743
36.	0.001219	0.000117	-0.002278	1.639921	0.113045	-0.488543
37.	0.000504	0.000040	-0.000526	1.830330	1.052415	-0.168359
38.	0.000497	-0.000061	-0.000719	-0.152234	-0.322418	-1.047758
39.	0.000542	-0.000113	-0.000879	-0.166389	-0.268093	-1.287399
40.	0.000483	-0.000234	-0.001031	2.305192	0.834378	-0.063829
41.	0.001544	0.000000	-0.000860	1.030909	0.889562	-0.160968
42.	0.001493	0.000000	-0.001247	-0.139234	-0.973732	-1.286447
43.	0.001555	0.000000	-0.001609	0.082949	-0.850134	-1.642381
44.	0.001427	0.000000	-0.001955	2.101678	0.783524	0.112314
45.	0.000886	0.000295	-0.000921	0.943354	0.637737	-0.159239
46.	0.000882	0.000132	-0.001098	-0.320780	-0.852782	-1.315698
47.	0.000969	-0.000011	-0.001254	-0.185519	-0.668876	-1.385087
48.	0.000871	-0.000192	-0.001422	2.289750	1.309929	0.194132
49.	0.000576	0.000000	-0.000808	0.914394	0.465727	-0.582222
50.	0.000602	0.000000	-0.001239	-0.012779	-0.690050	-0.901247
51.	0.000657	0.000000	-0.001372	0.118765	-0.264441	-1.194778
52.	0.000427	0.000000	-0.001176	2.057596	0.328216	-1.836916

FIGURE 6

(WINTER MU=.00)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.017287	0.011645	0.001640	0.000811	-0.007621	-0.005828
2.	0.017202	0.011561	0.001559	0.000723	-0.008252	-0.006287
3.	0.017113	0.011473	0.001475	0.000632	-0.008907	-0.006764
4.	0.017022	0.011385	0.001392	0.000543	-0.009541	-0.007225
5.	0.014940	0.009967	0.001395	0.000650	-0.006445	-0.004871
6.	0.014855	0.009885	0.001309	0.000555	-0.007129	-0.005370
7.	0.014780	0.009813	0.001222	0.000458	-0.007845	-0.005892
8.	0.014691	0.009727	0.001133	0.000361	-0.008530	-0.006392
9.	0.012703	0.008388	0.001201	0.000563	-0.004950	-0.003697
10.	0.012611	0.008300	0.001108	0.000461	-0.005694	-0.004223
11.	0.012542	0.008235	0.001015	0.000359	-0.006478	-0.004782
12.	0.012445	0.008141	0.000920	0.000255	-0.007235	-0.005326
13.	0.010563	0.006920	0.001031	0.000489	-0.003678	-0.002738
14.	0.010468	0.006828	0.000931	0.000381	-0.004449	-0.003258
15.	0.010418	0.006782	0.000834	0.000275	-0.005275	-0.003823
16.	0.010317	0.006692	0.000762	0.000135	-0.006070	-0.004372
17.	0.008585	0.005613	0.000882	0.000429	-0.002653	-0.001996
18.	0.008489	0.005519	0.000775	0.000314	-0.003427	-0.002493
19.	0.008471	0.005504	0.000676	0.000207	-0.004265	-0.003042
20.	0.008372	0.005427	0.000644	0.000017	-0.005068	-0.003571
21.	0.006807	0.004480	0.000761	0.000365	-0.001864	-0.001436
22.	0.006712	0.004383	0.000635	0.000260	-0.002623	-0.001908
23.	0.006732	0.004404	0.000537	0.000155	-0.003451	-0.002431
24.	0.006638	0.004346	0.000551	-0.000088	-0.004237	-0.002929
25.	0.005164	0.003418	0.000610	0.000317	-0.001276	-0.001016
26.	0.005149	0.003403	0.000507	0.000212	-0.002032	-0.001489
27.	0.005220	0.003473	0.000414	0.000115	-0.002827	-0.001978
28.	0.005130	0.003438	0.000484	-0.000185	-0.003562	-0.002424
29.	0.003840	0.002601	0.000494	0.000273	-0.001106	-0.000944
30.	0.003855	0.002617	0.000395	0.000176	-0.001724	-0.001298
31.	0.003977	0.002734	0.000311	0.000092	-0.002396	-0.001681
32.	0.003886	0.002720	0.000447	-0.000268	-0.003024	-0.002038
33.	0.002845	0.002024	0.000405	0.000249	-0.001010	-0.000894
34.	0.002865	0.002042	0.000307	0.000157	-0.001530	-0.001179
35.	0.003013	0.002181	0.000232	0.000086	-0.002080	-0.001471
36.	0.002913	0.002187	0.000441	-0.000335	-0.002592	-0.001741
37.	0.002077	0.001581	0.000325	0.000229	-0.000961	-0.000857
38.	0.002098	0.001596	0.000232	0.000143	-0.001396	-0.001094
39.	0.002262	0.001750	0.000181	0.000073	-0.001831	-0.001310
40.	0.002151	0.001766	0.000446	-0.000384	-0.002243	-0.001519
41.	0.001475	0.001217	0.000249	0.000201	-0.000926	-0.000825
42.	0.001490	0.001222	0.000163	0.000124	-0.001287	-0.001029
43.	0.001648	0.001370	0.000143	0.000050	-0.001613	-0.001182
44.	0.001525	0.001383	0.000445	-0.000414	-0.001936	-0.001348
45.	0.001002	0.000908	0.000171	0.000156	-0.000886	-0.000802
46.	0.001002	0.000891	0.000096	0.000085	-0.001190	-0.000997
47.	0.001122	0.000992	0.000094	0.000021	-0.001405	-0.001093
48.	0.000957	0.000941	0.000393	-0.000395	-0.001587	-0.001206
49.	0.000548	0.000548	0.000049	0.000049	-0.000732	-0.000732
50.	0.000614	0.000614	-0.000008	-0.000008	-0.001099	-0.001099
51.	0.000684	0.000684	-0.000038	-0.000038	-0.001109	-0.001109
52.	0.000430	0.000430	-0.000064	-0.000064	-0.000921	-0.000921

FIGURE 8

(WINTER MU=.00)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.008717	0.006347	0.004106	0.002569	-0.005707	-0.003769
2.	0.008696	0.006323	0.003928	0.002389	-0.006154	-0.004092
3.	0.008677	0.006301	0.003749	0.002209	-0.006620	-0.004423
4.	0.008653	0.006277	0.003570	0.002030	-0.007068	-0.004744
5.	0.007491	0.005446	0.003287	0.001968	-0.005408	-0.003461
6.	0.007463	0.005429	0.003125	0.001794	-0.005859	-0.003791
7.	0.007447	0.005425	0.002965	0.001620	-0.006327	-0.004126
8.	0.007420	0.005407	0.002803	0.001444	-0.006779	-0.004449
9.	0.006050	0.004458	0.002605	0.001358	-0.004490	-0.002601
10.	0.006028	0.004419	0.002418	0.001226	-0.004984	-0.002965
11.	0.006007	0.004419	0.002260	0.001060	-0.005496	-0.003345
12.	0.005976	0.004403	0.002096	0.000882	-0.005988	-0.003723
13.	0.004568	0.003498	0.002104	0.000858	-0.003412	-0.001747
14.	0.004564	0.003436	0.001872	0.000756	-0.003947	-0.002091
15.	0.004577	0.003423	0.001676	0.000634	-0.004508	-0.002459
16.	0.004550	0.003393	0.001498	0.000468	-0.005048	-0.002837
17.	0.003188	0.002655	0.001666	0.000463	-0.002590	-0.001149
18.	0.003207	0.002573	0.001390	0.000390	-0.003107	-0.001448
19.	0.003258	0.002573	0.001183	0.000292	-0.003661	-0.001777
20.	0.003239	0.002551	0.001008	0.000118	-0.004189	-0.002110
21.	0.002039	0.001957	0.001285	0.000184	-0.002013	-0.000748
22.	0.002087	0.001855	0.000972	0.000142	-0.002476	-0.001000
23.	0.002182	0.001878	0.000772	0.000068	-0.002978	-0.001280
24.	0.002168	0.001874	0.000620	-0.000123	-0.003440	-0.001557
25.	0.001171	0.001388	0.000949	0.000011	-0.001608	-0.000479
26.	0.001247	0.001266	0.000619	0.000001	-0.001995	-0.000696
27.	0.001380	0.001317	0.000452	-0.000048	-0.002426	-0.000933
28.	0.001355	0.001343	0.000352	-0.000267	-0.002797	-0.001161
29.	0.000578	0.000803	0.000513	0.000004	-0.001291	-0.000320
30.	0.000695	0.000757	0.000288	-0.000011	-0.001628	-0.000537
31.	0.000836	0.000858	0.000226	-0.000083	-0.001970	-0.000735
32.	0.000774	0.000907	0.000216	-0.000345	-0.002225	-0.000906
33.	0.000231	0.000432	0.000247	0.000000	-0.001181	-0.000458
34.	0.000361	0.000400	0.000089	-0.000011	-0.001314	-0.000598
35.	0.000492	0.000512	0.000122	-0.000078	-0.001502	-0.000681
36.	0.000380	0.000578	0.000200	-0.000347	-0.001662	-0.000765
37.	0.000197	0.000197	0.000021	0.000021	-0.000657	-0.000657
38.	0.000243	0.000243	-0.000077	-0.000077	-0.000817	-0.000817
39.	0.000280	0.000280	-0.000074	-0.000074	-0.000850	-0.000850
40.	0.000128	0.000128	-0.000085	-0.000085	-0.000753	-0.000753

FIGURE 4

(WINTER MU=.75)

node	dx(m)	dy(m)	dz(m)	P1(MPa)	P2(MPa)	P3(MPa)
1.	0.014041	0.000000	-0.006697	0.097621	-0.031905	-1.119654
2.	0.013943	0.000000	-0.007225	0.112236	0.018894	-0.912722
3.	0.013844	0.000000	-0.007768	0.117185	-0.013775	-0.645021
4.	0.013741	0.000000	-0.008292	0.090210	-0.035280	-0.371627
5.	0.008584	0.000000	-0.003259	1.131806	0.303996	0.011214
6.	0.008471	0.000000	-0.003870	0.070192	-0.489611	-0.744724
7.	0.008400	0.000000	-0.004527	0.056137	-0.558917	-0.846064
8.	0.008285	0.000000	-0.005164	0.927581	0.095080	0.032404
9.	0.006231	0.001794	-0.002769	1.349607	0.827180	0.010735
10.	0.006181	0.001542	-0.003336	0.065367	-0.357867	-0.597699
11.	0.006178	0.001297	-0.003948	0.053870	-0.482907	-1.034301
12.	0.006135	0.001043	-0.004544	0.791416	0.039899	-0.205078
13.	0.004228	0.001958	-0.002519	1.313325	1.129147	0.032878
14.	0.004216	0.001694	-0.003035	0.041461	-0.329363	-0.645437
15.	0.004257	0.001441	-0.003591	0.037800	-0.393052	-1.242587
16.	0.004256	0.001174	-0.004132	1.038494	0.067229	-0.415809
17.	0.002371	0.000989	-0.001187	1.812187	1.125254	0.029572
18.	0.002336	0.000814	-0.001543	0.010262	-0.215346	-0.394152
19.	0.002353	0.000664	-0.001936	0.024661	-0.274207	-1.133586
20.	0.002332	0.000490	-0.002323	1.277454	0.065306	-0.486144
21.	0.001046	0.000885	-0.000982	1.807958	1.630162	0.007008
22.	0.001042	0.000680	-0.001243	0.351168	0.009154	-0.515770
23.	0.001087	0.000510	-0.001522	0.245571	0.040572	-1.289319
24.	0.001100	0.000316	-0.001795	1.574077	0.015865	-0.655662
25.	0.004291	0.000000	-0.001199	1.468993	0.203462	-0.172755
26.	0.004237	0.000000	-0.001797	0.079759	-0.816745	-1.047787
27.	0.004249	0.000000	-0.002412	0.108399	-0.833976	-1.357082
28.	0.004138	0.000000	-0.002989	1.730764	0.439363	0.054394
29.	0.002552	0.000936	-0.001159	1.609165	0.537175	-0.163670
30.	0.002570	0.000702	-0.001655	0.054686	-0.773532	-0.969249
31.	0.002658	0.000488	-0.002155	0.083146	-0.813039	-1.542565
32.	0.002632	0.000238	-0.002620	1.599950	0.098936	0.075430
33.	0.001196	0.000779	-0.001192	1.417029	0.809200	-0.120636
34.	0.001239	0.000585	-0.001592	-0.068133	-0.882370	-1.193614
35.	0.001353	0.000425	-0.001974	-0.055405	-0.808246	-2.022770
36.	0.001357	0.000214	-0.002319	1.685035	0.113161	-0.527807
37.	0.000521	0.000088	-0.000519	1.896714	1.073587	-0.170818
38.	0.000519	-0.000020	-0.000736	-0.149902	-0.334151	-1.029928
39.	0.000569	-0.000077	-0.000920	-0.177663	-0.296609	-1.360195
40.	0.000516	-0.000204	-0.001093	2.270793	0.687027	-0.059170
41.	0.001376	0.000000	-0.000896	0.871437	0.833246	-0.160719
42.	0.001327	0.000000	-0.001194	-0.125289	-0.949990	-1.296702
43.	0.001387	0.000000	-0.001472	0.099021	-0.776180	-1.448492
44.	0.001253	0.000000	-0.001750	2.231932	1.186753	0.115802
45.	0.000940	0.000332	-0.000951	0.977769	0.621166	-0.156884
46.	0.000942	0.000154	-0.001162	-0.328333	-0.876221	-1.401117
47.	0.001037	-0.000003	-0.001347	-0.195466	-0.709360	-1.564348
48.	0.000947	-0.000197	-0.001536	2.211113	1.044704	0.189200
49.	0.000561	0.000000	-0.000771	0.919438	0.454587	-0.634232
50.	0.000586	0.000000	-0.001155	-0.024034	-0.668238	-0.828180
51.	0.000635	0.000000	-0.001245	0.153854	-0.247521	-1.140465
52.	0.000406	0.000000	-0.001053	2.143870	0.338745	-1.424980

FIGURE 6

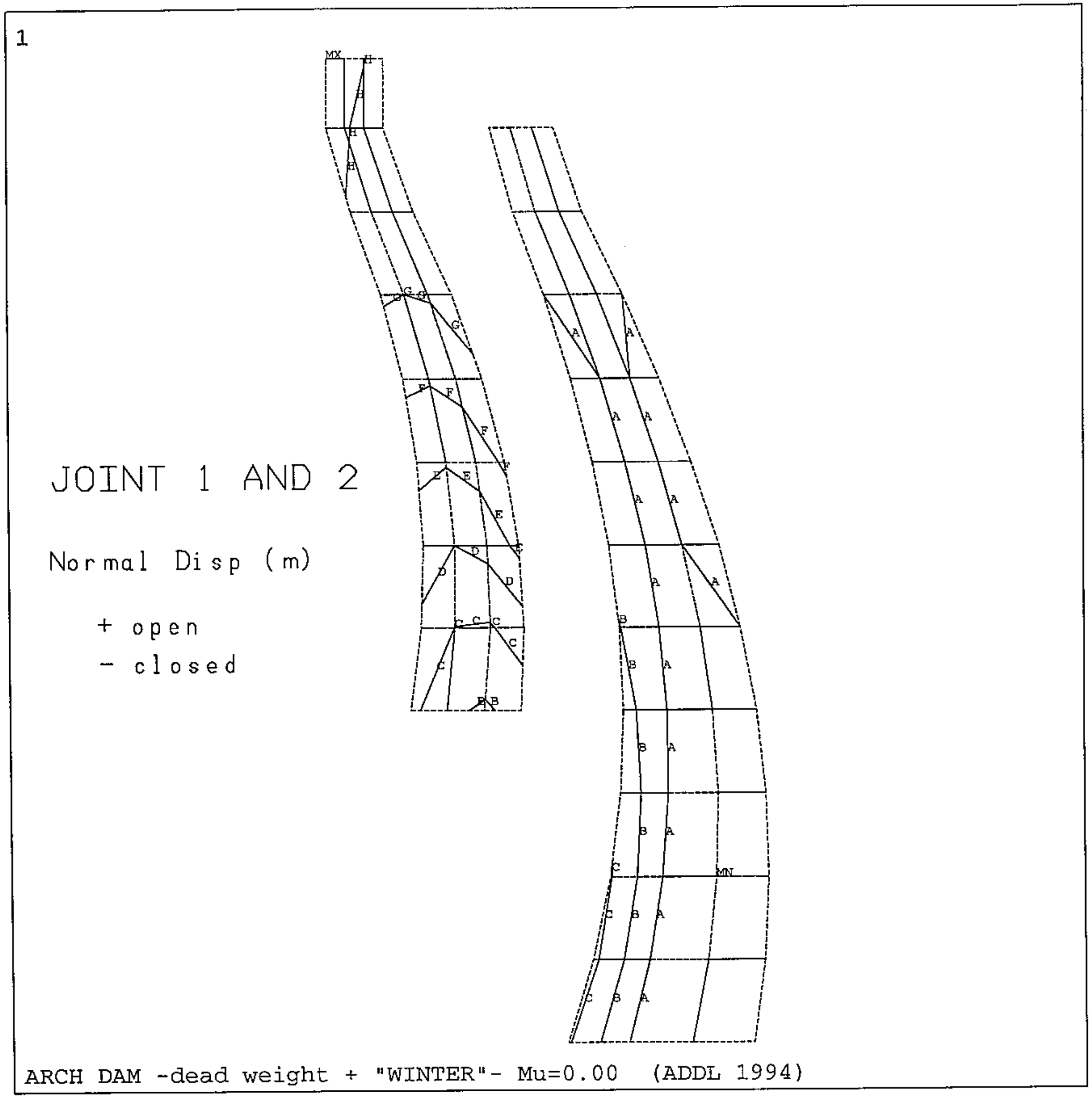
(WINTER MU=.75)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.013253	0.013253	0.001701	0.001702	-0.006473	-0.006473
2.	0.013176	0.013176	0.001567	0.001569	-0.006984	-0.006984
3.	0.013095	0.013095	0.001431	0.001432	-0.007517	-0.007517
4.	0.013011	0.013011	0.001297	0.001297	-0.008032	-0.008032
5.	0.011399	0.011399	0.001442	0.001444	-0.005464	-0.005463
6.	0.011323	0.011323	0.001299	0.001302	-0.006015	-0.006015
7.	0.011255	0.011255	0.001156	0.001158	-0.006591	-0.006591
8.	0.011173	0.011173	0.001013	0.001013	-0.007143	-0.007143
9.	0.009649	0.009649	0.001277	0.001278	-0.004204	-0.004204
10.	0.009568	0.009567	0.001123	0.001126	-0.004796	-0.004795
11.	0.009508	0.009508	0.000971	0.000972	-0.005421	-0.005420
12.	0.009413	0.009424	0.000819	0.000813	-0.006038	-0.006009
13.	0.008000	0.008000	0.001119	0.001120	-0.003153	-0.003152
14.	0.007916	0.007916	0.000957	0.000959	-0.003751	-0.003750
15.	0.007877	0.007879	0.000800	0.000801	-0.004402	-0.004389
16.	0.007779	0.007804	0.000683	0.000591	-0.005043	-0.004992
17.	0.006504	0.006504	0.000969	0.000969	-0.002320	-0.002320
18.	0.006421	0.006420	0.000802	0.000805	-0.002906	-0.002905
19.	0.006412	0.006414	0.000648	0.000648	-0.003570	-0.003522
20.	0.006315	0.006353	0.000574	0.000390	-0.004201	-0.004118
21.	0.005191	0.005187	0.000825	0.000824	-0.001694	-0.001673
22.	0.005102	0.005101	0.000660	0.000663	-0.002248	-0.002247
23.	0.005131	0.005129	0.000514	0.000513	-0.002907	-0.002833
24.	0.005037	0.005085	0.000496	0.000206	-0.003515	-0.003402
25.	0.003953	0.003952	0.000671	0.000673	-0.001199	-0.001199
26.	0.003948	0.003947	0.000524	0.000529	-0.001767	-0.001766
27.	0.004031	0.004022	0.000395	0.000394	-0.002398	-0.002317
28.	0.003939	0.004001	0.000445	0.000038	-0.002967	-0.002827
29.	0.002985	0.002984	0.000536	0.000539	-0.001086	-0.001085
30.	0.003010	0.003008	0.000404	0.000410	-0.001529	-0.001527
31.	0.003142	0.003128	0.000297	0.000296	-0.002058	-0.001961
32.	0.003046	0.003128	0.000424	-0.000111	-0.002540	-0.002373
33.	0.002283	0.002282	0.000429	0.000432	-0.001009	-0.001008
34.	0.002309	0.002308	0.000310	0.000316	-0.001374	-0.001373
35.	0.002470	0.002445	0.000224	0.000222	-0.001823	-0.001687
36.	0.002362	0.002463	0.000436	-0.000235	-0.002204	-0.002013
37.	0.001741	0.001741	0.000335	0.000337	-0.000953	-0.000953
38.	0.001766	0.001764	0.000231	0.000237	-0.001259	-0.001258
39.	0.001937	0.001916	0.000187	0.000143	-0.001620	-0.001483
40.	0.001819	0.001940	0.000454	-0.000332	-0.001937	-0.001728
41.	0.001305	0.001305	0.000246	0.000247	-0.000904	-0.000904
42.	0.001319	0.001318	0.000158	0.000163	-0.001161	-0.001161
43.	0.001480	0.001465	0.000148	0.000075	-0.001441	-0.001310
44.	0.001349	0.001485	0.000453	-0.000400	-0.001706	-0.001493
45.	0.000945	0.000945	0.000158	0.000158	-0.000855	-0.000855
46.	0.000938	0.000937	0.000085	0.000090	-0.001087	-0.001086
47.	0.001052	0.001043	0.000094	0.000017	-0.001279	-0.001168
48.	0.000879	0.001001	0.000389	-0.000408	-0.001442	-0.001273
49.	0.000551	0.000551	0.000048	0.000048	-0.000729	-0.000729
50.	0.000615	0.000615	0.000006	0.000006	-0.001084	-0.001084
51.	0.000680	0.000680	-0.000017	-0.000017	-0.001080	-0.001080
52.	0.000427	0.000427	-0.000054	-0.000054	-0.000890	-0.000890

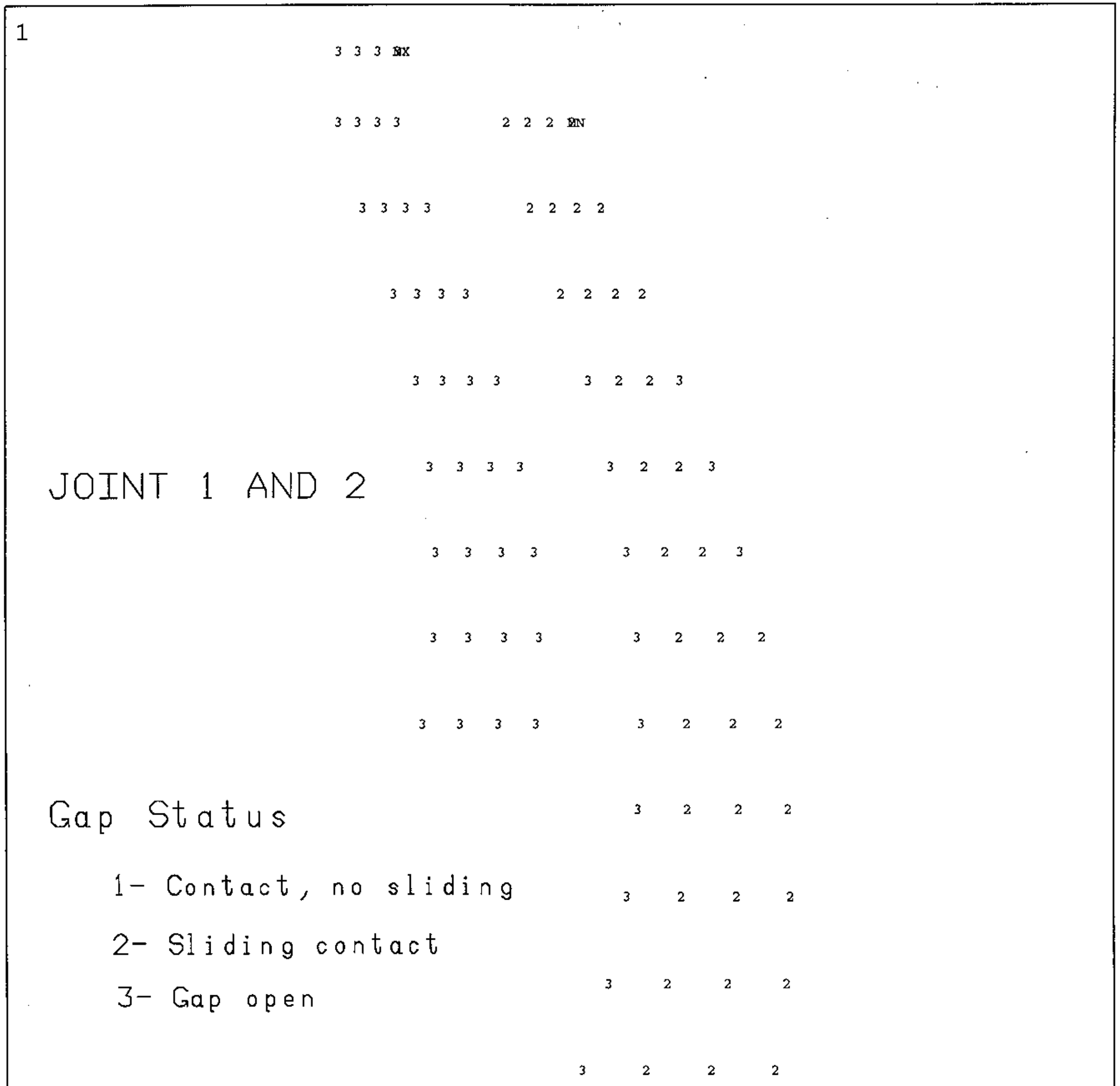
FIGURE 8

(WINTER MU=.75)

node	d'x(m)	d''x(m)	d'y(m)	d''y(m)	d'z(m)	d''z(m)
1.	0.007954	0.007861	0.004235	0.004157	-0.005418	-0.004286
2.	0.007974	0.007872	0.003965	0.003902	-0.005830	-0.004720
3.	0.007991	0.007889	0.003701	0.003639	-0.006243	-0.005171
4.	0.008004	0.007904	0.003441	0.003379	-0.006642	-0.005604
5.	0.006863	0.006736	0.003395	0.003161	-0.005103	-0.003923
6.	0.006880	0.006759	0.003138	0.002919	-0.005495	-0.004393
7.	0.006911	0.006796	0.002884	0.002675	-0.005910	-0.004859
8.	0.006930	0.006819	0.002629	0.002426	-0.006324	-0.005301
9.	0.005675	0.005357	0.002786	0.002155	-0.004305	-0.002835
10.	0.005692	0.005337	0.002512	0.001998	-0.004744	-0.003338
11.	0.005716	0.005361	0.002243	0.001813	-0.005205	-0.003857
12.	0.005724	0.005379	0.001986	0.001582	-0.005631	-0.004398
13.	0.004413	0.004051	0.002361	0.001377	-0.003301	-0.001835
14.	0.004439	0.003999	0.002066	0.001259	-0.003803	-0.002286
15.	0.004483	0.004001	0.001799	0.001118	-0.004333	-0.002768
16.	0.004488	0.003987	0.001547	0.000933	-0.004833	-0.003268
17.	0.003156	0.002972	0.001934	0.000788	-0.002498	-0.001173
18.	0.003200	0.002895	0.001608	0.000706	-0.003005	-0.001550
19.	0.003276	0.002903	0.001346	0.000598	-0.003550	-0.001964
20.	0.003282	0.002891	0.001114	0.000414	-0.004062	-0.002388
21.	0.002058	0.002126	0.001525	0.000377	-0.001922	-0.000751
22.	0.002127	0.002027	0.001173	0.000330	-0.002391	-0.001059
23.	0.002243	0.002055	0.000928	0.000251	-0.002903	-0.001399
24.	0.002250	0.002057	0.000732	0.000054	-0.003370	-0.001738
25.	0.001199	0.001469	0.001141	0.000119	-0.001518	-0.000481
26.	0.001293	0.001349	0.000779	0.000105	-0.001923	-0.000736
27.	0.001444	0.001403	0.000577	0.000053	-0.002376	-0.001013
28.	0.001437	0.001435	0.000442	-0.000169	-0.002765	-0.001281
29.	0.000595	0.000835	0.000649	0.000060	-0.001211	-0.000326
30.	0.000727	0.000792	0.000398	0.000042	-0.001571	-0.000568
31.	0.000884	0.000896	0.000308	-0.000033	-0.001941	-0.000792
32.	0.000838	0.000949	0.000271	-0.000297	-0.002222	-0.000985
33.	0.000234	0.000439	0.000329	0.000028	-0.001124	-0.000464
34.	0.000375	0.000409	0.000150	0.000014	-0.001281	-0.000620
35.	0.000519	0.000527	0.000161	-0.000056	-0.001496	-0.000721
36.	0.000419	0.000598	0.000218	-0.000327	-0.001681	-0.000816
37.	0.000186	0.000186	0.000042	0.000042	-0.000649	-0.000649
38.	0.000235	0.000235	-0.000061	-0.000061	-0.000821	-0.000821
39.	0.000281	0.000281	-0.000067	-0.000067	-0.000870	-0.000870
40.	0.000136	0.000136	-0.000084	-0.000084	-0.000780	-0.000780

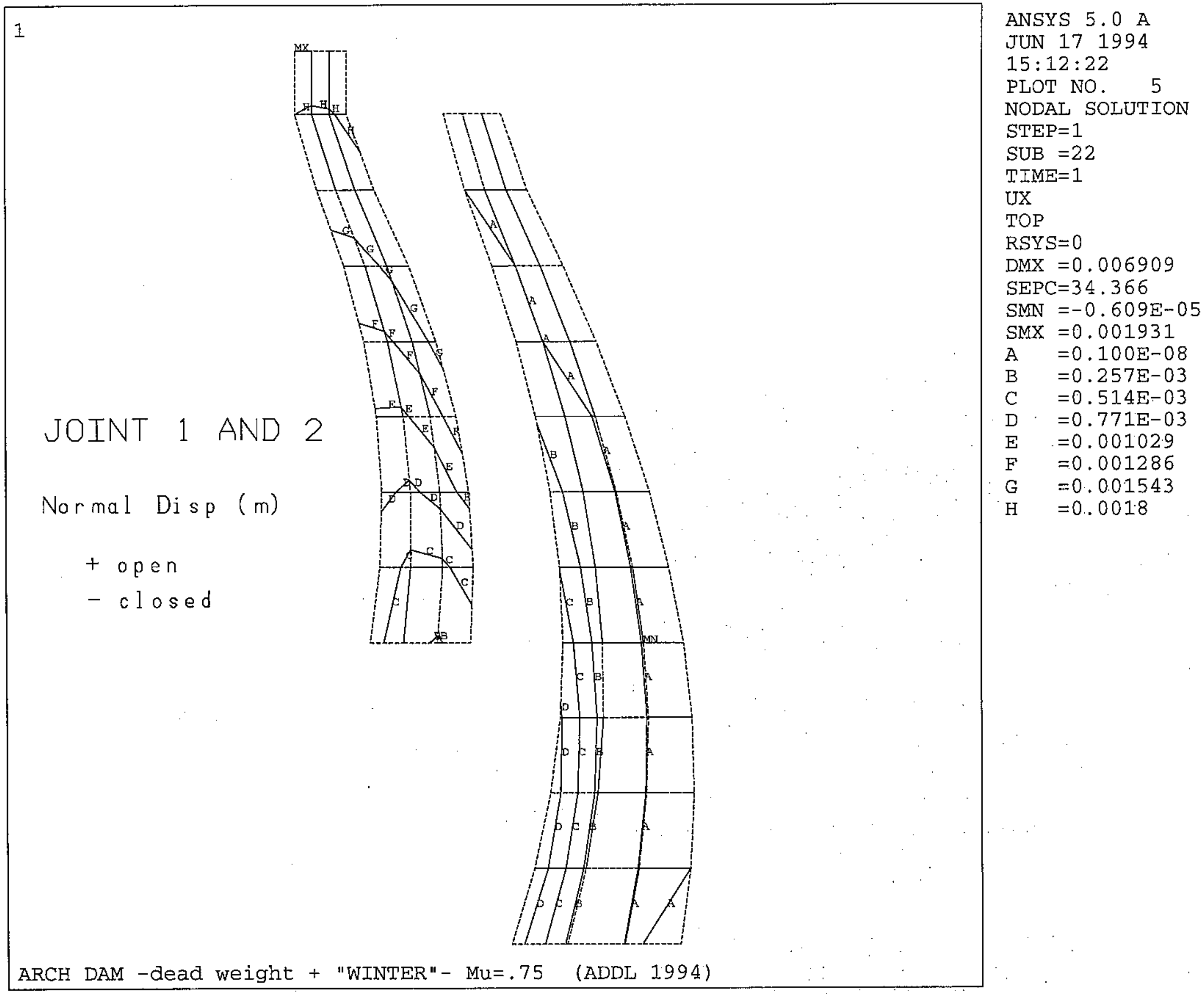


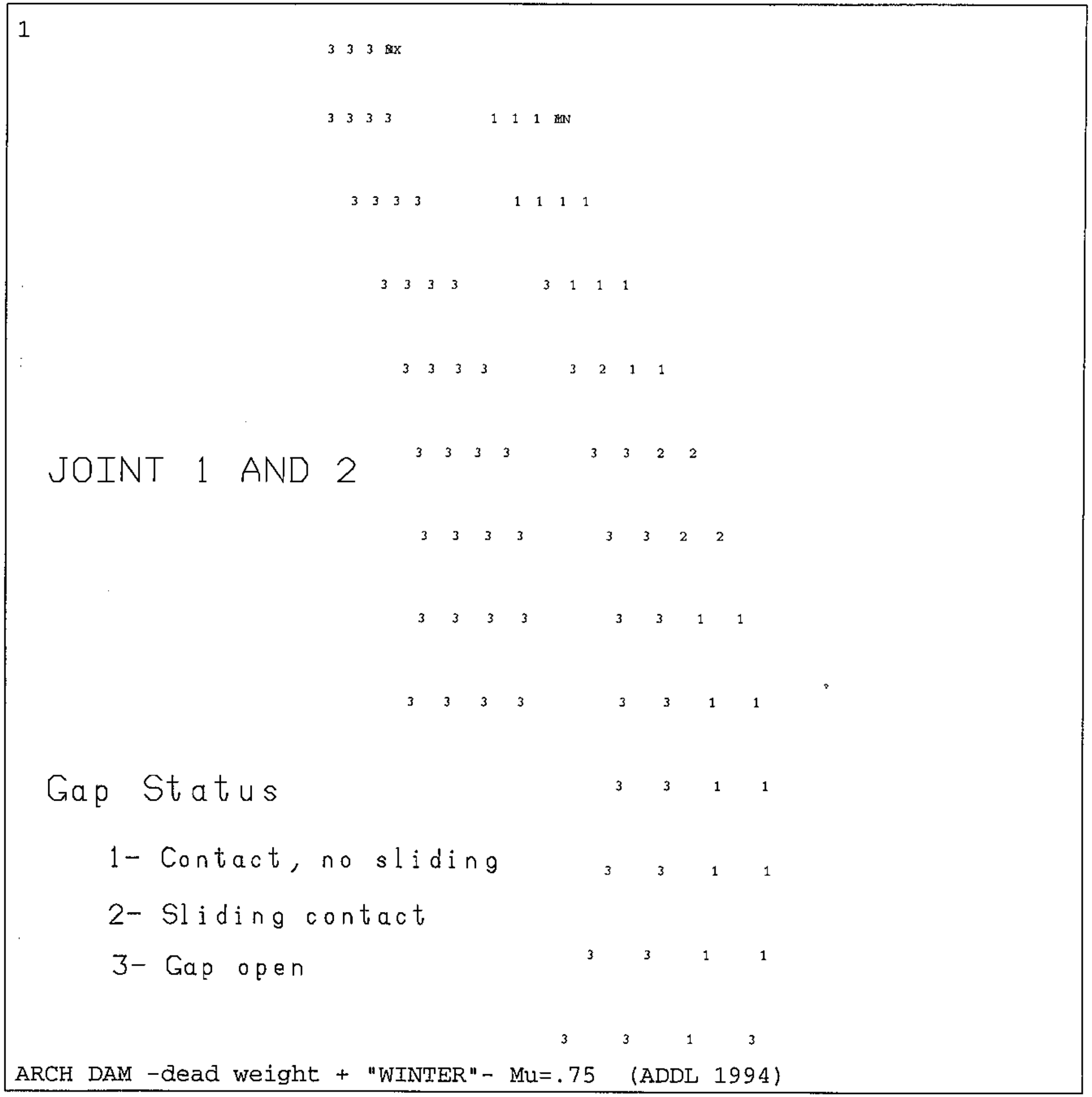
ANSYS 5.0 A
JUN 17 1994
15:11:54
PLOT NO. 1
NODAL SOLUTION
STEP=1
SUB =5
TIME=1
UX
TOP
RSYS=0
DMX =0.029121
SEPC=36.78
SMN =-0.571E-05
SMX =0.002368
A =0.100E-08
B =0.314E-03
C =0.629E-03
D =0.943E-03
E =0.001257
F =0.001571
G =0.001886
H =0.0022



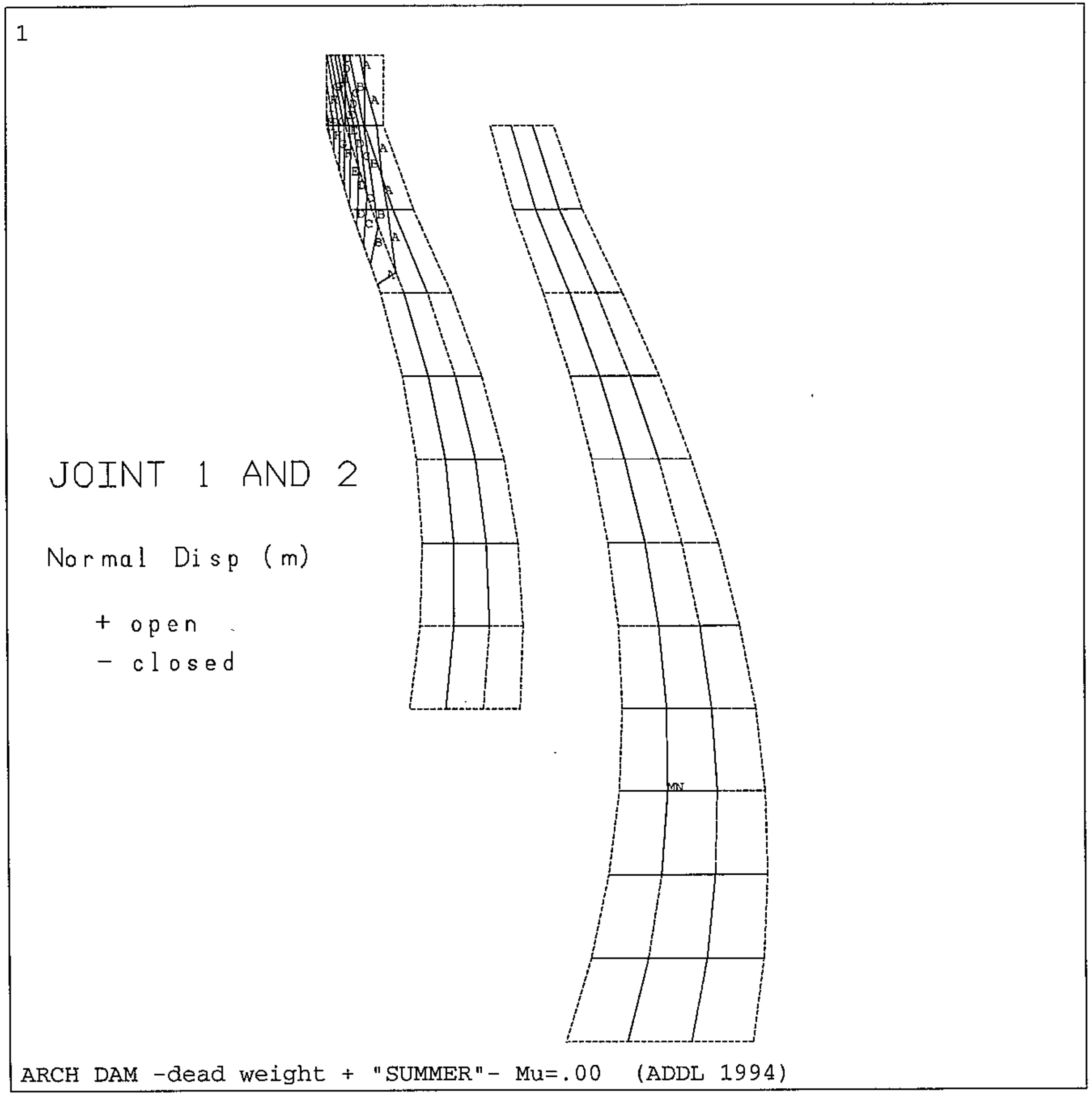
ARCH DAM -dead weight + "WINTER"- Mu=0.00 (ADDL 1994)

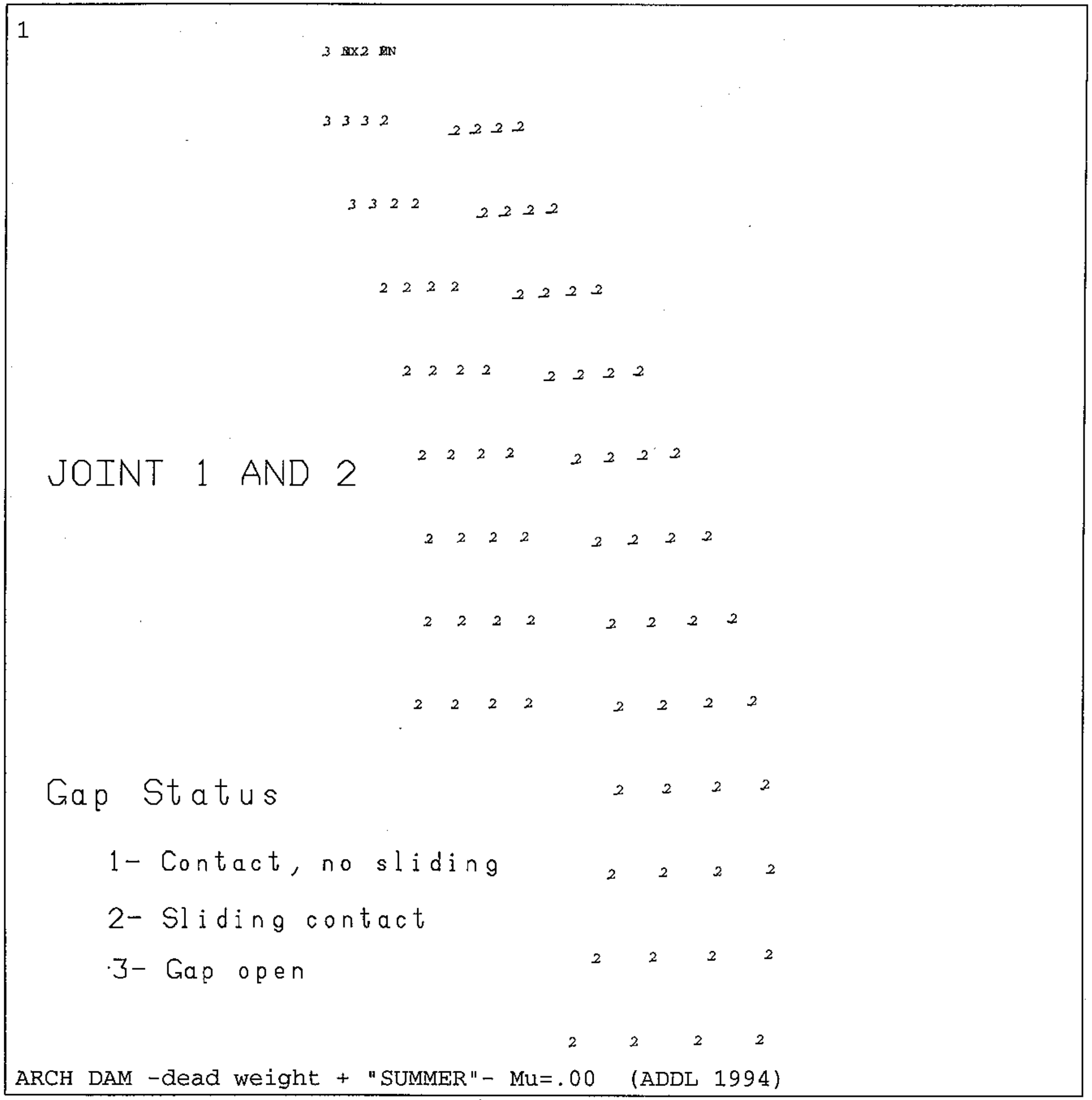
ANSYS 5.0 A
JUN 17 1994
15:34:10
PLOT NO. 4
ELEMENT SOLUTION
STEP=1
SUB =5
TIME=1
ST (NOAVG)
TOP
DMX =0.029121
SMN =2
SMX =3
A =2.111
B =2.222
C =2.333
D =2.444
E =2.556
F =2.667
G =2.778
H =2.889
I =3


1
JOINT 1 AND 2
Normal Disp (m)
+ open
− closed
ANSYS 5.0 A
JUN 17 1994
15:12:22
PLOT NO. 5
NODAL SOLUTION
STEP=1
SUB =22
TIME=1
UX
TOP
RSYS=0
DMX =0.006909
SEPC=34.366
SMN =-0.609E-05
SMX =0.001931
A =0.100E-08
B =0.257E-03
C =0.514E-03
D =0.771E-03
E =0.001029
F =0.001286
G =0.001543
H =0.0018
ARCH DAM -dead weight + "WINTER"- Mu=.75 (ADDL 1994)

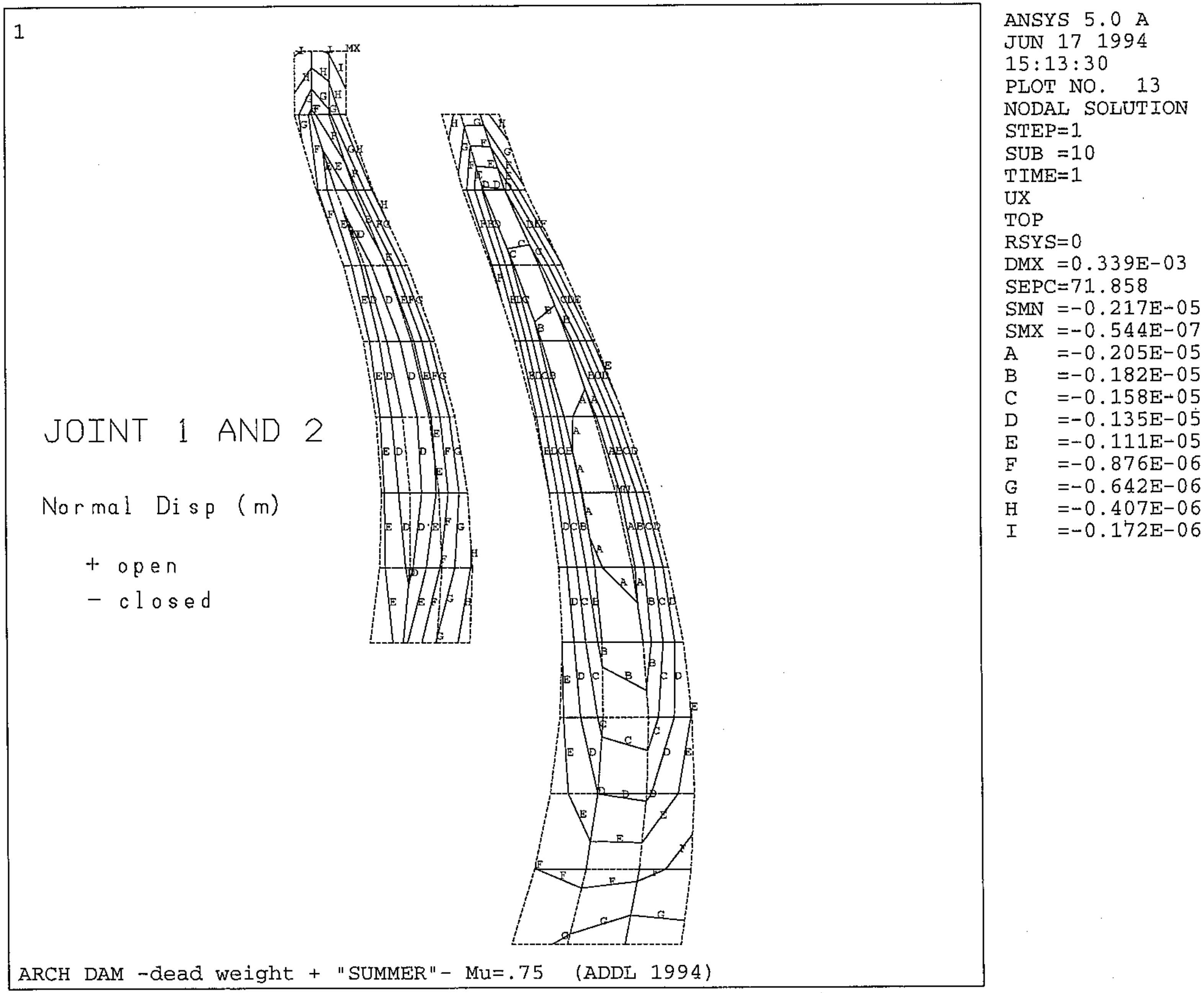


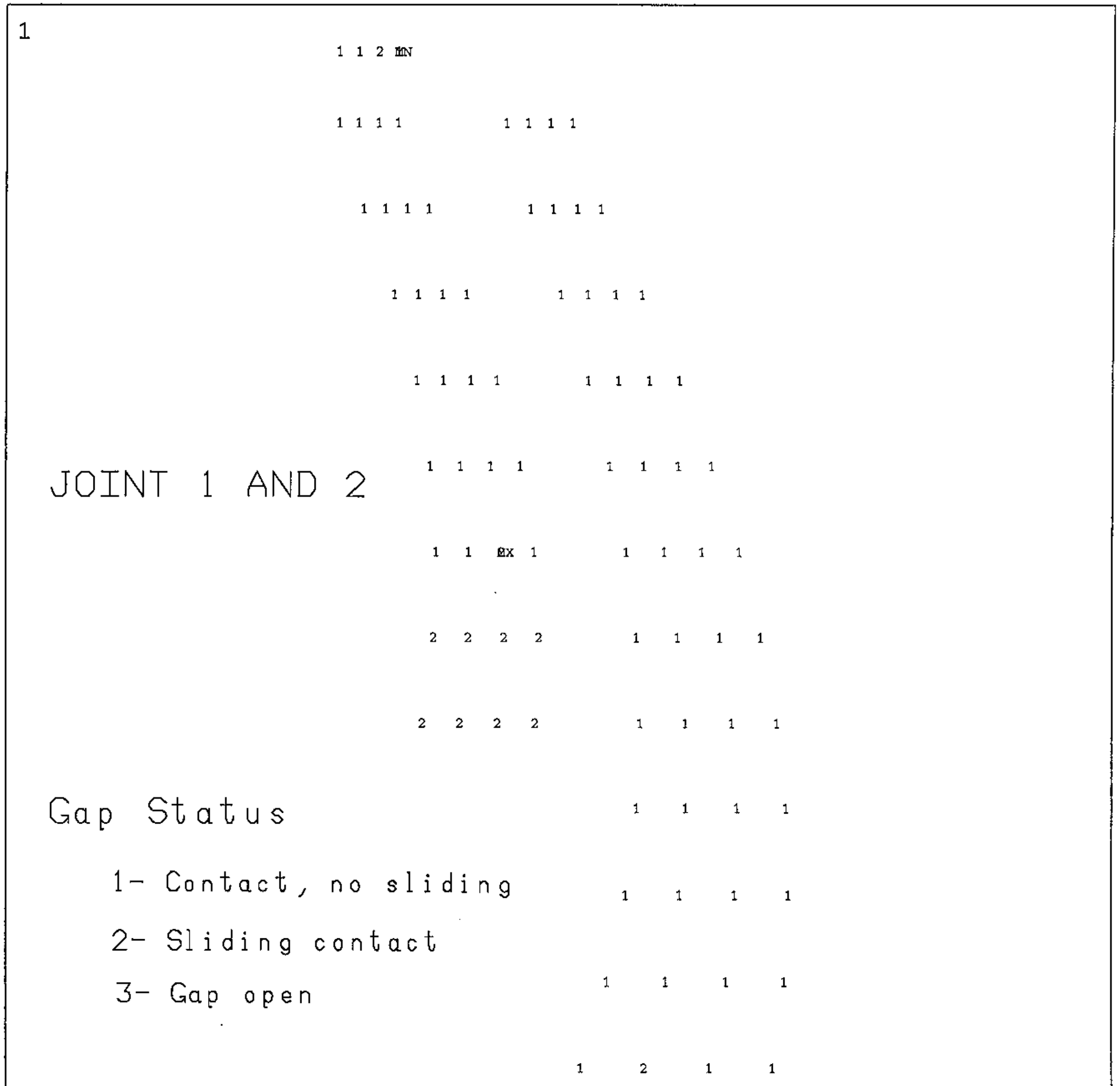
ANSYS 5.0 A
JUN 17 1994
15:34:37
PLOT NO. 8
ELEMENT SOLUTION
STEP=1
SUB =22
TIME=1
ST (NOAVG)
TOP
DMX =0.006909
SMN =1
SMX =3
A =1.222
B =1.444
C =1.667
D =1.889
E =2.111
F =2.333
G =2.556
H =2.778
I =3


1
JOINT 1 AND 2
Normal Disp (m)
+ open
− closed
MN
ANSYS 5.0 A
JUN 17 1994
15:12:52
PLOT NO. 9
NODAL SOLUTION
STEP=1
SUB =10
TIME=1
UX
TOP
RSYS=0
DMX =0.166052
SEPC=62.084
SMN =-0.166E-05
SMX =0.310E-03
A =0.157E-04
B =0.503E-04
C =0.849E-04
D =0.120E-03
E =0.154E-03
F =0.189E-03
G =0.223E-03
H =0.258E-03
I =0.293E-03
ARCH DAM -dead weight + "SUMMER"- Mu=.00 (ADDL 1994)



ANSYS 5.0 A
JUN 17 1994
15:35:07
PLOT NO. 12
ELEMENT SOLUTION
STEP=1
SUB =10
TIME=1
ST (NOAVG)
TOP
DMX =0.199132
SMN =2
SMX =3
A =2.111
B =2.222
C =2.333
D =2.444
E =2.556
F =2.667
G =2.778
H =2.889
I =3


1
JOINT 1 AND 2
Normal Disp (m)
+ open
– closed
ARCH DAM -dead weight + "SUMMER"- Mu=.75 (ADDL 1994)
ANSYS 5.0 A
JUN 17 1994
15:13:30
PLOT NO. 13
NODAL SOLUTION
STEP=1
SUB =10
TIME=1
UX
TOP
RSYS=0
DMX =0.339E-03
SEPC=71.858
SMN =-0.217E-05
SMX =-0.544E-07
A =-0.205E-05
B =-0.182E-05
C =-0.158E-05
D =-0.135E-05
E =-0.111E-05
F =-0.876E-06
G =-0.642E-06
H =-0.407E-06
I =-0.172E-06



ARCH DAM -dead weight + "SUMMER"- Mu=.75 (ADDL 1994)

ANSYS 5.0 A
JUN 17 1994
15:35:45
PLOT NO. 16
ELEMENT SOLUTION
STEP=1
SUB =10
TIME=1
ST (NOAVG)
TOP
DMX =0.339E-03
SMN =1
SMX =2
A =1.111
B =1.222
C =1.333
D =1.444
E =1.556
F =1.667
G =1.778
H =1.889
I =2

Third ICOLD Benchmark Workshop
on Numerical Analysis of Dams
Paris (France)
September 29–30, 1994

Theme A1

Non–linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam

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1. Introduction

For the benchmark analysis of Talvacchia Dam, two static analyses are performed with one Finite Element software, providing results in terms of displacements, stresses in some selected points and results regarding the state of contraction joints.

The software used for these analyses is ANSYS rev. 5.0, developed by S.A.S.I. (Swanson Analysis Systems, Inc., Houston, U.S.A.)

2. Main assumptions.

The first analysis assumes a "summer" thermal distribution with maximum level of impounded water. The second analysis assumes a "winter" thermal distribution with a reduced (50%) level of impounded water.

The weight of rock foundation is neglected.
The weight of the dam is applied entirely in a single step considering joints to be working.

Nodal distribution of temperatures producing a null distribution of thermal stresses is assumed to be uniformly equal to 0° C. In this thermal condition, joints are assumed to be in contact, with no stresses transmitted and with neither dead weight nor hydrostatic loads applied.

The main goal was to consider a mathematical model which is able to take into account the behaviour of given vertical contraction joints.

There have been performed, for both loading cases, supplementary analyses with monolithic structure (i.e. with no contraction joints).

3. Selected computational method and numerical model

The static analyses are performed using Finite Element software ANSYS rev. 5.0. For taking into account the behaviour of vertical contraction joints it was selected from ANSYS elements library a special type of contact element, named CONTAC52.

This is a three–dimensional interface element representing two surfaces which may maintain or break physical contact and may slide relative to each other. The element is capable of supporting only compression in the direction normal to the surfaces and shear (Coulomb friction) in the tangential direction. The element is defined by two nodes, each having three degrees of freedom – translations in the nodal x, y, z directions, two stiffnesses (k_n – normal stiffness, k_s – sticking stiffness or stiffness in the sliding direction), an initial gap (opening if positive, interference if negative) and an initial element status (closed sliding, closed no sliding or open).

The only material property used is the interface coefficient of friction μ.

The element operates bilinearly in the static analysis. Being non-linear the element requires an iterative solution.

4. Technical aspects

The computation times for each load case were:

– 53093 seconds (14 hours, 44 min, 53 sec) for winter loading conditions case;

– 54665 seconds (15 hours, 11 min, 05 sec) for summer loading conditions case.

The entire analysis was performed using a P.C. 486 DX (33 MHz, 8Mb RAM, 425 Mb HDD).

5. Results of the analyses

Figures 1 and 2 present results in terms of componental displacements (Dx, Dy, Dz) and principal stresses (P1–maximum, P2–intermediate, P3–minimum) in some selected nodal points (1...52), for both loading conditions. Positive displacements correspond to the positive directions of the global co-ordinate system.

Tensile stresses are assumed as positive.

Figures 3...6 present results in terms of displacements (Dx, Dy, Dz) of nodal points belonging to joints 1–4 and 2–3 in both loading conditions.

Figures 7...10 present results regarding the state of contraction joints and gap size (joint opening) for both loading conditions.

These last figures allow us observe that joints 1–4 are open in winter loading conditions (with a maximum gap size of 1.49 mm in nodal point 13) while joints 2–3 are partially closed (mainly in the upstream zone) and partially open (in the downstream zone and in the bottom third). The maximum gap size for joints 2–3 is 0.865 mm in nodal point 44.

The state of contraction joints for winter loading conditions is also represented in figure 11.

Analysing figures 9 and 10 we can conclude that in summer loading conditions the joints (1–4 and 2–3) are closed.

Some of the results provided by figures 1...10 are also represented in some charts, in figures 12...16.

6. Conclusions.

The computer code ANSYS rev. 5.0 is a powerful tool for F.E. structural analyses. The element library, containing almost 100 different types of elements is capable to provide the user with the most adequate elements for various types of analyses.

For modelling the behaviour of contraction joints, the authors of present paper have selected the special element named CONTAC52, a non-linear contact element. Being non-linear and requiring an iterative solution, the analysis may be time consuming and expensive.

The rate of convergence is influenced by the selection of values for normal and tangential stiffnesses k_n and k_s. So, it appears to be useful that these analyses should be performed by (or supervised by) an experienced F.E. code modeller and user.

Figure 1

Nodal displacements and stresses – WINTER

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.01529	0.00000	-0.00690	0.11230	-0.03214	-1.14762
2	0.01519	0.00000	-0.00747	0.10565	0.01843	-0.98915
3	0.01509	0.00000	-0.00805	0.10531	-0.00598	-0.76463
4	0.01499	0.00000	-0.00861	0.09077	-0.03666	-0.53762
5	0.00941	0.00000	-0.00329	1.10808	0.26822	0.00571
6	0.00930	0.00000	-0.00394	0.03646	-0.48711	-0.74378
7	0.00922	0.00000	-0.00465	0.02539	-0.55653	-0.85454
8	0.00911	0.00000	-0.00533	0.89195	0.04622	0.02526
9	0.00708	0.00183	-0.00277	1.57183	0.78485	0.01469
10	0.00703	0.00158	-0.00342	0.04222	-0.20215	-0.65036
11	0.00701	0.00134	-0.00412	0.01958	-0.48179	-1.07724
12	0.00697	0.00109	-0.00481	0.66853	0.04044	-0.34593
13	0.00513	0.00203	-0.00261	1.63315	1.10926	0.03184
14	0.00512	0.00177	-0.00326	0.01463	-0.25475	-0.65884
15	0.00515	0.00152	-0.00396	-0.00613	-0.47879	-1.43549
16	0.00514	0.00127	-0.00465	0.77896	0.06475	-0.89716
17	0.00221	0.00083	-0.00127	1.59612	1.05619	0.02776
18	0.00216	0.00068	-0.00158	-0.01038	-0.21490	-0.45813
19	0.00216	0.00054	-0.00192	-0.00474	-0.28787	-1.01142
20	0.00212	0.00039	-0.00225	1.20261	0.06463	-0.20606
21	0.00101	0.00085	-0.00103	1.76124	1.47816	0.00845
22	0.00100	0.00066	-0.00127	0.35288	-0.02135	-0.55774
23	0.00102	0.00049	-0.00153	0.26129	0.01288	-1.24127
24	0.00103	0.00031	-0.00179	1.57750	0.01866	-0.54951
25	0.00476	0.00000	-0.00110	1.48622	0.11919	-0.18474
26	0.00471	0.00000	-0.00175	0.03614	-0.79485	-1.06249
27	0.00470	0.00000	-0.00242	0.05422	-0.82989	-1.35713
28	0.00459	0.00000	-0.00305	1.69570	0.35887	0.05353
29	0.00286	0.00098	-0.00108	1.70930	0.48189	-0.17494
30	0.00289	0.00073	-0.00163	0.01154	-0.70774	-0.99333
31	0.00296	0.00049	-0.00218	0.02785	-0.82540	-1.57889
32	0.00295	0.00022	-0.00270	1.51790	0.07791	-0.07607
33	0.00138	0.00081	-0.00120	1.49896	0.76380	-0.14392
34	0.00143	0.00059	-0.00166	-0.10181	-0.91005	-1.23075
35	0.00154	0.00041	-0.00209	-0.10461	-0.87443	-2.21963
36	0.00156	0.00018	-0.00249	1.52143	0.11013	-0.96243
37	0.00052	0.00006	-0.00056	1.81125	0.96395	-0.18690
38	0.00052	-0.00004	-0.00076	-0.12929	-0.32424	-1.07772
39	0.00055	-0.00010	-0.00093	-0.10670	-0.32845	-1.33123
40	0.00050	-0.00022	-0.00109	2.24384	0.69639	-0.07839
41	0.00149	0.00000	-0.00078	0.86978	0.81996	-0.15736
42	0.00145	0.00000	-0.00113	-0.16790	-0.95235	-1.25060
43	0.00148	0.00000	-0.00145	0.05589	-0.77203	-1.45925
44	0.00135	0.00000	-0.00177	2.18274	1.08106	0.11331
45	0.00065	0.00025	-0.00096	0.92806	0.48291	-0.31679
46	0.00066	0.00008	-0.00115	-0.34970	-0.78949	-1.33732
47	0.00073	-0.00004	-0.00130	-0.14370	-0.61458	-1.54186
48	0.00064	-0.00020	-0.00143	2.32806	0.34847	-0.02184
49	0.00057	0.00000	-0.00071	0.95229	0.51358	-0.42809
50	0.00060	0.00000	-0.00111	-0.02328	-0.70444	-0.82463
51	0.00064	0.00000	-0.00123	0.08364	-0.20908	-1.11162
52	0.00041	0.00000	-0.00105	2.11653	0.32891	-1.50504

Figure 2

Nodal displacements and stresses – SUMMER

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.01693	0.00000	-0.00062	0.83931	0.40077	-2.68859
2	0.01704	0.00000	-0.00049	0.25986	-0.22491	-3.33789
3	0.01717	0.00000	-0.00038	0.22761	-0.05634	-2.64916
4	0.01729	0.00000	-0.00028	0.35733	0.00782	-2.02555
5	0.01641	0.00000	-0.00075	-0.16200	-2.06481	-4.41733
6	0.01650	0.00000	-0.00107	-0.13530	-0.50337	-3.02996
7	0.01658	0.00000	-0.00136	0.02237	-0.12592	-2.76372
8	0.01672	0.00000	-0.00163	-0.04900	-0.65100	-3.57353
9	0.01147	0.00219	-0.00059	-0.19426	-1.95315	-3.81577
10	0.01168	0.00174	-0.00079	-0.15639	-0.48343	-2.72438
11	0.01189	0.00126	-0.00095	-0.03628	-0.13674	-2.87639
12	0.01218	0.00081	-0.00109	-0.03464	-0.71378	-4.18252
13	0.00703	0.00152	-0.00054	-0.31779	-1.62602	-3.89317
14	0.00733	0.00104	-0.00059	-0.10335	-0.34999	-2.79611
15	0.00764	0.00051	-0.00060	0.12507	-0.20749	-3.21224
16	0.00803	0.00001	-0.00060	0.03323	-0.66377	-4.89727
17	0.00286	0.00050	-0.00034	-0.22162	-1.48029	-2.46765
18	0.00311	0.00022	-0.00031	0.05945	-0.22506	-1.98656
19	0.00335	-0.00006	-0.00026	0.46690	-0.16706	-3.04774
20	0.00368	-0.00030	-0.00020	0.02158	-0.43366	-5.42641
21	0.00110	-0.00061	-0.00042	-0.22753	-1.34907	-1.81404
22	0.00124	-0.00068	-0.00033	-0.08766	-0.17190	-1.19320
23	0.00139	-0.00077	-0.00021	0.13120	-0.11581	-2.11241
24	0.00160	-0.00079	-0.00011	-0.07851	-0.86937	-4.41721
25	0.01235	0.00000	0.00074	-0.31708	-2.22020	-4.24947
26	0.01243	0.00000	-0.00012	-0.14767	-0.46139	-2.19015
27	0.01247	0.00000	-0.00096	-0.03376	-0.41222	-1.94365
28	0.01264	0.00000	-0.00180	-0.09196	-2.25500	-3.72649
29	0.00842	0.00206	0.00044	-0.37360	-2.00558	-3.34602
30	0.00865	0.00159	-0.00026	-0.10263	-0.40159	-1.68048
31	0.00885	0.00109	-0.00095	-0.04781	-0.35949	-1.97718
32	0.00919	0.00064	-0.00163	-0.08300	-2.20756	-4.39364
33	0.00518	0.00129	0.00008	-0.47528	-1.85545	-2.32591
34	0.00548	0.00084	-0.00046	0.13317	-0.40024	-1.05776
35	0.00575	0.00035	-0.00100	0.20157	-0.41233	-2.02424
36	0.00617	-0.00005	-0.00154	-0.13298	-1.98127	-5.13964
37	0.00174	0.00026	-0.00022	-0.41238	-1.19013	-1.74999
38	0.00195	0.00004	-0.00052	0.47421	-0.30967	-0.74803
39	0.00212	-0.00020	-0.00082	0.22296	-0.56888	-2.02523
40	0.00240	-0.00030	-0.00110	0.55093	-2.31889	-4.76401
41	0.00504	0.00000	0.00135	-0.57749	-1.18268	-2.51043
42	0.00504	0.00000	0.00014	0.31807	-0.46915	-0.72925
43	0.00497	0.00000	-0.00105	-0.04298	-0.38207	-1.17739
44	0.00514	0.00000	-0.00217	-0.21822	-3.07578	-4.76391
45	0.00247	0.00059	0.00041	-0.46324	-1.11168	-1.87175
46	0.00265	0.00015	-0.00046	0.83821	0.21964	-0.84142
47	0.00278	-0.00027	-0.00132	0.07063	-0.07321	-2.33866
48	0.00310	-0.00060	-0.00209	0.78509	-2.61648	-5.81007
49	0.00159	0.00000	0.00034	3.27925	-0.11914	-0.43768
50	0.00172	0.00000	-0.00060	0.73820	0.55486	-0.45640
51	0.00170	0.00000	-0.00164	0.24282	-0.31346	-1.09835
52	0.00162	0.00000	-0.00223	-1.16800	-3.76536	-9.31253

Figure 3

Displacements at Joints 1 and 4 – WINTER

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.00660	0.01238	0.00316	0.00462	-0.00403	-0.00674
2	0.00657	0.01234	0.00300	0.00445	-0.00438	-0.00739
3	0.00653	0.01231	0.00283	0.00427	-0.00474	-0.00806
4	0.00650	0.01228	0.00266	0.00411	-0.00509	-0.00870
5	0.00566	0.01040	0.00243	0.00382	-0.00369	-0.00642
6	0.00563	0.01038	0.00229	0.00364	-0.00405	-0.00706
7	0.00561	0.01037	0.00213	0.00347	-0.00441	-0.00773
8	0.00559	0.01034	0.00197	0.00331	-0.00477	-0.00837
9	0.00462	0.00811	0.00166	0.00312	-0.00278	-0.00513
10	0.00457	0.00810	0.00155	0.00291	-0.00318	-0.00584
11	0.00454	0.00810	0.00142	0.00272	-0.00359	-0.00657
12	0.00451	0.00808	0.00126	0.00254	-0.00400	-0.00727
13	0.00361	0.00596	0.00105	0.00254	-0.00188	-0.00373
14	0.00354	0.00597	0.00096	0.00228	-0.00226	-0.00445
15	0.00352	0.00600	0.00085	0.00205	-0.00266	-0.00520
16	0.00348	0.00599	0.00069	0.00184	-0.00306	-0.00594
17	0.00273	0.00408	0.00059	0.00202	-0.00126	-0.00273
18	0.00265	0.00412	0.00051	0.00170	-0.00158	-0.00340
19	0.00263	0.00419	0.00042	0.00144	-0.00193	-0.00411
20	0.00261	0.00421	0.00026	0.00122	-0.00229	-0.00481
21	0.00201	0.00258	0.00026	0.00156	-0.00083	-0.00206
22	0.00191	0.00265	0.00021	0.00120	-0.00110	-0.00265
23	0.00192	0.00277	0.00013	0.00093	-0.00140	-0.00329
24	0.00191	0.00279	-0.00005	0.00073	-0.00170	-0.00388
25	0.00143	0.00147	0.00005	0.00115	-0.00055	-0.00162
26	0.00131	0.00157	0.00003	0.00078	-0.00078	-0.00211
27	0.00134	0.00172	-0.00003	0.00054	-0.00103	-0.00264
28	0.00136	0.00173	-0.00023	0.00038	-0.00127	-0.00312
29	0.00083	0.00071	0.00003	0.00065	-0.00037	-0.00129
30	0.00079	0.00086	0.00000	0.00038	-0.00060	-0.00171
31	0.00088	0.00101	-0.00008	0.00026	-0.00081	-0.00213
32	0.00092	0.00099	-0.00033	0.00020	-0.00098	-0.00245
33	0.00045	0.00027	0.00001	0.00032	-0.00050	-0.00119
34	0.00042	0.00042	-0.00001	0.00013	-0.00065	-0.00137
35	0.00053	0.00057	-0.00008	0.00012	-0.00074	-0.00162
36	0.00059	0.00049	-0.00035	0.00017	-0.00084	-0.00182
37	0.00020	0.00020	0.00003	0.00003	-0.00069	-0.00069
38	0.00025	0.00025	-0.00008	-0.00008	-0.00087	-0.00087
39	0.00030	0.00030	-0.00010	-0.00010	-0.00092	-0.00092
40	0.00015	0.00015	-0.00011	-0.00011	-0.00083	-0.00083

Figure 4

Displacements at Joints 2 and 3 – WINTER

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.01463	0.01463	0.00172	0.00172	-0.00670	-0.00670
2	0.01455	0.01455	0.00161	0.00161	-0.00726	-0.00726
3	0.01447	0.01447	0.00150	0.00150	-0.00784	-0.00784
4	0.01438	0.01438	0.00139	0.00139	-0.00841	-0.00841
5	0.01258	0.01258	0.00146	0.00146	-0.00562	-0.00562
6	0.01250	0.01250	0.00133	0.00133	-0.00623	-0.00623
7	0.01242	0.01242	0.00121	0.00121	-0.00686	-0.00686
8	0.01234	0.01234	0.00108	0.00108	-0.00747	-0.00747
9	0.01064	0.01064	0.00129	0.00129	-0.00428	-0.00428
10	0.01055	0.01055	0.00114	0.00114	-0.00493	-0.00493
11	0.01049	0.01049	0.00100	0.00100	-0.00561	-0.00561
12	0.01040	0.01039	0.00085	0.00085	-0.00626	-0.00628
13	0.00882	0.00882	0.00114	0.00114	-0.00314	-0.00318
14	0.00873	0.00873	0.00097	0.00097	-0.00381	-0.00382
15	0.00869	0.00869	0.00081	0.00081	-0.00450	-0.00453
16	0.00861	0.00859	0.00061	0.00069	-0.00517	-0.00523
17	0.00714	0.00722	0.00098	0.00098	-0.00223	-0.00233
18	0.00707	0.00712	0.00082	0.00082	-0.00289	-0.00295
19	0.00705	0.00710	0.00066	0.00066	-0.00356	-0.00367
20	0.00699	0.00700	0.00040	0.00058	-0.00423	-0.00434
21	0.00571	0.00576	0.00085	0.00085	-0.00158	-0.00164
22	0.00561	0.00568	0.00068	0.00068	-0.00221	-0.00225
23	0.00563	0.00568	0.00052	0.00052	-0.00283	-0.00298
24	0.00558	0.00559	0.00021	0.00050	-0.00346	-0.00363
25	0.00438	0.00438	0.00071	0.00071	-0.00110	-0.00110
26	0.00437	0.00437	0.00055	0.00055	-0.00172	-0.00172
27	0.00442	0.00445	0.00040	0.00040	-0.00230	-0.00243
28	0.00440	0.00436	0.00004	0.00044	-0.00286	-0.00305
29	0.00331	0.00331	0.00058	0.00058	-0.00098	-0.00098
30	0.00334	0.00334	0.00043	0.00043	-0.00147	-0.00147
31	0.00343	0.00346	0.00030	0.00030	-0.00193	-0.00207
32	0.00343	0.00336	-0.00011	0.00042	-0.00239	-0.00260
33	0.00252	0.00252	0.00046	0.00046	-0.00090	-0.00090
34	0.00255	0.00255	0.00034	0.00033	-0.00131	-0.00131
35	0.00266	0.00269	0.00021	0.00024	-0.00166	-0.00182
36	0.00268	0.00259	-0.00024	0.00043	-0.00203	-0.00225
37	0.00191	0.00191	0.00037	0.00036	-0.00085	-0.00085
38	0.00194	0.00194	0.00025	0.00025	-0.00119	-0.00119
39	0.00206	0.00208	0.00013	0.00021	-0.00145	-0.00161
40	0.00209	0.00197	-0.00034	0.00045	-0.00174	-0.00197
41	0.00141	0.00141	0.00027	0.00027	-0.00081	-0.00081
42	0.00143	0.00143	0.00018	0.00017	-0.00110	-0.00110
43	0.00155	0.00156	0.00006	0.00017	-0.00128	-0.00143
44	0.00157	0.00144	-0.00041	0.00045	-0.00150	-0.00173
45	0.00099	0.00100	0.00017	0.00017	-0.00077	-0.00078
46	0.00099	0.00100	0.00010	0.00010	-0.00104	-0.00104
47	0.00108	0.00109	-0.00000	0.00011	-0.00115	-0.00127
48	0.00103	0.00091	-0.00042	0.00039	-0.00128	-0.00146
49	0.00056	0.00056	0.00005	0.00005	-0.00068	-0.00068
50	0.00063	0.00063	0.00001	0.00001	-0.00104	-0.00104
51	0.00069	0.00069	-0.00002	-0.00002	-0.00106	-0.00106
52	0.00043	0.00043	-0.00006	-0.00006	-0.00089	-0.00089

Figure 5

Displacements at Joints 1 and 4 – SUMMER

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.00040	0.00040	-0.00174	-0.00174	0.00120	0.00120
2	0.00071	0.00073	-0.00211	-0.00211	0.00171	0.00172
3	0.00104	0.00104	-0.00248	-0.00248	0.00225	0.00225
4	0.00136	0.00136	-0.00285	-0.00285	0.00276	0.00276
5	0.00200	0.00200	-0.00128	-0.00128	0.00086	0.00086
6	0.00227	0.00227	-0.00164	-0.00164	0.00134	0.00134
7	0.00256	0.00256	-0.00200	-0.00201	0.00182	0.00182
8	0.00289	0.00289	-0.00234	-0.00234	0.00229	0.00229
9	0.00349	0.00349	-0.00038	-0.00039	0.00019	0.00019
10	0.00376	0.00376	-0.00075	-0.00075	0.00052	0.00052
11	0.00404	0.00404	-0.00113	-0.00113	0.00089	0.00089
12	0.00438	0.00438	-0.00148	-0.00149	0.00127	0.00127
13	0.00432	0.00432	0.00050	0.00050	-0.00026	-0.00026
14	0.00461	0.00462	0.00010	0.00010	-0.00010	-0.00010
15	0.00492	0.00493	-0.00031	-0.00032	0.00010	0.00010
16	0.00530	0.00530	-0.00069	-0.00069	0.00031	0.00031
17	0.00456	0.00456	0.00104	0.00104	-0.00033	-0.00033
18	0.00490	0.00490	0.00060	0.00059	-0.00034	-0.00034
19	0.00523	0.00523	0.00015	0.00015	-0.00032	-0.00032
20	0.00565	0.00565	-0.00025	-0.00025	-0.00030	-0.00030
21	0.00413	0.00479	0.00113	0.00113	-0.00018	-0.00035
22	0.00443	0.00510	0.00074	0.00074	-0.00045	-0.00039
23	0.00475	0.00536	0.00032	0.00032	-0.00061	-0.00052
24	0.00517	0.00578	-0.00004	-0.00004	-0.00065	-0.00077
25	0.00332	0.00477	0.00094	0.00094	-0.00015	-0.00022
26	0.00358	0.00499	0.00063	0.00063	-0.00039	-0.00057
27	0.00390	0.00513	0.00025	0.00025	-0.00061	-0.00094
28	0.00421	0.00555	-0.00001	-0.00001	-0.00103	-0.00112
29	0.00263	0.00387	0.00068	0.00068	-0.00003	-0.00027
30	0.00287	0.00412	0.00037	0.00037	-0.00045	-0.00069
31	0.00309	0.00431	0.00002	0.00002	-0.00074	-0.00122
32	0.00345	0.00470	-0.00020	-0.00020	-0.00119	-0.00160
33	0.00187	0.00282	0.00029	0.00029	-0.00032	-0.00012
34	0.00207	0.00304	0.00000	-0.00000	-0.00058	-0.00082
35	0.00234	0.00317	-0.00035	-0.00035	-0.00102	-0.00137
36	0.00268	0.00358	-0.00053	-0.00053	-0.00144	-0.00189
37	0.00123	0.00123	-0.00026	-0.00026	-0.00046	-0.00046
38	0.00153	0.00153	-0.00058	-0.00058	-0.00086	-0.00086
39	0.00175	0.00175	-0.00092	-0.00092	-0.00136	-0.00136
40	0.00185	0.00185	-0.00104	-0.00104	-0.00166	-0.00166

Displacements at Joints 2 and 3 – SUMMER

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.01500	0.01501	0.00085	0.00085	-0.00027	-0.00027
2	0.01516	0.01516	0.00058	0.00058	-0.00005	-0.00005
3	0.01533	0.01533	0.00030	0.00030	0.00013	0.00013
4	0.01550	0.01550	0.00003	0.00003	0.00030	0.00030
5	0.01551	0.01551	0.00108	0.00108	-0.00080	-0.00080
6	0.01564	0.01564	0.00081	0.00080	-0.00073	-0.00073
7	0.01577	0.01577	0.00052	0.00052	-0.00064	-0.00064
8	0.01595	0.01595	0.00023	0.00023	-0.00053	-0.00053
9	0.01550	0.01550	0.00135	0.00135	-0.00089	-0.00089
10	0.01564	0.01564	0.00108	0.00107	-0.00099	-0.00099
11	0.01578	0.01578	0.00078	0.00078	-0.00106	-0.00106
12	0.01597	0.01597	0.00050	0.00049	-0.00110	-0.00110
13	0.01500	0.01500	0.00151	0.00150	-0.00068	-0.00068
14	0.01515	0.01515	0.00122	0.00122	-0.00098	-0.00098
15	0.01528	0.01528	0.00093	0.00092	-0.00123	-0.00123
16	0.01550	0.01550	0.00064	0.00064	-0.00147	-0.00147
17	0.01405	0.01405	0.00156	0.00156	-0.00029	-0.00029
18	0.01421	0.01421	0.00127	0.00127	-0.00078	-0.00078
19	0.01433	0.01433	0.00097	0.00097	-0.00123	-0.00123
20	0.01457	0.01457	0.00068	0.00068	-0.00166	-0.00166
21	0.01275	0.01275	0.00153	0.00153	0.00019	0.00019
22	0.01291	0.01291	0.00124	0.00124	-0.00048	-0.00048
23	0.01302	0.01302	0.00093	0.00093	-0.00112	-0.00112
24	0.01327	0.01327	0.00065	0.00064	-0.00175	-0.00175
25	0.01121	0.01121	0.00144	0.00143	0.00063	0.00063
26	0.01137	0.01137	0.00115	0.00114	-0.00018	-0.00018
27	0.01146	0.01146	0.00084	0.00083	-0.00098	-0.00098
28	0.01173	0.01173	0.00055	0.00055	-0.00178	-0.00178
29	0.00951	0.00951	0.00129	0.00128	0.00098	0.00098
30	0.00967	0.00967	0.00100	0.00100	0.00004	0.00004
31	0.00975	0.00975	0.00069	0.00069	-0.00089	-0.00089
32	0.01002	0.01002	0.00042	0.00042	-0.00182	-0.00182
33	0.00775	0.00776	0.00109	0.00109	0.00117	0.00117
34	0.00790	0.00790	0.00081	0.00081	0.00014	0.00014
35	0.00796	0.00796	0.00051	0.00051	-0.00089	-0.00089
36	0.00823	0.00823	0.00026	0.00026	-0.00190	-0.00190
37	0.00601	0.00601	0.00087	0.00087	0.00119	0.00119
38	0.00613	0.00613	0.00060	0.00059	0.00010	0.00010
39	0.00615	0.00615	0.00031	0.00031	-0.00099	-0.00099
40	0.00641	0.00641	0.00008	0.00008	-0.00203	-0.00203
41	0.00434	0.00434	0.00062	0.00062	0.00103	0.00103
42	0.00442	0.00442	0.00036	0.00036	-0.00008	-0.00008
43	0.00439	0.00439	0.00010	0.00009	-0.00117	-0.00117
44	0.00462	0.00462	-0.00009	-0.00009	-0.00217	-0.00217
45	0.00279	0.00279	0.00035	0.00035	0.00070	0.00070
46	0.00283	0.00283	0.00012	0.00012	-0.00038	-0.00038
47	0.00275	0.00275	-0.00011	-0.00011	-0.00140	-0.00140
48	0.00295	0.00295	-0.00023	-0.00023	-0.00225	-0.00225
49	0.00134	0.00134	0.00006	0.00006	0.00013	0.00013
50	0.00146	0.00146	-0.00011	-0.00011	-0.00069	-0.00069
51	0.00146	0.00146	-0.00030	-0.00030	-0.00164	-0.00164
52	0.00143	0.00143	-0.00031	-0.00031	-0.00214	-0.00214

Figure 7

State of Contraction Joints 1 and 4 – WINTER

Node	Gap size (m)	State of joint
1	0.0014628	3
2	0.0014521	3
3	0.0014467	3
4	0.0014454	3
5	0.0013884	3
6	0.0013538	3
7	0.0013413	3
8	0.0013474	3
9	0.0014619	3
10	0.0013660	3
11	0.0013037	3
12	0.0012782	3
13	0.0014901	3
14	0.0013183	3
15	0.0011997	3
16	0.0011432	3
17	0.0014337	3
18	0.0011843	3
19	0.0010202	3
20	0.0009585	3
21	0.0013010	3
22	0.0009867	3
23	0.0008014	3
24	0.0007712	3
25	0.0010966	3
26	0.0007413	3
27	0.0005687	3
28	0.0006149	3
29	0.0006192	3
30	0.0003800	3
31	0.0003431	3
32	0.0005351	3
33	0.0003106	3
34	0.0001349	3
35	0.0002028	3
36	0.0005190	3
37		
38		
39		
40		

Legend:

1–contact, no sliding
2–sliding contact
3–open

Figure 8
State of Contraction Joints 2 and 3 – WINTER

Node	Gap size (m)	State of joint
1	-0.0000002	1
2	-0.0000003	1
3	-0.0000003	1
4	-0.0000001	1
5	-0.0000003	1
6	-0.0000007	1
7	-0.0000006	1
8	-0.0000002	1
9	-0.0000003	1
10	-0.0000006	1
11	-0.0000004	1
12	-0.0000000	1
13	-0.0000002	1
14	-0.0000005	1
15	-0.0000003	1
16	0.0000768	3
17	-0.0000001	1
18	-0.0000005	1
19	-0.0000002	1
20	0.0001771	3
21	-0.0000000	1
22	-0.0000005	1
23	-0.0000001	2
24	0.0002856	3
25	-0.0000004	1
26	-0.0000010	1
27	-0.0000001	1
28	0.0004021	3
29	-0.0000006	1
30	-0.0000014	1
31	-0.0000001	1
32	0.0005345	3
33	-0.0000005	1
34	-0.0000013	1
35	0.0000269	3
36	0.0006757	3
37	-0.0000004	1
38	-0.0000012	1
39	0.0000748	3
40	0.0007949	3
41	-0.0000003	1
42	-0.0000011	1
43	0.0001055	3
44	0.0008651	3
45	-0.0000002	1
46	-0.0000009	1
47	0.0001118	3
48	0.0008112	3
49		
50		
51		
52		

Figure 9

State of Contraction Joints 1 and 4 – SUMMER

Node	Gap size (m)	State of joint
1	-0.0000001	1
2	-0.0000003	1
3	-0.0000005	1
4	-0.0000003	1
5	-0.0000006	1
6	-0.0000015	1
7	-0.0000021	1
8	-0.0000012	1
9	-0.0000008	1
10	-0.0000022	1
11	-0.0000029	1
12	-0.0000018	1
13	-0.0000010	1
14	-0.0000025	1
15	-0.0000032	1
16	-0.0000020	1
17	-0.0000012	1
18	-0.0000028	1
19	-0.0000035	1
20	-0.0000022	1
21	-0.0000010	1
22	-0.0000025	1
23	-0.0000033	1
24	-0.0000022	1
25	-0.0000008	1
26	-0.0000019	1
27	-0.0000027	1
28	-0.0000021	1
29	-0.0000007	1
30	-0.0000015	1
31	-0.0000026	1
32	-0.0000021	1
33	-0.0000006	1
34	-0.0000013	1
35	-0.0000024	1
36	-0.0000020	1
37		
38		
39		
40		

Legend:

1–contact, no sliding
2–sliding contact
3–open

Figure 10

State of Contraction Joints 2 and 3 – SUMMER

Node	Gap size (m)	State of joint
1	-0.0000006	1
2	-0.0000011	1
3	-0.0000011	1
4	-0.0000005	1
5	-0.0000015	1
6	-0.0000029	1
7	-0.0000030	1
8	-0.0000016	1
9	-0.0000019	1
10	-0.0000036	1
11	-0.0000035	1
12	-0.0000018	1
13	-0.0000022	1
14	-0.0000042	1
15	-0.0000040	1
16	-0.0000020	1
17	-0.0000024	1
18	-0.0000045	1
19	-0.0000043	1
20	-0.0000023	1
21	-0.0000025	1
22	-0.0000046	1
23	-0.0000044	1
24	-0.0000024	1
25	-0.0000026	1
26	-0.0000045	1
27	-0.0000043	1
28	-0.0000024	1
29	-0.0000025	1
30	-0.0000043	1
31	-0.0000041	1
32	-0.0000024	1
33	-0.0000023	1
34	-0.0000038	1
35	-0.0000036	1
36	-0.0000023	1
37	-0.0000020	1
38	-0.0000030	1
39	-0.0000030	1
40	-0.0000021	1
41	-0.0000017	1
42	-0.0000021	1
43	-0.0000022	1
44	-0.0000019	1
45	-0.0000012	1
46	-0.0000010	1
47	-0.0000014	1
48	-0.0000017	1
49		
50		
51		
52		

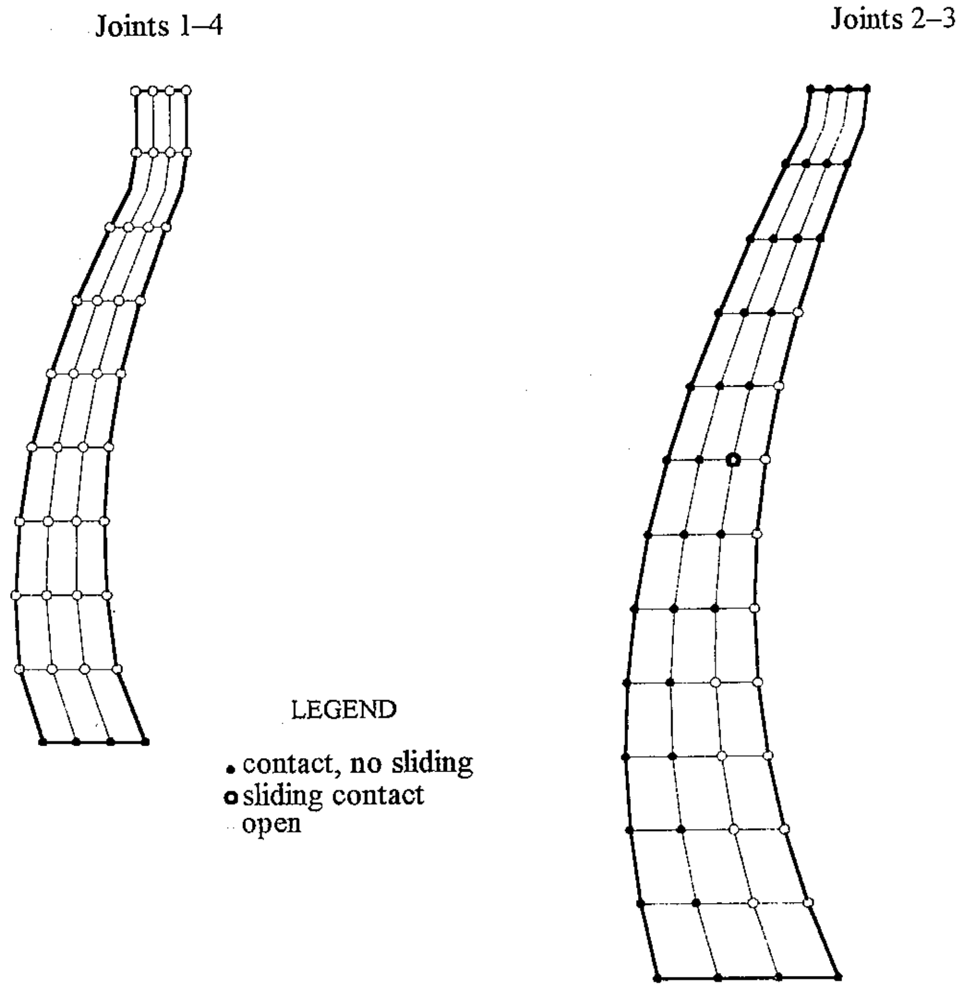
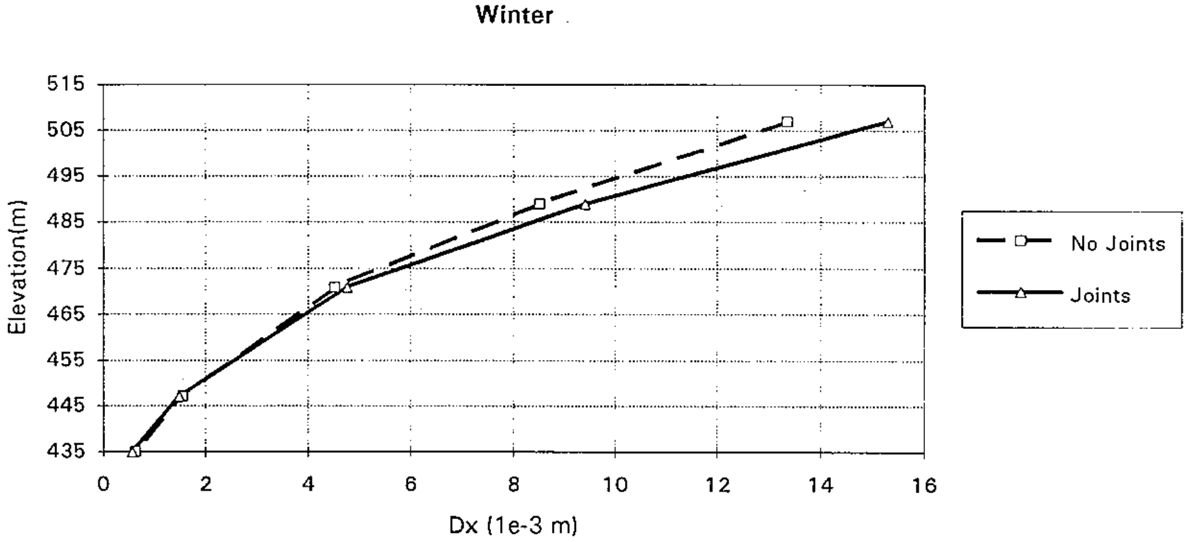
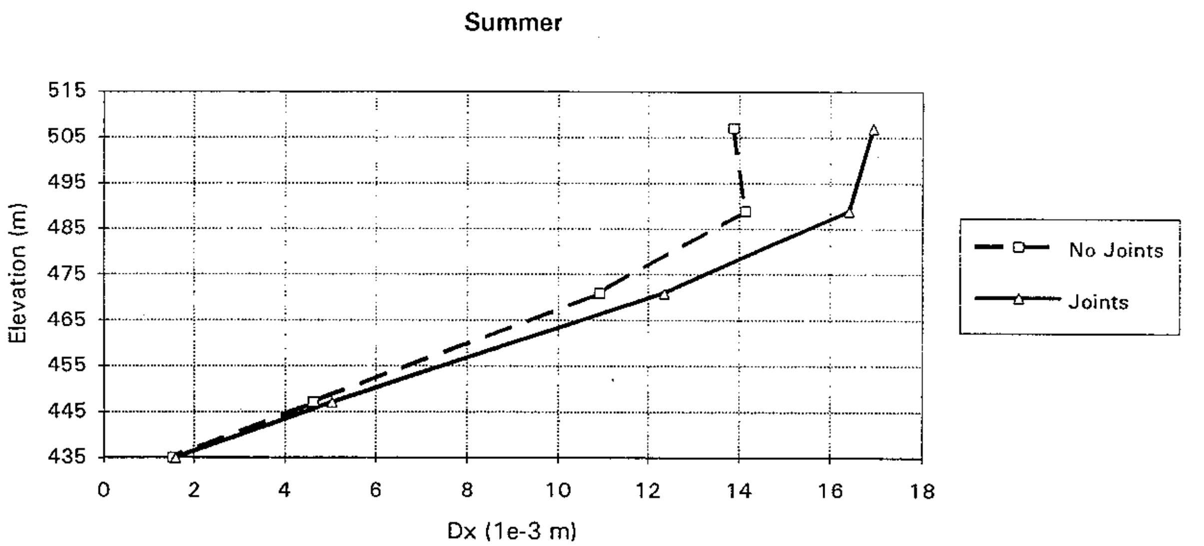


Figure 11
Maps of joint openings – WINTER loading conditions

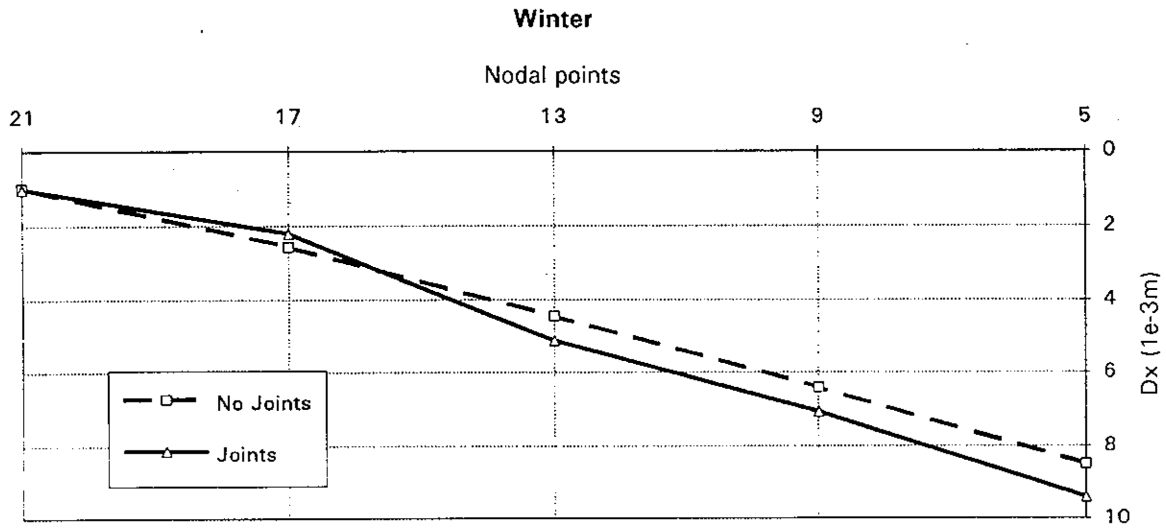


a.

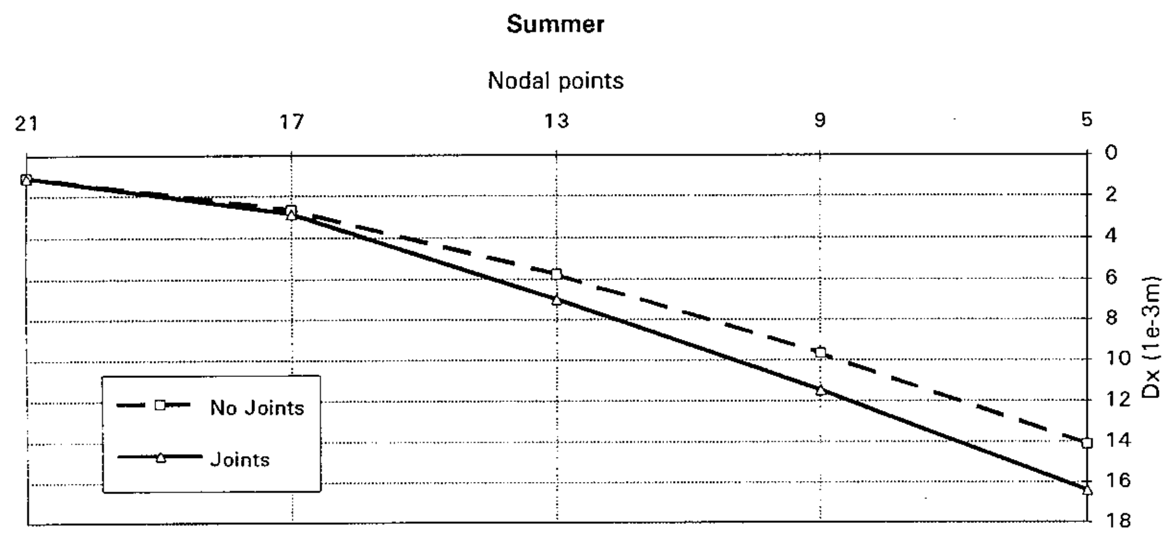


b.

Figure 12
Central cantilever – Displacements Dx for upstream nodal points
a–winter; b–summer

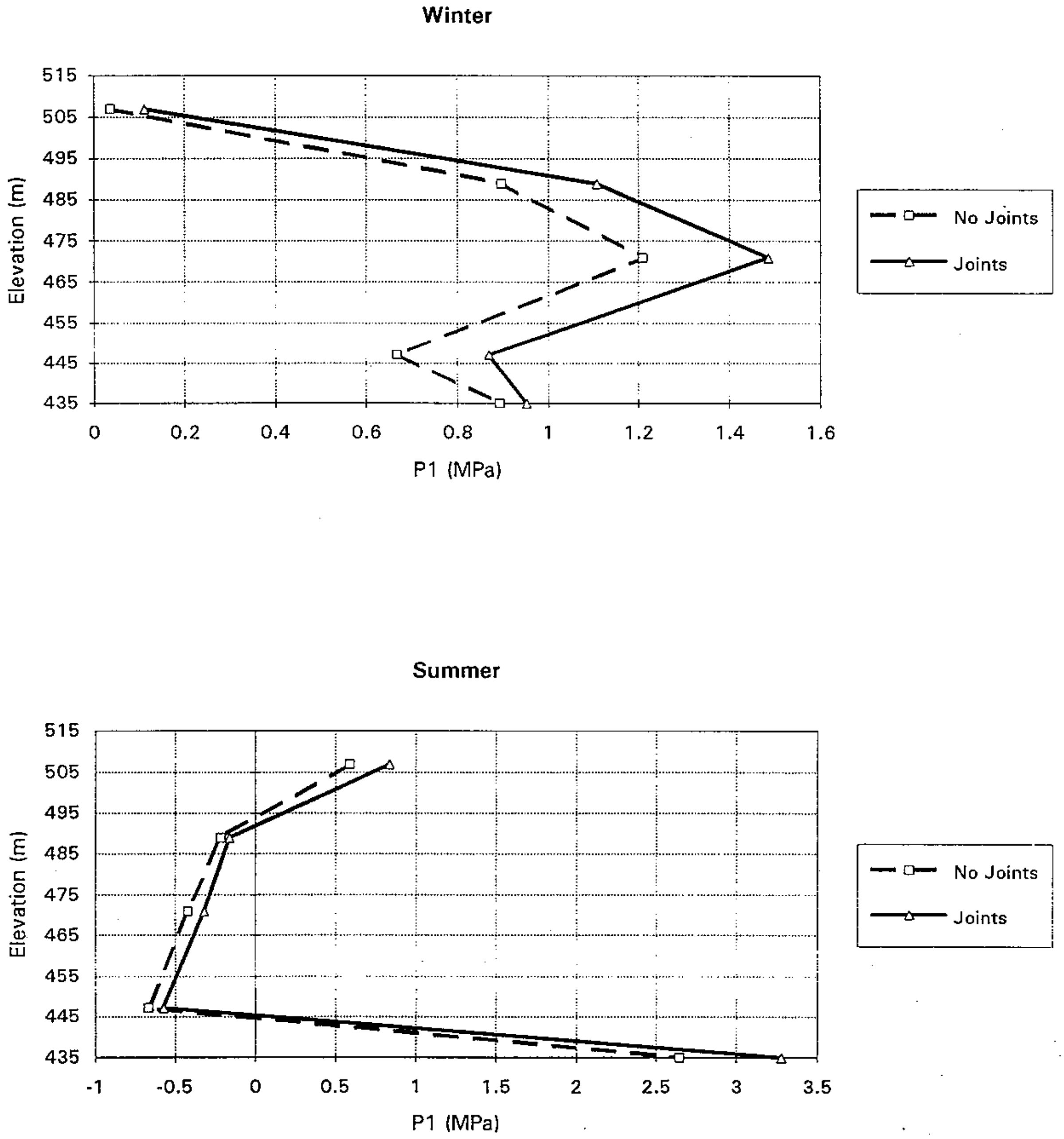


a.



b.

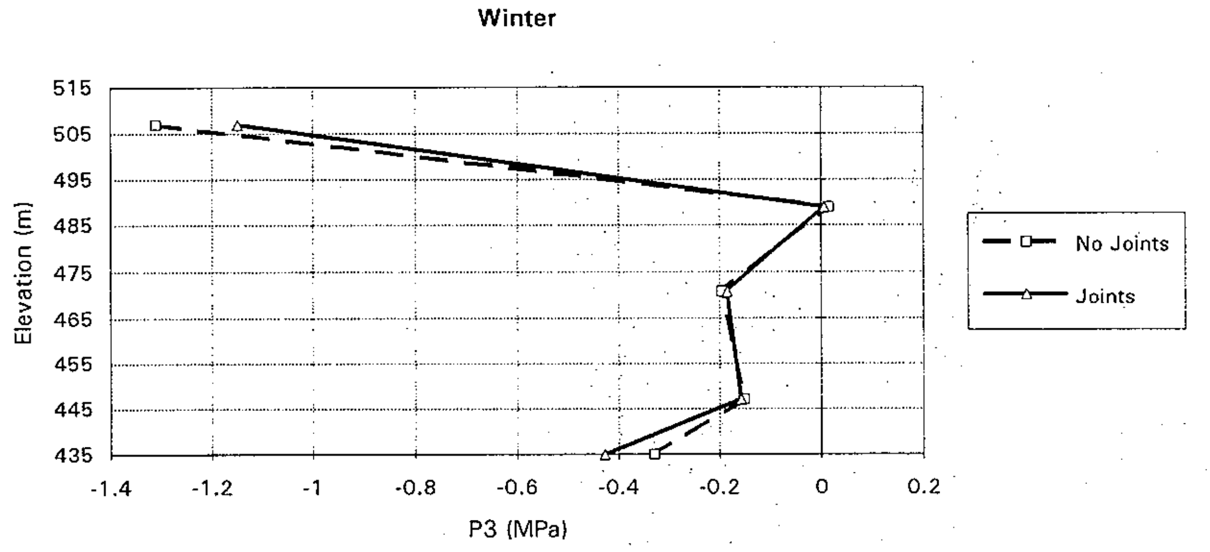
Figure 13
489.00 m elevation arch – Displacements Dx for upstream nodal points
a–winter; b–summer



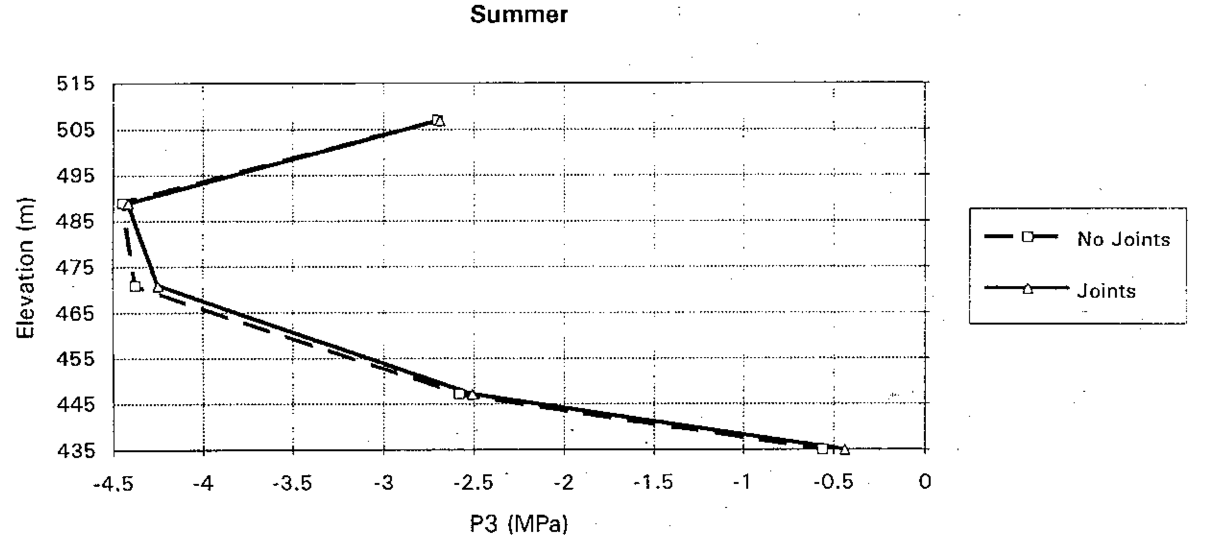
a.

b.

Figure 14
Central cantilever – Principal stresses P1 for upstream nodal points
a–winter; b–summer

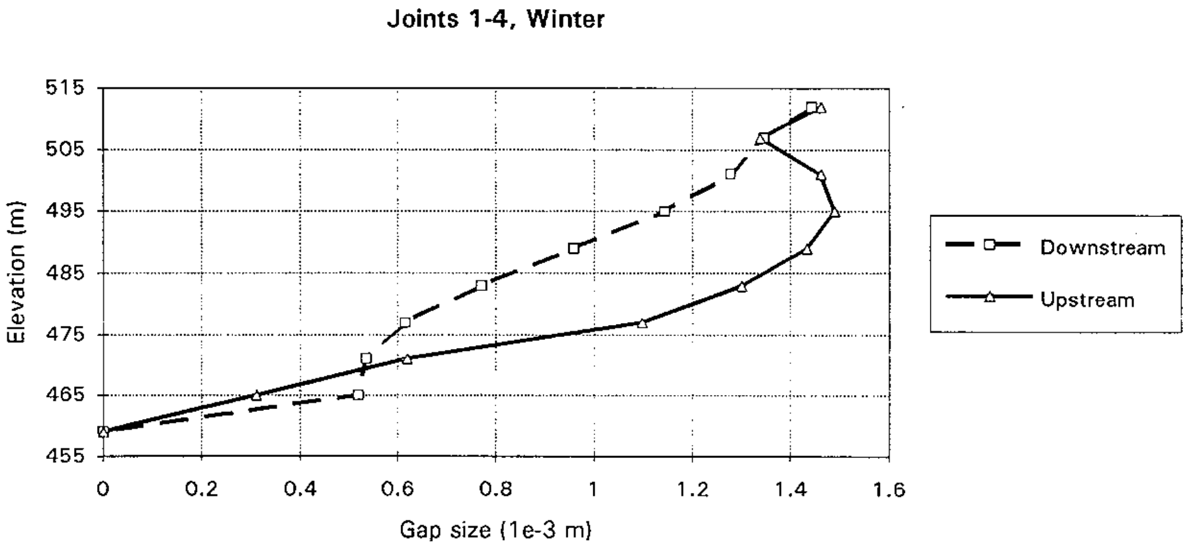


a.

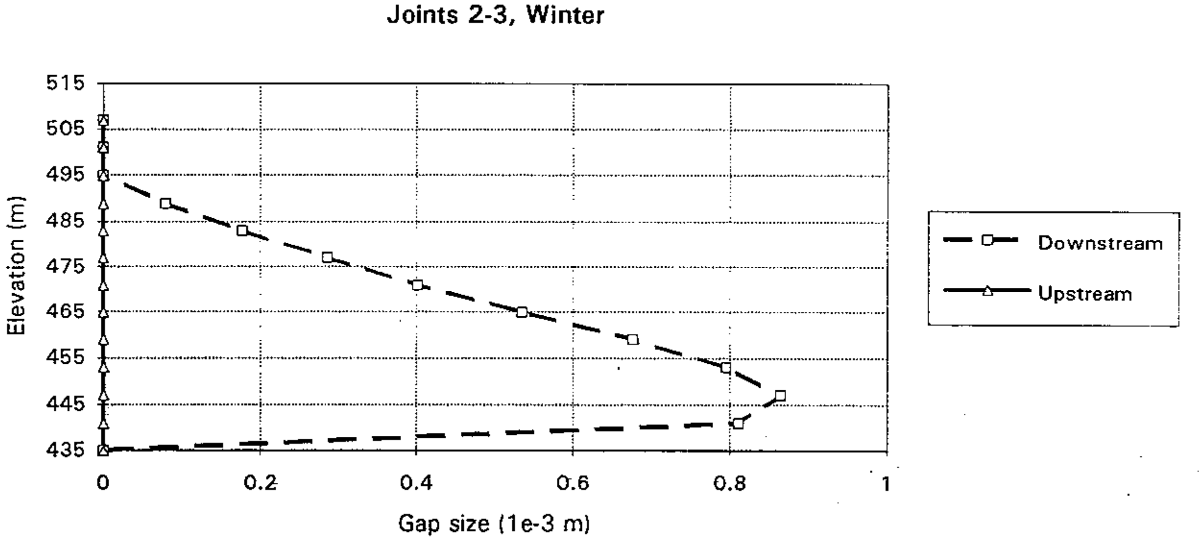


b.

Figure 15
Central cantilever – Principal stresses P3 for upstream nodal points
a–winter; b–summer



a.



b.

Figure 16
Joints openings – WINTER
a–Joints 1 and 4; b–Joints 2 and 3

Third Benchmark Workshop on
NUMERICAL ANALYSIS OF DAMS

Paris, September 29-30, 1994

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ABSTRACT

The results concerning the two analyses of *theme A1* are presented (referred to as "summer situation" and "winter situation", respectively).

A brief outline of the F.E.M. computer program CANT-SD, used to carry out the analyses, is reported. Some details about the joint element and its usage in this specific problem are also given.

The requested tables showing the values of displacements and stresses are set up according to the forms suggested. Maps of the joint openings are also provided.

1. BRIEF OUTLINE OF CANT-SD

The analyses were tackled by means of CANT-SD[1], a finite element computer program for non-linear static and dynamic analysis of structures, developed at CISE for ENEL-CRIS. The program CANT-SD deals with material non-linearity and allows the use of material models for steel, concrete and soils.

The behaviour of discontinuity surfaces (joints) is taken into account by means of suitable interface elements (joint elements): such elements connect the two sides of the discontinuity and make use of a specific friction no-tension material model expressed in the tangent plane.

Mass loads and pressure loads, as well as thermal fields and prescribed displacements, can be applied to the structure, and either linear or parabolic finite element meshes can be used. The time discretization is performed by an implicit method, either with or without numerical damping.

The consequent non-linear system of algebraic equations is solved by a classic Newton-Raphson iterative scheme: different possible choices are available for updating the tangent stiffness matrix.

The proper load step amplitude can be automatically selected according to energy and convergence indicators. Two different frontal solvers[2] are available for the linear system to be solved at each iteration, according to whether the system matrix is symmetric positive definite (case of elasto-plastic models with associated flow rule and positive hardening) or it is a general unsymmetric one (case of elasto-plastic models with non-associated flow rule, as it occurs for many soil and concrete models and for the joint model with friction).

The program CANT-SD is coded in FORTRAN 77 and effectively runs on the multiprocessor Alliant FX80, after many substantial modifications to exploit as much as possible the vector and parallel features of shared memory computers. The program is linked to suitable pre- and post-processors, both for creating the finite element mesh and prescribing the boundary conditions, and to visualize the results by means of contour plots and time history plots.

2. THE JOINT ELEMENT

The essential features of the element[3] may be stated in the following points:

1. it consists of two isoparametric faces coinciding with those of the three-dimensional elements placed along the discontinuity surface;
2. one local reference system is assumed for each couple of points placed on the two opposite faces;
3. the constitutive model links relative displacements to contact forces, both expressed in the local system;
4. it has neither mass nor damping.

The deformation field is represented by the local relative displacements vector $\delta\mathbf{v}$, related to the global nodal displacements vector $\delta\mathbf{u}$ according to:

$$\delta \boldsymbol{v} = \boldsymbol{B}\delta \boldsymbol{u} \qquad \boldsymbol{B} = \boldsymbol{T}\boldsymbol{N} \tag{1}$$

where **T** is the transformation matrix and **N** the shape function matrix.
The stress field is represented by the local surface forces vector **t**, related to the global nodal forces vector **r** according to:

$$\boldsymbol{r} = \int_A \boldsymbol{B}^T \boldsymbol{t} dA \tag{2}$$

A no-tension constitutive model is assumed between $\delta\mathbf{v}$ and **t**: if the considered point of the joint turns out to be open, **t** is set to nought. When the two faces are in contact, the constitutive law is elastic perfectly plastic, able to prevent penetration and to reproduce the Coulomb friction behaviour without dilatancy. The two following relations define the yield surface φ and the plastic potential surface Ψ of such law, being α the friction angle :

$$\varphi(\boldsymbol{t}) = \varphi(t_{s1},t_{s2},t_n) = \sqrt{t_{s1}^2+t_{s2}^2} - t_n tg\alpha \tag{3}$$

$$\psi(\boldsymbol{t}) = \psi(t_{s1},t_{s2},t_n) = \sqrt{t_{s1}^2+t_{s2}^2} \tag{4}$$

Following the usual elastoplastic theory, the equations (3) and (4) lead to the incremental elastoplastic stiffness matrix of the material:

$$\dot{\boldsymbol{t}} = \boldsymbol{D}^{ep}\ \delta\dot{\boldsymbol{v}} \tag{5}$$

The incremental stiffness matrix of the finite element, for contact and plastic flow condition, results therefore:

$$\boldsymbol{K}^{ep} = \int_A \boldsymbol{B}^T \boldsymbol{D}^{ep} \boldsymbol{B} dA \tag{6}$$

It can be noticed that such matrix is unsymmetric if $\alpha > 0$ (model with friction), as a consequence of the non-associated nature of the elastoplastic model.

The joint elements used for modelling the joints in the current benchmark were directly defined by the couples of nodes (geometrically coincident) given in the suggested mesh. Although the geometric thickness of the resulting joint elements is nought, it is possible to assign a "fictitious thickness" in order to define the element stiffness. Such "fictitious thickness" was assigned equal to 0.08 m. for every joint element in the mesh: this value is one hundred times smaller than the length of the adjacent elements. The elastic moduli E and G of the concrete were used for the joint material too. The value of the friction angle used in the analyses was α=0.75.

3. PRESENTATION OF THE RESULTS

The analyses were carried out using one half of the suggested parabolic finite element mesh, due to the simmetry both of the structure and of the load conditions. The final load condition was reached through the following path: dead weight (D), thermal distribution (T), water pressure (W). It is worth noting that the first step of the loading path is the same both for the "summer situation" and the "winter situation", while the second and the third steps are different.

3.1 Summer solution

Displacements and principal stresses[1] (for the final load condition D+T+W) in the prescribed nodes not belonging to joints are shown in Table 1. Displacements for each couple of the prescribed joint nodes are reported in Tables 2 and 3.

The joint (normal) opening maps for the final load condition (D+T+W) are shown in Figure 1a for joint No. 1 and in Figure 1b for joint No. 2 (positive values mean openings).

3.2 Winter solution

Displacements and principal stresses (for the final load condition D+T+W) in the prescribed nodes not belonging to joints, are shown in Table 4. Displacements for each couple of the prescribed joints nodes are reported in Tables 5 and 6.

The joint (normal) opening maps for final load condition (D+T+W) are shown in Figure 2a for joint No. 1 and in Figure 2b for joint No. 2 (positive values mean openings).

4. COMPUTATION TIMES

The analyses performed required approximately the following CPU times:

- *dead weight*: 15700 s.
- *summer thermal distribution:* 18600 s.
- *summer water pressure*: 22500 s.
- *winter thermal distribution:* 32500 s.
- *winter water pressure*: 18200 s.

The complete summer solution has then required 56800 CPUs, while the complete winter solution 66400 CPUs.

5. REFERENCES

[1] Bolognini, L., E. Bon, P. Masarati & F. Riccio 1992. *Il programma di calcolo strutturale ad elementi finiti CANT-SD per l'analisi non lineare tridimensionale statica e dinamica (versione 4.3)*. Rapporto Finale CISE 6894.

[2] Brusa, L. & F. Riccio 1989. A frontal technique for vector computers. *International Journal for Numerical Methods in Engineering* 28: 1635-1644.

[3] Bolognini, L., P. Masarati, A. Dusi & C. Galimberti 1992. Arch dams non-linear seismic analysis using a joint finite element. *Proc. 10th World Conference on Earthquake Engineering, Madrid*.

[1] The stress values are obtained as a mean of the nearest Gauss point values, for each element related to the considered node (the mean is computed before the calculation of principal stresses).

Table 1: Summer Case- Nodal Displacements and Principal Stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.13951E-01	-0.26989E-24	-0.42189E-03	0.4205E+06	0.3684E+06	-0.2765E+07
2	0.14078E-01	-0.20308E-24	-0.19610E-03	0.9629E+05	-0.1371E+06	-0.3199E+07
3	0.14209E-01	0.22034E-24	-0.47503E-05	0.3163E+05	-0.4085E+05	-0.2718E+07
4	0.14336E-01	0.40593E-24	0.17517E-03	0.3540E+05	-0.9617E+04	-0.2325E+07
5	0.14313E-01	-0.14420E-23	-0.84126E-03	-0.2246E+06	-0.1888E+07	-0.4282E+07
6	0.14399E-01	-0.22923E-23	-0.10764E-02	-0.1772E+06	-0.5594E+06	-0.3162E+07
7	0.14482E-01	-0.14112E-23	-0.12721E-02	-0.6359E+05	-0.1515E+06	-0.2943E+07
8	0.14629E-01	-0.12694E-24	-0.14483E-02	-0.4695E+05	-0.5743E+06	-0.3644E+07
9	0.97427E-02	0.17121E-02	-0.59039E-03	-0.2291E+06	-0.1721E+07	-0.3628E+07
10	0.99457E-02	0.12900E-02	-0.71811E-03	-0.1854E+06	-0.5044E+06	-0.2815E+07
11	0.10152E-01	0.85006E-03	-0.80943E-03	-0.9460E+05	-0.1905E+06	-0.3038E+07
12	0.10428E-01	0.43182E-03	-0.88973E-03	-0.5369E+05	-0.7431E+06	-0.4194E+07
13	0.57608E-02	0.11563E-02	-0.54152E-03	-0.2296E+06	-0.1686E+07	-0.2795E+07
14	0.60214E-02	0.74597E-03	-0.57983E-03	-0.1897E+06	-0.4628E+06	-0.2277E+07
15	0.62891E-02	0.31881E-03	-0.58208E-03	-0.5052E+05	-0.2028E+06	-0.2894E+07
16	0.66256E-02	-0.73091E-04	-0.58252E-03	-0.5508E+05	-0.7200E+06	-0.4437E+07
17	0.26786E-02	0.38329E-04	-0.34434E-03	-0.2266E+06	-0.1543E+07	-0.2050E+07
18	0.29131E-02	-0.21625E-03	-0.25845E-03	-0.1911E+06	-0.2961E+06	-0.1804E+07
19	0.31520E-02	-0.48235E-03	-0.14150E-03	0.3122E+05	-0.1401E+06	-0.2747E+07
20	0.34627E-02	-0.70010E-03	-0.20878E-04	-0.7191E+05	-0.6649E+06	-0.4619E+07
21	0.10764E-02	-0.84450E-03	-0.41314E-03	-0.2312E+06	-0.1289E+07	-0.1805E+07
22	0.12030E-02	-0.89821E-03	-0.29421E-03	-0.1492E+06	-0.1963E+06	-0.1398E+07
23	0.13270E-02	-0.95925E-03	-0.15406E-03	0.6409E+05	-0.1204E+06	-0.2292E+07
24	0.15193E-02	-0.96181E-03	-0.20944E-04	-0.1133E+06	-0.7632E+06	-0.4213E+07
25	0.10992E-01	-0.20435E-23	0.37755E-03	-0.4158E+06	-0.2045E+07	-0.4179E+07
26	0.11077E-01	-0.35215E-23	-0.35672E-03	-0.2771E+06	-0.5334E+06	-0.2495E+07
27	0.11113E-01	-0.27142E-23	-0.10746E-02	-0.1331E+06	-0.5417E+06	-0.2313E+07
28	0.11290E-01	-0.74750E-24	-0.17909E-02	-0.1078E+06	-0.2068E+07	-0.3843E+07
29	0.73773E-02	0.17605E-02	0.14446E-03	-0.4182E+06	-0.1815E+07	-0.3412E+07

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30	0.76068E-02	0.13103E-02	-0.41589E-03	-0.2477E+06	-0.4126E+06	-0.2019E+07
31	0.77966E-02	0.83436E-03	-0.96817E-03	-0.1516E+06	-0.4410E+06	-0.2290E+07
32	0.81292E-02	0.41037E-03	-0.15195E-02	-0.1088E+06	-0.2015E+07	-0.4292E+07
33	0.41094E-02	0.11816E-02	-0.14244E-03	-0.4144E+06	-0.1527E+07	-0.2473E+07
34	0.44121E-02	0.73766E-03	-0.55450E-03	-0.1106E+06	-0.3779E+06	-0.1516E+07
35	0.46816E-02	0.27079E-03	-0.96456E-03	-0.1727E+06	-0.4323E+06	-0.2353E+07
36	0.50917E-02	-0.10972E-03	-0.13751E-02	-0.9367E+05	-0.2169E+07	-0.4864E+07
37	0.18803E-02	0.12243E-03	-0.22329E-03	-0.3697E+06	-0.1243E+07	-0.1475E+07
38	0.21240E-02	-0.13541E-03	-0.49961E-03	0.2353E+06	-0.4029E+06	-0.9585E+06
39	0.23527E-02	-0.41716E-03	-0.78818E-03	0.4297E+05	-0.5907E+06	-0.2316E+07
40	0.26928E-02	-0.58381E-03	-0.10676E-02	0.2013E+06	-0.1954E+07	-0.4946E+07
41	0.46460E-02	-0.11212E-23	0.97494E-03	-0.6825E+06	-0.1285E+07	-0.2412E+07
42	0.46554E-02	-0.17512E-23	-0.94883E-04	0.4470E+05	-0.6956E+06	-0.7677E+06
43	0.45762E-02	-0.14383E-23	-0.11477E-02	-0.1935E+06	-0.6819E+06	-0.1267E+07
44	0.47477E-02	-0.17128E-24	-0.21312E-02	-0.2390E+06	-0.2974E+07	-0.4206E+07
45	0.23422E-02	0.49944E-03	0.22459E-03	-0.7107E+06	-0.7924E+06	-0.1684E+07
46	0.25112E-02	0.89179E-04	-0.55394E-03	0.4587E+06	0.3232E+05	-0.8639E+06
47	0.26142E-02	-0.31679E-03	-0.13192E-02	-0.9736E+05	-0.3461E+06	-0.2040E+07
48	0.29307E-02	-0.60947E-03	-0.20088E-02	0.1238E+06	-0.2428E+07	-0.5218E+07
49	0.15509E-02	-0.38663E-24	0.15325E-03	0.1286E+07	0.1556E+06	0.6516E+04
50	0.16686E-02	0.15724E-25	-0.70667E-03	0.2750E+06	0.2494E+06	-0.4335E+06
51	0.16248E-02	-0.19289E-24	-0.16443E-02	-0.3033E+05	-0.5389E+06	-0.1264E+07
52	0.15537E-02	0.56890E-24	-0.21733E-02	-0.7133E+06	-0.9922E+06	-0.3646E+07

Table 1: Summer Case- Nodal Displacements and Principal Stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.13951E-01	-0.26989E-24	-0.42189E-03	0.4205E+06	0.3684E+06	-0.2765E+07
2	0.14078E-01	-0.20308E-24	-0.19610E-03	0.9629E+05	-0.1371E+06	-0.3199E+07
3	0.14209E-01	0.22034E-24	-0.47503E-05	0.3163E+05	-0.4085E+05	-0.2718E+07
4	0.14336E-01	0.40593E-24	0.17517E-03	0.3540E+05	-0.9617E+04	-0.2325E+07
5	0.14313E-01	-0.14420E-23	-0.84126E-03	-0.2246E+06	-0.1888E+07	-0.4282E+07
6	0.14399E-01	-0.22923E-23	-0.10764E-02	-0.1772E+06	-0.5594E+06	-0.3162E+07
7	0.14482E-01	-0.14112E-23	-0.12721E-02	-0.6359E+05	-0.1515E+06	-0.2943E+07
8	0.14629E-01	-0.12694E-24	-0.14483E-02	-0.4695E+05	-0.5743E+06	-0.3644E+07
9	0.97427E-02	0.17121E-02	-0.59039E-03	-0.2291E+06	-0.1721E+07	-0.3628E+07
10	0.99457E-02	0.12900E-02	-0.71811E-03	-0.1854E+06	-0.5044E+06	-0.2815E+07
11	0.10152E-01	0.85006E-03	-0.80943E-03	-0.9460E+05	-0.1905E+06	-0.3038E+07
12	0.10428E-01	0.43182E-03	-0.88973E-03	-0.5369E+05	-0.7431E+06	-0.4194E+07
13	0.57608E-02	0.11563E-02	-0.54152E-03	-0.2296E+06	-0.1686E+07	-0.2795E+07
14	0.60214E-02	0.74597E-03	-0.57983E-03	-0.1897E+06	-0.4628E+06	-0.2277E+07
15	0.62891E-02	0.31881E-03	-0.58208E-03	-0.5052E+05	-0.2028E+06	-0.2894E+07
16	0.66256E-02	-0.73091E-04	-0.58252E-03	-0.5508E+05	-0.7200E+06	-0.4437E+07
17	0.26786E-02	0.38329E-04	-0.34434E-03	-0.2266E+06	-0.1543E+07	-0.2050E+07
18	0.29131E-02	-0.21625E-03	-0.25845E-03	-0.1911E+06	-0.2961E+06	-0.1804E+07
19	0.31520E-02	-0.48235E-03	-0.14150E-03	0.3122E+05	-0.1401E+06	-0.2747E+07
20	0.34627E-02	-0.70010E-03	-0.20878E-04	-0.7191E+05	-0.6649E+06	-0.4619E+07
21	0.10764E-02	-0.84450E-03	-0.41314E-03	-0.2312E+06	-0.1289E+07	-0.1805E+07
22	0.12030E-02	-0.89821E-03	-0.29421E-03	-0.1492E+06	-0.1963E+06	-0.1398E+07
23	0.13270E-02	-0.95925E-03	-0.15406E-03	0.6409E+05	-0.1204E+06	-0.2292E+07
24	0.15193E-02	-0.96181E-03	-0.20944E-04	-0.1133E+06	-0.7632E+06	-0.4213E+07
25	0.10992E-01	-0.20435E-23	0.37755E-03	-0.4158E+06	-0.2045E+07	-0.4179E+07
26	0.11077E-01	-0.35215E-23	-0.35672E-03	-0.2771E+06	-0.5334E+06	-0.2495E+07
27	0.11113E-01	-0.27142E-23	-0.10746E-02	-0.1331E+06	-0.5417E+06	-0.2313E+07
28	0.11290E-01	-0.74750E-24	-0.17909E-02	-0.1078E+06	-0.2068E+07	-0.3843E+07
29	0.73773E-02	0.17605E-02	0.14446E-03	-0.4182E+06	-0.1815E+07	-0.3412E+07

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30	0.76068E-02	0.13103E-02	-0.41589E-03	-0.2477E+06	-0.4126E+06	-0.2019E+07
31	0.77966E-02	0.83436E-03	-0.96817E-03	-0.1516E+06	-0.4410E+06	-0.2290E+07
32	0.81292E-02	0.41037E-03	-0.15195E-02	-0.1088E+06	-0.2015E+07	-0.4292E+07
33	0.41094E-02	0.11816E-02	-0.14244E-03	-0.4144E+06	-0.1527E+07	-0.2473E+07
34	0.44121E-02	0.73766E-03	-0.55450E-03	-0.1106E+06	-0.3779E+06	-0.1516E+07
35	0.46816E-02	0.27079E-03	-0.96456E-03	-0.1727E+06	-0.4323E+06	-0.2353E+07
36	0.50917E-02	-0.10972E-03	-0.13751E-02	-0.9367E+05	-0.2169E+07	-0.4864E+07
37	0.18803E-02	0.12243E-03	-0.22329E-03	-0.3697E+06	-0.1243E+07	-0.1475E+07
38	0.21240E-02	-0.13541E-03	-0.49961E-03	0.2353E+06	-0.4029E+06	-0.9585E+06
39	0.23527E-02	-0.41716E-03	-0.78818E-03	0.4297E+05	-0.5907E+06	-0.2316E+07
40	0.26928E-02	-0.58381E-03	-0.10676E-02	0.2013E+06	-0.1954E+07	-0.4946E+07
41	0.46460E-02	-0.11212E-23	0.97494E-03	-0.6825E+06	-0.1285E+07	-0.2412E+07
42	0.46554E-02	-0.17512E-23	-0.94883E-04	0.4470E+05	-0.6956E+06	-0.7677E+06
43	0.45762E-02	-0.14383E-23	-0.11477E-02	-0.1935E+06	-0.6819E+06	-0.1267E+07
44	0.47477E-02	-0.17128E-24	-0.21312E-02	-0.2390E+06	-0.2974E+07	-0.4206E+07
45	0.23422E-02	0.49944E-03	0.22459E-03	-0.7107E+06	-0.7924E+06	-0.1684E+07
46	0.25112E-02	0.89179E-04	-0.55394E-03	0.4587E+06	0.3232E+05	-0.8639E+06
47	0.26142E-02	-0.31679E-03	-0.13192E-02	-0.9736E+05	-0.3461E+06	-0.2040E+07
48	0.29307E-02	-0.60947E-03	-0.20088E-02	0.1238E+06	-0.2428E+07	-0.5218E+07
49	0.15509E-02	-0.38663E-24	0.15325E-03	0.1286E+07	0.1556E+06	0.6516E+04
50	0.16686E-02	0.15724E-25	-0.70667E-03	0.2750E+06	0.2494E+06	-0.4335E+06
51	0.16248E-02	-0.19289E-24	-0.16443E-02	-0.3033E+05	-0.5389E+06	-0.1264E+07
52	0.15537E-02	0.56890E-24	-0.21733E-02	-0.7133E+06	-0.9922E+06	-0.3646E+07

Table 2: Summer Case- Displacements at Joint 1

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	-0.39630E-03	-0.39816E-03	-0.21797E-02	-0.21799E-02	0.10857E-02	0.10826E-02
2	0.15922E-03	0.16082E-03	-0.27585E-02	-0.27600E-02	0.21545E-02	0.21517E-02
3	-0.12092E-03	-0.11984E-03	-0.24712E-02	-0.24717E-02	0.16104E-02	0.16091E-02
4	0.44050E-03	0.44303E-03	-0.30438E-02	-0.30456E-02	0.26834E-02	0.26809E-02
5	0.13098E-02	0.13019E-02	-0.16335E-02	-0.16398E-02	0.80018E-03	0.76783E-03
6	0.15271E-02	0.15181E-02	-0.19331E-02	-0.19409E-02	0.13079E-02	0.12738E-02
7	0.17711E-02	0.17662E-02	-0.22289E-02	-0.22364E-02	0.18095E-02	0.17872E-02
8	0.20362E-02	0.20399E-02	-0.25011E-02	-0.25064E-02	0.22999E-02	0.22832E-02
9	0.28814E-02	0.28270E-02	-0.76019E-03	-0.74423E-03	0.23678E-03	0.40147E-04
10	0.30991E-02	0.30518E-02	-0.10593E-02	-0.10499E-02	0.57499E-03	0.41502E-03
11	0.33371E-02	0.33016E-02	-0.13657E-02	-0.13650E-02	0.94433E-03	0.83346E-03
12	0.36212E-02	0.35897E-02	-0.16493E-02	-0.16583E-02	0.13323E-02	0.12525E-02
13	0.37625E-02	0.36998E-02	0.80829E-04	0.93536E-04	-0.16619E-03	-0.46811E-03
14	0.40059E-02	0.39400E-02	-0.24364E-03	-0.23234E-03	0.23436E-04	-0.27498E-03
15	0.42767E-02	0.41900E-02	-0.57561E-03	-0.57460E-03	0.25974E-03	-0.47592E-04
16	0.46038E-02	0.44966E-02	-0.88271E-03	-0.89685E-03	0.49606E-03	0.19610E-03
17	0.41144E-02	0.39930E-02	0.63930E-03	0.60469E-03	-0.27627E-03	-0.56994E-03
18	0.43747E-02	0.42537E-02	0.28872E-03	0.26267E-03	-0.22760E-03	-0.56293E-03
19	0.46419E-02	0.45197E-02	-0.75784E-04	-0.92631E-04	-0.13029E-03	-0.53489E-03
20	0.49850E-02	0.48476E-02	-0.39491E-03	-0.40575E-03	-0.76230E-05	-0.52414E-03
21	0.40491E-02	0.38026E-02	0.94589E-03	0.82114E-03	-0.22370E-03	-0.48132E-03
22	0.43293E-02	0.40837E-02	0.57283E-03	0.45758E-03	-0.32178E-03	-0.62804E-03
23	0.45986E-02	0.43588E-02	0.18306E-03	0.78905E-04	-0.38769E-03	-0.75851E-03
24	0.49622E-02	0.47210E-02	-0.14894E-03	-0.23538E-03	-0.39696E-03	-0.95205E-03
25	0.36407E-02	0.33129E-02	0.99229E-03	0.79383E-03	-0.11164E-03	-0.36070E-03
26	0.39332E-02	0.36099E-02	0.60562E-03	0.41738E-03	-0.34847E-03	-0.62245E-03
27	0.42063E-02	0.38872E-02	0.20251E-03	0.20706E-04	-0.57956E-03	-0.87242E-03
28	0.45824E-02	0.42808E-02	-0.12690E-03	-0.29143E-03	-0.75652E-03	-0.11799E-02
29	0.29710E-02	0.26681E-02	0.79281E-03	0.57532E-03	-0.35221E-04	-0.28548E-03
30	0.32656E-02	0.29695E-02	0.40869E-03	0.20539E-03	-0.39068E-03	-0.62712E-03
31	0.35177E-02	0.32340E-02	0.16956E-04	-0.17723E-03	-0.74825E-03	-0.95149E-03
32	0.39096E-02	0.36504E-02	-0.27123E-03	-0.45584E-03	-0.10824E-02	-0.13140E-02
33	0.21643E-02	0.19894E-02	0.37846E-03	0.21494E-03	-0.83041E-04	-0.24763E-03
34	0.24237E-02	0.22681E-02	0.16675E-04	-0.12166E-03	-0.49362E-03	-0.65113E-03
35	0.26626E-02	0.24911E-02	-0.35404E-03	-0.49917E-03	-0.95714E-03	-0.10118E-02
36	0.30218E-02	0.28860E-02	-0.59731E-03	-0.74256E-03	-0.14083E-02	-0.13768E-02
37	0.11882E-02	0.11882E-02	-0.29652E-03	-0.29652E-03	-0.38434E-03	-0.38434E-03
38	0.14283E-02	0.14283E-02	-0.58405E-03	-0.58405E-03	-0.73241E-03	-0.73241E-03
39	0.16126E-02	0.16126E-02	-0.91860E-03	-0.91860E-03	-0.11877E-02	-0.11877E-02
40	0.17143E-02	0.17143E-02	-0.10282E-02	-0.10282E-02	-0.14793E-02	-0.14793E-02

Table 3: Summer Case- Displacements at Joint 2

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.12395E-01	0.12391E-01	0.54191E-03	0.53597E-03	-0.19763E-03	-0.21136E-03
2	0.12552E-01	0.12553E-01	0.30091E-03	0.29316E-03	0.45819E-04	0.45485E-04
3	0.12717E-01	0.12719E-01	0.56728E-04	0.50391E-04	0.26353E-03	0.26355E-03
4	0.12878E-01	0.12879E-01	-0.18618E-03	-0.19160E-03	0.46970E-03	0.46946E-03
5	0.13146E-01	0.13126E-01	0.78652E-03	0.77983E-03	-0.64495E-03	-0.68888E-03
6	0.13245E-01	0.13230E-01	0.53376E-03	0.52771E-03	-0.51516E-03	-0.54891E-03
7	0.13362E-01	0.13356E-01	0.27252E-03	0.26672E-03	-0.36766E-03	-0.37995E-03
8	0.13511E-01	0.13513E-01	0.18173E-04	0.11516E-04	-0.20589E-03	-0.20485E-03
9	0.13337E-01	0.13316E-01	0.10694E-02	0.10614E-02	-0.80812E-03	-0.88214E-03
10	0.13453E-01	0.13434E-01	0.80801E-03	0.80177E-03	-0.84324E-03	-0.90518E-03
11	0.13572E-01	0.13558E-01	0.53667E-03	0.53019E-03	-0.84624E-03	-0.88487E-03
12	0.13736E-01	0.13737E-01	0.27435E-03	0.26646E-03	-0.83969E-03	-0.83834E-03
13	0.13047E-01	0.13033E-01	0.12375E-02	0.12297E-02	-0.68695E-03	-0.78979E-03
14	0.13170E-01	0.13155E-01	0.96866E-03	0.96317E-03	-0.89651E-03	-0.98835E-03
15	0.13292E-01	0.13276E-01	0.68867E-03	0.68249E-03	-0.10748E-02	-0.11419E-02
16	0.13474E-01	0.13468E-01	0.41745E-03	0.40814E-03	-0.12551E-02	-0.12612E-02
17	0.12334E-01	0.12329E-01	0.13103E-02	0.13029E-02	-0.37478E-03	-0.49827E-03
18	0.12463E-01	0.12456E-01	0.10381E-02	0.10339E-02	-0.75488E-03	-0.87950E-03
19	0.12580E-01	0.12564E-01	0.75240E-03	0.74746E-03	-0.11018E-02	-0.12264E-02
20	0.12790E-01	0.12757E-01	0.47565E-03	0.46493E-03	-0.14532E-02	-0.15472E-02
21	0.11301E-01	0.11284E-01	0.13128E-02	0.13016E-02	0.71507E-05	-0.10911E-03
22	0.11431E-01	0.11413E-01	0.10377E-02	0.10312E-02	-0.52514E-03	-0.66021E-03
23	0.11530E-01	0.11511E-01	0.74845E-03	0.74306E-03	-0.10280E-02	-0.11908E-02
24	0.11746E-01	0.11720E-01	0.47872E-03	0.47018E-03	-0.15256E-02	-0.17170E-02
25	0.10046E-01	0.99866E-02	0.12595E-02	0.12397E-02	0.37978E-03	0.28042E-03
26	0.10174E-01	0.10116E-01	0.98178E-03	0.96727E-03	-0.28738E-03	-0.41499E-03
27	0.10254E-01	0.10199E-01	0.68987E-03	0.67724E-03	-0.93732E-03	-0.10996E-02
28	0.10474E-01	0.10425E-01	0.42686E-03	0.41289E-03	-0.15709E-02	-0.17967E-02
29	0.86380E-02	0.85393E-02	0.11534E-02	0.11249E-02	0.68778E-03	0.59440E-03

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30	0.87592E-02	0.86632E-02	0.87570E-03	0.85258E-03	-0.97206E-04	-0.21498E-03
31	0.88196E-02	0.87281E-02	0.58446E-03	0.56314E-03	-0.87899E-03	-0.10213E-02
32	0.90455E-02	0.89646E-02	0.33012E-03	0.30701E-03	-0.16445E-02	-0.18344E-02
33	0.71360E-02	0.70240E-02	0.99814E-03	0.96472E-03	0.88626E-03	0.78860E-03
34	0.72441E-02	0.71378E-02	0.72410E-03	0.69695E-03	0.45644E-05	-0.10586E-03
35	0.72792E-02	0.71834E-02	0.43871E-03	0.41473E-03	-0.88870E-03	-0.99845E-03
36	0.74924E-02	0.74364E-02	0.20636E-03	0.18518E-03	-0.17556E-02	-0.18879E-02
37	0.56011E-02	0.55038E-02	0.80091E-03	0.76825E-03	0.94474E-03	0.84044E-03
38	0.56870E-02	0.55984E-02	0.53572E-03	0.51022E-03	-0.91855E-05	-0.11123E-03
39	0.56915E-02	0.56160E-02	0.26438E-03	0.24319E-03	-0.97734E-03	-0.10543E-02
40	0.58995E-02	0.58614E-02	0.61468E-04	0.43613E-04	-0.19180E-02	-0.19565E-02
41	0.40933E-02	0.40324E-02	0.57154E-03	0.54414E-03	0.84340E-03	0.73601E-03
42	0.41473E-02	0.40974E-02	0.32104E-03	0.30392E-03	-0.14774E-03	-0.23751E-03
43	0.41147E-02	0.40771E-02	0.69785E-04	0.59714E-04	-0.11445E-02	-0.11829E-02
44	0.43041E-02	0.43105E-02	-0.88763E-04	-0.96668E-04	-0.20622E-02	-0.20674E-02
45	0.26741E-02	0.26716E-02	0.32137E-03	0.29890E-03	0.59134E-03	0.50607E-03
46	0.26910E-02	0.26887E-02	0.10209E-03	0.95508E-04	-0.39905E-03	-0.48188E-03
47	0.26027E-02	0.26252E-02	-0.11377E-03	-0.11957E-03	-0.13115E-02	-0.14008E-02
48	0.27603E-02	0.27727E-02	-0.21699E-03	-0.24649E-03	-0.21210E-02	-0.21316E-02
49	0.13191E-02	0.13191E-02	0.43058E-04	0.43058E-04	0.32142E-04	0.32142E-04
50	0.14307E-02	0.14307E-02	-0.11456E-03	-0.11456E-03	-0.72190E-03	-0.72190E-03
51	0.13965E-02	0.13965E-02	-0.29695E-03	-0.29695E-03	-0.15867E-02	-0.15867E-02
52	0.13697E-02	0.13697E-02	-0.30765E-03	-0.30765E-03	-0.20616E-02	-0.20616E-02

Table 4: Winter Case- Nodal Displacements and Principal Stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.13588E-01	-0.84712E-24	-0.67999E-02	0.6148E+05	-0.2646E+05	-0.1200E+07
2	0.13493E-01	-0.20905E-23	-0.73145E-02	0.8271E+05	-0.3840E+05	-0.1100E+07
3	0.13395E-01	-0.19529E-23	-0.78452E-02	0.6993E+05	-0.4064E+05	-0.8794E+06
4	0.13296E-01	-0.11535E-23	-0.83595E-02	0.5105E+05	-0.1519E+05	-0.6223E+06
5	0.82537E-02	-0.16780E-23	-0.33835E-02	0.9015E+06	0.3270E+06	0.2236E+05
6	0.81409E-02	-0.40237E-23	-0.39899E-02	0.6851E+05	-0.4546E+06	-0.5696E+06
7	0.80689E-02	-0.34631E-23	-0.46391E-02	0.6554E+05	-0.4050E+06	-0.7797E+06
8	0.79527E-02	-0.20417E-23	-0.52674E-02	0.8271E+06	0.4155E+05	0.5156E+04
9	0.61331E-02	0.16995E-02	-0.27361E-02	0.1260E+07	0.6692E+06	0.2165E+05
10	0.60759E-02	0.14746E-02	-0.33156E-02	0.7217E+05	-0.2549E+06	-0.5456E+06
11	0.60653E-02	0.12584E-02	-0.39433E-02	0.5685E+05	-0.4783E+06	-0.9711E+06
12	0.60144E-02	0.10339E-02	-0.45580E-02	0.5245E+06	0.4421E+05	-0.3422E+06
13	0.43750E-02	0.19546E-02	-0.25196E-02	0.1265E+07	0.9501E+06	0.3906E+05
14	0.43475E-02	0.17233E-02	-0.30855E-02	0.5496E+05	-0.2461E+06	-0.5397E+06
15	0.43730E-02	0.15081E-02	-0.36997E-02	0.4699E+05	-0.4053E+06	-0.1246E+07
16	0.43571E-02	0.12819E-02	-0.43026E-02	0.6447E+06	0.6425E+05	-0.7392E+06
17	0.21737E-02	0.73044E-03	-0.11774E-02	0.1369E+07	0.9478E+06	0.3788E+05
18	0.21346E-02	0.56415E-03	-0.14653E-02	0.5366E+05	-0.1153E+06	-0.3468E+06
19	0.21454E-02	0.42323E-03	-0.17828E-02	0.5445E+05	-0.1582E+06	-0.8472E+06
20	0.21161E-02	0.25768E-03	-0.20919E-02	0.1067E+07	0.6766E+05	-0.1374E+06
21	0.96346E-03	0.70053E-03	-0.10254E-02	0.1640E+07	0.1211E+07	0.2053E+05
22	0.94727E-03	0.51286E-03	-0.12416E-02	0.4165E+06	0.2237E+05	-0.4957E+06
23	0.97841E-03	0.36205E-03	-0.14730E-02	0.3133E+06	0.4620E+05	-0.1129E+07
24	0.97677E-03	0.18477E-03	-0.16995E-02	0.1428E+07	0.3461E+05	-0.5032E+06
25	0.39772E-02	-0.12558E-23	-0.13107E-02	0.1248E+07	0.1625E+06	-0.1267E+06
26	0.39231E-02	-0.28851E-23	-0.19066E-02	0.6415E+05	-0.7180E+06	-0.9602E+06
27	0.39357E-02	-0.24239E-23	-0.25165E-02	0.1030E+06	-0.7317E+06	-0.1261E+07
28	0.38263E-02	-0.15724E-23	-0.30903E-02	0.1375E+07	0.1636E+06	0.7918E+05
29	0.24395E-02	0.85727E-03	-0.11590E-02	0.1361E+07	0.4305E+06	-0.1166E+06

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30	0.24521E-02	0.63812E-03	-0.16440E-02	0.5194E+05	-0.6637E+06	-0.8678E+06
31	0.25350E-02	0.43923E-03	-0.21320E-02	0.9022E+05	-0.7001E+06	-0.1381E+07
32	0.25045E-02	0.20353E-03	-0.25844E-02	0.1299E+07	0.8894E+05	-0.6055E+05
33	0.11563E-02	0.73817E-03	-0.11980E-02	0.1132E+07	0.6525E+06	-0.8414E+05
34	0.11925E-02	0.55410E-03	-0.16026E-02	-0.1503E+05	-0.7399E+06	-0.1088E+07
35	0.13006E-02	0.40825E-03	-0.19870E-02	0.1241E+05	-0.6801E+06	-0.1902E+07
36	0.13007E-02	0.20889E-03	-0.23326E-02	0.1291E+07	0.1011E+06	-0.7524E+06
37	0.51696E-03	0.59425E-04	-0.49002E-03	0.1497E+07	0.8062E+06	-0.1010E+06
38	0.51344E-03	-0.45935E-04	-0.69355E-03	-0.4018E+05	-0.1687E+06	-0.8051E+06
39	0.56159E-03	-0.10198E-03	-0.86077E-03	-0.2853E+05	-0.4606E+05	-0.1018E+07
40	0.50276E-03	-0.22794E-03	-0.10216E-02	0.1974E+07	0.5062E+06	0.4512E+05
41	0.12285E-02	-0.69296E-24	-0.10451E-02	0.6051E+06	0.5521E+06	-0.1508E+06
42	0.11837E-02	-0.17980E-23	-0.12995E-02	-0.1313E+06	-0.8868E+06	-0.1219E+07
43	0.12460E-02	-0.15949E-23	-0.15346E-02	0.6430E+05	-0.6531E+06	-0.1319E+07
44	0.11130E-02	-0.12025E-23	-0.17683E-02	0.1824E+07	0.8513E+06	0.1391E+06
45	0.59248E-03	0.19669E-03	-0.10113E-02	0.7380E+06	0.1755E+06	-0.2245E+06
46	0.60157E-03	0.46091E-04	-0.11652E-02	-0.2840E+06	-0.6829E+06	-0.1215E+07
47	0.67782E-03	-0.51298E-04	-0.12836E-02	-0.6534E+05	-0.4269E+06	-0.1295E+07
48	0.57100E-03	-0.19202E-03	-0.13869E-02	0.2037E+07	0.2896E+06	0.1832E+05
49	0.54355E-03	-0.24247E-24	-0.86044E-03	0.1184E+06	0.7364E+05	-0.5345E+06
50	0.56287E-03	-0.90795E-24	-0.12152E-02	-0.1652E+05	-0.3488E+06	-0.8609E+06
51	0.60929E-03	-0.81790E-24	-0.12696E-02	0.5426E+05	-0.1782E+06	-0.1059E+07
52	0.38039E-03	-0.37139E-24	-0.10505E-02	0.3254E+06	-0.8628E+05	-0.9559E+06

***Table 5:** Winter Case- Displacements at Joint 1*

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.63749E-02	0.10292E-01	0.25959E-02	0.45787E-02	-0.37249E-02	-0.61795E-02
2	0.63104E-02	0.10258E-01	0.22288E-02	0.42235E-02	-0.43606E-02	-0.72963E-02
3	0.63413E-02	0.10278E-01	0.24084E-02	0.44027E-02	-0.40349E-02	-0.67309E-02
4	0.62764E-02	0.10232E-01	0.20547E-02	0.40469E-02	-0.46738E-02	-0.78438E-02
5	0.55066E-02	0.86982E-02	0.20045E-02	0.38003E-02	-0.34277E-02	-0.58630E-02
6	0.54822E-02	0.86765E-02	0.18406E-02	0.36265E-02	-0.37446E-02	-0.64142E-02
7	0.54761E-02	0.86609E-02	0.16662E-02	0.34659E-02	-0.40688E-02	-0.69861E-02
8	0.54615E-02	0.86246E-02	0.14767E-02	0.33141E-02	-0.43756E-02	-0.75341E-02
9	0.45968E-02	0.68109E-02	0.14017E-02	0.31330E-02	-0.25568E-02	-0.46857E-02
10	0.45875E-02	0.67707E-02	0.12210E-02	0.29802E-02	-0.29093E-02	-0.53085E-02
11	0.46051E-02	0.67442E-02	0.10304E-02	0.28379E-02	-0.32709E-02	-0.59497E-02
12	0.46041E-02	0.67121E-02	0.83485E-03	0.26861E-02	-0.36440E-02	-0.65629E-02
13	0.36199E-02	0.50090E-02	0.92167E-03	0.25294E-02	-0.17013E-02	-0.34222E-02
14	0.35643E-02	0.50129E-02	0.80792E-03	0.22852E-02	-0.20490E-02	-0.40446E-02
15	0.35597E-02	0.50356E-02	0.67162E-03	0.20816E-02	-0.24172E-02	-0.47000E-02
16	0.35376E-02	0.50142E-02	0.49059E-03	0.19021E-02	-0.27949E-02	-0.53415E-02
17	0.27540E-02	0.34358E-02	0.52766E-03	0.19944E-02	-0.11033E-02	-0.25321E-02
18	0.26780E-02	0.34643E-02	0.44443E-03	0.17001E-02	-0.14084E-02	-0.31140E-02
19	0.26838E-02	0.35258E-02	0.33507E-03	0.14740E-02	-0.17431E-02	-0.37404E-02
20	0.26672E-02	0.35175E-02	0.15034E-03	0.12818E-02	-0.20831E-02	-0.43416E-02
21	0.20315E-02	0.21651E-02	0.23895E-03	0.15306E-02	-0.69975E-03	-0.19310E-02
22	0.19335E-02	0.22231E-02	0.18922E-03	0.11973E-02	-0.96252E-03	-0.24444E-02
23	0.19611E-02	0.23304E-02	0.10764E-03	0.97498E-03	-0.12499E-02	-0.30028E-02
24	0.19616E-02	0.23290E-02	-0.92268E-04	0.80291E-03	-0.15367E-02	-0.35199E-02
25	0.14361E-02	0.12200E-02	0.51610E-04	0.11239E-02	-0.43464E-03	-0.15283E-02
26	0.13187E-02	0.13079E-02	0.36235E-04	0.77454E-03	-0.65832E-03	-0.19508E-02
27	0.13729E-02	0.14526E-02	-0.18802E-04	0.58649E-03	-0.90645E-03	-0.24269E-02
28	0.14014E-02	0.14407E-02	-0.24442E-03	0.46675E-03	-0.11454E-02	-0.28383E-02
29	0.82906E-03	0.58510E-03	0.29307E-04	0.62591E-03	-0.27602E-03	-0.12190E-02
30	0.78482E-03	0.71060E-03	0.11331E-04	0.38562E-03	-0.50444E-03	-0.15873E-02
31	0.88914E-03	0.86354E-03	-0.64164E-04	0.30560E-03	-0.71033E-03	-0.19624E-02
32	0.94642E-03	0.81320E-03	-0.33069E-03	0.27872E-03	-0.89149E-03	-0.22470E-02
33	0.44497E-03	0.22028E-03	0.22976E-04	0.31183E-03	-0.42239E-03	-0.11299E-02
34	0.41292E-03	0.35687E-03	0.53069E-05	0.14031E-03	-0.56531E-03	-0.12852E-02
35	0.52433E-03	0.49695E-03	-0.68768E-04	0.16011E-03	-0.66018E-03	-0.14949E-02
36	0.57927E-03	0.39475E-03	-0.34274E-03	0.22808E-03	-0.75875E-03	-0.16703E-02
37	0.18846E-03	0.18846E-03	0.36084E-04	0.36084E-04	-0.62877E-03	-0.62877E-03
38	0.23503E-03	0.23503E-03	-0.64746E-04	-0.64746E-04	-0.79263E-03	-0.79263E-03
39	0.27626E-03	0.27626E-03	-0.67014E-04	-0.67014E-04	-0.83785E-03	-0.83785E-03
40	0.12633E-03	0.12633E-03	-0.85805E-04	-0.85805E-04	-0.75208E-03	-0.75208E-03

Table 6: Winter Case- Displacements at Joint 2

	[m]					
Node	D'x	D"x	D'y	D"y	D'z	D"z
1	0.12956E-01	0.12956E-01	0.16979E-02	0.16955E-02	-0.65228E-02	-0.65235E-02
2	0.12872E-01	0.12872E-01	0.15922E-02	0.15904E-02	-0.70418E-02	-0.70420E-02
3	0.12787E-01	0.12787E-01	0.14822E-02	0.14806E-02	-0.75759E-02	-0.75767E-02
4	0.12699E-01	0.12699E-01	0.13753E-02	0.13740E-02	-0.80936E-02	-0.80949E-02
5	0.11095E-01	0.11094E-01	0.14059E-02	0.14046E-02	-0.54772E-02	-0.54786E-02
6	0.11012E-01	0.11012E-01	0.12810E-02	0.12792E-02	-0.60289E-02	-0.60295E-02
7	0.10938E-01	0.10938E-01	0.11579E-02	0.11568E-02	-0.66050E-02	-0.66053E-02
8	0.10851E-01	0.10849E-01	0.10359E-02	0.10365E-02	-0.71565E-02	-0.71647E-02
9	0.93731E-02	0.93364E-02	0.12088E-02	0.12091E-02	-0.41710E-02	-0.42980E-02
10	0.92795E-02	0.92552E-02	0.10674E-02	0.10659E-02	-0.47810E-02	-0.48562E-02
11	0.92166E-02	0.91876E-02	0.92880E-03	0.92777E-03	-0.53985E-02	-0.54796E-02
12	0.91338E-02	0.90874E-02	0.76532E-03	0.81005E-03	-0.59946E-02	-0.60830E-02
13	0.77164E-02	0.77383E-02	0.10203E-02	0.10347E-02	-0.30398E-02	-0.33482E-02
14	0.76317E-02	0.76401E-02	0.88114E-03	0.89124E-03	-0.36522E-02	-0.39168E-02
15	0.75948E-02	0.75857E-02	0.73424E-03	0.75712E-03	-0.42996E-02	-0.45479E-02
16	0.75182E-02	0.74839E-02	0.52352E-03	0.66611E-03	-0.49354E-02	-0.51453E-02
17	0.62046E-02	0.62920E-02	0.84981E-03	0.88819E-03	-0.22043E-02	-0.25303E-02
18	0.61145E-02	0.61961E-02	0.72291E-03	0.74440E-03	-0.27729E-02	-0.31202E-02
19	0.61058E-02	0.61736E-02	0.57591E-03	0.63007E-03	-0.34016E-02	-0.37584E-02
20	0.60418E-02	0.60718E-02	0.33105E-03	0.59109E-03	-0,40175E-02	-0.43581E-02
21	0.49115E-02	0.49569E-02	0.69175E-03	0.78352E-03	-0.16006E-02	-0.18716E-02
22	0.48178E-02	0.48730E-02	0.59217E-03	0.60975E-03	-0.21257E-02	-0.24542E-02
23	0.48445E-02	0.48900E-02	0.44254E-03	0.51146E-03	-0.27173E-02	-0.30935E-02
24	0.47965E-02	0.47930E-02	0.15432E-03	0.52433E-03	-0.32855E-02	-0.36895E-02
25	0.37473E-02	0.37058E-02	0.61644E-03	0.60779E-03	-0.11647E-02	-0.13669E-02
26	0.37269E-02	0.36878E-02	0.48225E-03	0.47835E-03	-0.16896E-02	-0.19521E-02
27	0.37965E-02	0.37576E-02	0.32980E-03	0.39578E-03	-0.22214E-02	-0.25676E-02
28	0.37710E-02	0.36661E-02	-0.13441E-04	0.46588E-03	-0.27204E-02	-0.31253E-02
29	0.28451E-02	0.27260E-02	0.51291E-03	0.48833E-03	-0.10678E-02	-0.12360E-02

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30	0.28527E-02	0.27334E-02	0.38439E-03	0.36442E-03	-0.14756E-02	-0.16752E-02
31	0.29701E-02	0.28499E-02	0.23312E-03	0.30414E-03	-0.18876E-02	-0.21910E-02
32	0.29667E-02	0.27585E-02	-0.16279E-03	0.43584E-03	-0.22859E-02	-0.26547E-02
33	0.22011E-02	0.20470E-02	0.42748E-03	0.39267E-03	-0.99884E-03	-0.11596E-02
34	0.22111E-02	0.20549E-02	0.30636E-03	0.27594E-03	-0.13363E-02	-0.15035E-02
35	0.23516E-02	0.21938E-02	0.15083E-03	0.24954E-03	-0.16453E-02	-0.19133E-02
36	0.23611E-02	0.20940E-02	-0.28237E-03	0.43967E-03	-0.19466E-02	-0.22715E-02
37	0.17001E-02	0.15526E-02	0.34652E-03	0.30916E-03	-0.94454E-03	-0.10997E-02
38	0.17094E-02	0.15580E-02	0.23690E-03	0.20360E-03	-0.12281E-02	-0.13721E-02
39	0.18603E-02	0.17136E-02	0.84367E-04	0.21220E-03	-0.14536E-02	-0.16821E-02
40	0.18757E-02	0.16047E-02	-0.37049E-03	0.45819E-03	-0.16833E-02	-0.19593E-02
41	0.12828E-02	0.11823E-02	0.25202E-03	0.22842E-03	-0.89596E-03	-0.10326E-02
42	0.12812E-02	0.11819E-02	0.16227E-03	0.13912E-03	-0.11545E-02	-0.12361E-02
43	0.14220E-02	0.13332E-02	0.27689E-04	0.17539E-03	-0.12940E-02	-0.14706E-02
44	0.14321E-02	0.12094E-02	-0.42597E-03	0.46494E-03	-0.14649E-02	-0.16924E-02
45	0.91728E-03	0.89800E-03	0.13142E-03	0.14771E-03	-0.85277E-03	-0.94335E-03
46	0.88994E-03	0.89252E-03	0.74947E-04	0.77633E-04	-0.10923E-02	-0.11091E-02
47	0.10066E-02	0.98026E-03	-0.12833E-04	0.11019E-03	-0.11573E-02	-0.12784E-02
48	0.96626E-03	0.81422E-03	-0.42028E-03	0.40077E-03	-0.12451E-02	-0.14132E-02
49	0.54123E-03	0.54123E-03	0.30960E-04	0.30960E-04	-0.75943E-03	-0.75943E-03
50	0.59970E-03	0.59970E-03	-0.94868E-05	-0.94868E-05	-0.10918E-02	-0.10918E-02
51	0.66315E-03	0.66315E-03	-0.22750E-04	-0.22750E-04	-0.10677E-02	-0.10677E-02
52	0.40723E-03	0.40723E-03	-0.54153E-04	-0.54153E-04	-0.87100E-03	-0.87100E-03

*Figure 1: Summer Case, Load Condition (D+T+W): **a)** Opening Maps for Joint 1; **b)** Opening Maps for Joint 2*

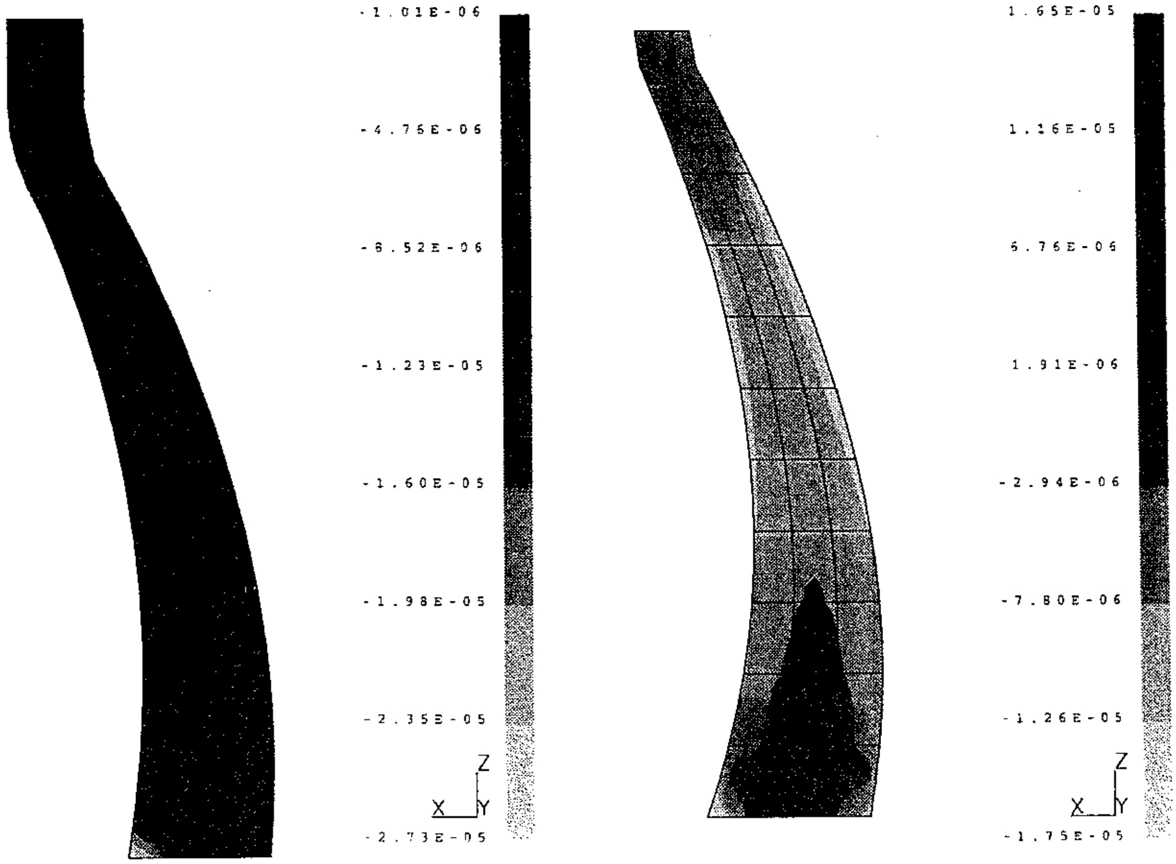
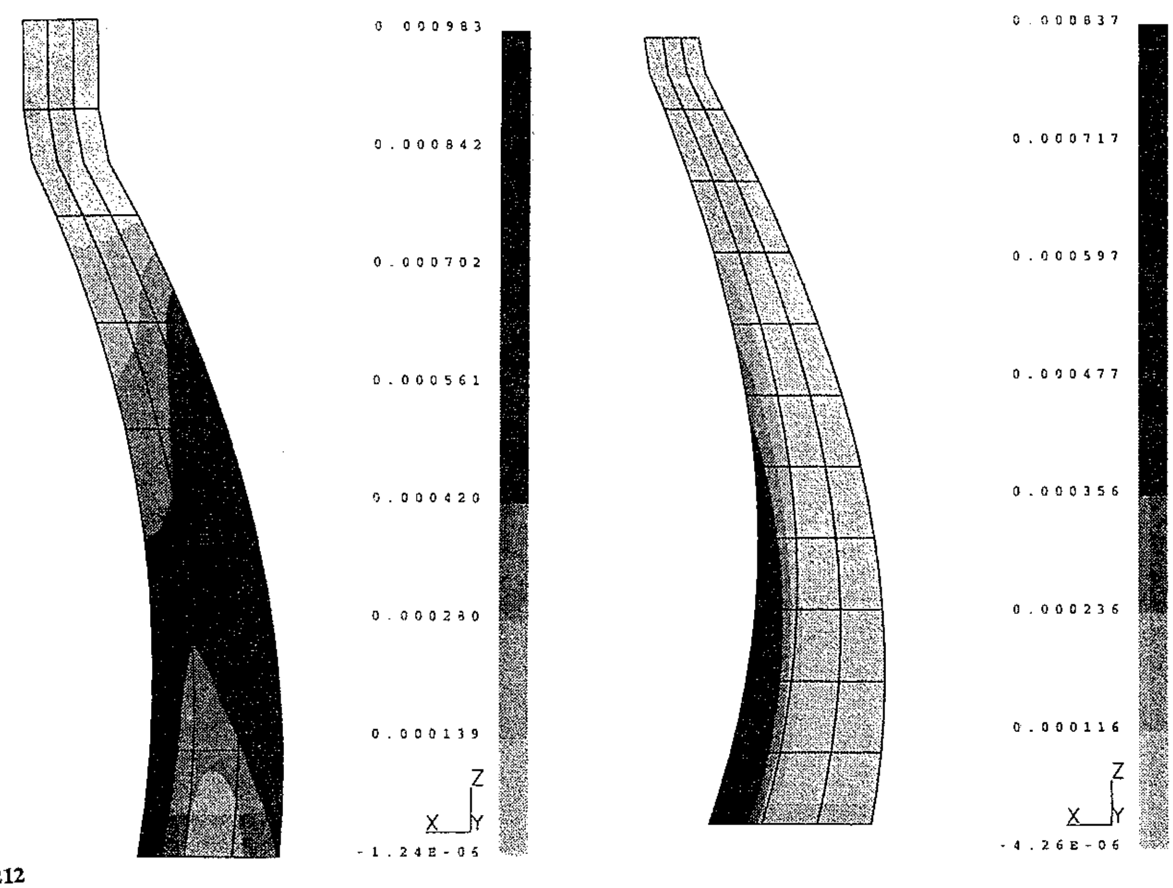


*Figure 2: Winter Case, Load Condition (D+T+W): **a)** Opening Maps for Joint 1; **b)** Opening Maps for Joint 2*



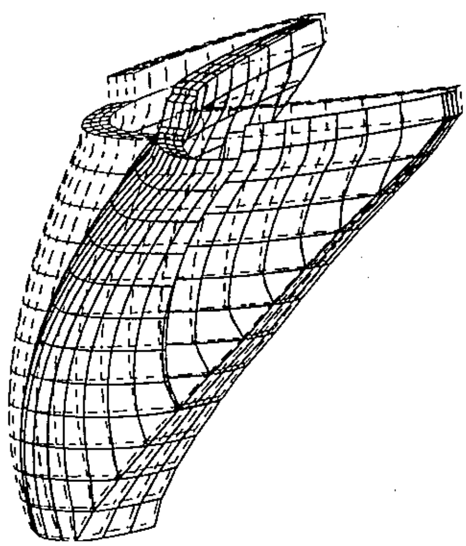
NOTES

THIRD I C O L D BENCHMARK WORKSHOP ON NUMERICAL ANALYSIS OF DAMS

Paris (France)
September 29 - 30, 1994

Theme A1 :

Non-linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam.



(Talvacchia Dam, Italy)

Program : **COBEF 4 • 09**

NOTEN

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PRESENTATION

This paper describes the results obtained for the 77 m high Talvacchia arch dam, in Italy, of non-linear analysis under dead weight, hydrostatic and steady-state thermal loading. The first part of this document presents the assumptions adopted for the numerical analysis. The second part presents the results requested by the organization committee.

1. ASSUMPTIONS ADOPTED FOR THE CALCULATION

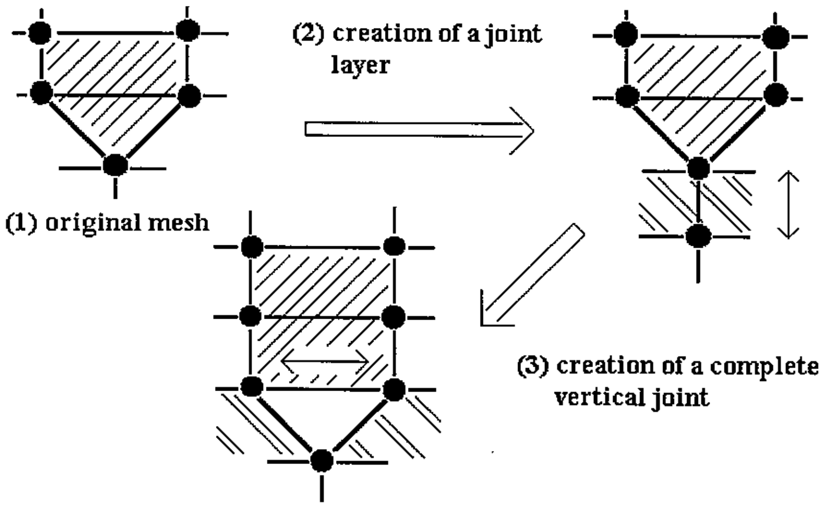
1.1. The program

The FEM code used for the analysis is COBEF (release 4.09), which has been developed by Coyne et Bellier and used for general purpose structural calculations. The non-linear behaviour of joints has been obtained by NOTEN, which is the non-linear part of COBEF and which allows the user to introduce joint elements in the structures wherever he wants to (even in a dam foundation).

1.2. The Finite Element Mesh

The mesh provided by the Organizers has been used after making the following modifications :

- A full joint layer has been adopted between the dam and its foundation in order to provide the structure with complete vertical joints and allow them to slide and open from the crest to the base if they want to, which was not the case with the mesh provided originally.



- The geometrical thickness of the joints has been increased to 0.5 m. This is simply an artifact for accelerating the convergence process of the non-linear calculation. The rigidity factor of the joints has been set to :

K_n=7.2 10^9 N.m^{-3}
K_t=3.0 10^9 N.m^{-3}

these values are equivalent to :

Young's elastic modulus (vertical joints)	E_y=3.6 10^9 N.m^{-2}
Poisson ration coefficient (vertical joints)	ν=0.2

As a consequence, the local deformations of the joints (and consequently, the overall deformation of the dam) are slightly increased. Even if this last assumption slightly overestimates the displacements, we have checked that it does not significantly affect the results, in terms of stresses, forces and relative displacements of the vertical joints, which are the main results expected from this study.

As the mesh is symmetrical, we could have used a half-mesh, but for easier graphical outputs, we chose to use the whole mesh.

1.3. Loading conditions

For both proposed loading conditions, calculations have been performed under the assumption of the presence of friction on joints' faces.

The weight of rock foundation has not been taken into account, as requested.

1.4. Physical and mechanical parameters

We have used the values which had to be assumed. The reader can easily refer to the instructions form provided by the organization committee.

The non-linear calculations have been performed as follows :

i) a linear-elastic calculation with complete loadings (dead weight + summer thermal distribution + water level 507 m a.s.l. and dead weight + winter thermal distribution + water level 471 m a.s.l.) so as to obtain the elastic reference.

ii) for each of the two load cases, a non-linear calculation, using an iterative method and starting from the elastic reference.

2. THE RESULTS

As requested, the results have been collected according to the suggested tables and pictures. For the part of the "summer" loading, the results are presented in appendix 1, and for the part of the "winter" one, they are presented in appendix 2. As requested, positive displacements correspond to the positive directions of the global reference axes, and tensile stresses are assumed to be positive. The node numbers which appear in the tables are defined according to the pictures provided by the organization committee.

The results are recorded on a diskette which is attached to this report.

2.1. Comments on the "summer" loading

(equilibrium obtained after 4 iterations)

There is no significant sliding (of the order of 1/10 mm) and no significant opening (of the order of 1/100 mm).

2.2. Comments on the "winter" loading

(equilibrium obtained after 57 iterations)

For the part of joint 1, we can notice a relative sliding of the order of 1 to 2 mm. For this joint, it is the "right bank" face which slides towards the top. We have drawn the iso-opening. The opening of joint 1 is less than 1 mm. This joint is closed at its crest.

For the part of joint 2, there is no significant relative sliding between the faces. The iso-opening picture shows that the opening takes place on the downstream part of the joint and that the upstream part is still closed.

One must notice that joint 1 is opened at its base. This opening has been made possible by our modifications of the mesh, and then tends to justify these operations.

To conclude, as shown in the tables, the results relating to joints 1 and 4 on the one hand, and joints 2 and 3, on the other hand, are symmetrical except for calculation precision limits.

Appendix 1.

Results concerning the "summer" loading

Displacements at joint 1

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	-0,0001	-0,0019	0,0011	-0,0001	-0,0020	0,0012
2	0,0002	-0,0022	0,0016	0,0003	-0,0023	0,0017
3	0,0004	-0,0025	0,0021	0,0006	-0,0027	0,0022
4	0,0007	-0,0028	0,0026	0,0009	-0,0030	0,0027
5	0,0015	-0,0014	0,0007	0,0016	-0,0015	0,0009
6	0,0017	-0,0017	0,0012	0,0019	-0,0019	0,0014
7	0,0020	-0,0020	0,0017	0,0021	-0,0022	0,0018
8	0,0022	-0,0022	0,0022	0,0025	-0,0026	0,0023
9	0,0030	-0,0004	0,0001	0,0031	-0,0006	0,0002
10	0,0032	-0,0007	0,0004	0,0034	-0,0010	0,0006
11	0,0035	-0,0010	0,0008	0,0037	-0,0014	0,0009
12	0,0037	-0,0013	0,0012	0,0040	-0,0018	0,0013
13	0,0039	0,0004	-0,0003	0,0040	0,0002	-0,0003
14	0,0041	0,0001	-0,0002	0,0043	-0,0002	-0,0001
15	0,0044	-0,0003	0,0001	0,0046	-0,0006	0,0001
16	0,0047	-0,0005	0,0003	0,0049	-0,0010	0,0003
17	0,0042	0,0009	-0,0004	0,0043	0,0007	-0,0004
18	0,0044	0,0006	-0,0004	0,0046	0,0003	-0,0004
19	0,0047	0,0002	-0,0004	0,0049	-0,0002	-0,0004
20	0,0050	-0,0001	-0,0003	0,0053	-0,0006	-0,0003
21	0,0040	0,0011	-0,0003	0,0042	0,0009	-0,0004
22	0,0043	0,0007	-0,0005	0,0045	0,0005	-0,0005
23	0,0046	0,0003	-0,0006	0,0047	0,0000	-0,0006
24	0,0049	0,0001	-0,0007	0,0052	-0,0004	-0,0008
25	0,0035	0,0011	-0,0002	0,0037	0,0009	-0,0003
26	0,0038	0,0006	-0,0005	0,0040	0,0005	-0,0005
27	0,0041	0,0003	-0,0007	0,0043	0,0000	-0,0008
28	0,0044	0,0000	-0,0010	0,0047	-0,0004	-0,0011
29	0,0029	0,0008	-0,0001	0,0030	0,0006	-0,0002
30	0,0032	0,0004	-0,0005	0,0033	0,0003	-0,0006
31	0,0034	0,0000	-0,0008	0,0036	-0,0002	-0,0010
32	0,0037	-0,0002	-0,0012	0,0040	-0,0006	-0,0014
33	0,0021	0,0004	-0,0002	0,0022	0,0003	-0,0002
34	0,0023	0,0000	-0,0006	0,0025	-0,0001	-0,0007
35	0,0025	-0,0004	-0,0010	0,0027	-0,0005	-0,0012
36	0,0028	-0,0005	-0,0014	0,0032	-0,0009	-0,0016
37	0,0012	-0,0003	-0,0004	0,0012	-0,0003	-0,0004
38	0,0014	-0,0006	-0,0008	0,0014	-0,0006	-0,0008
39	0,0016	-0,0009	-0,0012	0,0017	-0,0010	-0,0013
40	0,0017	-0,0010	-0,0016	0,0019	-0,0011	-0,0016

Displacements at joint 2

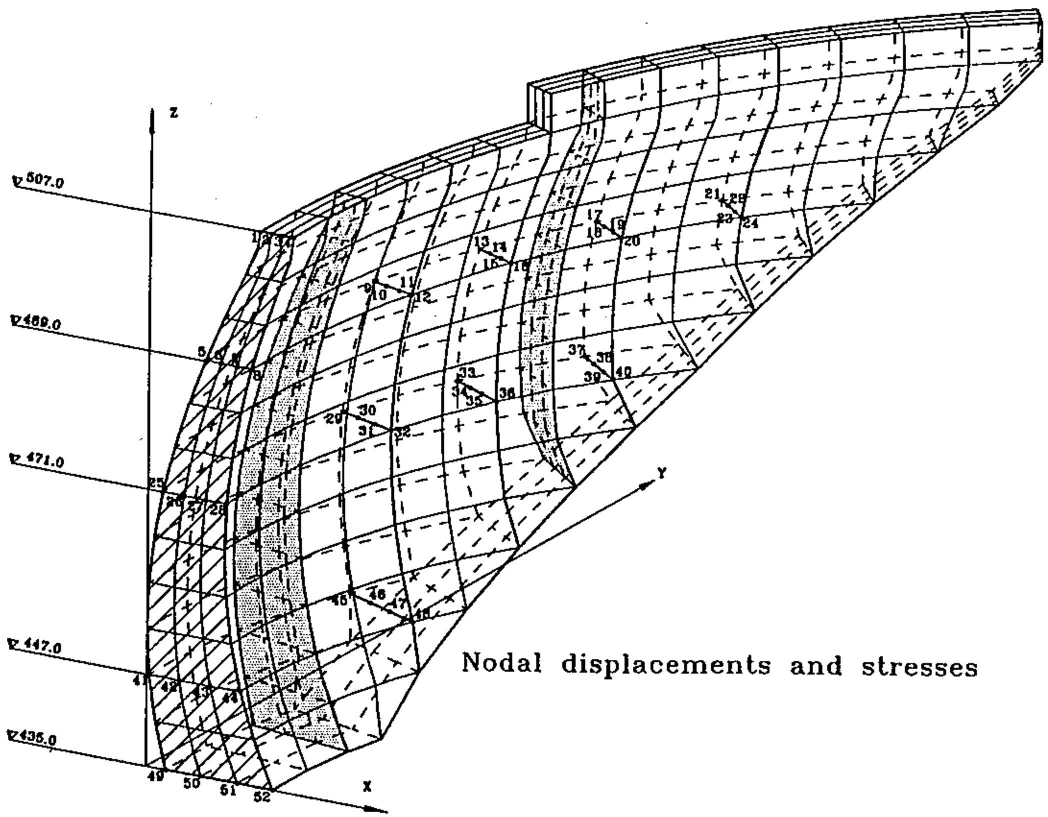
	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0,0138	0,0010	-0,0003	0,0139	0,0005	-0,0003
2	0,0139	0,0007	-0,0001	0,0140	0,0003	-0,0001
3	0,0141	0,0004	0,0001	0,0142	0,0000	0,0001
4	0,0143	0,0001	0,0003	0,0144	-0,0002	0,0003
5	0,0144	0,0012	-0,0008	0,0145	0,0008	-0,0007
6	0,0145	0,0009	-0,0007	0,0146	0,0005	-0,0006
7	0,0146	0,0006	-0,0005	0,0147	0,0003	-0,0005
8	0,0148	0,0004	-0,0004	0,0149	0,0000	-0,0004
9	0,0145	0,0015	-0,0009	0,0146	0,0011	-0,0009
10	0,0146	0,0012	-0,0010	0,0147	0,0008	-0,0009
11	0,0147	0,0009	-0,0010	0,0148	0,0005	-0,0009
12	0,0149	0,0006	-0,0010	0,0150	0,0002	-0,0010
13	0,0141	0,0017	-0,0007	0,0142	0,0012	-0,0007
14	0,0142	0,0014	-0,0010	0,0143	0,0009	-0,0009
15	0,0143	0,0011	-0,0012	0,0144	0,0007	-0,0012
16	0,0145	0,0008	-0,0014	0,0146	0,0003	-0,0014
17	0,0133	0,0018	-0,0004	0,0134	0,0013	-0,0004
18	0,0134	0,0014	-0,0008	0,0135	0,0010	-0,0008
19	0,0135	0,0011	-0,0012	0,0136	0,0007	-0,0012
20	0,0137	0,0009	-0,0016	0,0138	0,0004	-0,0016
21	0,0121	0,0017	0,0000	0,0122	0,0013	0,0001
22	0,0122	0,0014	-0,0005	0,0123	0,0010	-0,0005
23	0,0123	0,0011	-0,0011	0,0124	0,0007	-0,0011
24	0,0125	0,0008	-0,0017	0,0126	0,0004	-0,0017
25	0,0107	0,0017	0,0005	0,0108	0,0012	0,0005
26	0,0108	0,0013	-0,0003	0,0109	0,0009	-0,0003
27	0,0109	0,0010	-0,0010	0,0110	0,0006	-0,0010
28	0,0111	0,0007	-0,0017	0,0112	0,0003	-0,0018
29	0,0091	0,0015	0,0008	0,0092	0,0011	0,0008
30	0,0093	0,0011	0,0000	0,0093	0,0008	-0,0001
31	0,0093	0,0008	-0,0009	0,0094	0,0005	-0,0010
32	0,0095	0,0006	-0,0018	0,0096	0,0002	-0,0018
33	0,0075	0,0013	0,0010	0,0076	0,0009	0,0010
34	0,0076	0,0009	0,0001	0,0077	0,0007	0,0000
35	0,0076	0,0006	-0,0009	0,0077	0,0004	-0,0010
36	0,0078	0,0004	-0,0018	0,0079	0,0000	-0,0019
37	0,0058	0,0010	0,0011	0,0059	0,0007	0,0011
38	0,0059	0,0007	0,0001	0,0060	0,0005	0,0000
39	0,0059	0,0004	-0,0010	0,0060	0,0002	-0,0010
40	0,0061	0,0002	-0,0019	0,0062	-0,0001	-0,0021
41	0,0042	0,0008	0,0009	0,0043	0,0005	0,0009
42	0,0043	0,0004	-0,0001	0,0043	0,0003	-0,0001
43	0,0042	0,0001	-0,0011	0,0043	0,0000	-0,0012
44	0,0044	0,0000	-0,0021	0,0045	-0,0003	-0,0022
45	0,0027	0,0005	0,0007	0,0028	0,0003	0,0007
46	0,0027	0,0001	-0,0004	0,0028	0,0001	-0,0004
47	0,0026	-0,0001	-0,0013	0,0027	-0,0001	-0,0015
48	0,0028	-0,0001	-0,0022	0,0029	-0,0004	-0,0023
49	0,0013	0,0001	0,0001	0,0013	0,0000	0,0001
50	0,0014	-0,0001	-0,0007	0,0014	-0,0001	-0,0007
51	0,0014	-0,0003	-0,0016	0,0014	-0,0003	-0,0016
52	0,0014	-0,0002	-0,0021	0,0014	-0,0004	-0,0021

Displacements at joint 3

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0,0139	-0,0005	-0,0003	0,0138	-0,0010	-0,0003
2	0,0140	-0,0003	-0,0001	0,0139	-0,0007	-0,0001
3	0,0142	0,0000	0,0001	0,0141	-0,0004	0,0001
4	0,0144	0,0002	0,0003	0,0143	-0,0001	0,0003
5	0,0145	-0,0008	-0,0007	0,0144	-0,0012	-0,0008
6	0,0146	-0,0005	-0,0006	0,0145	-0,0009	-0,0007
7	0,0147	-0,0003	-0,0005	0,0146	-0,0006	-0,0005
8	0,0149	0,0000	-0,0004	0,0148	-0,0004	-0,0004
9	0,0146	-0,0011	-0,0009	0,0145	-0,0015	-0,0009
10	0,0147	-0,0008	-0,0009	0,0146	-0,0012	-0,0010
11	0,0148	-0,0005	-0,0009	0,0147	-0,0009	-0,0010
12	0,0150	-0,0002	-0,0010	0,0149	-0,0006	-0,0010
13	0,0142	-0,0012	-0,0007	0,0141	-0,0017	-0,0007
14	0,0143	-0,0009	-0,0009	0,0142	-0,0014	-0,0010
15	0,0144	-0,0007	-0,0012	0,0143	-0,0011	-0,0012
16	0,0146	-0,0003	-0,0014	0,0145	-0,0008	-0,0014
17	0,0134	-0,0013	-0,0004	0,0133	-0,0018	-0,0004
18	0,0135	-0,0010	-0,0008	0,0134	-0,0014	-0,0008
19	0,0136	-0,0007	-0,0012	0,0135	-0,0011	-0,0012
20	0,0138	-0,0004	-0,0016	0,0137	-0,0009	-0,0016
21	0,0122	-0,0013	0,0001	0,0121	-0,0017	0,0000
22	0,0123	-0,0010	-0,0005	0,0122	-0,0014	-0,0005
23	0,0124	-0,0007	-0,0011	0,0123	-0,0011	-0,0011
24	0,0126	-0,0004	-0,0017	0,0125	-0,0008	-0,0017
25	0,0108	-0,0012	0,0005	0,0107	-0,0016	0,0005
26	0,0109	-0,0009	-0,0003	0,0108	-0,0013	-0,0003
27	0,0110	-0,0006	-0,0010	0,0109	-0,0010	-0,0010
28	0,0112	-0,0003	-0,0018	0,0111	-0,0007	-0,0017
29	0,0092	-0,0011	0,0008	0,0091	-0,0015	0,0008
30	0,0093	-0,0008	-0,0001	0,0093	-0,0011	0,0000
31	0,0094	-0,0005	-0,0010	0,0093	-0,0008	-0,0009
32	0,0096	-0,0002	-0,0018	0,0095	-0,0006	-0,0018
33	0,0076	-0,0009	0,0010	0,0075	-0,0013	0,0010
34	0,0077	-0,0007	0,0000	0,0076	-0,0009	0,0001
35	0,0077	-0,0004	-0,0010	0,0076	-0,0006	-0,0009
36	0,0079	0,0000	-0,0019	0,0078	-0,0004	-0,0018
37	0,0059	-0,0007	0,0011	0,0058	-0,0010	0,0011
38	0,0060	-0,0005	0,0000	0,0059	-0,0007	0,0001
39	0,0060	-0,0002	-0,0010	0,0059	-0,0004	-0,0010
40	0,0062	0,0001	-0,0021	0,0061	-0,0002	-0,0019
41	0,0043	-0,0005	0,0009	0,0042	-0,0008	0,0009
42	0,0043	-0,0003	-0,0001	0,0043	-0,0004	-0,0001
43	0,0043	0,0000	-0,0012	0,0042	-0,0001	-0,0011
44	0,0045	0,0003	-0,0022	0,0044	0,0000	-0,0021
45	0,0028	-0,0003	0,0007	0,0027	-0,0005	0,0007
46	0,0028	-0,0001	-0,0004	0,0027	-0,0001	-0,0004
47	0,0027	0,0001	-0,0015	0,0026	0,0001	-0,0013
48	0,0029	0,0004	-0,0023	0,0028	0,0001	-0,0022
49	0,0013	0,0000	0,0001	0,0013	-0,0001	0,0001
50	0,0014	0,0001	-0,0007	0,0014	0,0001	-0,0007
51	0,0014	0,0003	-0,0016	0,0014	0,0003	-0,0016
52	0,0014	0,0004	-0,0021	0,0014	0,0002	-0,0021

Diplacements at joint 4

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	-0,0001	0,0020	0,0012	-0,0001	0,0019	0,0011
2	0,0003	0,0023	0,0017	0,0002	0,0022	0,0016
3	0,0006	0,0027	0,0022	0,0004	0,0025	0,0021
4	0,0009	0,0030	0,0027	0,0007	0,0028	0,0026
5	0,0016	0,0015	0,0009	0,0015	0,0014	0,0007
6	0,0019	0,0019	0,0014	0,0017	0,0017	0,0012
7	0,0021	0,0022	0,0018	0,0020	0,0020	0,0017
8	0,0025	0,0026	0,0023	0,0022	0,0022	0,0022
9	0,0031	0,0006	0,0002	0,0030	0,0004	0,0001
10	0,0034	0,0010	0,0006	0,0032	0,0007	0,0004
11	0,0037	0,0014	0,0009	0,0035	0,0010	0,0008
12	0,0040	0,0018	0,0013	0,0037	0,0013	0,0012
13	0,0040	-0,0002	-0,0003	0,0039	-0,0004	-0,0003
14	0,0043	0,0002	-0,0001	0,0041	-0,0001	-0,0002
15	0,0046	0,0006	0,0001	0,0044	0,0003	0,0001
16	0,0049	0,0010	0,0003	0,0047	0,0005	0,0003
17	0,0043	-0,0007	-0,0004	0,0042	-0,0009	-0,0004
18	0,0046	-0,0003	-0,0004	0,0044	-0,0006	-0,0004
19	0,0049	0,0002	-0,0004	0,0047	-0,0002	-0,0004
20	0,0053	0,0006	-0,0003	0,0050	0,0001	-0,0003
21	0,0042	-0,0009	-0,0004	0,0040	-0,0011	-0,0003
22	0,0045	-0,0005	-0,0005	0,0043	-0,0007	-0,0005
23	0,0047	0,0000	-0,0006	0,0046	-0,0003	-0,0006
24	0,0052	0,0004	-0,0008	0,0049	-0,0001	-0,0007
25	0,0037	-0,0009	-0,0003	0,0035	-0,0011	-0,0002
26	0,0040	-0,0005	-0,0005	0,0038	-0,0006	-0,0005
27	0,0043	0,0000	-0,0008	0,0041	-0,0003	-0,0007
28	0,0047	0,0004	-0,0011	0,0044	0,0000	-0,0010
29	0,0030	-0,0006	-0,0002	0,0029	-0,0008	-0,0001
30	0,0033	-0,0003	-0,0006	0,0032	-0,0004	-0,0005
31	0,0036	0,0002	-0,0010	0,0034	0,0000	-0,0008
32	0,0040	0,0006	-0,0014	0,0037	0,0002	-0,0012
33	0,0022	-0,0003	-0,0002	0,0021	-0,0004	-0,0002
34	0,0025	0,0001	-0,0007	0,0023	0,0000	-0,0006
35	0,0027	0,0005	-0,0012	0,0025	0,0004	-0,0010
36	0,0032	0,0009	-0,0016	0,0028	0,0005	-0,0014
37	0,0012	0,0003	-0,0004	0,0012	0,0003	-0,0004
38	0,0014	0,0006	-0,0008	0,0014	0,0006	-0,0008
39	0,0017	0,0010	-0,0013	0,0016	0,0009	-0,0012
40	0,0019	0,0011	-0,0016	0,0017	0,0010	-0,0016



Nodal displacements and stresses

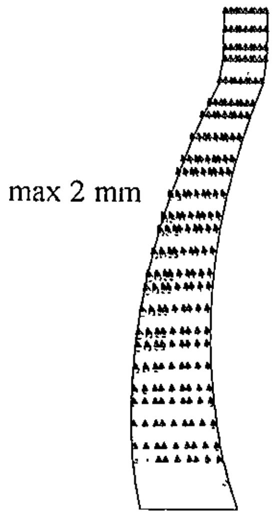
Nodal displacements and stresses

Node	[m] D'x	D'y	D'z	[MPa] P1	P2	P3
1	0.0155	0.0000	-0.0005	0.15	0.05	-3.03
2	0.0157	0.0000	-0.0003	0.04	-0.20	-3.33
3	0.0158	0.0000	-0.0002	0.03	-0.05	-2.67
4	0.0159	0.0000	0.0000	0.06	0.00	-2.11
5	0.0155	0.0000	-0.0008	-0.17	-2.05	-4.43
6	0.0156	0.0000	-0.0011	-0.11	-0.46	-3.04
7	0.0157	0.0000	-0.0013	0.03	-0.07	-2.78
8	0.0158	0.0000	-0.0015	0.01	-0.58	-3.59
9	0.0107	-0.0021	-0.0006	-0.17	-1.91	-3.72
10	0.0109	-0.0016	-0.0008	-0.12	-0.43	-2.66
11	0.0111	-0.0011	-0.0009	-0.02	-0.10	-2.82
12	0.0114	-0.0007	-0.0010	0.01	-0.72	-4.14
13	0.0064	-0.0014	-0.0005	-0.18	-1.78	-3.01
14	0.0067	-0.0009	-0.0005	-0.10	-0.32	-2.12
15	0.0069	-0.0004	-0.0006	0.07	-0.07	-2.61
16	0.0073	0.0000	-0.0006	0.00	-0.70	-4.36
17	0.0028	-0.0003	-0.0004	-0.17	-1.73	-2.07
18	0.0031	-0.0001	-0.0004	-0.09	-0.18	-1.57
19	0.0033	0.0002	-0.0003	0.21	-0.05	-2.46
20	0.0036	0.0004	-0.0002	-0.01	-0.61	-4.64
21	0.0011	0.0007	-0.0004	-0.15	-1.38	-1.78
22	0.0013	0.0007	-0.0003	-0.06	-0.14	-1.17
23	0.0014	0.0008	-0.0002	0.16	-0.10	-2.08
24	0.0016	0.0008	-0.0001	-0.01	-0.85	-4.34
25	0.0118	0.0000	0.0006	-0.33	-2.23	-4.34
26	0.0119	0.0000	-0.0002	-0.16	-0.38	-2.25
27	0.0120	0.0000	-0.0010	0.00	-0.36	-1.98
28	0.0121	0.0000	-0.0018	0.01	-2.14	-3.77
29	0.0079	-0.0020	0.0003	-0.34	-1.95	-3.51
30	0.0082	-0.0015	-0.0003	-0.08	-0.31	-1.77
31	0.0084	-0.0010	-0.0010	0.01	-0.30	-1.99
32	0.0087	-0.0006	-0.0016	0.00	-2.13	-4.38
33	0.0045	-0.0013	0.0000	-0.34	-1.70	-2.55
34	0.0048	-0.0009	-0.0005	0.15	-0.26	-1.18
35	0.0051	-0.0003	-0.0010	0.18	-0.25	-1.94
36	0.0055	0.0001	-0.0014	0.02	-2.08	-4.92
37	0.0019	-0.0002	-0.0003	-0.33	-1.42	-1.60
38	0.0021	0.0001	-0.0005	0.41	-0.18	-0.74
39	0.0024	0.0004	-0.0009	0.32	-0.19	-2.05
40	0.0027	0.0005	-0.0011	0.38	-2.22	-4.99
41	0.0049	0.0000	0.0012	-0.59	-1.27	-2.56
42	0.0049	0.0000	0.0001	0.31	-0.45	-0.68
43	0.0048	0.0000	-0.0011	-0.04	-0.33	-1.07
44	0.0050	0.0000	-0.0022	-0.03	-3.06	-4.54
45	0.0024	-0.0006	0.0004	-0.56	-1.09	-1.90
46	0.0026	-0.0002	-0.0005	0.84	0.27	-0.85
47	0.0027	0.0003	-0.0013	0.23	0.05	-1.93
48	0.0030	0.0006	-0.0021	0.52	-2.48	-5.34
49	0.0016	0.0000	0.0003	2.35	-0.46	-0.65
50	0.0017	0.0000	-0.0006	0.76	0.71	-0.48
51	0.0016	0.0000	-0.0017	0.36	-0.43	-0.94
52	0.0016	0.0000	-0.0023	-0.49	-3.39	-7.98

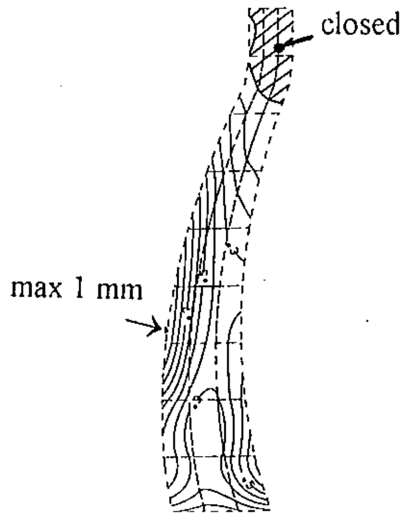
Appendix 2.

Results concerning the "winter" loading

relative sliding of the faces



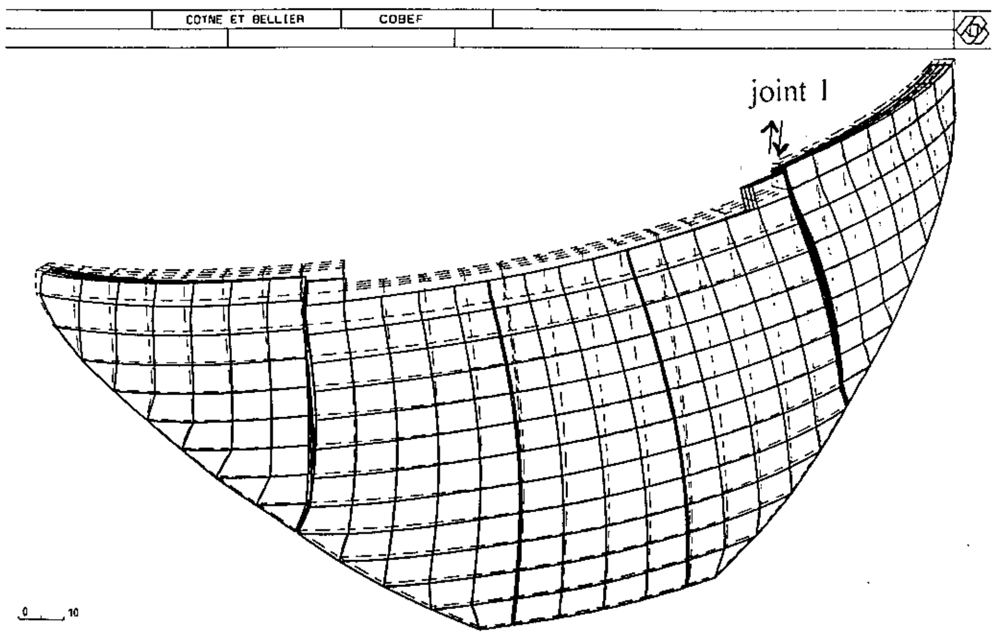
iso-opening of the joint



Displacements at joint 1

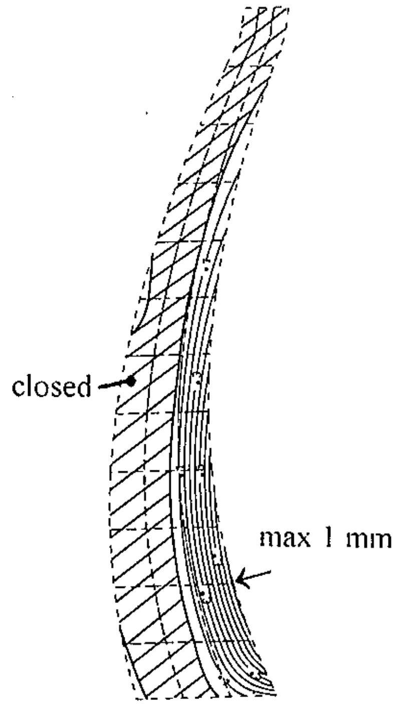
Node	D'x	D'y	D'z	D"x	D"y	D"z
	[m]					
1	0.0079	0.0042	-0.0043	0.0078	0.0042	-0.0054
2	0.0079	0.0039	-0.0047	0.0079	0.0039	-0.0058
3	0.0079	0.0037	-0.0051	0.0079	0.0036	-0.0062
4	0.0079	0.0034	-0.0056	0.0079	0.0034	-0.0066
5	0.0068	0.0032	-0.0039	0.0067	0.0033	-0.0051
6	0.0068	0.0030	-0.0043	0.0067	0.0030	-0.0055
7	0.0068	0.0028	-0.0048	0.0068	0.0028	-0.0059
8	0.0068	0.0025	-0.0052	0.0068	0.0025	-0.0064
9	0.0054	0.0023	-0.0028	0.0054	0.0027	-0.0042
10	0.0054	0.0021	-0.0033	0.0055	0.0024	-0.0047
11	0.0055	0.0019	-0.0039	0.0055	0.0022	-0.0051
12	0.0055	0.0016	-0.0044	0.0055	0.0019	-0.0056
13	0.0041	0.0015	-0.0018	0.0042	0.0023	-0.0033
14	0.0041	0.0013	-0.0023	0.0042	0.0020	-0.0038
15	0.0041	0.0012	-0.0028	0.0043	0.0017	-0.0043
16	0.0041	0.0010	-0.0033	0.0043	0.0014	-0.0048
17	0.0030	0.0008	-0.0011	0.0030	0.0019	-0.0025
18	0.0029	0.0008	-0.0015	0.0030	0.0015	-0.0030
19	0.0030	0.0006	-0.0019	0.0031	0.0013	-0.0035
20	0.0029	0.0005	-0.0024	0.0031	0.0010	-0.0040
21	0.0021	0.0004	-0.0007	0.0019	0.0015	-0.0019
22	0.0020	0.0004	-0.0010	0.0020	0.0011	-0.0024
23	0.0021	0.0003	-0.0014	0.0021	0.0009	-0.0029
24	0.0021	0.0001	-0.0017	0.0021	0.0007	-0.0033
25	0.0015	0.0001	-0.0004	0.0011	0.0011	-0.0015
26	0.0013	0.0001	-0.0007	0.0012	0.0007	-0.0019
27	0.0014	0.0001	-0.0010	0.0014	0.0005	-0.0024
28	0.0014	-0.0002	-0.0013	0.0014	0.0004	-0.0027
29	0.0008	0.0000	-0.0003	0.0006	0.0006	-0.0012
30	0.0008	0.0000	-0.0005	0.0007	0.0004	-0.0016
31	0.0009	0.0000	-0.0008	0.0008	0.0003	-0.0019
32	0.0010	-0.0003	-0.0010	0.0008	0.0002	-0.0022
33	0.0004	0.0000	-0.0004	0.0002	0.0003	-0.0011
34	0.0004	0.0000	-0.0006	0.0004	0.0001	-0.0013
35	0.0005	-0.0001	-0.0007	0.0005	0.0001	-0.0015
36	0.0006	-0.0003	-0.0008	0.0004	0.0002	-0.0017
37	0.0002	0.0000	-0.0006	0.0002	0.0001	-0.0007
38	0.0002	-0.0001	-0.0008	0.0002	-0.0001	-0.0009
39	0.0003	-0.0001	-0.0008	0.0003	0.0000	-0.0009
40	0.0001	-0.0002	-0.0007	0.0001	0.0000	-0.0009

global displacement of the dam

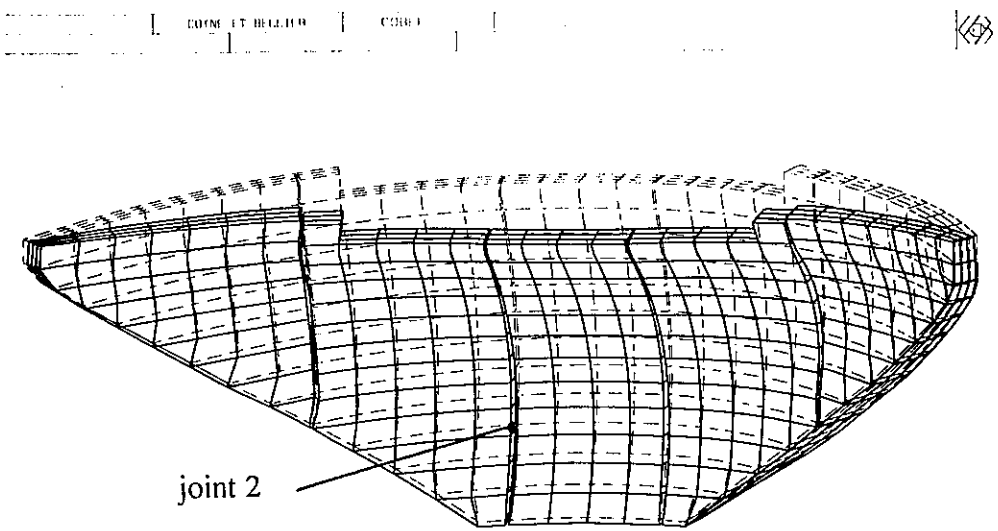


iso-opening of the joint

no significant sliding



global displacement of the dam



Displacements at joint 2

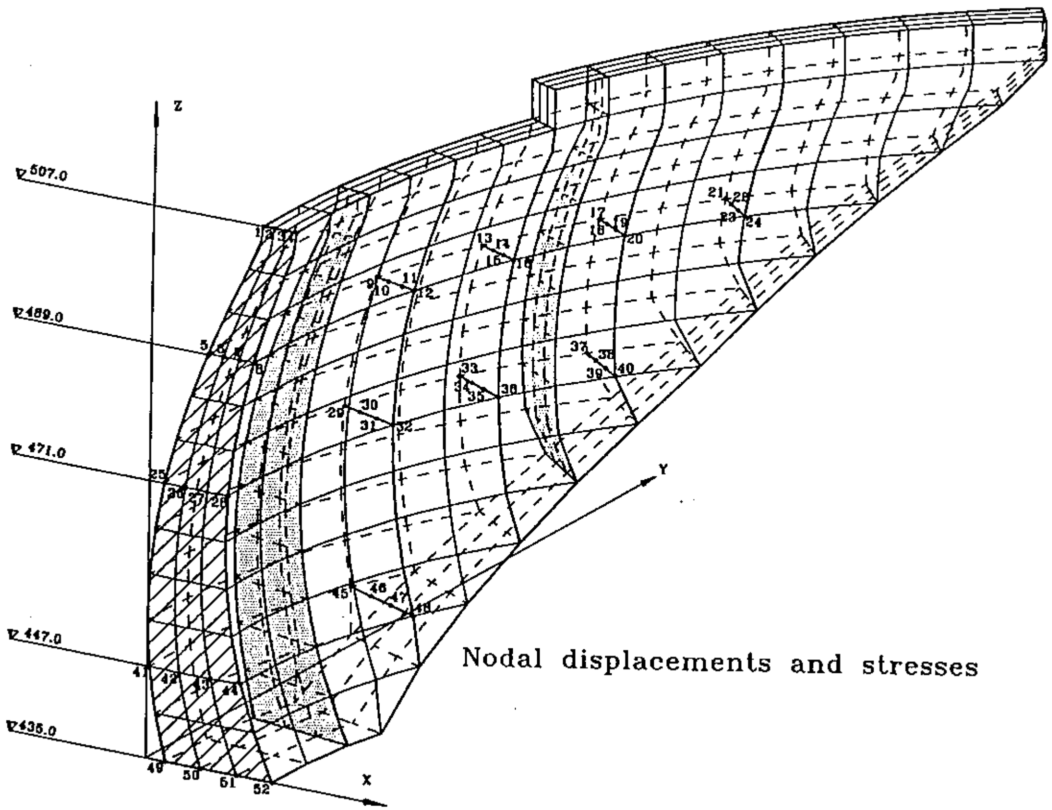
Node	D'x	D'y	D'z	D"x	D"y	D"z
	[m]					
1	0.0131	0.0018	-0.0065	0.0131	0.0016	-0.0065
2	0.0130	0.0016	-0.0070	0.0130	0.0015	-0.0070
3	0.0129	0.0015	-0.0075	0.0129	0.0014	-0.0075
4	0.0128	0.0013	-0.0080	0.0128	0.0013	-0.0081
5	0.0112	0.0015	-0.0054	0.0112	0.0014	-0.0055
6	0.0111	0.0013	-0.0060	0.0111	0.0012	-0.0060
7	0.0111	0.0012	-0.0066	0.0111	0.0011	-0.0066
8	0.0110	0.0010	-0.0071	0.0110	0.0010	-0.0071
9	0.0095	0.0013	-0.0042	0.0095	0.0012	-0.0042
10	0.0094	0.0011	-0.0048	0.0094	0.0011	-0.0048
11	0.0093	0.0010	-0.0054	0.0093	0.0009	-0.0054
12	0.0093	0.0008	-0.0060	0.0092	0.0008	-0.0060
13	0.0078	0.0011	-0.0031	0.0078	0.0011	-0.0032
14	0.0077	0.0010	-0.0037	0.0078	0.0009	-0.0038
15	0.0077	0.0008	-0.0043	0.0077	0.0008	-0.0044
16	0.0076	0.0006	-0.0049	0.0076	0.0007	-0.0050
17	0.0063	0.0009	-0.0023	0.0064	0.0009	-0.0023
18	0.0063	0.0008	-0.0029	0.0063	0.0008	-0.0029
19	0.0063	0.0006	-0.0035	0.0063	0.0006	-0.0036
20	0.0062	0.0004	-0.0041	0.0062	0.0006	-0.0042
21	0.0050	0.0008	-0.0017	0.0050	0.0008	-0.0017
22	0.0049	0.0007	-0.0022	0.0050	0.0006	-0.0023
23	0.0050	0.0005	-0.0028	0.0050	0.0005	-0.0029
24	0.0049	0.0002	-0.0034	0.0049	0.0005	-0.0035
25	0.0038	0.0007	-0.0012	0.0038	0.0006	-0.0012
26	0.0038	0.0006	-0.0017	0.0038	0.0005	-0.0018
27	0.0039	0.0004	-0.0023	0.0039	0.0004	-0.0024
28	0.0039	0.0000	-0.0028	0.0038	0.0005	-0.0030
29	0.0029	0.0005	-0.0011	0.0029	0.0005	-0.0011
30	0.0029	0.0004	-0.0015	0.0029	0.0003	-0.0015
31	0.0030	0.0003	-0.0019	0.0030	0.0003	-0.0021
32	0.0030	-0.0002	-0.0023	0.0029	0.0004	-0.0025
33	0.0022	0.0004	-0.0010	0.0022	0.0004	-0.0010
34	0.0022	0.0003	-0.0014	0.0022	0.0002	-0.0014
35	0.0024	0.0002	-0.0017	0.0024	0.0003	-0.0018
36	0.0024	-0.0003	-0.0020	0.0023	0.0005	-0.0022
37	0.0017	0.0003	-0.0010	0.0017	0.0003	-0.0010
38	0.0017	0.0003	-0.0012	0.0017	0.0002	-0.0013
39	0.0019	0.0001	-0.0015	0.0019	0.0002	-0.0016
40	0.0019	-0.0004	-0.0017	0.0017	0.0005	-0.0019
41	0.0013	0.0002	-0.0009	0.0013	0.0002	-0.0009
42	0.0013	0.0002	-0.0011	0.0013	0.0001	-0.0012
43	0.0014	0.0000	-0.0013	0.0014	0.0002	-0.0014
44	0.0014	-0.0004	-0.0015	0.0013	0.0005	-0.0017
45	0.0009	0.0001	-0.0008	0.0009	0.0002	-0.0009
46	0.0009	0.0001	-0.0011	0.0009	0.0000	-0.0011
47	0.0010	0.0000	-0.0011	0.0010	0.0001	-0.0012
48	0.0010	-0.0004	-0.0012	0.0008	0.0004	-0.0014
49	0.0005	0.0000	-0.0007	0.0005	0.0000	-0.0007
50	0.0006	0.0000	-0.0010	0.0006	0.0000	-0.0010
51	0.0007	0.0000	-0.0010	0.0007	0.0000	-0.0011
52	0.0004	-0.0001	-0.0008	0.0004	0.0000	-0.0009

Displacements at joint 3

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0131	-0.0016	-0.0065	0.0131	-0.0018	-0.0065
2	0.0130	-0.0015	-0.0070	0.0130	-0.0016	-0.0070
3	0.0129	-0.0014	-0.0075	0.0129	-0.0015	-0.0075
4	0.0128	-0.0013	-0.0081	0.0128	-0.0013	-0.0080
5	0.0112	-0.0014	-0.0055	0.0112	-0.0015	-0.0054
6	0.0111	-0.0012	-0.0060	0.0111	-0.0013	-0.0060
7	0.0111	-0.0011	-0.0066	0.0111	-0.0012	-0.0066
8	0.0110	-0.0010	-0.0071	0.0110	-0.0010	-0.0071
9	0.0095	-0.0012	-0.0042	0.0095	-0.0013	-0.0042
10	0.0094	-0.0011	-0.0048	0.0094	-0.0011	-0.0048
11	0.0093	-0.0009	-0.0054	0.0093	-0.0010	-0.0054
12	0.0092	-0.0008	-0.0060	0.0093	-0.0008	-0.0060
13	0.0078	-0.0011	-0.0032	0.0078	-0.0011	-0.0031
14	0.0078	-0.0009	-0.0038	0.0077	-0.0010	-0.0037
15	0.0077	-0.0008	-0.0044	0.0077	-0.0008	-0.0043
16	0.0076	-0.0007	-0.0050	0.0076	-0.0006	-0.0049
17	0.0064	-0.0009	-0.0023	0.0063	-0.0009	-0.0023
18	0.0063	-0.0008	-0.0029	0.0063	-0.0008	-0.0029
19	0.0063	-0.0006	-0.0036	0.0063	-0.0006	-0.0035
20	0.0062	-0.0006	-0.0042	0.0062	-0.0004	-0.0041
21	0.0050	-0.0008	-0.0017	0.0050	-0.0008	-0.0017
22	0.0050	-0.0006	-0.0023	0.0049	-0.0007	-0.0022
23	0.0050	-0.0005	-0.0029	0.0050	-0.0005	-0.0028
24	0.0049	-0.0005	-0.0035	0.0049	-0.0002	-0.0034
25	0.0038	-0.0006	-0.0012	0.0038	-0.0007	-0.0012
26	0.0038	-0.0005	-0.0018	0.0038	-0.0005	-0.0017
27	0.0039	-0.0004	-0.0024	0.0039	-0.0004	-0.0023
28	0.0038	-0.0005	-0.0030	0.0039	0.0000	-0.0028
29	0.0029	-0.0005	-0.0011	0.0029	-0.0005	-0.0011
30	0.0029	-0.0003	-0.0015	0.0029	-0.0004	-0.0015
31	0.0030	-0.0003	-0.0021	0.0030	-0.0003	-0.0019
32	0.0029	-0.0004	-0.0025	0.0030	0.0002	-0.0023
33	0.0022	-0.0004	-0.0010	0.0022	-0.0004	-0.0010
34	0.0022	-0.0002	-0.0014	0.0022	-0.0003	-0.0014
35	0.0024	-0.0003	-0.0018	0.0024	-0.0002	-0.0017
36	0.0023	-0.0005	-0.0022	0.0024	0.0003	-0.0020
37	0.0017	-0.0003	-0.0010	0.0017	-0.0003	-0.0010
38	0.0017	-0.0002	-0.0013	0.0017	-0.0003	-0.0012
39	0.0019	-0.0002	-0.0016	0.0019	-0.0001	-0.0015
40	0.0017	-0.0005	-0.0019	0.0019	0.0004	-0.0017
41	0.0013	-0.0002	-0.0009	0.0013	-0.0002	-0.0009
42	0.0013	-0.0001	-0.0012	0.0013	-0.0002	-0.0011
43	0.0014	-0.0002	-0.0014	0.0014	0.0000	-0.0013
44	0.0013	-0.0005	-0.0017	0.0014	0.0004	-0.0015
45	0.0009	-0.0002	-0.0009	0.0009	-0.0001	-0.0008
46	0.0009	0.0000	-0.0011	0.0009	-0.0001	-0.0011
47	0.0010	-0.0001	-0.0012	0.0010	0.0000	-0.0011
48	0.0008	-0.0004	-0.0014	0.0010	0.0004	-0.0012
49	0.0005	0.0000	-0.0007	0.0005	0.0000	-0.0007
50	0.0006	0.0000	-0.0010	0.0006	0.0000	-0.0010
51	0.0007	0.0000	-0.0011	0.0007	0.0000	-0.0010
52	0.0004	0.0000	-0.0009	0.0004	0.0001	-0.0008

Displacements at joint 4

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0078	-0.0042	-0.0054	0.0079	-0.0042	-0.0043
2	0.0079	-0.0039	-0.0058	0.0079	-0.0039	-0.0047
3	0.0079	-0.0037	-0.0062	0.0079	-0.0037	-0.0051
4	0.0079	-0.0034	-0.0066	0.0079	-0.0034	-0.0056
5	0.0067	-0.0033	-0.0051	0.0068	-0.0032	-0.0039
6	0.0067	-0.0030	-0.0055	0.0068	-0.0030	-0.0043
7	0.0068	-0.0028	-0.0059	0.0068	-0.0028	-0.0048
8	0.0068	-0.0025	-0.0064	0.0068	-0.0025	-0.0052
9	0.0054	-0.0027	-0.0042	0.0054	-0.0023	-0.0028
10	0.0055	-0.0024	-0.0047	0.0054	-0.0021	-0.0033
11	0.0055	-0.0022	-0.0051	0.0055	-0.0019	-0.0039
12	0.0055	-0.0019	-0.0056	0.0055	-0.0017	-0.0044
13	0.0042	-0.0023	-0.0033	0.0041	-0.0015	-0.0018
14	0.0042	-0.0020	-0.0038	0.0041	-0.0013	-0.0023
15	0.0043	-0.0017	-0.0043	0.0041	-0.0012	-0.0028
16	0.0043	-0.0014	-0.0048	0.0041	-0.0010	-0.0033
17	0.0030	-0.0019	-0.0025	0.0030	-0.0008	-0.0011
18	0.0030	-0.0015	-0.0030	0.0029	-0.0008	-0.0015
19	0.0031	-0.0013	-0.0035	0.0030	-0.0007	-0.0019
20	0.0031	-0.0010	-0.0040	0.0030	-0.0005	-0.0024
21	0.0019	-0.0015	-0.0019	0.0021	-0.0004	-0.0007
22	0.0020	-0.0011	-0.0024	0.0020	-0.0004	-0.0010
23	0.0021	-0.0009	-0.0029	0.0021	-0.0003	-0.0014
24	0.0021	-0.0007	-0.0033	0.0021	-0.0001	-0.0017
25	0.0011	-0.0011	-0.0015	0.0015	-0.0001	-0.0004
26	0.0012	-0.0007	-0.0019	0.0013	-0.0001	-0.0007
27	0.0014	-0.0005	-0.0024	0.0014	-0.0001	-0.0010
28	0.0014	-0.0004	-0.0027	0.0014	0.0002	-0.0013
29	0.0006	-0.0006	-0.0012	0.0008	0.0000	-0.0003
30	0.0007	-0.0004	-0.0016	0.0008	0.0000	-0.0005
31	0.0008	-0.0003	-0.0019	0.0009	0.0000	-0.0008
32	0.0008	-0.0002	-0.0022	0.0010	0.0003	-0.0010
33	0.0002	-0.0003	-0.0011	0.0004	0.0000	-0.0004
34	0.0004	-0.0001	-0.0013	0.0004	0.0000	-0.0006
35	0.0005	-0.0001	-0.0015	0.0005	0.0001	-0.0007
36	0.0004	-0.0002	-0.0017	0.0006	0.0003	-0.0008
37	0.0002	0.0000	-0.0007	0.0002	0.0000	-0.0006
38	0.0002	0.0001	-0.0009	0.0002	0.0001	-0.0008
39	0.0003	0.0000	-0.0009	0.0003	0.0001	-0.0008
40	0.0001	0.0000	-0.0009	0.0001	0.0001	-0.0007



Nodal displacements and stresses

Nodal displacements and stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0,0138	0,0000	-0,0067	0,06	-0,02	-1.13
2	0,0137	0,0000	-0,0072	0,08	-0,07	-0,98
3	0,0136	0,0000	-0,0078	0,06	-0,04	-0,69
4	0,0135	0,0000	-0,0083	0,06	-0,03	-0,38
5	0,0084	0,0000	-0,0033	1,09	0,31	-0,03
6	0,0083	0,0000	-0,0039	0,02	-0,55	-0,77
7	0,0082	0,0000	-0,0045	0,01	-0,58	-0,90
8	0,0081	0,0000	-0,0052	0,92	0,05	-0,01
9	0,0061	-0,0017	-0,0028	1,31	0,80	-0,02
10	0,0061	-0,0015	-0,0033	0,02	-0,41	-0,64
11	0,0061	-0,0012	-0,0039	0,01	-0,52	-1,09
12	0,0060	-0,0010	-0,0045	0,77	0,00	-0,25
13	0,0041	-0,0019	-0,0025	1,30	1,06	-0,02
14	0,0041	-0,0016	-0,0030	-0,04	-0,39	-0,69
15	0,0041	-0,0014	-0,0036	-0,04	-0,44	-1,30
16	0,0041	-0,0011	-0,0041	1,02	0,01	-0,48
17	0,0024	-0,0010	-0,0011	1,77	1,09	-0,03
18	0,0024	-0,0009	-0,0015	-0,08	-0,31	-0,44
19	0,0024	-0,0007	-0,0019	-0,07	-0,35	-1,22
20	0,0024	-0,0005	-0,0023	1,21	0,00	-0,57
21	0,0011	-0,0009	-0,0010	1,76	1,58	-0,06
22	0,0011	-0,0007	-0,0012	0,27	0,01	-0,55
23	0,0011	-0,0005	-0,0015	0,17	0,02	-1,34
24	0,0012	-0,0003	-0,0018	1,52	-0,03	-0,67
25	0,0041	0,0000	-0,0012	1,58	0,32	-0,12
26	0,0041	0,0000	-0,0018	-0,02	-0,90	-1,14
27	0,0041	0,0000	-0,0024	0,03	-0,93	-1,46
28	0,0040	0,0000	-0,0030	1,62	0,32	-0,03
29	0,0025	-0,0009	-0,0012	1,70	0,63	-0,10
30	0,0025	-0,0007	-0,0017	-0,04	-0,88	-1,05
31	0,0026	-0,0004	-0,0021	0,00	-0,91	-1,63
32	0,0026	-0,0002	-0,0026	1.52	0.02	-0,01
33	0,0011	-0,0007	-0,0012	1,49	0.88	-0,09
34	0,0012	-0,0005	-0,0016	-0,21	-0,97	-1.28
35	0,0013	-0,0004	-0,0020	-0,19	-0,89	-2.09
36	0,0013	-0,0002	-0,0023	1,62	0,01	-0,58
37	0,0005	-0,0001	-0,0005	1,97	1,14	-0,08
38	0,0005	0,0000	-0,0007	-0,36	-0,47	-1,09
39	0,0006	0,0001	-0,0009	-0,41	-0,46	-1,48
40	0,0005	0,0002	-0,0011	2,12	0,60	-0,06
41	0,0013	0,0000	-0,0009	0,76	0,73	-0,29
42	0,0013	0,0000	-0,0012	-0,21	-1,07	-1,38
43	0,0013	0,0000	-0,0015	0,00	-0,92	-1,55
44	0,0012	0,0000	-0,0017	2,03	1,06	-0,01
45	0,0006	-0,0002	-0,0010	0,85	0,37	-0,35
46	0,0006	0,0000	-0,0012	-0,46	-0,91	-1,44
47	0,0007	0,0001	-0,0013	-0,24	-0,77	-1,61
48	0,0006	0,0002	-0,0014	2,22	0,40	-0,07
49	0,0005	0,0000	-0,0008	0,73	0,08	-0,81
50	0,0006	0,0000	-0,0012	-0,11	-0,77	-0,91
51	0,0006	0,0000	-0,0012	0,01	-0,39	-1,21
52	0,0004	0,0000	-0,0010	2,08	0,21	-1,40

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Displacements at joint 1

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	-0.0001	-0.0019	0.0011	-0.0001	-0.0020	0.0012
2	0.0002	-0.0022	0.0016	0.0003	-0.0023	0.0017
3	0.0004	-0.0025	0.0021	0.0006	-0.0027	0.0022
4	0.0007	-0.0028	0.0026	0.0009	-0.0030	0.0027
5	0.0015	-0.0014	0.0007	0.0016	-0.0015	0.0009
6	0.0017	-0.0017	0.0012	0.0019	-0.0019	0.0014
7	0.0020	-0.0020	0.0017	0.0021	-0.0022	0.0018
8	0.0022	-0.0022	0.0022	0.0025	-0.0026	0.0023
9	0.0030	-0.0004	0.0001	0.0031	-0.0006	0.0002
10	0.0032	-0.0007	0.0004	0.0034	-0.0010	0.0006
11	0.0035	-0.0010	0.0008	0.0037	-0.0014	0.0009
12	0.0037	-0.0013	0.0012	0.0040	-0.0018	0.0013
13	0.0039	0.0004	-0.0003	0.0040	0.0002	-0.0003
14	0.0041	0.0001	-0.0002	0.0043	-0.0002	-0.0001
15	0.0044	-0.0003	0.0001	0.0046	-0.0006	0.0001
16	0.0047	-0.0005	0.0003	0.0049	-0.0010	0.0003
17	0.0042	0.0009	-0.0004	0.0043	0.0007	-0.0004
18	0.0044	0.0006	-0.0004	0.0046	0.0003	-0.0004
19	0.0047	0.0002	-0.0004	0.0049	-0.0002	-0.0004
20	0.0050	-0.0001	-0.0003	0.0053	-0.0006	-0.0003
21	0.0040	0.0011	-0.0003	0.0042	0.0009	-0.0004
22	0.0043	0.0007	-0.0005	0.0045	0.0005	-0.0005
23	0.0046	0.0003	-0.0006	0.0047	0.0000	-0.0006
24	0.0049	0.0001	-0.0007	0.0052	-0.0004	-0.0008
25	0.0035	0.0011	-0.0002	0.0037	0.0009	-0.0003
26	0.0038	0.0006	-0.0005	0.0040	0.0005	-0.0005
27	0.0041	0.0003	-0.0007	0.0043	0.0000	-0.0008
28	0.0044	0.0000	-0.0010	0.0047	-0.0004	-0.0011
29	0.0029	0.0008	-0.0001	0.0030	0.0006	-0.0002
30	0.0032	0.0004	-0.0005	0.0033	0.0003	-0.0006
31	0.0034	0.0000	-0.0008	0.0036	-0.0002	-0.0010
32	0.0037	-0.0002	-0.0012	0.0040	-0.0006	-0.0014
33	0.0021	0.0004	-0.0002	0.0022	0.0003	-0.0002
34	0.0023	0.0000	-0.0006	0.0025	-0.0001	-0.0007
35	0.0025	-0.0004	-0.0010	0.0027	-0.0005	-0.0012
36	0.0028	-0.0005	-0.0014	0.0032	-0.0009	-0.0016
37	0.0012	-0.0003	-0.0004	0.0012	-0.0003	-0.0004
38	0.0014	-0.0006	-0.0008	0.0014	-0.0006	-0.0008
39	0.0016	-0.0009	-0.0012	0.0017	-0.0010	-0.0013
40	0.0017	-0.0010	-0.0016	0.0019	-0.0011	-0.0016

Displacements at joint 2

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0138	0.0010	-0.0003	0.0139	0.0005	-0.0003
2	0.0139	0.0007	-0.0001	0.0140	0.0003	-0.0001
3	0.0141	0.0004	0.0001	0.0142	0.0000	0.0001
4	0.0143	0.0001	0.0003	0.0144	-0.0002	0.0003
5	0.0144	0.0012	-0.0008	0.0145	0.0008	-0.0007
6	0.0145	0.0009	-0.0007	0.0146	0.0005	-0.0006
7	0.0146	0.0006	-0.0005	0.0147	0.0003	-0.0005
8	0.0148	0.0004	-0.0004	0.0149	0.0000	-0.0004
9	0.0145	0.0015	-0.0009	0.0146	0.0011	-0.0009
10	0.0146	0.0012	-0.0010	0.0147	0.0008	-0.0009
11	0.0147	0.0009	-0.0010	0.0148	0.0005	-0.0009
12	0.0149	0.0006	-0.0010	0.0150	0.0002	-0.0010
13	0.0141	0.0017	-0.0007	0.0142	0.0012	-0.0007
14	0.0142	0.0014	-0.0010	0.0143	0.0009	-0.0009
15	0.0143	0.0011	-0.0012	0.0144	0.0007	-0.0012
16	0.0145	0.0008	-0.0014	0.0146	0.0003	-0.0014
17	0.0133	0.0018	-0.0004	0.0134	0.0013	-0.0004
18	0.0134	0.0014	-0.0008	0.0135	0.0010	-0.0008
19	0.0135	0.0011	-0.0012	0.0136	0.0007	-0.0012
20	0.0137	0.0009	-0.0016	0.0138	0.0004	-0.0016
21	0.0121	0.0017	0.0000	0.0122	0.0013	0.0001
22	0.0122	0.0014	-0.0005	0.0123	0.0010	-0.0005
23	0.0123	0.0011	-0.0011	0.0124	0.0007	-0.0011
24	0.0125	0.0008	-0.0017	0.0126	0.0004	-0.0017
25	0.0107	0.0017	0.0005	0.0108	0.0012	0.0005
26	0.0108	0.0013	-0.0003	0.0109	0.0009	-0.0003
27	0.0109	0.0010	-0.0010	0.0110	0.0006	-0.0010
28	0.0111	0.0007	-0.0017	0.0112	0.0003	-0.0018
29	0.0091	0.0015	0.0008	0.0092	0.0011	0.0008
30	0.0093	0.0011	0.0000	0.0093	0.0008	-0.0001
31	0.0093	0.0008	-0.0009	0.0094	0.0005	-0.0010
32	0.0095	0.0006	-0.0018	0.0096	0.0002	-0.0018
33	0.0075	0.0013	0.0010	0.0076	0.0009	0.0010
34	0.0076	0.0009	0.0001	0.0077	0.0007	0.0000
35	0.0076	0.0006	-0.0009	0.0077	0.0004	-0.0010
36	0.0078	0.0004	-0.0018	0.0079	0.0000	-0.0019
37	0.0058	0.0010	0.0011	0.0059	0.0007	0.0011
38	0.0059	0.0007	0.0001	0.0060	0.0005	0.0000
39	0.0059	0.0004	-0.0010	0.0060	0.0002	-0.0010
40	0.0061	0.0002	-0.0019	0.0062	-0.0001	-0.0021
41	0.0042	0.0008	0.0009	0.0043	0.0005	0.0009
42	0.0043	0.0004	-0.0001	0.0043	0.0003	-0.0001
43	0.0042	0.0001	-0.0011	0.0043	0.0000	-0.0012
44	0.0044	0.0000	-0.0021	0.0045	-0.0003	-0.0022
45	0.0027	0.0005	0.0007	0.0028	0.0003	0.0007
46	0.0027	0.0001	-0.0004	0.0028	0.0001	-0.0004
47	0.0026	-0.0001	-0.0013	0.0027	-0.0001	-0.0015
48	0.0028	-0.0001	-0.0022	0.0029	-0.0004	-0.0023
49	0.0013	0.0001	0.0001	0.0013	0.0000	0.0001
50	0.0014	-0.0001	-0.0007	0.0014	-0.0001	-0.0007
51	0.0014	-0.0003	-0.0016	0.0014	-0.0003	-0.0016
52	0.0014	-0.0002	-0.0021	0.0014	-0.0004	-0.0021

Displacements at joint 3

Node	D'x	D'y	D'z	D"x	D"y	D"z
	[m]					
1	0.0139	-0.0005	-0.0003	0.0138	-0.0010	-0.0003
2	0.0140	-0.0003	-0.0001	0.0139	-0.0007	-0.0001
3	0.0142	0.0000	0.0001	0.0141	-0.0004	0.0001
4	0.0144	0.0002	0.0003	0.0143	-0.0001	0.0003
5	0.0145	-0.0008	-0.0007	0.0144	-0.0012	-0.0008
6	0.0146	-0.0005	-0.0006	0.0145	-0.0009	-0.0007
7	0.0147	-0.0003	-0.0005	0.0146	-0.0006	-0.0005
8	0.0149	0.0000	-0.0004	0.0148	-0.0004	-0.0004
9	0.0146	-0.0011	-0.0009	0.0145	-0.0015	-0.0009
10	0.0147	-0.0008	-0.0009	0.0146	-0.0012	-0.0010
11	0.0148	-0.0005	-0.0009	0.0147	-0.0009	-0.0010
12	0.0150	-0.0002	-0.0010	0.0149	-0.0006	-0.0010
13	0.0142	-0.0012	-0.0007	0.0141	-0.0017	-0.0007
14	0.0143	-0.0009	-0.0009	0.0142	-0.0014	-0.0010
15	0.0144	-0.0007	-0.0012	0.0143	-0.0011	-0.0012
16	0.0146	-0.0003	-0.0014	0.0145	-0.0008	-0.0014
17	0.0134	-0.0013	-0.0004	0.0133	-0.0018	-0.0004
18	0.0135	-0.0010	-0.0008	0.0134	-0.0014	-0.0008
19	0.0136	-0.0007	-0.0012	0.0135	-0.0011	-0.0012
20	0.0138	-0.0004	-0.0016	0.0137	-0.0009	-0.0016
21	0.0122	-0.0013	0.0001	0.0121	-0.0017	0.0000
22	0.0123	-0.0010	-0.0005	0.0122	-0.0014	-0.0005
23	0.0124	-0.0007	-0.0011	0.0123	-0.0011	-0.0011
24	0.0126	-0.0004	-0.0017	0.0125	-0.0008	-0.0017
25	0.0108	-0.0012	0.0005	0.0107	-0.0016	0.0005
26	0.0109	-0.0009	-0.0003	0.0108	-0.0013	-0.0003
27	0.0110	-0.0006	-0.0010	0.0109	-0.0010	-0.0010
28	0.0112	-0.0003	-0.0018	0.0111	-0.0007	-0.0017
29	0.0092	-0.0011	0.0008	0.0091	-0.0015	0.0008
30	0.0093	-0.0008	-0.0001	0.0093	-0.0011	0.0000
31	0.0094	-0.0005	-0.0010	0.0093	-0.0008	-0.0009
32	0.0096	-0.0002	-0.0018	0.0095	-0.0006	-0.0018
33	0.0076	-0.0009	0.0010	0.0075	-0.0013	0.0010
34	0.0077	-0.0007	0.0000	0.0076	-0.0009	0.0001
35	0.0077	-0.0004	-0.0010	0.0076	-0.0006	-0.0009
36	0.0079	0.0000	-0.0019	0.0078	-0.0004	-0.0018
37	0.0059	-0.0007	0.0011	0.0058	-0.0010	0.0011
38	0.0060	-0.0005	0.0000	0.0059	-0.0007	0.0001
39	0.0060	-0.0002	-0.0010	0.0059	-0.0004	-0.0010
40	0.0062	0.0001	-0.0021	0.0061	-0.0002	-0.0019
41	0.0043	-0.0005	0.0009	0.0042	-0.0008	0.0009
42	0.0043	-0.0003	-0.0001	0.0043	-0.0004	-0.0001
43	0.0043	0.0000	-0.0012	0.0042	-0.0001	-0.0011
44	0.0045	0.0003	-0.0022	0.0044	0.0000	-0.0021
45	0.0028	-0.0003	0.0007	0.0027	-0.0005	0.0007
46	0.0028	-0.0001	-0.0004	0.0027	-0.0001	-0.0004
47	0.0027	0.0001	-0.0015	0.0026	0.0001	-0.0013
48	0.0029	0.0004	-0.0023	0.0028	0.0001	-0.0022
49	0.0013	0.0000	0.0001	0.0013	-0.0001	0.0001
50	0.0014	0.0001	-0.0007	0.0014	0.0001	-0.0007
51	0.0014	0.0003	-0.0016	0.0014	0.0003	-0.0016
52	0.0014	0.0004	-0.0021	0.0014	0.0002	-0.0021

Diplacements at joint 4

Node	D'x	D'y	D'z	D"x	D"y	D"z
	[m]					
1	-0.0001	0.0020	0.0012	-0.0001	0.0019	0.0011
2	0.0003	0.0023	0.0017	0.0002	0.0022	0.0016
3	0.0006	0.0027	0.0022	0.0004	0.0025	0.0021
4	0.0009	0.0030	0.0027	0.0007	0.0028	0.0026
5	0.0016	0.0015	0.0009	0.0015	0.0014	0.0007
6	0.0019	0.0019	0.0014	0.0017	0.0017	0.0012
7	0.0021	0.0022	0.0018	0.0020	0.0020	0.0017
8	0.0025	0.0026	0.0023	0.0022	0.0022	0.0022
9	0.0031	0.0006	0.0002	0.0030	0.0004	0.0001
10	0.0034	0.0010	0.0006	0.0032	0.0007	0.0004
11	0.0037	0.0014	0.0009	0.0035	0.0010	0.0008
12	0.0040	0.0018	0.0013	0.0037	0.0013	0.0012
13	0.0040	-0.0002	-0.0003	0.0039	-0.0004	-0.0003
14	0.0043	0.0002	-0.0001	0.0041	-0.0001	-0.0002
15	0.0046	0.0006	0.0001	0.0044	0.0003	0.0001
16	0.0049	0.0010	0.0003	0.0047	0.0005	0.0003
17	0.0043	-0.0007	-0.0004	0.0042	-0.0009	-0.0004
18	0.0046	-0.0003	-0.0004	0.0044	-0.0006	-0.0004
19	0.0049	0.0002	-0.0004	0.0047	-0.0002	-0.0004
20	0.0053	0.0006	-0.0003	0.0050	0.0001	-0.0003
21	0.0042	-0.0009	-0.0004	0.0040	-0.0011	-0.0003
22	0.0045	-0.0005	-0.0005	0.0043	-0.0007	-0.0005
23	0.0047	0.0000	-0.0006	0.0046	-0.0003	-0.0006
24	0.0052	0.0004	-0.0008	0.0049	-0.0001	-0.0007
25	0.0037	-0.0009	-0.0003	0.0035	-0.0011	-0.0002
26	0.0040	-0.0005	-0.0005	0.0038	-0.0006	-0.0005
27	0.0043	0.0000	-0.0008	0.0041	-0.0003	-0.0007
28	0.0047	0.0004	-0.0011	0.0044	0.0000	-0.0010
29	0.0030	-0.0006	-0.0002	0.0029	-0.0008	-0.0001
30	0.0033	-0.0003	-0.0006	0.0032	-0.0004	-0.0005
31	0.0036	0.0002	-0.0010	0.0034	0.0000	-0.0008
32	0.0040	0.0006	-0.0014	0.0037	0.0002	-0.0012
33	0.0022	-0.0003	-0.0002	0.0021	-0.0004	-0.0002
34	0.0025	0.0001	-0.0007	0.0023	0.0000	-0.0006
35	0.0027	0.0005	-0.0012	0.0025	0.0004	-0.0010
36	0.0032	0.0009	-0.0016	0.0028	0.0005	-0.0014
37	0.0012	0.0003	-0.0004	0.0012	0.0003	-0.0004
38	0.0014	0.0006	-0.0008	0.0014	0.0006	-0.0008
39	0.0017	0.0010	-0.0013	0.0016	0.0009	-0.0012
40	0.0019	0.0011	-0.0016	0.0017	0.0010	-0.0016

Nodal displacements and stresses

	[m]			[MPa]		
Node	D'x	D'y	D'z	P1	P2	P3
1	0.0155	0.0000	-0.0005	0.15	0.05	-3.03
2	0.0157	0.0000	-0.0003	0.04	-0.20	-3.33
3	0.0158	0.0000	-0.0002	0.03	-0.05	-2.67
4	0.0159	0.0000	0.0000	0.06	0.00	-2.11
5	0.0155	0.0000	-0.0008	-0.17	-2.05	-4.43
6	0.0156	0.0000	-0.0011	-0.11	-0.46	-3.04
7	0.0157	0.0000	-0.0013	0.03	-0.07	-2.78
8	0.0158	0.0000	-0.0015	0.01	-0.58	-3.59
9	0.0107	-0.0021	-0.0006	-0.17	-1.91	-3.72
10	0.0109	-0.0016	-0.0008	-0.12	-0.43	-2.66
11	0.0111	-0.0011	-0.0009	-0.02	-0.10	-2.82
12	0.0114	-0.0007	-0.0010	0.01	-0.72	-4.14
13	0.0064	-0.0014	-0.0005	-0.18	-1.78	-3.01
14	0.0067	-0.0009	-0.0005	-0.10	-0.32	-2.12
15	0.0069	-0.0004	-0.0006	0.07	-0.07	-2.61
16	0.0073	0.0000	-0.0006	0.00	-0.70	-4.36
17	0.0028	-0.0003	-0.0004	-0.17	-1.73	-2.07
18	0.0031	-0.0001	-0.0004	-0.09	-0.18	-1.57
19	0.0033	0.0002	-0.0003	0.21	-0.05	-2.46
20	0.0036	0.0004	-0.0002	-0.01	-0.61	-4.64
21	0.0011	0.0007	-0.0004	-0.15	-1.38	-1.78
22	0.0013	0.0007	-0.0003	-0.06	-0.14	-1.17
23	0.0014	0.0008	-0.0002	0.16	-0.10	-2.08
24	0.0016	0.0008	-0.0001	-0.01	-0.85	-4.34
25	0.0118	0.0000	0.0006	-0.33	-2.23	-4.34
26	0.0119	0.0000	-0.0002	-0.16	-0.38	-2.25
27	0.0120	0.0000	-0.0010	0.00	-0.36	-1.98
28	0.0121	0.0000	-0.0018	0.01	-2.14	-3.77
29	0.0079	-0.0020	0.0003	-0.34	-1.95	-3.51
30	0.0082	-0.0015	-0.0003	-0.08	-0.31	-1.77
31	0.0084	-0.0010	-0.0010	0.01	-0.30	-1.99
32	0.0087	-0.0006	-0.0016	0.00	-2.13	-4.38
33	0.0045	-0.0013	0.0000	-0.34	-1.70	-2.55
34	0.0048	-0.0009	-0.0005	0.15	-0.26	-1.18
35	0.0051	-0.0003	-0.0010	0.18	-0.25	-1.94
36	0.0055	0.0001	-0.0014	0.02	-2.08	-4.92
37	0.0019	-0.0002	-0.0003	-0.33	-1.42	-1.60
38	0.0021	0.0001	-0.0005	0.41	-0.18	-0.74
39	0.0024	0.0004	-0.0009	0.32	-0.19	-2.05
40	0.0027	0.0005	-0.0011	0.38	-2.22	-4.99
41	0.0049	0.0000	0.0012	-0.59	-1.27	-2.56
42	0.0049	0.0000	0.0001	0.31	-0.45	-0.68
43	0.0048	0.0000	-0.0011	-0.04	-0.33	-1.07
44	0.0050	0.0000	-0.0022	-0.03	-3.06	-4.54
45	0.0024	-0.0006	0.0004	-0.56	-1.09	-1.90
46	0.0026	-0.0002	-0.0005	0.84	0.27	-0.85
47	0.0027	0.0003	-0.0013	0.23	0.05	-1.93
48	0.0030	0.0006	-0.0021	0.52	-2.48	-5.34
49	0.0016	0.0000	0.0003	2.35	-0.46	-0.65
50	0.0017	0.0000	-0.0006	0.76	0.71	-0.48
51	0.0016	0.0000	-0.0017	0.36	-0.43	-0.94
52	0.0016	0.0000	-0.0023	-0.49	-3.39	-7.98

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Displacements at joint 1

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0079	0.0042	-0.0043	0.0078	0.0042	-0.0054
2	0.0079	0.0039	-0.0047	0.0079	0.0039	-0.0058
3	0.0079	0.0037	-0.0051	0.0079	0.0036	-0.0062
4	0.0079	0.0034	-0.0056	0.0079	0.0034	-0.0066
5	0.0068	0.0032	-0.0039	0.0067	0.0033	-0.0051
6	0.0068	0.0030	-0.0043	0.0067	0.0030	-0.0055
7	0.0068	0.0028	-0.0048	0.0068	0.0028	-0.0059
8	0.0068	0.0025	-0.0052	0.0068	0.0025	-0.0064
9	0.0054	0.0023	-0.0028	0.0054	0.0027	-0.0042
10	0.0054	0.0021	-0.0033	0.0055	0.0024	-0.0047
11	0.0055	0.0019	-0.0039	0.0055	0.0022	-0.0051
12	0.0055	0.0016	-0.0044	0.0055	0.0019	-0.0056
13	0.0041	0.0015	-0.0018	0.0042	0.0023	-0.0033
14	0.0041	0.0013	-0.0023	0.0042	0.0020	-0.0038
15	0.0041	0.0012	-0.0028	0.0043	0.0017	-0.0043
16	0.0041	0.0010	-0.0033	0.0043	0.0014	-0.0048
17	0.0030	0.0008	-0.0011	0.0030	0.0019	-0.0025
18	0.0029	0.0008	-0.0015	0.0030	0.0015	-0.0030
19	0.0030	0.0006	-0.0019	0.0031	0.0013	-0.0035
20	0.0029	0.0005	-0.0024	0.0031	0.0010	-0.0040
21	0.0021	0.0004	-0.0007	0.0019	0.0015	-0.0019
22	0.0020	0.0004	-0.0010	0.0020	0.0011	-0.0024
23	0.0021	0.0003	-0.0014	0.0021	0.0009	-0.0029
24	0.0021	0.0001	-0.0017	0.0021	0.0007	-0.0033
25	0.0015	0.0001	-0.0004	0.0011	0.0011	-0.0015
26	0.0013	0.0001	-0.0007	0.0012	0.0007	-0.0019
27	0.0014	0.0001	-0.0010	0.0014	0.0005	-0.0024
28	0.0014	-0.0002	-0.0013	0.0014	0.0004	-0.0027
29	0.0008	0.0000	-0.0003	0.0006	0.0006	-0.0012
30	0.0008	0.0000	-0.0005	0.0007	0.0004	-0.0016
31	0.0009	0.0000	-0.0008	0.0008	0.0003	-0.0019
32	0.0010	-0.0003	-0.0010	0.0008	0.0002	-0.0022
33	0.0004	0.0000	-0.0004	0.0002	0.0003	-0.0011
34	0.0004	0.0000	-0.0006	0.0004	0.0001	-0.0013
35	0.0005	-0.0001	-0.0007	0.0005	0.0001	-0.0015
36	0.0006	-0.0003	-0.0008	0.0004	0.0002	-0.0017
37	0.0002	0.0000	-0.0006	0.0002	0.0001	-0.0007
38	0.0002	-0.0001	-0.0008	0.0002	-0.0001	-0.0009
39	0.0003	-0.0001	-0.0008	0.0003	0.0000	-0.0009
40	0.0001	-0.0002	-0.0007	0.0001	0.0000	-0.0009

Displacements at joint 2

Node	[m]					
	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0131	0.0018	-0.0065	0.0131	0.0016	-0.0065
2	0.0130	0.0016	-0.0070	0.0130	0.0015	-0.0070
3	0.0129	0.0015	-0.0075	0.0129	0.0014	-0.0075
4	0.0128	0.0013	-0.0080	0.0128	0.0013	-0.0081
5	0.0112	0.0015	-0.0054	0.0112	0.0014	-0.0055
6	0.0111	0.0013	-0.0060	0.0111	0.0012	-0.0060
7	0.0111	0.0012	-0.0066	0.0111	0.0011	-0.0066
8	0.0110	0.0010	-0.0071	0.0110	0.0010	-0.0071
9	0.0095	0.0013	-0.0042	0.0095	0.0012	-0.0042
10	0.0094	0.0011	-0.0048	0.0094	0.0011	-0.0048
11	0.0093	0.0010	-0.0054	0.0093	0.0009	-0.0054
12	0.0093	0.0008	-0.0060	0.0092	0.0008	-0.0060
13	0.0078	0.0011	-0.0031	0.0078	0.0011	-0.0032
14	0.0077	0.0010	-0.0037	0.0078	0.0009	-0.0038
15	0.0077	0.0008	-0.0043	0.0077	0.0008	-0.0044
16	0.0076	0.0006	-0.0049	0.0076	0.0007	-0.0050
17	0.0063	0.0009	-0.0023	0.0064	0.0009	-0.0023
18	0.0063	0.0008	-0.0029	0.0063	0.0008	-0.0029
19	0.0063	0.0006	-0.0035	0.0063	0.0006	-0.0036
20	0.0062	0.0004	-0.0041	0.0062	0.0006	-0.0042
21	0.0050	0.0008	-0.0017	0.0050	0.0008	-0.0017
22	0.0049	0.0007	-0.0022	0.0050	0.0006	-0.0023
23	0.0050	0.0005	-0.0028	0.0050	0.0005	-0.0029
24	0.0049	0.0002	-0.0034	0.0049	0.0005	-0.0035
25	0.0038	0.0007	-0.0012	0.0038	0.0006	-0.0012
26	0.0038	0.0006	-0.0017	0.0038	0.0005	-0.0018
27	0.0039	0.0004	-0.0023	0.0039	0.0004	-0.0024
28	0.0039	0.0000	-0.0028	0.0038	0.0005	-0.0030
29	0.0029	0.0005	-0.0011	0.0029	0.0005	-0.0011
30	0.0029	0.0004	-0.0015	0.0029	0.0003	-0.0015
31	0.0030	0.0003	-0.0019	0.0030	0.0003	-0.0021
32	0.0030	-0.0002	-0.0023	0.0029	0.0004	-0.0025
33	0.0022	0.0004	-0.0010	0.0022	0.0004	-0.0010
34	0.0022	0.0003	-0.0014	0.0022	0.0002	-0.0014
35	0.0024	0.0002	-0.0017	0.0024	0.0003	-0.0018
36	0.0024	-0.0003	-0.0020	0.0023	0.0005	-0.0022
37	0.0017	0.0003	-0.0010	0.0017	0.0003	-0.0010
38	0.0017	0.0003	-0.0012	0.0017	0.0002	-0.0013
39	0.0019	0.0001	-0.0015	0.0019	0.0002	-0.0016
40	0.0019	-0.0004	-0.0017	0.0017	0.0005	-0.0019
41	0.0013	0.0002	-0.0009	0.0013	0.0002	-0.0009
42	0.0013	0.0002	-0.0011	0.0013	0.0001	-0.0012
43	0.0014	0.0000	-0.0013	0.0014	0.0002	-0.0014
44	0.0014	-0.0004	-0.0015	0.0013	0.0005	-0.0017
45	0.0009	0.0001	-0.0008	0.0009	0.0002	-0.0009
46	0.0009	0.0001	-0.0011	0.0009	0.0000	-0.0011
47	0.0010	0.0000	-0.0011	0.0010	0.0001	-0.0012
48	0.0010	-0.0004	-0.0012	0.0008	0.0004	-0.0014
49	0.0005	0.0000	-0.0007	0.0005	0.0000	-0.0007
50	0.0006	0.0000	-0.0010	0.0006	0.0000	-0.0010
51	0.0007	0.0000	-0.0010	0.0007	0.0000	-0.0011
52	0.0004	-0.0001	-0.0008	0.0004	0.0000	-0.0009

Displacements at joint 3

	[m]					
Node	D'x	D'y	D'z	D"x	D"y	D"z
1	0.0131	-0.0016	-0.0065	0.0131	-0.0018	-0.0065
2	0.0130	-0.0015	-0.0070	0.0130	-0.0016	-0.0070
3	0.0129	-0.0014	-0.0075	0.0129	-0.0015	-0.0075
4	0.0128	-0.0013	-0.0081	0.0128	-0.0013	-0.0080
5	0.0112	-0.0014	-0.0055	0.0112	-0.0015	-0.0054
6	0.0111	-0.0012	-0.0060	0.0111	-0.0013	-0.0060
7	0.0111	-0.0011	-0.0066	0.0111	-0.0012	-0.0066
8	0.0110	-0.0010	-0.0071	0.0110	-0.0010	-0.0071
9	0.0095	-0.0012	-0.0042	0.0095	-0.0013	-0.0042
10	0.0094	-0.0011	-0.0048	0.0094	-0.0011	-0.0048
11	0.0093	-0.0009	-0.0054	0.0093	-0.0010	-0.0054
12	0.0092	-0.0008	-0.0060	0.0093	-0.0008	-0.0060
13	0.0078	-0.0011	-0.0032	0.0078	-0.0011	-0.0031
14	0.0078	-0.0009	-0.0038	0.0077	-0.0010	-0.0037
15	0.0077	-0.0008	-0.0044	0.0077	-0.0008	-0.0043
16	0.0076	-0.0007	-0.0050	0.0076	-0.0006	-0.0049
17	0.0064	-0.0009	-0.0023	0.0063	-0.0009	-0.0023
18	0.0063	-0.0008	-0.0029	0.0063	-0.0008	-0.0029
19	0.0063	-0.0006	-0.0036	0.0063	-0.0006	-0.0035
20	0.0062	-0.0006	-0.0042	0.0062	-0.0004	-0.0041
21	0.0050	-0.0008	-0.0017	0.0050	-0.0008	-0.0017
22	0.0050	-0.0006	-0.0023	0.0049	-0.0007	-0.0022
23	0.0050	-0.0005	-0.0029	0.0050	-0.0005	-0.0028
24	0.0049	-0.0005	-0.0035	0.0049	-0.0002	-0.0034
25	0.0038	-0.0006	-0.0012	0.0038	-0.0007	-0.0012
26	0.0038	-0.0005	-0.0018	0.0038	-0.0005	-0.0017
27	0.0039	-0.0004	-0.0024	0.0039	-0.0004	-0.0023
28	0.0038	-0.0005	-0.0030	0.0039	0.0000	-0.0028
29	0.0029	-0.0005	-0.0011	0.0029	-0.0005	-0.0011
30	0.0029	-0.0003	-0.0015	0.0029	-0.0004	-0.0015
31	0.0030	-0.0003	-0.0021	0.0030	-0.0003	-0.0019
32	0.0029	-0.0004	-0.0025	0.0030	0.0002	-0.0023
33	0.0022	-0.0004	-0.0010	0.0022	-0.0004	-0.0010
34	0.0022	-0.0002	-0.0014	0.0022	-0.0003	-0.0014
35	0.0024	-0.0003	-0.0018	0.0024	-0.0002	-0.0017
36	0.0023	-0.0005	-0.0022	0.0024	0.0003	-0.0020
37	0.0017	-0.0003	-0.0010	0.0017	-0.0003	-0.0010
38	0.0017	-0.0002	-0.0013	0.0017	-0.0003	-0.0012
39	0.0019	-0.0002	-0.0016	0.0019	-0.0001	-0.0015
40	0.0017	-0.0005	-0.0019	0.0019	0.0004	-0.0017
41	0.0013	-0.0002	-0.0009	0.0013	-0.0002	-0.0009
42	0.0013	-0.0001	-0.0012	0.0013	-0.0002	-0.0011
43	0.0014	-0.0002	-0.0014	0.0014	0.0000	-0.0013
44	0.0013	-0.0005	-0.0017	0.0014	0.0004	-0.0015
45	0.0009	-0.0002	-0.0009	0.0009	-0.0001	-0.0008
46	0.0009	0.0000	-0.0011	0.0009	-0.0001	-0.0011
47	0.0010	-0.0001	-0.0012	0.0010	0.0000	-0.0011
48	0.0008	-0.0004	-0.0014	0.0010	0.0004	-0.0012
49	0.0005	0.0000	-0.0007	0.0005	0.0000	-0.0007
50	0.0006	0.0000	-0.0010	0.0006	0.0000	-0.0010
51	0.0007	0.0000	-0.0011	0.0007	0.0000	-0.0010
52	0.0004	0.0000	-0.0009	0.0004	0.0001	-0.0008

Displacements at joint 4

Node	[m] D'x	D'y	D'z	D"x	D"y	D"z
1	0.0078	-0.0042	-0.0054	0.0079	-0.0042	-0.0043
2	0.0079	-0.0039	-0.0058	0.0079	-0.0039	-0.0047
3	0.0079	-0.0037	-0.0062	0.0079	-0.0037	-0.0051
4	0.0079	-0.0034	-0.0066	0.0079	-0.0034	-0.0056
5	0.0067	-0.0033	-0.0051	0.0068	-0.0032	-0.0039
6	0.0067	-0.0030	-0.0055	0.0068	-0.0030	-0.0043
7	0.0068	-0.0028	-0.0059	0.0068	-0.0028	-0.0048
8	0.0068	-0.0025	-0.0064	0.0068	-0.0025	-0.0052
9	0.0054	-0.0027	-0.0042	0.0054	-0.0023	-0.0028
10	0.0055	-0.0024	-0.0047	0.0054	-0.0021	-0.0033
11	0.0055	-0.0022	-0.0051	0.0055	-0.0019	-0.0039
12	0.0055	-0.0019	-0.0056	0.0055	-0.0017	-0.0044
13	0.0042	-0.0023	-0.0033	0.0041	-0.0015	-0.0018
14	0.0042	-0.0020	-0.0038	0.0041	-0.0013	-0.0023
15	0.0043	-0.0017	-0.0043	0.0041	-0.0012	-0.0028
16	0.0043	-0.0014	-0.0048	0.0041	-0.0010	-0.0033
17	0.0030	-0.0019	-0.0025	0.0030	-0.0008	-0.0011
18	0.0030	-0.0015	-0.0030	0.0029	-0.0008	-0.0015
19	0.0031	-0.0013	-0.0035	0.0030	-0.0007	-0.0019
20	0.0031	-0.0010	-0.0040	0.0030	-0.0005	-0.0024
21	0.0019	-0.0015	-0.0019	0.0021	-0.0004	-0.0007
22	0.0020	-0.0011	-0.0024	0.0020	-0.0004	-0.0010
23	0.0021	-0.0009	-0.0029	0.0021	-0.0003	-0.0014
24	0.0021	-0.0007	-0.0033	0.0021	-0.0001	-0.0017
25	0.0011	-0.0011	-0.0015	0.0015	-0.0001	-0.0004
26	0.0012	-0.0007	-0.0019	0.0013	-0.0001	-0.0007
27	0.0014	-0.0005	-0.0024	0.0014	-0.0001	-0.0010
28	0.0014	-0.0004	-0.0027	0.0014	0.0002	-0.0013
29	0.0006	-0.0006	-0.0012	0.0008	0.0000	-0.0003
30	0.0007	-0.0004	-0.0016	0.0008	0.0000	-0.0005
31	0.0008	-0.0003	-0.0019	0.0009	0.0000	-0.0008
32	0.0008	-0.0002	-0.0022	0.0010	0.0003	-0.0010
33	0.0002	-0.0003	-0.0011	0.0004	0.0000	-0.0004
34	0.0004	-0.0001	-0.0013	0.0004	0.0000	-0.0006
35	0.0005	-0.0001	-0.0015	0.0005	0.0001	-0.0007
36	0.0004	-0.0002	-0.0017	0.0006	0.0003	-0.0008
37	0.0002	0.0000	-0.0007	0.0002	0.0000	-0.0006
38	0.0002	0.0001	-0.0009	0.0002	0.0001	-0.0008
39	0.0003	0.0000	-0.0009	0.0003	0.0001	-0.0008
40	0.0001	0.0000	-0.0009	0.0001	0.0001	-0.0007

Nodal displacements and stresses

	[m]			[MPa]		
Node	Dx	Dy	Dz	P1	P2	P3
1	0.0138	0.0000	-0.0067	0.06	-0.02	-1.13
2	0.0137	0.0000	-0.0072	0.08	-0.07	-0.98
3	0.0136	0.0000	-0.0078	0.06	-0.04	-0.69
4	0.0135	0.0000	-0.0083	0.06	-0.03	-0.38
5	0.0084	0.0000	-0.0033	1.09	0.31	-0.03
6	0.0083	0.0000	-0.0039	0.02	-0.55	-0.77
7	0.0082	0.0000	-0.0045	0.01	-0.58	-0.90
8	0.0081	0.0000	-0.0052	0.92	0.05	-0.01
9	0.0061	-0.0017	-0.0028	1.31	0.80	-0.02
10	0.0061	-0.0015	-0.0033	0.02	-0.41	-0.64
11	0.0061	-0.0012	-0.0039	0.01	-0.52	-1.09
12	0.0060	-0.0010	-0.0045	0.77	0.00	-0.25
13	0.0041	-0.0019	-0.0025	1.30	1.06	-0.02
14	0.0041	-0.0016	-0.0030	-0.04	-0.39	-0.69
15	0.0041	-0.0014	-0.0036	-0.04	-0.44	-1.30
16	0.0041	-0.0011	-0.0041	1.02	0.01	-0.48
17	0.0024	-0.0010	-0.0011	1.77	1.09	-0.03
18	0.0024	-0.0009	-0.0015	-0.08	-0.31	-0.44
19	0.0024	-0.0007	-0.0019	-0.07	-0.35	-1.22
20	0.0024	-0.0005	-0.0023	1.21	0.00	-0.57
21	0.0011	-0.0009	-0.0010	1.76	1.58	-0.06
22	0.0011	-0.0007	-0.0012	0.27	0.01	-0.55
23	0.0011	-0.0005	-0.0015	0.17	0.02	-1.34
24	0.0012	-0.0003	-0.0018	1.52	-0.03	-0.67
25	0.0041	0.0000	-0.0012	1.58	0.32	-0.12
26	0.0041	0.0000	-0.0018	-0.02	-0.90	-1.14
27	0.0041	0.0000	-0.0024	0.03	-0.93	-1.46
28	0.0040	0.0000	-0.0030	1.62	0.32	-0.03
29	0.0025	-0.0009	-0.0012	1.70	0.63	-0.10
30	0.0025	-0.0007	-0.0017	-0.04	-0.88	-1.05
31	0.0026	-0.0004	-0.0021	0.00	-0.91	-1.63
32	0.0026	-0.0002	-0.0026	1.52	0.02	-0.01
33	0.0011	-0.0007	-0.0012	1.49	0.88	-0.09
34	0.0012	-0.0005	-0.0016	-0.21	-0.97	-1.28
35	0.0013	-0.0004	-0.0020	-0.19	-0.89	-2.09
36	0.0013	-0.0002	-0.0023	1.62	0.01	-0.58
37	0.0005	-0.0001	-0.0005	1.97	1.14	-0.08
38	0.0005	0.0000	-0.0007	-0.36	-0.47	-1.09
39	0.0006	0.0001	-0.0009	-0.41	-0.46	-1.48
40	0.0005	0.0002	-0.0011	2.12	0.60	-0.06
41	0.0013	0.0000	-0.0009	0.76	0.73	-0.29
42	0.0013	0.0000	-0.0012	-0.21	-1.07	-1.38
43	0.0013	0.0000	-0.0015	0.00	-0.92	-1.55
44	0.0012	0.0000	-0.0017	2.03	1.06	-0.01
45	0.0006	-0.0002	-0.0010	0.85	0.37	-0.35
46	0.0006	0.0000	-0.0012	-0.46	-0.91	-1.44
47	0.0007	0.0001	-0.0013	-0.24	-0.77	-1.61
48	0.0006	0.0002	-0.0014	2.22	0.40	-0.07
49	0.0005	0.0000	-0.0008	0.73	0.08	-0.81
50	0.0006	0.0000	-0.0012	-0.11	-0.77	-0.91
51	0.0006	0.0000	-0.0012	0.01	-0.39	-1.21
52	0.0004	0.0000	-0.0010	2.08	0.21	-1.40

Non linear analysis of joint behaviour under thermal and hydrostatic loads for an arch dam. Theme A1.

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1 - Introduction

This paper presents the numerical results of the non linear analysis of the Talvacchia arch dam proposed by the organising committee of the third ICOLD Benchmark Workshop on Numerical Analysis of Dams. The input data suggested by the organisers are supposed to be known. Only the results are presented here.

The numerical model proposed represents the Talvacchia arch dam supported by its rock foundation. The aim of this modelisation is to evaluate the displacements and the stresses into the dam under :

1 - the self weight of the dam
2 - the distribution of temperature into the dam
3 - the impounded water level

Two loadings are considered :

1 - Dead weight + "summer" thermal distribution + water level 507 m a. s. l.
2 - Dead weight + "winter" thermal distribution + water level 471 m a. s. l.

2 - Software and Hardware used

The non linear analysis were performed with the computer program GEFDYN. It offers the possibility to evaluate static and dynamic response of geomechanical structures; coupled behaviour of soils, concrete or rocks can be taken into account.
The analysis were performed on a Sparc server 1000 using the operating system Solaris 2.3.

3 - Mesh detail

3.1 - Interface elements

The interface elements used are quadratic plane interface elements. Their reference element is shown figure 1.

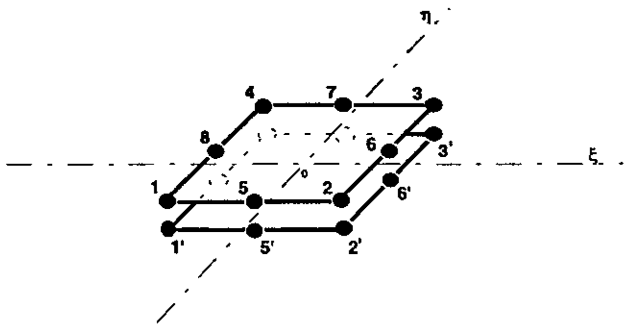

Figure 1 - Reference element of the quadratic plane interface element.

Constitutive model

The interface element is a no-tension joint.

When it is closed, the non linear constitutive model of the interface elements is an elastoplastic law. The yield criterion f and the plastic potential g of the law are Mohr-Coulomb type functions. :

$f = \tau - \sigma_n \tan\phi - c$

$g = \tau - \sigma_n \tan\psi$

Such a law is entirely defined by the five following parameters :

- normal siffness k_{nn},
- shear stiffness k_{ss},
- cohesion c,
- friction angle ϕ,
- dilatancy angle ψ.

Integration scheme

The spatial integration on an interface element is performed at its Newton-Cotes integration points. The integration order is 3.

3.2 - Three-dimensional structural elements

The three dimensional elements used were the hexa 20 and the penta 15 of the suggested model. Behaviour law is supposed to be elastic and is defined by the three following parameters :

- Young modulus E,
- Poisson ratio ν,
- thermal dilatation coefficient α.

The spatial integration on a three-dimensional structural elements is performed at its Gauss integration points (integration order 2).

4 - Loading steps

The two following loading have been considered :

First loading :

The summer distribution of temperature and water level at 507 m are considered. Dead weight, water loading and thermal distribution are applied entirely in a single step.

Second loading :

The winter distribution of temperature and water level at 507 m are considered. Dead weight, water loading and thermal distribution are applied entirely in a single step.

Note:

Another type of loading have been taken into account to be compared with the previous one :

- First step, only the self weight of the dam is applied,
- Second step, the thermal distribution and the water level are applied.

5 - Global equilibrium, non linear solution technique

The linearization of the equilibrium equation of the structure gives the equation 1 which is expressed at step n and iteration i.

$$\underline{\underline{\mathbf{K}}}_0\left(\left(\underline{\mathbf{U}}^i_{\tau_n}-\underline{\mathbf{U}}_{\tau_{n-1}}\right)-\left(\underline{\mathbf{U}}^{i-1}_{\tau_n}-\underline{\mathbf{U}}_{\tau_{n-1}}\right)\right)=\left(\underline{\mathbf{F}}_{\tau_n}-\underline{\mathbf{F}}_{\tau_{n-1}}\right)-\left(\underline{\mathbf{L}}^{i-1}_{\tau_n}-\underline{\mathbf{L}}_{\tau_{n-1}}\right) \quad (1)$$

where, $\underline{\underline{\mathbf{K}}}_0$ is auxiliary stiffness matrix,
$\underline{\mathbf{U}}$ is the nodal displacements vector,
$\underline{\mathbf{F}}$ is the nodal forces vector,
$\underline{\mathbf{L}}$ is the nodal forces vector calculated at the iteration i.

To evaluate the equilibrium at time τ_n, the modified Newton Raphson method has been adopted.

6 - Results

The results of the **theme A1** are on the floppy disk. The form adopted is the one suggested by the organisers.

For each loading, one linear elastic and three non linear elasto plastic analyse have been performed using different parameters for the constitutive model.

6.1 - Parameters

The following table gives the parameters used to perform the linear elastic analysis and the non linear elastoplastic analyse numbered 1, 2 and 3.

	Elastic analysis	Non linear analysis 1	Non linear analysis 2	Non linear analysis 3
k_{nn}	1.0e+14 N/m	1.0e+10 N/m	1.0e+12 N/m	1.0e+12 N/m
k_{ss}	1.0e+14 N/m	1.0e+08 N/m	1.0e+10 N/m	1.0e+08 N/m
c		0.0e+00 N/m	0.0e+00 N/m	0.0e+00 N/m
ϕ		37°	37°	37°
ψ		0°	0°	0°

Note about the elastic computations :

1 - The interface elements used in the elastic analysis have a tension resistance.

2 - k_{nn} and k_{ss} have been chosen very high so that the joints cannot open or slide.

6.2 - Graphical results

For each computation, graphical results are given in annexe.
The graphical results proposed are deformed shapes and projections of the principal stresses on the upstream and downstream faces of the dam.

<u>Deformed shapes :</u>

The multiplication factor is 1000.

<u>Principal stresses, signification of the arrows :</u>

The length shows the intensity of the stress.

We use : ≪——≫ for a compression stress
≫——≪ for a tension stress

Figures 0.0 to 0.3 :
Results of the elastic computation with the summer conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 1.0 to 1.3 :
Results of the elastic computation with the winter conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 2.0 to 2.3 :
Results of the non linear computation N°1 with the summer conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 3.0 to 3.3 :
Results of the non linear computation N°1 with the winter conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 4.0 to 4.3 :
Results of the non linear computation N°2 with the summer conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 5.0 to 5.3 :
Results of the non linear computation N°2 with the winter conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 6.0 to 6.3 :
Results of the non linear computation N°3 with the summer conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

Figures 7.0 to 7.3 :
Results of the non linear computation N°3 with the winter conditions.
Deformed shapes and projections of the principal stresses on the faces of the dam.

The important tangential displacements along the joints shown in the results of the computations 1 and 3 are mostly elastic.

6.3 - Convergence analysis

Some convergence problems have been observed and analysed. In most of the non linear analyse, the residuum obtained by the iterative computation reaches a threshold. Figure 2 shows the typical evolution of the disturbance of the equilibrium with the iterations. We can observe that after a few iterations the residuum observed is entirely due to the degrees of

freedom of the interface elements nodes. This phenomenon is certainly due to the modified Newton Raphson method. The auxiliary stiffness matrix $\underline{\underline{\mathbf{K}}}_0$ is not modified if the joint is open or close during the computation step.
Thus, even if a global convergence is reached, the results at the joints nodes might not be acceptable. It asks the question of the improvment of the local convergence and thus of the iterative scheme. Modification during the iterations of the auxiliary operator could bring a first answer to this problem.

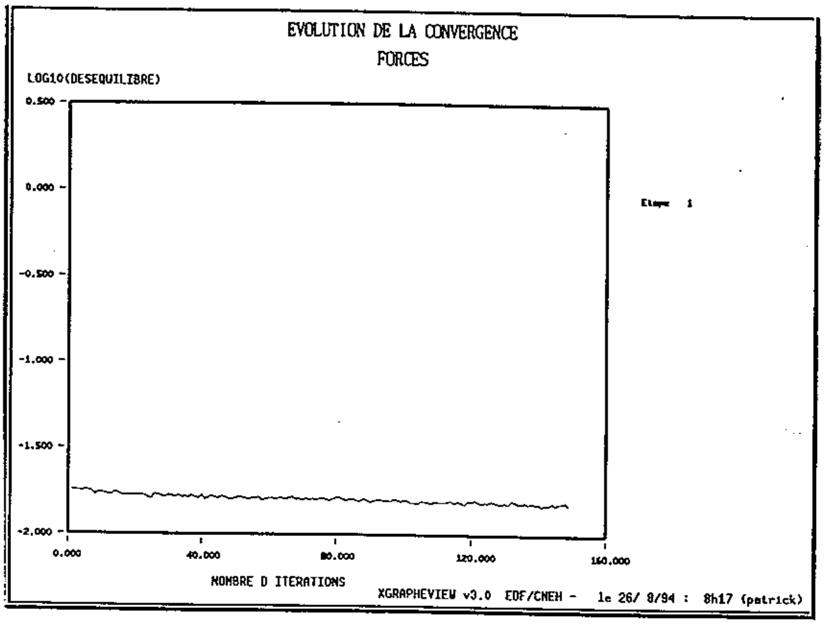

Figure 2 - Typical graph showing the convergence in terms of strength.

7 - Conclusion

It seems that the results obtained are very dependent on the physical characteristics of the vertical joints of the dam. In fact, such a benchmark is twice fruitful. On one hand, the capacity of the computation program can be evaluate and on the other hand it can be the beginning of a parametric analysis of the interface laws used to modelize vertical joints of arch dams. The effect of such parameters as the normal stiffness k_{nn}, the shear stiffness k_{ss} and the dilatancy can't be neglected.

Disk contents

The following table gives the names of the files on the disk and their contents :

Name	Content
sumel.ico	Tables of the **linear elastic** analysis results. The **summer** loading conditions are considered.
sumnl1.ico	**Non linear analysis N°1.** Tables of the **non linear** analysis **N°1** results. The **summer** loading conditions are considered.
sumnl2.ico	**Non linear analysis N°2.** Tables of the **non linear** analysis **N°2** results. The **summer** loading conditions are considered.
sumnl3.ico	**Non linear analysis N°3.** Tables of the **non linear** analysis **N°3** results. The **summer** loading conditions are considered.
winel.ico	Tables of the **linear elastic** analysis results. The **winter** loading conditions are considered.
winnl1.ico	**Non linear analysis N°1.** Tables of the **non linear** analysis **N°1** results. The **winter** loading conditions are considered.
winnl2.ico	**Non linear analysis N°2.** Tables of the **non linear** analysis **N°2** results. The **winter** loading conditions are considered.
winnl3.ico	**Non linear analysis N°3.** Tables of the **non linear** analysis **N°3** results. The **winter** loading conditions are considered.

Annexe

Graphical results

Elastic computation - Summer conditions.

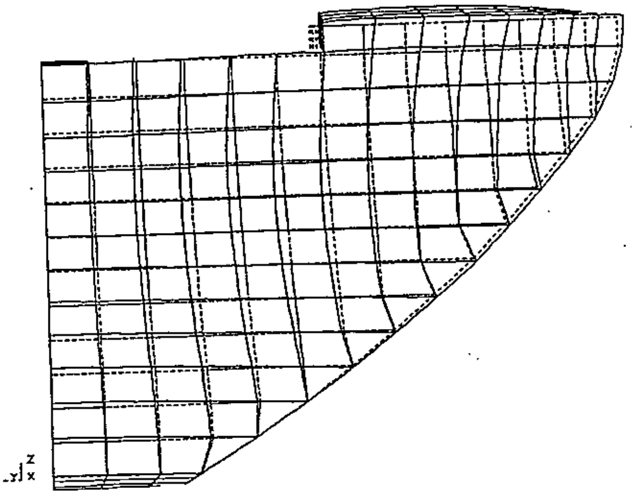

Figure 0.0 - Upstream view.

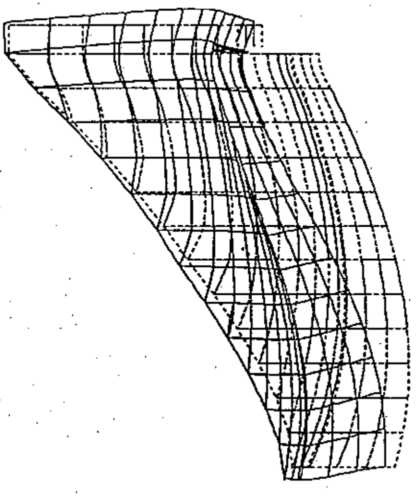

Figure 0.1 - Lateral view.

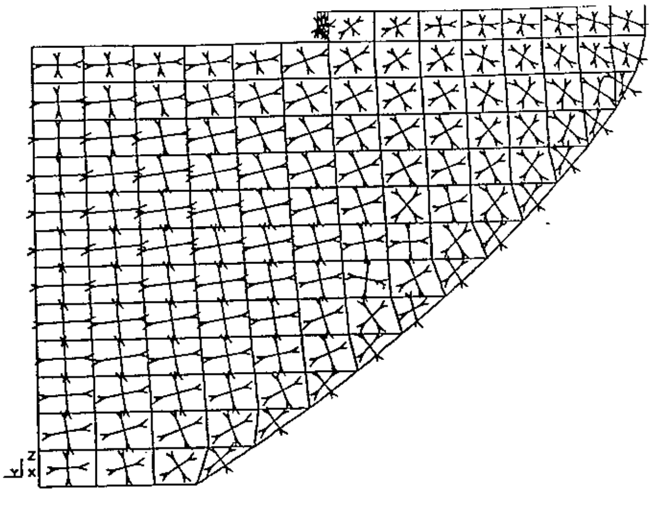

Figure 0.2 - Upstream view.

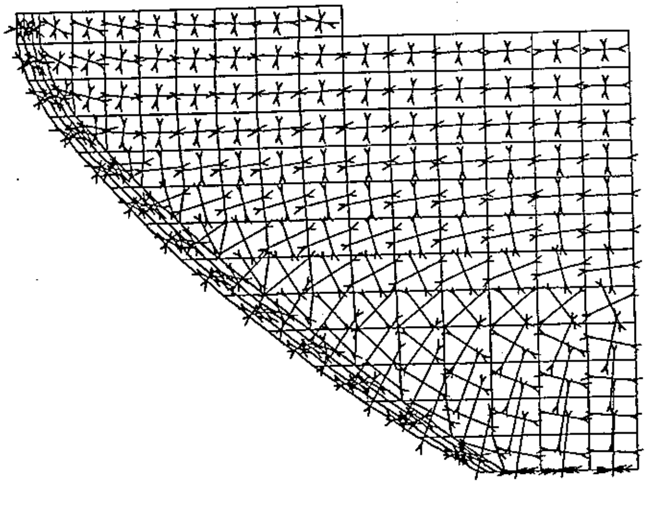

Figure 0.3 - Downstream view.

Elastic computation - Winter conditions.

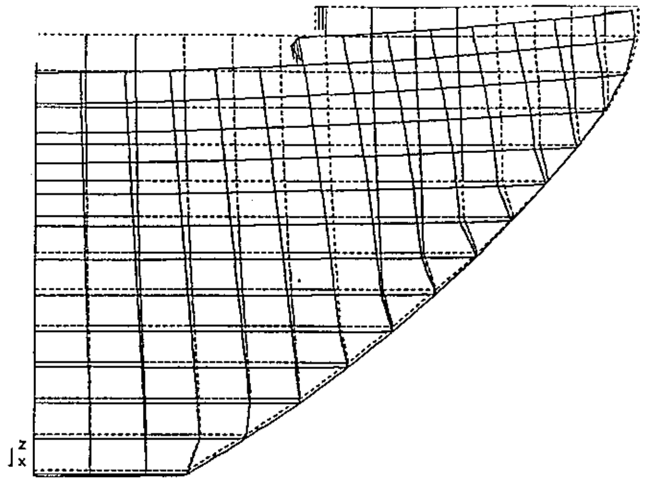

Figure 1.0 - Upstream view.

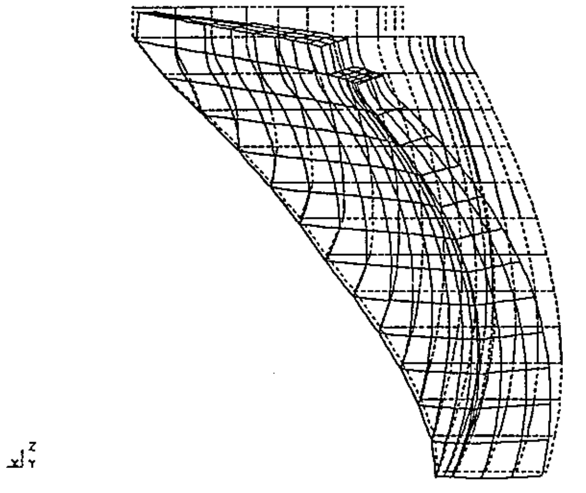

Figure 1.1 - Lateral view.

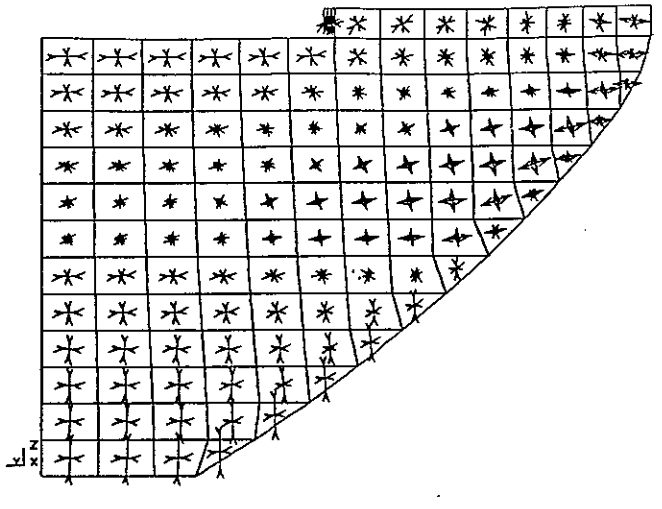

Figure 1.2 - Upstream view.

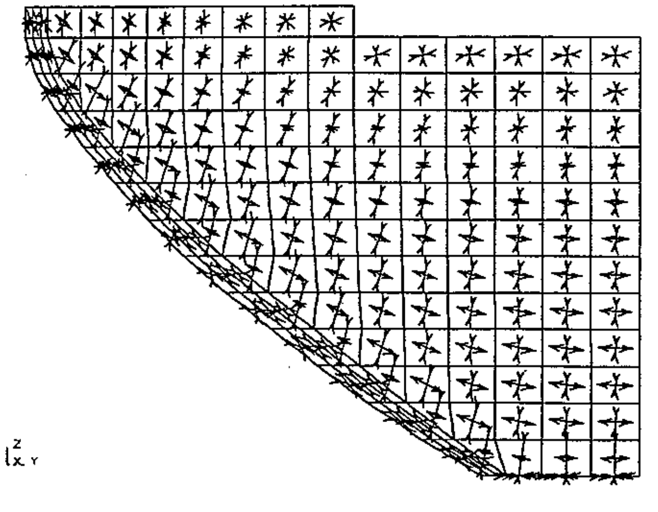

Figure 1.3 - Downstream view.

Non linear computation N°1 - Summer conditions.

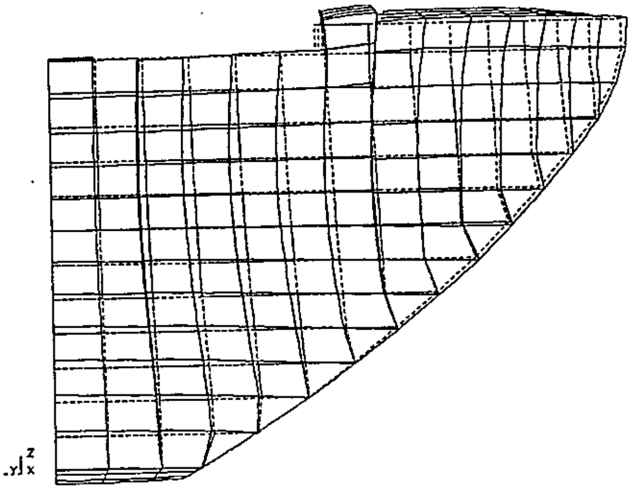

Figure 2.0 - Upstream view.

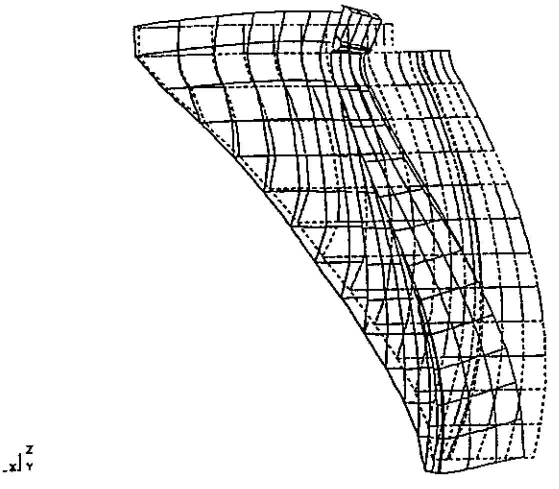

Figure 2.1 - Lateral view.

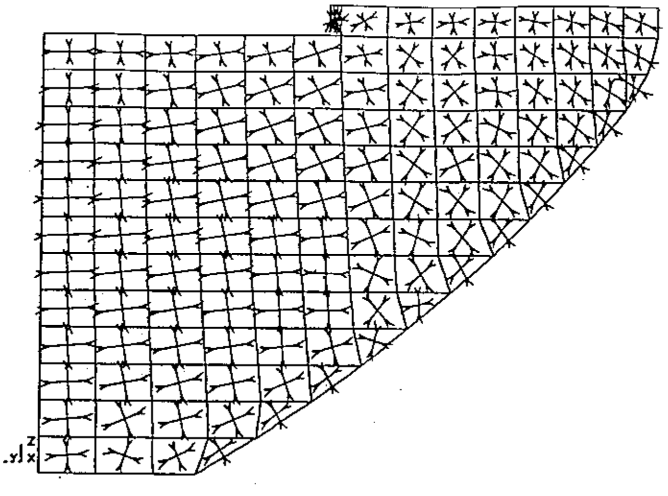

Figure 2.2 - Upstream view.

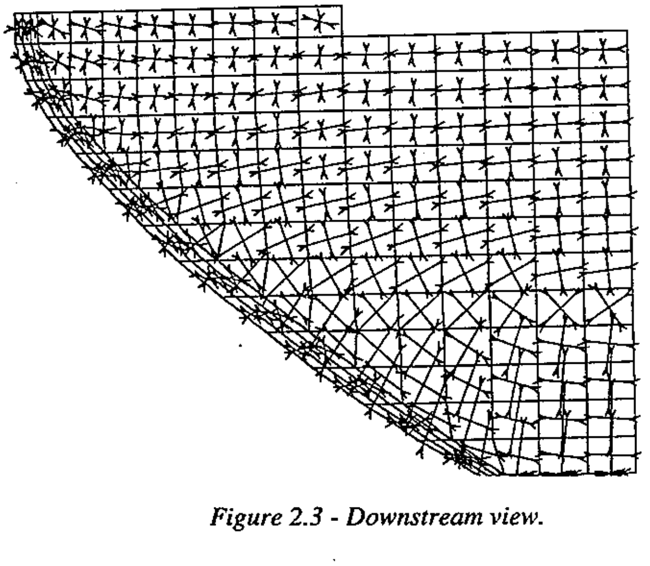

Figure 2.3 - Downstream view.

Non linear computation N°1 - Winter conditions.

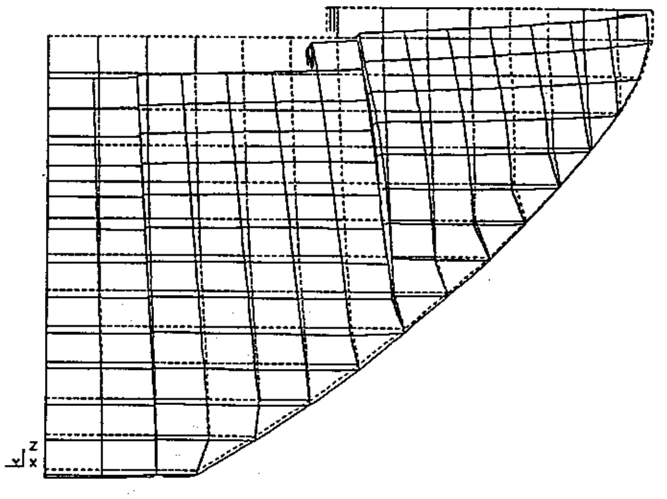

Figure 3.0 - Upstream view.

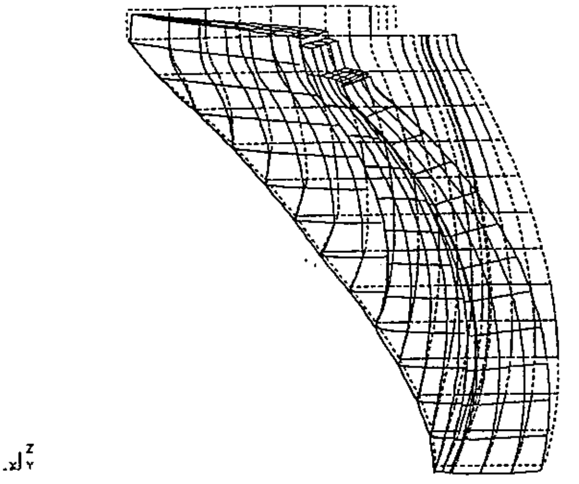

Figure 3.1 - Lateral view.

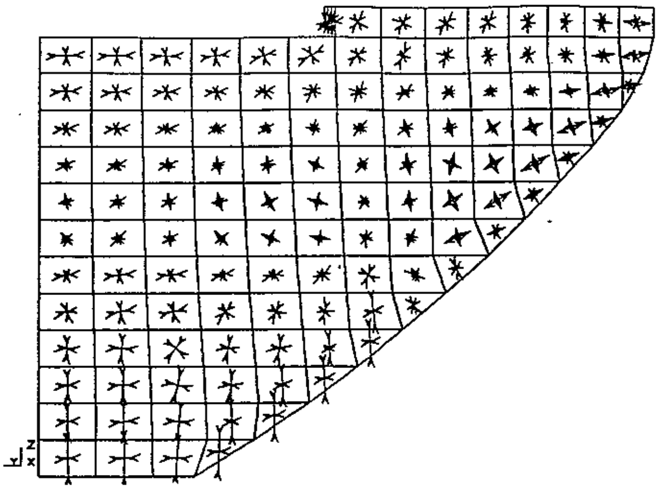

Figure 3.2 - Upstream view.

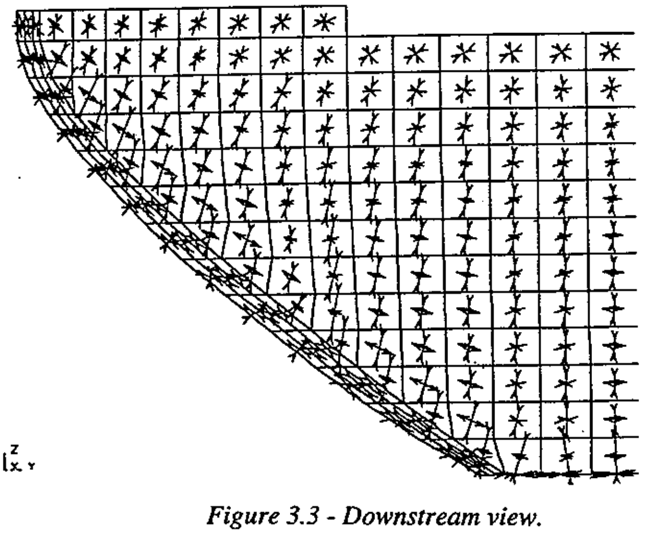

Figure 3.3 - Downstream view.

Non linear computation N°2 - Summer conditions.

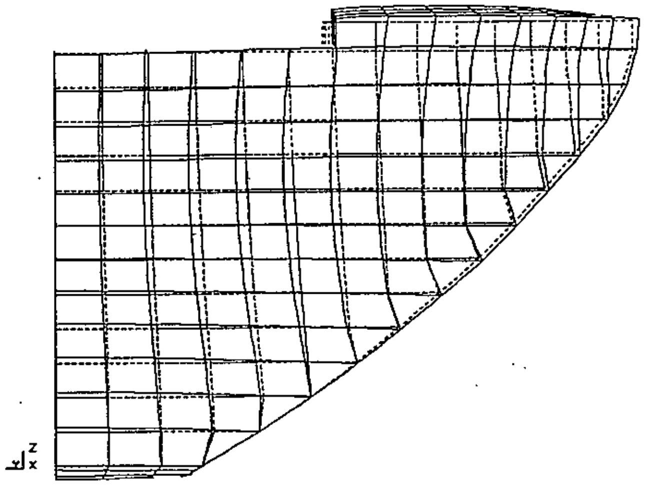

Figure 4.0 - Upstream view.

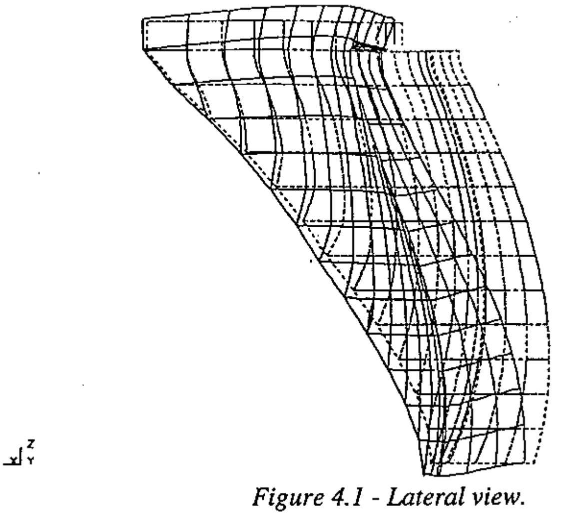

Figure 4.1 - Lateral view.

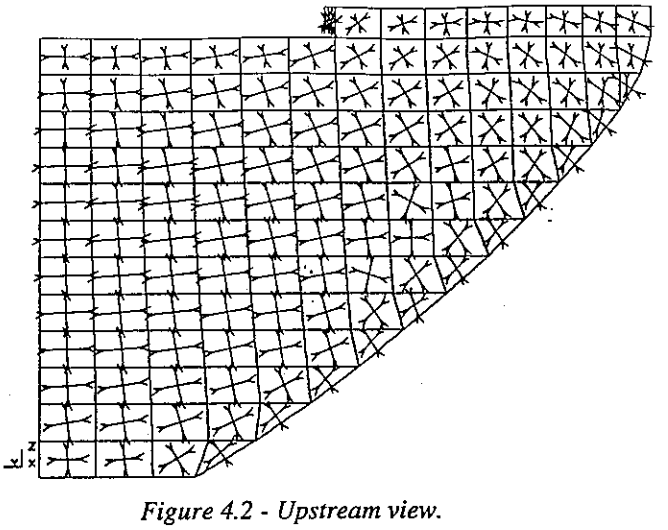

Figure 4.2 - Upstream view.

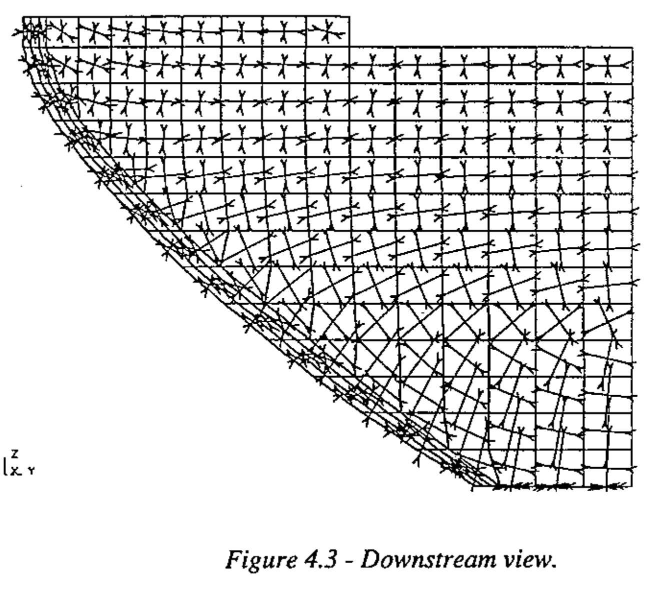

Figure 4.3 - Downstream view.

Non linear computation N°2- Winter conditions.

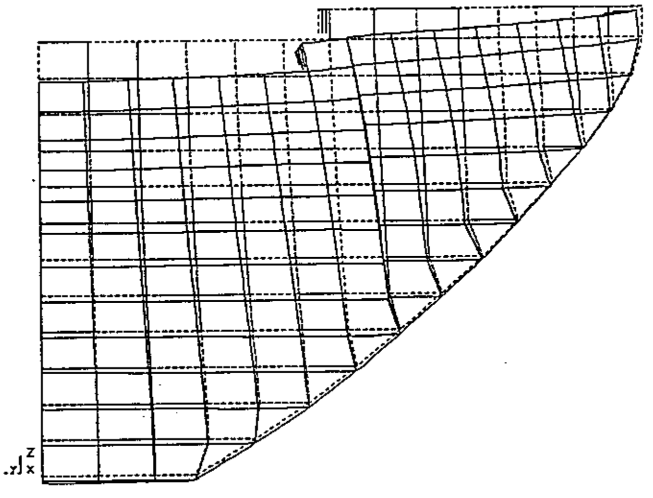

Figure 5.0 - Upstream view.

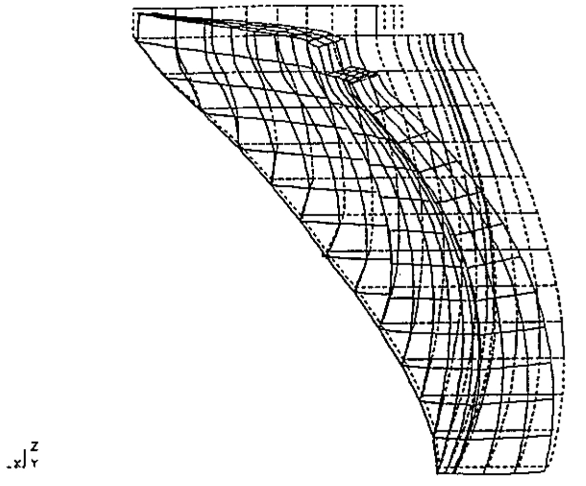

Figure 5.1 - Lateral view.

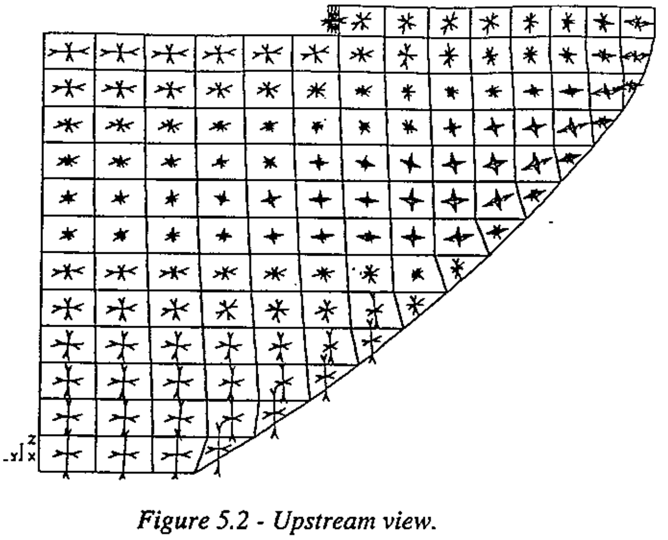

Figure 5.2 - Upstream view.

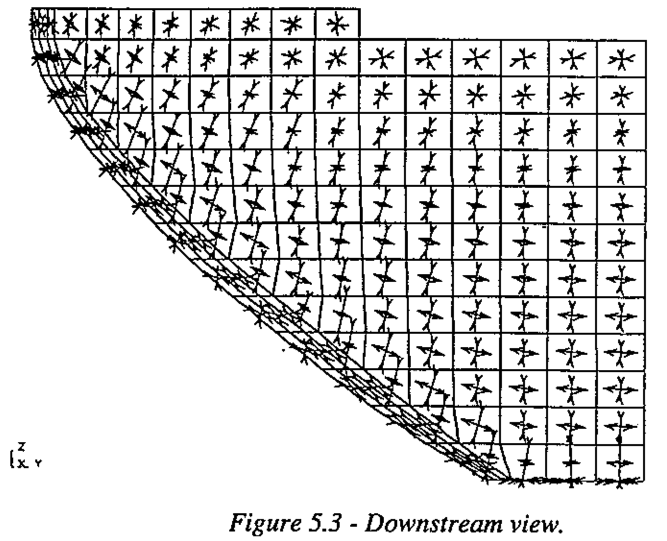

Figure 5.3 - Downstream view.

Non linear computation N°3 - Summer conditions.

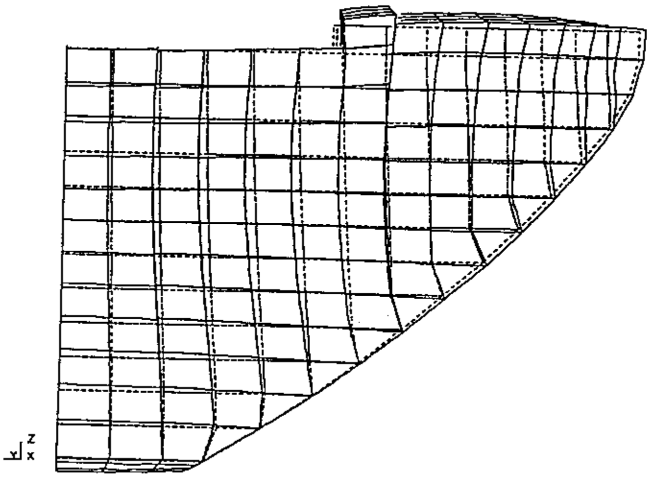

Figure - 6.0 Upstream view.

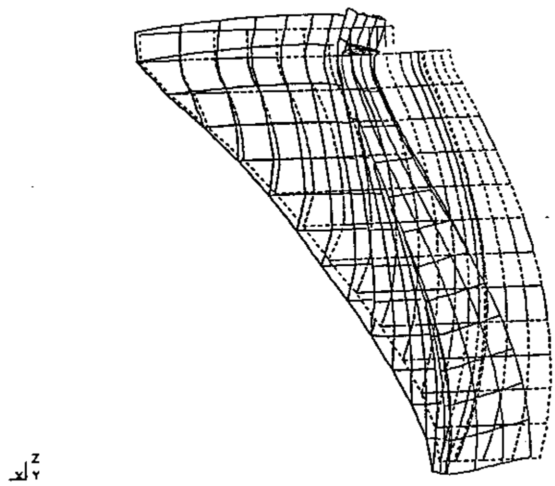

Figure 6.1 - Lateral view.

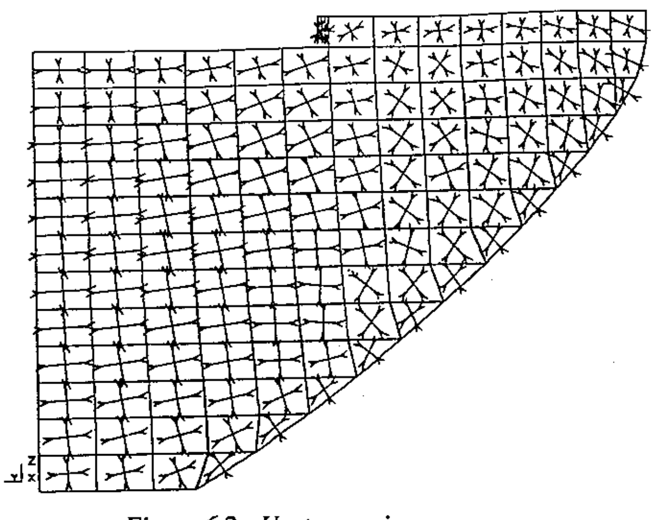

Figure 6.2 - Upstream view.

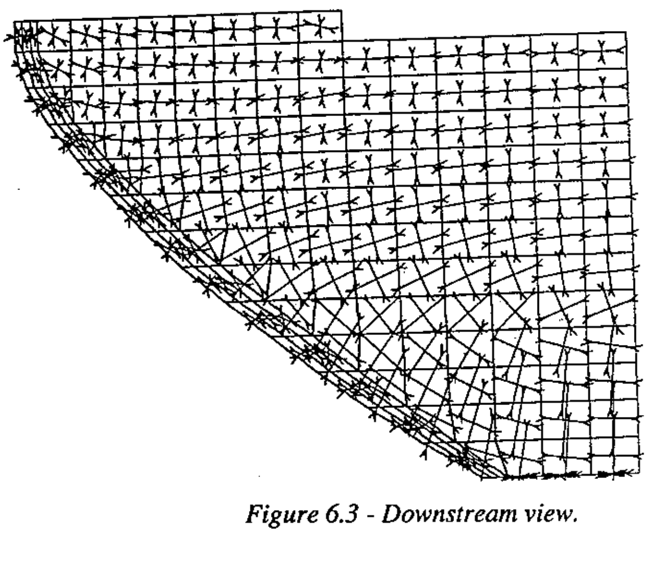

Figure 6.3 - Downstream view.

Non linear computation N°3 - Winter conditions.

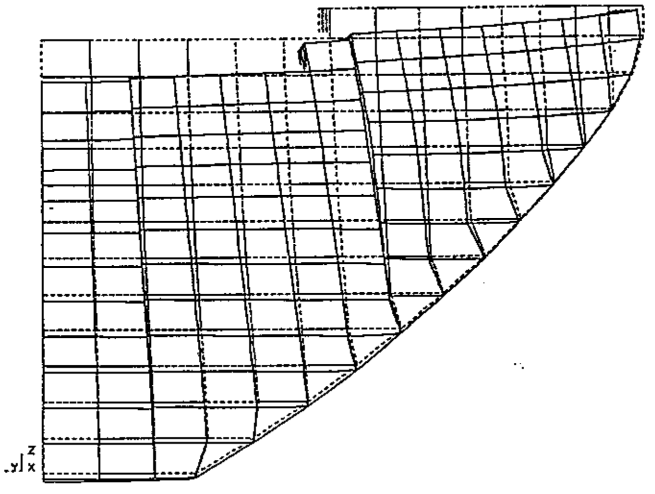

Figure 7.0 - Upstream view.

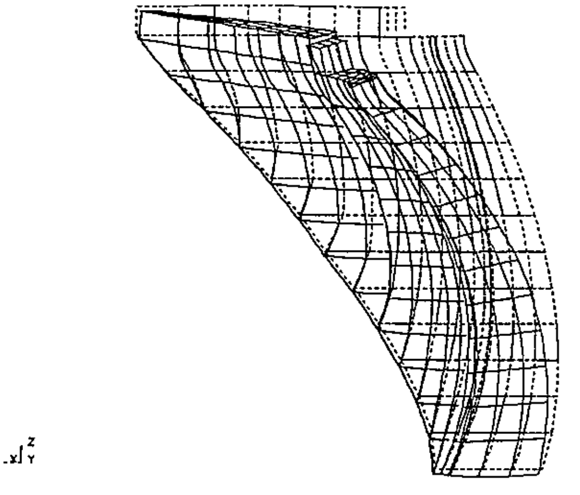

Figure 7.1 - Lateral view.

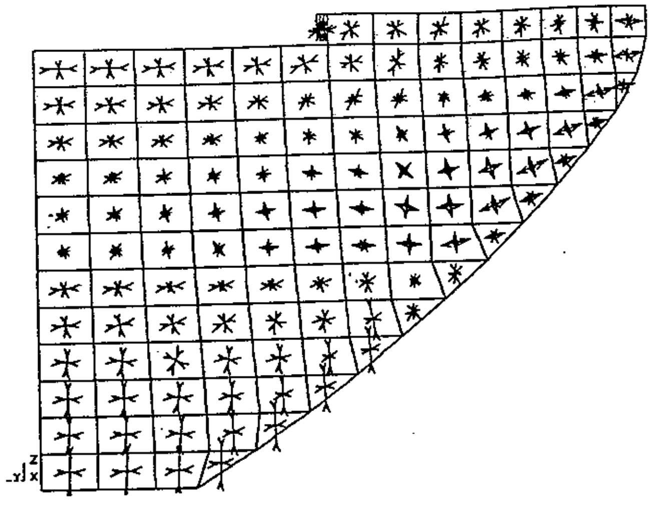

Figure 7.2 - Upstream view.

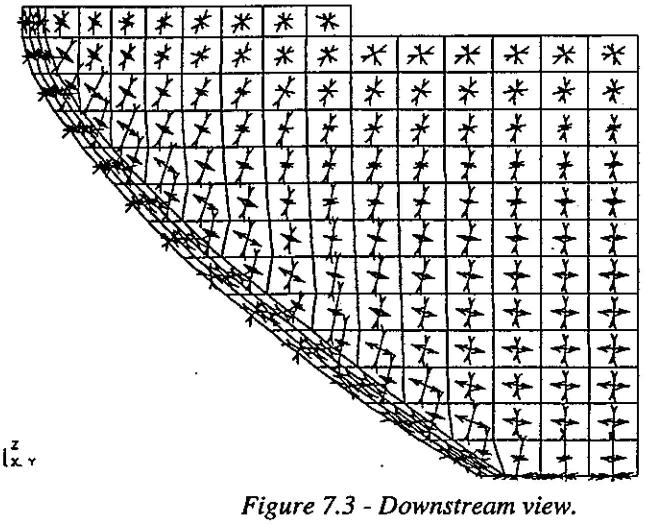

Figure 7.3 - Downstream view.

NOTES

MERLIN Analysis

Theme A1

Non-linear analysis of joint behavior under thermal and hydrostatic loads for an arch dam

Third ICOLD Benchmark Workshop
On Numerical Analysis of Dams,
Paris, (France), Sept. 29-30, 1994

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1 Introduction

In this report, results for theme A1 of the third ICOLD benchmark analysis are presented. The results were obtained using the finite element program MERLIN[1] [2], [3], developed at the University of Colorado under the contract from the Electric Power Research Institute, (Palo-Alto). In theme A1, a problem involving the simulation of non-linear behavior of contraction joints in an arch dam under two different loading conditions is defined. The double curvature arch dam is subjected to self weight, hydrostatic and temperature loads. Two load cases are analyzed: winter and summer loading. The theme emphasises modeling of the opening of the vertical contraction joints. The geometry, finite element model and material properties used in this analysis were specified by the organizers of the Third ICOLD Benchmark Workshop on Numerical Analysis [1].

2 Finite element model

To allow insertion of interface elements and to account for the different materials sharing a common interface at the foundation, a number of nodes were added to the original mesh, and pairs of master/slaves nodes were defined. Two finite element models were generated. First model consists of only low order brick, wedge end interface elements and second model is constructed using higher order elements. In the second case, only the symmetric half of the dam is modeled to reduce the memory requirements and execution time. The adopted meshes are shown in Figures 1 and the element types used in the two analyses are

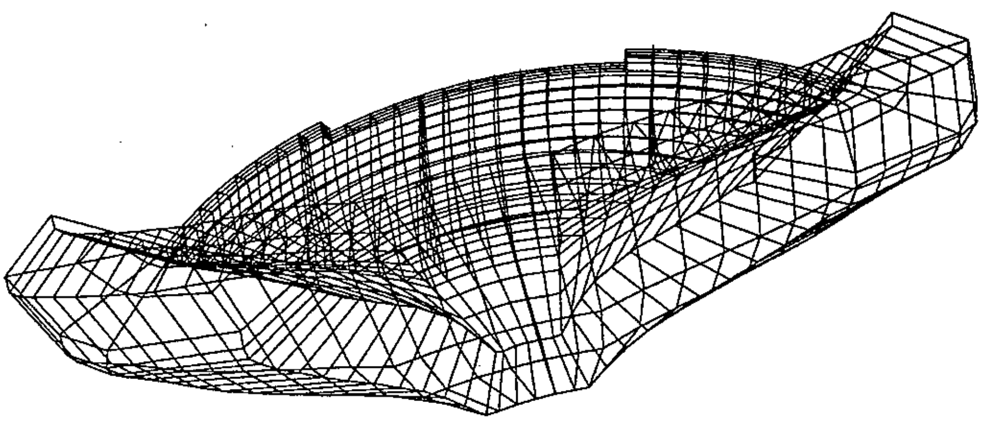

Figure 1: Finite element model with low order elements.

summarized in Table 1. The first mesh consists of eight noded low order bricks with selective reduced integration and standard six noded isoparametric wedge elements. The contraction joints are modeled using eight noded continuous interface elements. The second mesh consists of standard twenty noded bricks and fifteen noded isoparametric wedges. The sixteen noded continuous interface elements are used

[1]MERLIN is separately described in the appendix of theme A2.

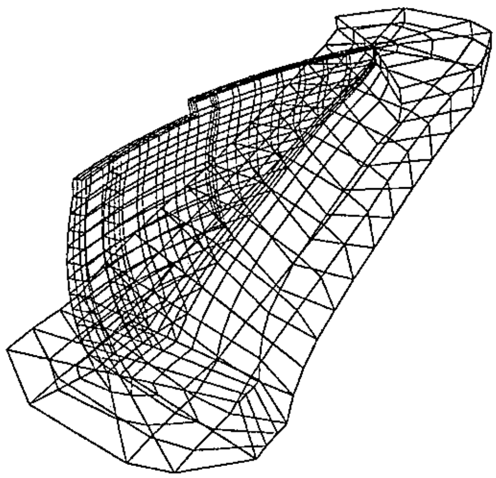

Figure 2: Finite element model with higher order elements.

to represent the contraction joints. The interface elements are placed only in the vertical contraction joints. A rigid connection was assumed between the dam and the foundation.

3 Material properties

The material properties used were the same as those specified by the benchmark organizers [1], Table 2. Both concrete and rock were assumed to behave elastically. The contraction joints are modeled using an interface crack model (ICM)[4]. The failure envelope, F, of the ICM model, shown in Figure 3, has the following mathematical formulation:

$$F = \tau^2 - 2\,c\,\tan(\phi_f)(\sigma_t - \sigma) - \tan(\phi_f)^2(\sigma^2 - \sigma_t^2) = 0 \tag{1}$$

where:

- c is the cohesion.
- ϕ_f is the angle of friction.
- σ_t is the tensile strength of the interface.
- σ and τ is the normal stress and shear stress in the interface respectively.

The evolution of the failure function is based on a softening parameter u_{ieff} which is the norm of the inelastic displacement vector $\mathbf{u}_i$. The inelastic displacement vector can be obtained by the decomposition of the displacement vector $\mathbf{u}$ into an elastic part $\mathbf{u_e}$ and an inelastic part $\mathbf{u_i}$. The inelastic part can be subsequently decomposed into plastic (irreversible) displacements $\mathbf{u_p}$ and fracturing displacements $\mathbf{u_f}$. It is assumed that the plastic displacements are induced by friction between the surfaces and the fracturing displacements are caused by the formation of microcracks.

$$\mathbf{u} = \mathbf{u_e} + \mathbf{u_i}, \qquad \mathbf{u_i} = \mathbf{u_p} + \mathbf{u_f}, \qquad u_{ieff} = ||\mathbf{u}_i|| = (u_{ix}^2 + u_{iy}^2)^{1/2}$$
$$F = F(c, \sigma_t, \phi_f), \qquad c = c(u_{ieff}), \qquad \sigma_t = \sigma_t(u_{ieff}) \tag{2}$$

Table 1: Adopted element types

Element type	Number of nodes	Description
Mesh 1		
B8SRI	8	Brick element with improved bending behavior
W6	6	Standard isoparametric wedge element
I8	8	Continuous interface element
Mesh 2		
B20	20	Standard isoparametric brick element
W15	15	Standard isoparametric wedge element
I16	16	Continuous interface element

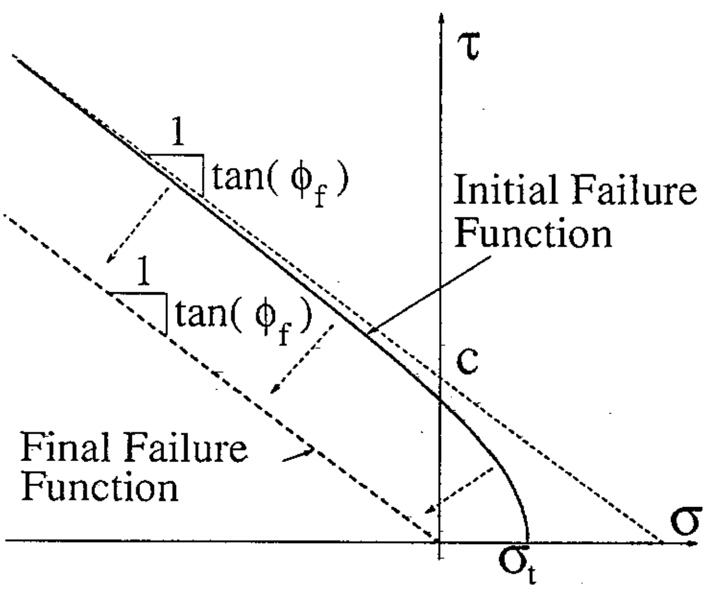

Figure 3: Failure function.

The residual shear strength is given by $\tau = \tan(\phi_f)\,\sigma$. This relationship can be recovered from the failure function by setting c and σ_t equal to 0, which corresponds to the final shape of the failure function on Figure 3. In the presented analysis, only the residual shear strength was considered, as no values for tensile strength and cohesion were available. This corresponds to a conservative assumption of zero tensile strength in the contraction joints.

To model the initial state of the interface artificially high values of normal and tangential stiffnesses are assumed. Considering the values of stresses in the dam of the order of 10^0 MPa, this assumption results in errors in the resulting joint openings in the order of 10^{-7} m, (10^{-4} mm).

Table 2: Material properties

Material property	Symbol	Value
Concrete		
Elastic modulus	E	36 GPa
Poisson's ratio	ν	0.2
Coeff. of thermal expansion	α	0.7×10^{-5} deg C^{-1}
Specific weight	γ_c	24000 $\frac{N}{m^3}$
Rock		
Elastic modulus	E	12 GPa
Poisson's ratio	ν	0.16
Interface		
Normal stiffness	K_n	36000 $\frac{GPa}{m}$
Tangent stiffness	K_t	15000 $\frac{GPa}{m}$
Tensile strength	σ_t	0.0 MPa
Cohesion	c	0.0 MPa
Friction angle	ϕ_f	36.87 deg
Dilatancy angle	ϕ_d	0.0 deg
Mode I fracture energy	G_F^I	0.0 $\frac{N}{m}$
Mode II fracture energy	G_F^{II}	0.0 $\frac{N}{m}$
Water		
Specific weight	γ_w	10000 $\frac{N}{m^{-3}}$

4 Summer loading

For the summer loading condition, three different loads were considered:

- body forces in the dam,
- hydrostatic pressure on the upstream side of the dam and foundation from water elevation of 507 m,
- and thermal loading due to the prescribed summer temperature distribution in the dam.

Since no information was provided with regard to the loading history or the temperature distribution for lower water elevations, all the above loads were applied in a single load increment. Both finite element meshes were used to analyse this loading condition to investigate the infuence of element type. An

Table 3: Nodal displacements and stresses for summer loading with low order elements.

Node	Dx	Dy	Dz	P1	P2	P3
		[m]			[MPa]	
1	1.2638e-02	-6.2452e-08	-7.9616e-04	7.6524e+05	-1.3891e+05	-2.4226e+06
2	1.2751e-02	-8.1997e-08	-6.1558e-04	-7.5607e+05	-1.2371e+06	-3.8182e+06
3	1.2892e-02	-9.6717e-08	-4.7350e-04	-1.7265e+05	-5.5503e+05	-2.9691e+06
4	1.3019e-02	-1.1604e-07	-3.5128e-04	-4.1340e+04	-1.6776e+05	-2.2811e+06
5	1.2623e-02	-1.0091e-08	-1.2115e-03	-7.1773e+05	-1.9912e+06	-4.3116e+06
6	1.2706e-02	-2.3562e-08	-1.4471e-03	2.9062e+05	-2.5687e+05	-2.7495e+06
7	1.2789e-02	-4.3279e-08	-1.6390e-03	2.8670e+05	6.3642e+04	-2.6024e+06
8	1.2934e-02	-5.8017e-08	-1.8154e-03	-9.4062e+05	-9.4931e+05	-3.7929e+06
9	8.2377e-03	-1.5066e-03	-9.5313e-04	-6.5142e+05	-1.8412e+06	-3.4662e+06
10	8.4344e-03	-1.0972e-03	-1.0726e-03	3.1115e+05	-1.9040e+05	-2.3228e+06
11	8.6362e-03	-6.7864e-04	-1.1492e-03	3.1283e+05	6.3103e+04	-2.6179e+06
12	7.3938e-04	6.6486e-04	-5.1711e-04	-2.2963e+06	-2.9103e+06	-4.7374e+06
13	4.5764e-03	-8.9602e-04	-7.8262e-04	-6.0103e+05	-1.7138e+06	-2.5778e+06
14	4.8202e-03	-5.2116e-04	-7.9802e-04	3.2056e+05	-1.3742e+05	-1.8122e+06
15	5.0711e-03	-1.3811e-04	-7.7597e-04	3.2259e+05	7.3342e+04	-2.5187e+06
16	5.3945e-03	2.2167e-04	-7.5093e-04	-1.1121e+06	-1.1921e+06	-4.7835e+06
17	1.8522e-03	1.8534e-04	-6.7623e-04	-6.0211e+05	-1.5149e+06	-1.8428e+06
18	2.0540e-03	3.9046e-04	-5.9667e-04	3.1956e+05	9.5039e+04	-1.3081e+06
19	2.2647e-03	6.0377e-04	-4.8178e-04	3.3927e+05	2.3452e+05	-2.2993e+06
20	2.5410e-03	7.7643e-04	-3.7345e-04	-1.0598e+06	-1.2479e+06	-4.8444e+06
21	6.7952e-04	8.7984e-04	-6.3093e-04	-7.5790e+05	-1.3268e+06	-1.6550e+06
22	7.9171e-04	9.3432e-04	-5.1596e-04	2.0276e+05	6.2863e+04	-1.0938e+06
23	8.9098e-04	9.6076e-04	-3.7002e-04	1.2700e+05	6.2421e+02	-2.0458e+06
24	1.0081e-03	9.1141e-04	-2.2949e-04	-1.4360e+06	-1.6644e+06	-4.5326e+06
25	9.3896e-03	2.6319e-08	-1.1557e-04	-1.2647e+06	-2.2023e+06	-4.2057e+06
26	9.4742e-03	1.1229e-08	-8.1248e-04	4.1372e+05	-4.0634e+04	-1.8809e+06
27	9.5167e-03	2.2604e-09	-1.4904e-03	5.8733e+05	-7.9180e+04	-1.6928e+06
28	9.6966e-03	-1.3746e-08	-2.1664e-03	-1.6512e+06	-2.6859e+06	-4.1950e+06
29	6.0012e-03	-1.4102e-03	-3.2506e-04	-1.2292e+06	-1.9144e+06	-3.3030e+06
30	6.2154e-03	-1.0079e-03	-8.4886e-04	4.4083e+05	1.3533e+05	-1.3405e+06
31	6.4022e-03	-5.7197e-04	-1.3621e-03	6.0620e+05	1.2230e+04	-1.7189e+06
32	6.7282e-03	-2.0069e-04	-1.8725e-03	-1.7040e+06	-2.7330e+06	-4.7759e+06
33	3.1935e-03	-7.7386e-04	-5.2026e-04	-1.1493e+06	-1.5663e+06	-2.3144e+06
34	3.4586e-03	-4.1015e-04	-8.8440e-04	4.9373e+05	2.6556e+05	-8.3704e+05
35	3.6920e-03	-3.5254e-05	-1.2362e-03	7.2691e+05	1.5364e+05	-1.6729e+06
36	4.0870e-03	2.5589e-04	-1.5875e-03	-1.6153e+06	-2.9151e+06	-5.4249e+06
37	1.3163e-03	3.3015e-04	-7.0876e-04	-1.0150e+06	-1.1857e+06	-1.6681e+06
38	1.4965e-03	4.6230e-04	-9.2101e-04	6.2421e+05	3.5326e+05	-4.0913e+05
39	1.6291e-03	5.9005e-04	-1.0425e-03	9.4931e+05	8.7378e+04	-1.5535e+06
40	2.0598e-03	6.7215e-04	-1.2465e-03	-1.0830e+06	-3.1223e+06	-5.3785e+06
41	3.5811e-03	2.8162e-08	1.8375e-04	-1.0433e+06	-1.7273e+06	-2.4509e+06
42	3.5908e-03	1.8161e-08	-7.1456e-04	8.2302e+05	-3.9188e+04	-6.5887e+04
43	3.5133e-03	2.2046e-08	-1.6012e-03	6.9407e+05	-9.8111e+04	-9.5620e+05
44	3.7115e-03	1.3273e-08	-2.3498e-03	-2.3951e+06	-3.9205e+06	-5.7315e+06
45	1.7369e-03	-1.6773e-04	-5.2063e-04	-3.9990e+05	-1.5149e+06	-1.8322e+06
46	1.8523e-03	1.8468e-04	-1.1479e-03	7.1596e+05	4.5118e+05	-2.2715e+05
47	1.8667e-03	4.1767e-04	-1.5862e-03	1.0401e+06	4.6395e+05	-1.0593e+06
48	2.3089e-03	5.7587e-04	-2.0789e-03	-1.6175e+06	-3.6689e+06	-6.1711e+06
49	1.2042e-03	1.7920e-08	-8.5036e-04	2.1835e+06	-1.1311e+05	-5.8006e+05
50	1.2698e-03	5.9117e-09	-1.2204e-03	1.3811e+06	9.3874e+05	5.6456e+03
51	1.2572e-03	2.3116e-08	-1.9430e-03	4.7664e+05	3.3741e+05	-9.8875e+05
52	1.2086e-03	2.2095e-08	-2.1239e-03	-3.5760e+06	-4.1503e+06	-7.5439e+06

Table 4: Nodal displacements and stresses for summer loading with high order elements.

Node	Dx	Dy	Dz	P1	P2	P3
		[m]			[MPa]	
1	1.3282e-02	0.0000e+00	-6.9800e-04	5.4635e+05	4.4245e+05	-2.2042e+06
2	1.3386e-02	0.0000e+00	-4.7400e-04	-9.7954e+05	-1.1405e+06	-3.8701e+06
3	1.3526e-02	0.0000e+00	-2.8900e-04	-4.3120e+05	-5.0857e+05	-3.0555e+06
4	1.3652e-02	0.0000e+00	-1.1800e-04	-1.4109e+05	-1.7823e+05	-2.5318e+06
5	1.3572e-02	0.0000e+00	-1.1560e-03	-4.0815e+05	-1.6916e+06	-4.0831e+06
6	1.3662e-02	0.0000e+00	-1.3870e-03	1.2641e+05	-3.5646e+05	-2.8959e+06
7	1.3749e-02	0.0000e+00	-1.5790e-03	1.5668e+05	3.1707e+04	-2.7305e+06
8	1.3899e-02	0.0000e+00	-1.7520e-03	-7.8605e+05	-1.1872e+06	-4.1229e+06
9	9.1290e-03	-1.5830e-03	-9.4000e-04	-4.2352e+05	-1.5848e+06	-3.4864e+06
10	9.3320e-03	-1.1730e-03	-1.0580e-03	1.2676e+05	-2.9305e+05	-2.5154e+06
11	9.5400e-03	-7.4600e-04	-1.1390e-03	1.5357e+05	1.9158e+04	-2.7694e+06
12	9.8140e-03	-3.3900e-04	-1.2070e-03	-8.0724e+05	-1.2812e+06	-4.5103e+06
13	5.2850e-03	-9.9200e-04	-7.9500e-04	-4.3779e+05	-1.5192e+06	-2.7487e+06
14	5.5400e-03	-6.0000e-04	-8.1400e-04	1.3096e+05	-2.3584e+05	-1.9985e+06
15	5.8050e-03	-1.9300e-04	-7.9900e-04	1.6152e+05	2.3379e+04	-2.6590e+06
16	6.1370e-03	1.8200e-04	-7.7900e-04	-8.2623e+05	-1.3487e+06	-4.7258e+06
17	2.2880e-03	1.5200e-04	-7.1000e-04	-4.5247e+05	-1.3558e+06	-2.0609e+06
18	2.5100e-03	3.8300e-04	-6.3000e-04	1.3779e+05	-3.0248e+04	-1.4784e+06
19	2.7400e-03	6.2200e-04	-5.2100e-04	2.5246e+05	1.3136e+05	-2.4223e+06
20	3.0370e-03	8.1700e-04	-4.1200e-04	-8.4280e+05	-1.2347e+06	-4.7323e+06
21	8.8800e-04	9.9400e-04	-6.7900e-04	-4.6189e+05	-1.2081e+06	-1.7765e+06
22	1.0020e-03	1.0290e-03	-5.5300e-04	1.5487e+05	3.7715e+04	-1.1320e+06
23	1.1150e-03	1.0680e-03	-4.0600e-04	2.2767e+05	9.8684e+04	-2.0421e+06
24	1.2940e-03	1.0510e-03	-2.6600e-04	-8.5632e+05	-1.4589e+06	-4.3831e+06
25	1.0309e-02	0.0000e+00	-3.1000e-05	-9.1380e+05	-2.0679e+06	-4.0820e+06
26	1.0399e-02	0.0000e+00	-7.4300e-04	2.0265e+05	-1.4871e+05	-2.0474e+06
27	1.0447e-02	0.0000e+00	-1.4400e-03	3.4746e+05	-1.7829e+05	-1.9085e+06
28	1.0633e-02	0.0000e+00	-2.1350e-03	-1.2049e+06	-2.7148e+06	-4.4138e+06
29	6.8350e-03	-1.5290e-03	-2.7500e-04	-9.2912e+05	-1.8511e+06	-3.3644e+06
30	7.0600e-03	-1.1070e-03	-8.2200e-04	2.1003e+05	-5.7157e+03	-1.5569e+06
31	7.2520e-03	-6.6100e-04	-1.3600e-03	3.3387e+05	-8.9896e+04	-1.8812e+06
32	7.5840e-03	-2.6500e-04	-1.8990e-03	-1.2258e+06	-2.6665e+06	-4.7608e+06
33	3.8220e-03	-9.1300e-04	-4.9200e-04	-9.3907e+05	-1.5849e+06	-2.5253e+06
34	4.1060e-03	-5.1300e-04	-8.8600e-04	3.0997e+05	9.9396e+04	-1.0603e+06
35	4.3620e-03	-9.3000e-05	-1.2780e-03	3.3469e+05	-3.0848e+04	-1.9469e+06
36	4.7550e-03	2.4300e-04	-1.6680e-03	-1.2431e+06	-2.6931e+06	-5.2115e+06
37	1.6710e-03	2.2800e-04	-7.0700e-04	-9.3136e+05	-1.2816e+06	-1.8763e+06
38	1.8820e-03	4.2900e-04	-9.3400e-04	5.0366e+05	9.9021e+04	-6.3382e+05
39	2.0820e-03	6.4600e-04	-1.1590e-03	3.2166e+05	-9.6725e+04	-1.8522e+06
40	2.4140e-03	7.4400e-04	-1.3890e-03	-1.2917e+06	-2.8242e+06	-5.3470e+06
41	4.1860e-03	0.0000e+00	3.9100e-04	-1.2289e+06	-1.4539e+06	-2.4309e+06
42	4.2060e-03	0.0000e+00	-6.1400e-04	5.4494e+05	-2.1276e+05	-2.4902e+05
43	4.1350e-03	0.0000e+00	-1.5890e-03	4.4271e+05	-2.3771e+05	-8.9490e+05
44	4.3320e-03	0.0000e+00	-2.4870e-03	-1.4882e+06	-3.6148e+06	-4.8642e+06
45	2.0980e-03	-2.4600e-04	-3.6000e-04	-7.6090e+05	-1.3146e+06	-1.7861e+06
46	2.2530e-03	1.1600e-04	-1.0610e-03	7.4105e+05	4.1140e+05	-3.1394e+05
47	2.3520e-03	4.6100e-04	-1.7250e-03	3.4219e+05	2.3849e+05	-1.3467e+06
48	2.6990e-03	6.9200e-04	-2.3260e-03	-1.6208e+06	-3.2432e+06	-5.6334e+06
49	1.3610e-03	0.0000e+00	-5.9400e-04	6.0116e+05	-1.1623e+06	-1.2016e+06
50	1.4950e-03	0.0000e+00	-1.2220e-03	1.0563e+06	8.0703e+05	7.0465e+04
51	1.4740e-03	0.0000e+00	-2.0320e-03	6.7646e+04	-4.2636e+04	-1.4187e+06
52	1.4260e-03	0.0000e+00	-2.4260e-03	-2.0297e+06	-3.4727e+06	-6.3503e+06

iterative process based on Newton's method with line search was used to determine the state of static equilibrium. Table 9 summarizes the prescribed convergence criteria and convergence characteristics of the iterative solution. The computed displacements and principal stresses at the nodes specified by the benchmark organizers are listed in Tables 3 for Mesh 1 and in Tables 4 for Mesh 2. Nodal displacements of both sides of the joints are listed in Tables 5,7 for Mesh 1 and in Tables 6,8 for Mesh 2.

We note that, in these tables, indices ' and " refer to the right and left face of a joint respectively, where right and left is considered in the orographic sense, i.e. looking at the dam from upstream. Due to the symmetry of the problem, only the displacements of the joints on the right side of the dam are listed, and are labeled A and B, where A denotes the first joint to the right from the center of the dam, and B denotes the second joint. The results in Tables 5,7, 6,8, and the convergence characteristics in Table 9, clearly show that there are no significant joint openings in this loading case, and that all joints effectively remain closed for this loading case. The investigation of the influence of element type shows, that there are no significant differencies between the two meshes. As it was to be expected Mesh 2 shows more flexibility then Mesh 1. The difference between the two crest displacements is equivalent to 5 % of the smaller of the two values.

Table 5: Displacements at joint A for summer loading with low order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	1.1048e-02	1.1048e-02	5.2968e-04	5.2960e-04	-5.7836e-04	-5.7835e-04
2	1.1195e-02	1.1195e-02	2.8236e-04	2.8227e-04	-3.6781e-04	-3.6781e-04
3	1.1374e-02	1.1374e-02	3.0245e-05	3.0164e-05	-1.9286e-04	-1.9286e-04
4	1.1538e-02	1.1538e-02	-2.1631e-04	-2.1639e-04	-3.8942e-05	-3.8942e-05
5	1.1579e-02	1.1579e-02	7.4568e-04	7.4560e-04	-1.0234e-03	-1.0233e-03
6	1.1683e-02	1.1683e-02	4.8320e-04	4.8312e-04	-9.4177e-04	-9.4176e-04
7	1.1811e-02	1.1811e-02	2.1824e-04	2.1816e-04	-8.0567e-04	-8.0567e-04
8	1.1970e-02	1.1970e-02	-4.6428e-05	-4.6508e-05	-6.7666e-04	-6.7666e-04
9	1.1684e-02	1.1684e-02	9.7894e-04	9.7884e-04	-1.2257e-03	-1.2257e-03
10	1.1798e-02	1.1798e-02	7.2897e-04	7.2889e-04	-1.2529e-03	-1.2529e-03
11	1.1919e-02	1.1919e-02	4.5736e-04	4.5728e-04	-1.2569e-03	-1.2568e-03
12	1.2087e-02	1.2087e-02	1.9991e-04	1.9983e-04	-1.2410e-03	-1.2410e-03
13	1.1387e-02	1.1387e-02	1.1310e-03	1.1309e-03	-1.1311e-03	-1.1311e-03
14	1.1507e-02	1.1507e-02	8.6340e-04	8.6332e-04	-1.3336e-03	-1.3336e-03
15	1.1628e-02	1.1628e-02	5.9465e-04	5.9457e-04	-1.4926e-03	-1.4926e-03
16	1.1812e-02	1.1812e-02	3.2684e-04	3.2674e-04	-1.6378e-03	-1.6378e-03
17	1.0683e-02	1.0683e-02	1.1734e-03	1.1733e-03	-8.5816e-04	-8.5815e-04
18	1.0807e-02	1.0807e-02	9.1750e-04	9.1743e-04	-1.2250e-03	-1.2250e-03
19	1.0922e-02	1.0922e-02	6.3562e-04	6.3554e-04	-1.5605e-03	-1.5605e-03
20	1.1119e-02	1.1119e-02	3.7579e-04	3.7569e-04	-1.8801e-03	-1.8801e-03
21	9.6884e-03	9.6884e-03	1.1586e-03	1.1585e-03	-5.1028e-04	-5.1028e-04
22	9.8162e-03	9.8162e-03	8.8942e-04	8.8936e-04	-1.0315e-03	-1.0315e-03
23	9.9168e-03	9.9168e-03	6.1880e-04	6.1873e-04	-1.5252e-03	-1.5252e-03
24	1.0129e-02	1.0129e-02	3.5202e-04	3.5193e-04	-2.0142e-03	-2.0143e-03
25	8.4441e-03	8.4441e-03	1.0607e-03	1.0606e-03	-1.7450e-04	-1.7450e-04
26	8.5684e-03	8.5684e-03	8.1101e-04	8.1095e-04	-8.2261e-04	-8.2261e-04
27	8.6566e-03	8.6566e-03	5.2922e-04	5.2916e-04	-1.4538e-03	-1.4538e-03
28	8.8808e-03	8.8808e-03	2.8604e-04	2.8595e-04	-2.0832e-03	-2.0832e-03
29	7.1168e-03	7.1168e-03	9.3995e-04	9.3987e-04	7.3906e-05	7.3910e-05
30	7.2360e-03	7.2360e-03	6.7858e-04	6.7853e-04	-6.6995e-04	-6.6995e-04
31	7.2981e-03	7.2981e-03	4.2190e-04	4.2185e-04	-1.4039e-03	-1.4039e-03
32	7.5350e-03	7.5350e-03	1.7530e-04	1.7521e-04	-2.1366e-03	-2.1366e-03
33	5.6982e-03	5.6983e-03	7.5074e-04	7.5067e-04	1.9780e-04	1.9781e-04
34	5.8010e-03	5.8010e-03	5.2474e-04	5.2470e-04	-6.0614e-04	-6.0614e-04
35	5.8481e-03	5.8481e-03	2.5827e-04	2.5823e-04	-1.4085e-03	-1.4085e-03
36	6.0926e-03	6.0926e-03	6.5323e-05	6.5245e-05	-2.1921e-03	-2.1921e-03
37	4.3619e-03	4.3619e-03	5.7444e-04	5.7438e-04	1.7431e-04	1.7431e-04
38	4.4496e-03	4.4496e-03	3.3476e-04	3.3473e-04	-6.5711e-04	-6.5711e-04
39	4.4508e-03	4.4508e-03	1.1901e-04	1.1898e-04	-1.4717e-03	-1.4717e-03
40	4.6932e-03	4.6933e-03	-8.1704e-05	-8.1775e-05	-2.2579e-03	-2.2579e-03
41	3.0847e-03	3.0847e-03	3.4087e-04	3.4082e-04	-8.3148e-06	-8.3145e-06
42	3.1286e-03	3.1286e-03	1.5944e-04	1.5943e-04	-8.1382e-04	-8.1383e-04
43	3.1022e-03	3.1022e-03	-6.8424e-05	-6.8441e-05	-1.6027e-03	-1.6028e-03
44	3.3337e-03	3.3337e-03	-1.5424e-04	-1.5431e-04	-2.2601e-03	-2.2601e-03
45	1.9898e-03	1.9898e-03	1.5248e-04	1.5242e-04	-3.1406e-04	-3.1406e-04
46	2.0139e-03	2.0139e-03	-3.5282e-05	-3.5322e-05	-1.0871e-03	-1.0875e-03
47	1.9552e-03	1.9552e-03	-1.6665e-04	-1.6668e-04	-1.6872e-03	-1.6874e-03
48	2.2032e-03	2.2032e-03	-2.8606e-04	-2.8619e-04	-2.2016e-03	-2.2017e-03
49	1.0322e-03	1.0322e-03	-7.5757e-05	-7.5757e-05	-9.0145e-04	-9.0145e-04
50	1.1030e-03	1.1030e-03	-1.7339e-04	-1.7339e-04	-1.2169e-03	-1.2169e-03
51	1.1182e-03	1.1182e-03	-3.2995e-04	-3.2995e-04	-1.8353e-03	-1.8353e-03
52	1.1053e-03	1.1053e-03	-2.6057e-04	-2.6057e-04	-1.9835e-03	-1.9835e-03

Table 6: Displacements at joint A for summer loading with high order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
			[m]			
1	1.1710e-02	1.1710e-02	-5.1000e-04	-5.1000e-04	-5.0000e-04	-5.0000e-04
2	1.1848e-02	1.1848e-02	-2.6100e-04	-2.6100e-04	-2.4800e-04	-2.4800e-04
3	1.2022e-02	1.2022e-02	-1.6000e-05	-1.6000e-05	-3.2000e-05	-3.2000e-05
4	1.2184e-02	1.2184e-02	2.3000e-04	2.3000e-04	1.7000e-04	1.7000e-04
5	1.2399e-02	1.2399e-02	-7.3800e-04	-7.3800e-04	-9.7600e-04	-9.7600e-04
6	1.2509e-02	1.2509e-02	-4.9000e-04	-4.8900e-04	-8.4200e-04	-8.4200e-04
7	1.2635e-02	1.2635e-02	-2.3100e-04	-2.3100e-04	-6.8500e-04	-6.8500e-04
8	1.2792e-02	1.2792e-02	2.3000e-05	2.3000e-05	-5.2100e-04	-5.2100e-04
9	1.2608e-02	1.2608e-02	-1.0060e-03	-1.0060e-03	-1.1850e-03	-1.1850e-03
10	1.2724e-02	1.2724e-02	-7.5200e-04	-7.5200e-04	-1.2060e-03	-1.2060e-03
11	1.2849e-02	1.2849e-02	-4.8700e-04	-4.8700e-04	-1.1900e-03	-1.1900e-03
12	1.3021e-02	1.3021e-02	-2.2900e-04	-2.2900e-04	-1.1550e-03	-1.1550e-03
13	1.2335e-02	1.2335e-02	-1.1610e-03	-1.1610e-03	-1.0900e-03	-1.0900e-03
14	1.2460e-02	1.2460e-02	-9.0200e-04	-9.0200e-04	-1.2880e-03	-1.2880e-03
15	1.2585e-02	1.2585e-02	-6.3200e-04	-6.3200e-04	-1.4480e-03	-1.4480e-03
16	1.2773e-02	1.2773e-02	-3.7100e-04	-3.7100e-04	-1.5910e-03	-1.5910e-03
17	1.1636e-02	1.1636e-02	-1.2200e-03	-1.2200e-03	-8.0800e-04	-8.0800e-04
18	1.1767e-02	1.1767e-02	-9.5900e-04	-9.5900e-04	-1.1820e-03	-1.1820e-03
19	1.1886e-02	1.1886e-02	-6.8500e-04	-6.8500e-04	-1.5220e-03	-1.5220e-03
20	1.2089e-02	1.2089e-02	-4.2200e-04	-4.2200e-04	-1.8510e-03	-1.8510e-03
21	1.0609e-02	1.0609e-02	-1.2020e-03	-1.2020e-03	-4.4800e-04	-4.4800e-04
22	1.0742e-02	1.0742e-02	-9.4000e-04	-9.4000e-04	-9.7900e-04	-9.7900e-04
23	1.0849e-02	1.0849e-02	-6.6400e-04	-6.6400e-04	-1.4870e-03	-1.4870e-03
24	1.1066e-02	1.1066e-02	-4.0400e-04	-4.0400e-04	-1.9890e-03	-1.9890e-03
25	9.3530e-03	9.3530e-03	-1.1210e-03	-1.1200e-03	-9.9000e-05	-9.9000e-05
26	9.4840e-03	9.4840e-03	-8.6100e-04	-8.6100e-04	-7.6500e-04	-7.6500e-04
27	9.5760e-03	9.5760e-03	-5.8600e-04	-5.8600e-04	-1.4160e-03	-1.4160e-03
28	9.8060e-03	9.8060e-03	-3.3400e-04	-3.3400e-04	-2.0670e-03	-2.0670e-03
29	7.9560e-03	7.9560e-03	-9.9000e-04	-9.9000e-04	1.7400e-04	1.7400e-04
30	8.0820e-03	8.0820e-03	-7.3600e-04	-7.3600e-04	-5.9900e-04	-5.9900e-04
31	8.1550e-03	8.1550e-03	-4.6500e-04	-4.6500e-04	-1.3680e-03	-1.3680e-03
32	8.3960e-03	8.3960e-03	-2.2700e-04	-2.2700e-04	-2.1340e-03	-2.1340e-03
33	6.4940e-03	6.4940e-03	-8.2100e-04	-8.2100e-04	3.2800e-04	3.2800e-04
34	6.6090e-03	6.6090e-03	-5.7500e-04	-5.7500e-04	-5.2500e-04	-5.2500e-04
35	6.6580e-03	6.6580e-03	-3.1400e-04	-3.1400e-04	-1.3780e-03	-1.3780e-03
36	6.9060e-03	6.9060e-03	-9.7000e-05	-9.6000e-05	-2.2180e-03	-2.2180e-03
37	5.0340e-03	5.0340e-03	-6.2200e-04	-6.2200e-04	3.3700e-04	3.3700e-04
38	5.1290e-03	5.1290e-03	-3.8800e-04	-3.8800e-04	-5.6400e-04	-5.6400e-04
39	5.1470e-03	5.1470e-03	-1.4400e-04	-1.4400e-04	-1.4610e-03	-1.4610e-03
40	5.3930e-03	5.3930e-03	4.3000e-05	4.3000e-05	-2.3220e-03	-2.3220e-03
41	3.6360e-03	3.6360e-03	-4.0400e-04	-4.0400e-04	1.8800e-04	1.8800e-04
42	3.7030e-03	3.7030e-03	-1.8800e-04	-1.8800e-04	-7.2200e-04	-7.2300e-04
43	3.6820e-03	3.6820e-03	3.4000e-05	3.4000e-05	-1.6080e-03	-1.6110e-03
44	3.9190e-03	3.9190e-03	1.7500e-04	1.7500e-04	-2.4170e-03	-2.4170e-03
45	2.3570e-03	2.3590e-03	-1.7300e-04	-1.7400e-04	-9.4000e-05	-9.8000e-05
46	2.3840e-03	2.3950e-03	1.5000e-05	5.0000e-06	-9.5800e-04	-1.0060e-03
47	2.3150e-03	2.3370e-03	1.9500e-04	1.9500e-04	-1.7430e-03	-1.8080e-03
48	2.5200e-03	2.5230e-03	2.8200e-04	2.8300e-04	-2.4200e-03	-2.4290e-03
49	1.1710e-03	1.1710e-03	5.6000e-05	5.6000e-05	-6.9300e-04	-6.9300e-04
50	1.2000e-03	1.2000e-03	2.2600e-04	2.2600e-04	-1.2370e-03	-1.2370e-03
51	1.2780e-03	1.2780e-03	3.4500e-04	3.4500e-04	-1.9740e-03	-1.9740e-03
52	1.2660e-03	1.2660e-03	3.3400e-04	3.3400e-04	-2.3230e-03	-2.3230e-03

Table 7: Displacements at Joint B for summer loading with low order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	-9.2388e-04	-9.2384e-04	-2.1172e-03	-2.1172e-03	8.6078e-04	8.6081e-04
2	-6.5910e-04	-6.5907e-04	-2.3910e-03	-2.3910e-03	1.3623e-03	1.3623e-03
3	-3.9490e-04	-3.9485e-04	-2.6527e-03	-2.6528e-03	1.8667e-03	1.8667e-03
4	-1.3196e-04	-1.3195e-04	-2.9188e-03	-2.9189e-03	2.3778e-03	2.3779e-03
5	5.3143e-04	5.3145e-04	-1.5963e-03	-1.5964e-03	5.6304e-04	5.6307e-04
6	7.4036e-04	7.4039e-04	-1.8609e-03	-1.8610e-03	1.0112e-03	1.0112e-03
7	9.7658e-04	9.7662e-04	-2.1291e-03	-2.1291e-03	1.4685e-03	1.4685e-03
8	1.2328e-03	1.2329e-03	-2.3639e-03	-2.3640e-03	1.9412e-03	1.9412e-03
9	1.9003e-03	1.9004e-03	-8.1613e-04	-8.1618e-04	-1.1648e-04	-1.1645e-04
10	2.1056e-03	2.1056e-03	-1.0698e-03	-1.0699e-03	2.2097e-04	2.2099e-04
11	2.3305e-03	2.3305e-03	-1.3369e-03	-1.3370e-03	5.7059e-04	5.7060e-04
12	2.6037e-03	2.6038e-03	-1.5880e-03	-1.5881e-03	9.3488e-04	9.3488e-04
13	2.7001e-03	2.7002e-03	-8.0322e-05	-8.0373e-05	-5.7615e-04	-5.7614e-04
14	2.9227e-03	2.9227e-03	-3.6905e-04	-3.6910e-04	-3.9102e-04	-3.9101e-04
15	3.1607e-03	3.1607e-03	-6.6250e-04	-6.6257e-04	-1.7221e-04	-1.7220e-04
16	3.4510e-03	3.4511e-03	-9.2768e-04	-9.2779e-04	5.5595e-05	5.5599e-05
17	3.0097e-03	3.0098e-03	3.4724e-04	3.4719e-04	-7.1583e-04	-7.1583e-04
18	3.2451e-03	3.2451e-03	5.0525e-05	5.0482e-05	-6.7641e-04	-6.7641e-04
19	3.4910e-03	3.4911e-03	-2.5961e-04	-2.5967e-04	-6.0837e-04	-6.0837e-04
20	3.8063e-03	3.8064e-03	-5.2797e-04	-5.2807e-04	-5.3191e-04	-5.3192e-04
21	2.9792e-03	2.9792e-03	5.3828e-04	5.3823e-04	-6.9787e-04	-6.9787e-04
22	3.2221e-03	3.2221e-03	2.3401e-04	2.3398e-04	-7.9439e-04	-7.9440e-04
23	3.4644e-03	3.4644e-03	-8.7180e-05	-8.7239e-05	-8.6509e-04	-8.6511e-04
24	3.7935e-03	3.7935e-03	-3.5600e-04	-3.5609e-04	-9.4368e-04	-9.4370e-04
25	2.5932e-03	2.5933e-03	4.5714e-04	4.5710e-04	-6.3540e-04	-6.3541e-04
26	2.8453e-03	2.8453e-03	1.6386e-04	1.6383e-04	-8.4033e-04	-8.4034e-04
27	3.0768e-03	3.0769e-03	-1.3857e-04	-1.3862e-04	-1.0274e-03	-1.0274e-03
28	3.4460e-03	3.4461e-03	-3.7626e-04	-3.7636e-04	-1.2177e-03	-1.2177e-03
29	2.1588e-03	2.1588e-03	2.9189e-04	2.9185e-04	-6.2655e-04	-6.2656e-04
30	2.3908e-03	2.3908e-03	7.9761e-06	7.9567e-06	-8.9081e-04	-8.9083e-04
31	2.6162e-03	2.6163e-03	-3.0856e-04	-3.0861e-04	-1.1736e-03	-1.1736e-03
32	2.9104e-03	2.9105e-03	-4.8841e-04	-4.8849e-04	-1.4191e-03	-1.4192e-03
33	1.5243e-03	1.5243e-03	-1.2918e-04	-1.2921e-04	-6.8655e-04	-6.8655e-04
34	1.7380e-03	1.7380e-03	-3.5899e-04	-3.5901e-04	-1.0290e-03	-1.0290e-03
35	1.8723e-03	1.8724e-03	-5.4795e-04	-5.4800e-04	-1.2483e-03	-1.2483e-03
36	2.3595e-03	2.3595e-03	-6.8453e-04	-6.8473e-04	-1.5601e-03	-1.5601e-03
37	1.0569e-03	1.0569e-03	-5.0663e-04	-5.0663e-04	-9.6224e-04	-9.6224e-04
38	1.1889e-03	1.1889e-03	-6.4344e-04	-6.4344e-04	-1.0817e-03	-1.0817e-03
39	1.3429e-03	1.3429e-03	-9.0129e-04	-9.0129e-04	-1.3984e-03	-1.3984e-03
40	1.3401e-03	1.3401e-03	-8.8412e-04	-8.8412e-04	-1.4672e-03	-1.4672e-03

Table 8: Displacements at Joint B for summer loading with high order elements

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	-7.6500e-04	-7.6500e-04	2.2760e-03	2.2760e-03	7.7200e-04	7.7200e-04
2	-4.9100e-04	-4.9100e-04	2.5570e-03	2.5570e-03	1.3210e-03	1.3210e-03
3	-2.1100e-04	-2.1100e-04	2.8330e-03	2.8330e-03	1.8690e-03	1.8690e-03
4	6.8000e-05	6.8000e-05	3.1110e-03	3.1110e-03	2.4000e-03	2.4000e-03
5	9.0500e-04	9.0500e-04	1.6960e-03	1.6960e-03	5.2200e-04	5.2200e-04
6	1.1240e-03	1.1240e-03	1.9840e-03	1.9840e-03	1.0080e-03	1.0080e-03
7	1.3680e-03	1.3680e-03	2.2670e-03	2.2670e-03	1.5030e-03	1.5030e-03
8	1.6350e-03	1.6350e-03	2.5340e-03	2.5340e-03	1.9860e-03	1.9860e-03
9	2.4130e-03	2.4130e-03	8.2500e-04	8.2500e-04	-1.4300e-04	-1.4300e-04
10	2.6250e-03	2.6250e-03	1.1120e-03	1.1120e-03	2.0900e-04	2.0900e-04
11	2.8620e-03	2.8620e-03	1.4060e-03	1.4060e-03	5.9700e-04	5.9700e-04
12	3.1390e-03	3.1390e-03	1.6780e-03	1.6780e-03	9.9300e-04	9.9300e-04
13	3.2730e-03	3.2730e-03	3.5000e-05	3.5000e-05	-6.0600e-04	-6.0600e-04
14	3.5070e-03	3.5070e-03	3.4200e-04	3.4200e-04	-4.1700e-04	-4.1700e-04
15	3.7610e-03	3.7610e-03	6.5800e-04	6.5800e-04	-1.8800e-04	-1.8800e-04
16	4.0650e-03	4.0650e-03	9.4700e-04	9.4700e-04	5.0000e-05	5.0000e-05
17	3.6090e-03	3.6090e-03	-4.3600e-04	-4.3600e-04	-7.3900e-04	-7.3900e-04
18	3.8600e-03	3.8600e-03	-1.1200e-04	-1.1200e-04	-7.0700e-04	-7.0700e-04
19	4.1200e-03	4.1200e-03	2.2400e-04	2.2500e-04	-6.4100e-04	-6.4100e-04
20	4.4490e-03	4.4490e-03	5.2200e-04	5.2200e-04	-5.7300e-04	-5.7300e-04
21	3.5270e-03	3.5270e-03	-6.2200e-04	-6.2200e-04	-7.0600e-04	-7.0600e-04
22	3.7910e-03	3.7910e-03	-2.9100e-04	-2.9100e-04	-8.1500e-04	-8.1500e-04
23	4.0510e-03	4.0510e-03	5.6000e-05	5.6000e-05	-9.0100e-04	-9.0100e-04
24	4.4030e-03	4.4030e-03	3.4900e-04	3.5000e-04	-9.9100e-04	-9.9100e-04
25	3.1450e-03	3.1450e-03	-5.7500e-04	-5.7400e-04	-6.3000e-04	-6.3000e-04
26	3.4140e-03	3.4140e-03	-2.4600e-04	-2.4600e-04	-8.5600e-04	-8.5600e-04
27	3.6700e-03	3.6700e-03	1.0200e-04	1.0200e-04	-1.0730e-03	-1.0730e-03
28	4.0360e-03	4.0360e-03	3.7500e-04	3.7500e-04	-1.2910e-03	-1.2910e-03
29	2.5700e-03	2.5710e-03	-3.4100e-04	-3.4100e-04	-5.9400e-04	-5.9400e-04
30	2.8360e-03	2.8360e-03	-2.7000e-05	-2.7000e-05	-9.0600e-04	-9.0600e-04
31	3.0700e-03	3.0700e-03	2.9800e-04	2.9800e-04	-1.2070e-03	-1.2070e-03
32	3.4460e-03	3.4460e-03	5.2100e-04	5.2200e-04	-1.5160e-03	-1.5160e-03
33	1.9110e-03	1.9110e-03	2.9000e-05	2.9000e-05	-6.2700e-04	-6.2700e-04
34	2.1440e-03	2.1440e-03	3.1400e-04	3.1400e-04	-9.9400e-04	-9.9400e-04
35	2.3460e-03	2.3460e-03	6.1800e-04	6.1800e-04	-1.3410e-03	-1.3410e-03
36	2.7290e-03	2.7280e-03	8.0100e-04	8.0200e-04	-1.6850e-03	-1.6850e-03
37	1.1700e-03	1.1700e-03	5.4800e-04	5.4800e-04	-9.2700e-04	-9.2700e-04
38	1.3610e-03	1.3610e-03	7.5000e-04	7.5000e-04	-1.1420e-03	-1.1420e-03
39	1.5530e-03	1.5530e-03	1.0470e-03	1.0470e-03	-1.5390e-03	-1.5390e-03
40	1.5810e-03	1.5810e-03	1.1100e-03	1.1100e-03	-1.7250e-03	-1.7250e-03

Table 9: Convergence characteristics for summer loading.

Convergence parameter	Mesh 1	Mesh 2
Maximal number of iterations	500	500
Prescribed relative displacement error	0.2 %	0.1 %
Prescribed relative residual error	1.0 %	1.0 %
Prescribed absolute residual error	10.0 %	5.0 %
Number of iterations	2	13

5 Winter loading

In the winter loading condition, three different loads are considered:

- body forces in the dam,
- hydrostatic pressure on the upstream side of the dam and foundation from water elevation of 471 m,
- and thermal loading due to the prescribed winter temperature distribution in the dam.

Since no informations pertaining to the loading history or the temperature distributions for lower water elevations were available, all the above loads were applied in a single load increment, and an iterative process was utilized to determine a state of statical equilibrium. Again both finite element meshes are used to analyze this loading condition to investigate the infuence of element type. The Newton method with tangent stiffness and line searches is used in the iterative process. Table 16 summarizes the prescribed convergence criteria and convergence characteristics of the iterative solution. The displacements and principal stresses at the nodes specified by the benchmark organizers are listed in in Tables 10 for Mesh 1 and in Tables 11 for Mesh 2. The displacements of the nodes across the joint faces are listed in Tables 12, 14 and Tables 13, 15 for Mesh 1 and 2 respectively. In these tables, indices ' and " refer to the right and left face of a joint respectively, where right and left is considered in the orographic sense, i.e. looking at the dam from upstream. Because of the symmetry of the problem, only the displacements of the joints on the right side of the dam are listed, and are labeled A and B, where A denotes the first joint to the right from the center of the dam, and B denotes the second joint. In this loading case joint openings and slidings can be observed in all joints and large differencies exist between the mesh with low order and higher order elements. Some major results are plotted in Figures 4, 6,5 and 7.

Joint A, (joints 2 and 3), opens at the bottom of downstream face and small openings can also be observed at the bottom of the upstream face. Figures 4 and 5 shows the contour areas of normal joint opening and of tangential sliding displacements for Mesh 1 and Mesh 2 respectively. It can be seen that the total opened area of the joint is larger for Mesh 2 then for Mesh 1. Also the value of the maximal opening is much larger if higher order elements are used. While the maximal joint opening in Mesh 1 is about 1 mm, it is 10 mm in the case of Mesh 2; a difference of 900 %. Tensile stresses of about 3 MPa occur on the downstream face in this loading case due to the thermally induced negative strains on this face. Thus, it is speculated that the thermal load is the main cause for the joint openings.

Joint B, (joints 1 and 4), shows even larger differencies between the two meshes. In Mesh 1, the joint opens at the bottom of upstream face and slidings are observed at the bottom of the downstream face. In Mesh 2, the joint is fully opened along it's whole height. Contour plots of normal opening and tangential sliding displacements in joint B are shown in Figure 6 and 7.

6 Conclusions

A full three-dimensional analysis of an arch dam was performed. The main objective of the analysis was to model the behavior of four vertical contraction joints. The requested results: displacements, principal stresses and displacements at selected nodes are listed in Sections 4 and 5. In the case of joint displacements, because of the symmetry of the problem, only the results from the two right joints, (looking from upstream), are provided. From these analysis the following qualitative conclusions can be drawn:

- There is no joint opening or sliding during summer.
- During winter, some joint opening and sliding develops in the lower parts of joint A, and joint B opens fully along its whole height.

Table 10: Nodal displacements and stresses for winter loading with low order elements.

Node	Dx	Dy	Dz	P1	P2	P3
		[m]			[MPa]	
1	3.3499e-02	5.4147e-08	-8.2279e-03	-1.4675e+05	-2.6585e+05	-4.5400e+06
2	3.3422e-02	5.1587e-08	-8.8931e-03	3.0535e+04	-8.6313e+04	-3.6203e+06
3	3.3333e-02	5.5162e-08	-9.5821e-03	1.6107e+05	-2.4859e+04	-2.6717e+06
4	3.3238e-02	5.2844e-08	-1.0247e-02	2.6205e+05	8.9051e+04	-1.7239e+06
5	2.5820e-02	2.9334e-08	-3.6725e-03	4.7611e+05	-3.8101e+05	-3.7450e+06
6	2.5738e-02	3.5336e-08	-4.7445e-03	-5.1647e+05	-1.3166e+06	-4.1619e+06
7	2.5684e-02	3.3701e-08	-5.8360e-03	-4.3902e+05	-7.3232e+05	-3.0512e+06
8	2.5576e-02	3.9004e-08	-6.8566e-03	1.5435e+06	1.0388e+06	-2.3516e+05
9	1.8477e-02	-4.2180e-03	-2.8093e-03	6.4035e+05	2.4098e+04	-2.2384e+06
10	1.8594e-02	-3.4757e-03	-3.7376e-03	-4.9987e+05	-1.1823e+06	-3.4112e+06
11	1.8752e-02	-2.7254e-03	-4.6890e-03	-4.3330e+05	-7.7462e+05	-3.0225e+06
12	7.2929e-04	5.6143e-04	-1.0418e-03	1.3287e+06	9.4590e+05	-2.6231e+06
13	1.1929e-02	-3.9893e-03	-2.1496e-03	7.7933e+05	4.4021e+05	-8.1992e+05
14	1.2162e-02	-3.2095e-03	-2.9091e-03	-4.9176e+05	-9.9275e+05	-2.6137e+06
15	1.2446e-02	-2.4302e-03	-3.6921e-03	-4.5485e+05	-6.9645e+05	-2.8937e+06
16	1.2692e-02	-1.6326e-03	-4.4345e-03	1.3406e+06	9.2349e+05	-1.4196e+06
17	6.1493e-03	-2.5275e-03	-1.5929e-03	1.0460e+06	8.4269e+05	5.0014e+05
18	6.3917e-03	-1.9189e-03	-2.1417e-03	-4.3857e+05	-6.2650e+05	-1.7820e+06
19	6.7000e-03	-1.3088e-03	-2.7071e-03	-4.2087e+05	-4.9732e+05	-2.6382e+06
20	6.9674e-03	-6.8876e-04	-3.2512e-03	1.5283e+06	8.8805e+05	-1.4871e+06
21	2.2856e-03	-8.5737e-04	-1.2394e-03	1.9942e+06	1.4630e+06	1.1820e+06
22	2.4448e-03	-4.9305e-04	-1.5314e-03	2.8152e+04	-2.8844e+05	-1.1506e+06
23	2.6767e-03	-1.1890e-04	-1.8827e-03	-2.7218e+05	-4.5889e+05	-2.4492e+06
24	2.8269e-03	2.0778e-04	-2.1851e-03	1.6069e+06	1.0038e+06	-1.2714e+06
25	1.6382e-02	2.0611e-08	4.7939e-04	3.1937e+05	2.1292e+04	-3.4026e+06
26	1.6368e-02	1.8229e-08	-1.1321e-03	-6.2431e+05	-1.5546e+06	-3.8447e+06
27	1.6401e-02	2.6770e-08	-2.7361e-03	-8.5334e+05	-1.7545e+06	-2.7200e+06
28	1.6277e-02	2.5304e-08	-4.4179e-03	1.9109e+06	1.8342e+06	1.6350e+06
29	1.0565e-02	-2.8122e-03	2.8242e-04	8.4454e+05	3.6783e+05	-1.7868e+06
30	1.0774e-02	-2.0870e-03	-1.0498e-03	-6.5340e+05	-1.2439e+06	-3.0619e+06
31	1.1049e-02	-1.3478e-03	-2.4351e-03	-8.0126e+05	-1.2291e+06	-3.0808e+06
32	1.1212e-02	-5.8864e-04	-3.6750e-03	1.7520e+06	1.6491e+06	-3.1535e+05
33	5.7304e-03	-2.0137e-03	-8.1566e-05	1.4799e+06	4.5038e+05	-3.2258e+05
34	6.0386e-03	-1.3065e-03	-1.1245e-03	-6.7988e+05	-9.6061e+05	-2.4543e+06
35	6.4183e-03	-6.3211e-04	-2.1838e-03	-7.9313e+05	-8.6875e+05	-3.3676e+06
36	6.7155e-03	9.3053e-05	-3.0624e-03	1.6450e+06	1.4923e+06	-1.5615e+06
37	2.2107e-03	-2.9547e-04	-5.7292e-04	1.6104e+06	7.0094e+05	9.4575e+04
38	2.3842e-03	1.3580e-04	-1.2003e-03	-5.7145e+05	-1.1749e+06	-1.9410e+06
39	2.6025e-03	4.6899e-04	-1.6987e-03	-6.8179e+05	-1.0973e+06	-3.6280e+06
40	2.8959e-03	9.6725e-04	-2.4103e-03	1.4671e+06	1.1312e+06	-2.9074e+06
41	5.1544e-03	7.7617e-09	1.1089e-03	2.7889e+06	5.6402e+05	4.7724e+05
42	5.0127e-03	2.6046e-09	-3.0496e-04	-2.8799e+05	-1.5121e+06	-1.5324e+06
43	5.0153e-03	1.8906e-08	-1.7986e-03	-8.4909e+05	-1.2162e+06	-2.7984e+06
44	4.8572e-03	1.5151e-08	-3.1427e-03	2.5534e+06	1.7133e+06	-1.5539e+06
45	2.3496e-03	-4.6393e-04	-6.9847e-05	3.1425e+06	1.4523e+06	1.4559e+05
46	2.3344e-03	1.3115e-04	-1.0519e-03	-5.2291e+05	-9.4297e+05	-1.8285e+06
47	2.4567e-03	4.6135e-04	-1.7516e-03	-3.2041e+05	-8.5515e+05	-3.1135e+06
48	2.4919e-03	8.7994e-04	-2.5463e-03	2.4189e+06	1.5020e+06	-2.6738e+06
49	1.4100e-03	-1.6062e-09	-3.2316e-04	6.2039e+06	3.7357e+06	3.0898e+06
50	1.4663e-03	-1.2402e-08	-1.0896e-03	7.4043e+05	-1.9271e+05	-9.4832e+05
51	1.5437e-03	2.2476e-08	-1.9527e-03	5.6690e+05	3.7319e+05	-1.6830e+06
52	1.2181e-03	2.5437e-08	-1.9598e-03	2.6033e+06	1.8531e+06	-3.7427e+06

Table 11: Nodal displacements and stresses for winter loading with high order elements.

Node	Dx	Dy	Dz	P1	P2	P3
		[m]			[MPa]	
1	1.0287e-02	0.0000e+00	-4.0680e-03	1.4525e+05	7.4196e+04	5.5426e+04
2	1.0181e-02	0.0000e+00	-4.3320e-03	2.1281e+05	1.6085e+05	1.3841e+05
3	1.0072e-02	0.0000e+00	-4.6035e-03	2.1817e+05	2.1262e+05	1.5858e+05
4	9.9651e-03	0.0000e+00	-4.8659e-03	2.3910e+05	1.2940e+05	7.8777e+04
5	7.6435e-03	0.0000e+00	-1.6820e-03	9.8793e+05	8.3457e+05	5.5253e+05
6	7.5236e-03	0.0000e+00	-2.0360e-03	-2.4663e+05	-4.8097e+05	-5.5098e+05
7	7.4389e-03	0.0000e+00	-2.4144e-03	-2.4084e+05	-4.7940e+05	-5.2385e+05
8	7.3142e-03	0.0000e+00	-2.7666e-03	1.0421e+06	9.2265e+05	5.7229e+05
9	5.6953e-03	-1.5704e-03	-1.3932e-03	1.1315e+06	1.0072e+06	5.6553e+05
10	5.6316e-03	-1.3496e-03	-1.7371e-03	-2.5573e+05	-4.3521e+05	-4.9415e+05
11	5.6072e-03	-1.1338e-03	-2.1059e-03	-2.5391e+05	-5.1949e+05	-5.5505e+05
12	5.5433e-03	-9.1090e-04	-2.4521e-03	9.6971e+05	8.8825e+05	5.8899e+05
13	4.0119e-03	-1.8563e-03	-1.1923e-03	1.1277e+06	1.0624e+06	5.7626e+05
14	3.9726e-03	-1.6452e-03	-1.5195e-03	-2.8305e+05	-4.6432e+05	-4.9269e+05
15	3.9772e-03	-1.4451e-03	-1.8711e-03	-2.8604e+05	-5.0705e+05	-6.4597e+05
16	3.9402e-03	-1.2317e-03	-2.2020e-03	1.0155e+06	8.0794e+05	6.0239e+05
17	1.9242e-03	-7.3194e-05	-4.9403e-04	1.3417e+06	1.0837e+06	5.9145e+05
18	1.8694e-03	7.1385e-05	-6.3506e-04	-2.3731e+05	-3.0671e+05	-5.2350e+05
19	1.8563e-03	1.9312e-04	-7.9171e-04	-2.7907e+05	-3.0952e+05	-6.2356e+05
20	1.8018e-03	3.3824e-04	-9.3568e-04	1.3212e+06	9.2895e+05	6.2770e+05
21	9.2188e-04	-2.7059e-04	-5.4163e-04	1.7864e+06	1.1948e+06	6.0405e+05
22	8.7858e-04	-1.1583e-04	-6.5462e-04	1.5145e+05	-3.0533e+05	-5.6946e+05
23	8.7399e-04	6.8227e-06	-7.7609e-04	8.9634e+04	-3.2497e+05	-8.1192e+05
24	8.3529e-04	1.5706e-04	-8.9218e-04	1.7631e+06	7.2536e+05	6.4957e+05
25	4.7730e-03	0.0000e+00	4.9183e-05	6.8481e+05	1.6044e+05	-4.4376e+04
26	4.7209e-03	0.0000e+00	-4.2560e-04	-3.7282e+05	-7.4950e+05	-1.2179e+06
27	4.7142e-03	0.0000e+00	-9.1859e-04	-4.6108e+05	-8.6828e+05	-1.0179e+06
28	4.5797e-03	0.0000e+00	-1.3737e-03	1.9254e+06	1.8679e+06	1.1425e+06
29	3.0408e-03	-9.6861e-04	4.0504e-05	9.1496e+05	2.1034e+05	1.6423e+05
30	3.0625e-03	-7.2687e-04	-3.8456e-04	-4.0834e+05	-6.6122e+05	-1.1026e+06
31	3.1352e-03	-4.9663e-04	-8.2179e-04	-4.8263e+05	-8.6463e+05	-1.0606e+06
32	3.0882e-03	-2.2852e-04	-1.2315e-03	1.9413e+06	1.6683e+06	1.1490e+06
33	1.6556e-03	-8.6699e-04	1.1787e-05	9.1405e+05	4.6705e+05	1.6918e+05
34	1.6877e-03	-6.7773e-04	-3.7130e-04	-4.7745e+05	-7.6200e+05	-9.2493e+05
35	1.7739e-03	-5.1472e-04	-7.5061e-04	-5.2940e+05	-8.4412e+05	-1.2025e+06
36	1.7496e-03	-2.9320e-04	-1.1115e-03	1.9123e+06	1.3203e+06	1.1261e+06
37	6.3371e-04	8.8169e-05	1.8241e-04	1.2195e+06	5.4422e+05	1.6115e+05
38	6.3085e-04	2.0188e-04	2.1193e-05	-3.0226e+05	-5.8771e+05	-8.9793e+05
39	6.6517e-04	2.8209e-04	-1.1993e-04	-2.5563e+05	-6.3492e+05	-1.0182e+06
40	5.9711e-04	4.3128e-04	-2.6546e-04	2.4779e+06	1.4325e+06	1.0886e+06
41	1.7663e-03	0.0000e+00	4.0489e-04	1.3355e+06	1.0072e+06	4.5920e+05
42	1.6778e-03	0.0000e+00	-3.0211e-05	-6.0573e+05	-9.3838e+05	-1.0677e+06
43	1.6965e-03	0.0000e+00	-4.3979e-04	-5.7032e+05	-9.0400e+05	-1.0273e+06
44	1.5160e-03	0.0000e+00	-8.8477e-04	2.5133e+06	2.2423e+06	1.3870e+06
45	7.5169e-04	-2.3940e-04	7.2275e-05	1.5477e+06	1.2487e+06	5.4666e+05
46	7.4193e-04	-1.7355e-05	-2.0327e-04	-5.7644e+05	-7.5781e+05	-9.0810e+05
47	8.1353e-04	1.3065e-04	-4.2217e-04	-4.9558e+05	-6.1154e+05	-1.3048e+06
48	6.9002e-04	3.2158e-04	-6.4069e-04	2.9043e+06	1.5506e+06	1.2004e+06
49	4.9763e-04	0.0000e+00	9.1415e-05	1.9716e+06	1.5998e+06	1.0699e+06
50	5.4096e-04	0.0000e+00	-2.5676e-04	-3.7682e+05	-7.4225e+05	-8.1828e+05
51	5.8223e-04	0.0000e+00	-4.5175e-04	-2.3420e+05	-2.8504e+05	-1.0387e+06
52	3.7120e-04	0.0000e+00	-4.1988e-04	2.7310e+06	1.4989e+06	9.3815e+05

Table 12: Displacements at joint A for winter loading with low order elements

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[in]					
1	3.0993e-02	3.0993e-02	2.9961e-03	2.9960e-03	-7.7749e-03	-7.7749e-03
2	3.0970e-02	3.0970e-02	2.5886e-03	2.5885e-03	-8.4088e-03	-8.4088e-03
3	3.0970e-02	3.0938e-02	2.5885e-03	2.1682e-03	-8.4088e-03	-9.0649e-03
4	3.0899e-02	3.0899e-02	1.7580e-03	1.7579e-03	-9.6966e-03	-9.6966e-03
5	2.8681e-02	2.8681e-02	2.8220e-03	2.8219e-03	-6.6097e-03	-6.6097e-03
6	2.8661e-02	2.8661e-02	2.3964e-03	2.3963e-03	-7.3115e-03	-7.3115e-03
7	2.8645e-02	2.8645e-02	1.9598e-03	1.9597e-03	-8.0321e-03	-8.0321e-03
8	2.8612e-02	2.8612e-02	1.5223e-03	1.5223e-03	-8.7155e-03	-8.7155e-03
9	2.6329e-02	2.6329e-02	2.8071e-03	2.8070e-03	-5.0054e-03	-5.0054e-03
10	2.6304e-02	2.6304e-02	2.3749e-03	2.3748e-03	-5.8552e-03	-5.8552e-03
11	2.6295e-02	2.6295e-02	1.9186e-03	1.9186e-03	-6.7250e-03	-6.7250e-03
12	2.6255e-02	2.6255e-02	1.4693e-03	1.4693e-03	-7.5390e-03	-7.5390e-03
13	2.3768e-02	2.3768e-02	2.7384e-03	2.7383e-03	-3.4117e-03	-3.4117e-03
14	2.3749e-02	2.3749e-02	2.2735e-03	2.2733e-03	-4.4471e-03	-4.4471e-03
15	2.3759e-02	2.3759e-02	1.8059e-03	1.8058e-03	-5.5040e-03	-5.5040e-03
16	2.3720e-02	2.3720e-02	1.3285e-03	1.3284e-03	-6.4932e-03	-6.4932e-03
17	2.0940e-02	2.0940e-02	2.5724e-03	2.5723e-03	-1.9054e-03	-1.9054e-03
18	2.0922e-02	2.0922e-02	2.1038e-03	2.1037e-03	-3.1218e-03	-3.1218e-03
19	2.0958e-02	2.0958e-02	1.6150e-03	1.6149e-03	-4.3820e-03	-4.3820e-03
20	2.0920e-02	2.0920e-02	1.1271e-03	1.1270e-03	-5.5704e-03	-5.5704e-03
21	1.7967e-02	1.7967e-02	2.3573e-03	2.3572e-03	-5.6639e-04	-5.6639e-04
22	1.7944e-02	1.7944e-02	1.8618e-03	1.8617e-03	-1.9740e-03	-1.9741e-03
23	1.8004e-02	1.8004e-02	1.3778e-03	1.3777e-03	-3.4167e-03	-3.4167e-03
24	1.7970e-02	1.7969e-02	8.6823e-04	8.6821e-04	-4.7896e-03	-4.7908e-03
25	1.4770e-02	1.4770e-02	2.0373e-03	2.0372e-03	4.2159e-04	4.2159e-04
26	1.4827e-02	1.4827e-02	1.5708e-03	1.5707e-03	-1.1042e-03	-1.1042e-03
27	1.4934e-02	1.4934e-02	1.0824e-03	1.0823e-03	-2.6581e-03	-2.6581e-03
28	1.4919e-02	1.4885e-02	5.8528e-04	5.8511e-04	-4.0463e-03	-4.2943e-03
29	1.1837e-02	1.1837e-02	1.7225e-03	1.7224e-03	9.4499e-04	9.4499e-04
30	1.1898e-02	1.1898e-02	1.2517e-03	1.2517e-03	-5.7245e-04	-5.7247e-04
31	1.2034e-02	1.2034e-02	8.0660e-04	8.0656e-04	-2.1440e-03	-2.1441e-03
32	1.2031e-02	1.1992e-02	2.1937e-04	4.1577e-04	-3.4974e-03	-3.9387e-03
33	9.0699e-03	9.0700e-03	1.3546e-03	1.3546e-03	1.1772e-03	1.1772e-03
34	9.1078e-03	9.1078e-03	9.2615e-04	9.2610e-04	-3.2250e-04	-3.2253e-04
35	9.2539e-03	9.2541e-03	4.9841e-04	4.9840e-04	-1.8505e-03	-1.8512e-03
36	9.2714e-03	9.2109e-03	-1.4785e-04	2.9932e-04	-3.0923e-03	-3.6970e-03
37	6.6700e-03	6.6700e-03	1.0310e-03	1.0310e-03	1.1301e-03	1.1300e-03
38	6.6817e-03	6.6818e-03	6.0273e-04	6.0269e-04	-2.9869e-04	-2.9871e-04
39	6.7814e-03	6.8276e-03	2.7013e-04	2.6908e-04	-1.5556e-03	-1.8965e-03
40	6.8321e-03	6.7477e-03	-4.8895e-04	2.2561e-04	-2.8275e-03	-3.4734e-03
41	4.5254e-03	4.5254e-03	6.5048e-04	6.5047e-04	8.3100e-04	8.3098e-04
42	4.4638e-03	4.4638e-03	3.2541e-04	3.2539e-04	-4.6238e-04	-4.6240e-04
43	4.5143e-03	4.5916e-03	-2.0541e-05	6.2967e-05	-1.4763e-03	-1.9691e-03
44	4.5272e-03	4.4706e-03	-6.6300e-04	2.3880e-04	-2.5798e-03	-3.2052e-03
45	2.7949e-03	2.7797e-03	2.8035e-04	4.1601e-04	4.0656e-04	3.3054e-04
46	2.6654e-03	2.6586e-03	6.2227e-05	5.8615e-05	-7.9223e-04	-8.2594e-04
47	2.6678e-03	2.7117e-03	-1.9175e-04	-1.2948e-06	-1.4973e-03	-1.8926e-03
48	2.6243e-03	2.5614e-03	-8.2978e-04	1.6345e-04	-2.3014e-03	-2.7160e-03
49	1.2586e-03	1.2586e-03	-1.9693e-05	-1.9693e-05	-3.8030e-04	-3.8030e-04
50	1.3253e-03	1.3253e-03	-1.2855e-04	-1.2855e-04	-1.0351e-03	-1.0351e-03
51	1.4299e-03	1.4299e-03	-3.0288e-04	-3.0288e-04	-1.6966e-03	-1.6966e-03
52	1.1202e-03	1.1202e-03	-2.8504e-04	-2.8504e-04	-1.7032e-03	-1.7032e-03

Table 13: Displacements at joint A for winter loading with high order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	1.0027e-02	1.0026e-02	-1.2124e-03	-1.1833e-03	-4.0596e-03	-4.0613e-03
2	9.9380e-03	9.9280e-03	-1.0466e-03	-1.1410e-03	-4.3272e-03	-4.3222e-03
3	9.8494e-03	9.8258e-03	-8.7639e-04	-1.1018e-03	-4.5994e-03	-4.5915e-03
4	9.7639e-03	9.7236e-03	-7.0957e-04	-1.0637e-03	-4.8620e-03	-4.8510e-03
5	9.1229e-03	9.1277e-03	-1.0966e-03	-1.0857e-03	-3.3074e-03	-3.3068e-03
6	9.0375e-03	9.0312e-03	-9.3836e-04	-1.0288e-03	-3.5982e-03	-3.5928e-03
7	8.9649e-03	8.9407e-03	-7.6123e-04	-9.8809e-04	-3.9010e-03	-3.8919e-03
8	8.8821e-03	8.8368e-03	-5.7359e-04	-9.5824e-04	-4.1889e-03	-4.1747e-03
9	8.2585e-03	8.2595e-03	-1.0393e-03	-1.0323e-03	-2.4482e-03	-2.4485e-03
10	8.1678e-03	8.1634e-03	-8.9022e-04	-9.4508e-04	-2.7743e-03	-2.7715e-03
11	8.1063e-03	8.0836e-03	-7.0363e-04	-8.9720e-04	-3.1192e-03	-3.1125e-03
12	8.0217e-03	7.9734e-03	-4.9012e-04	-8.7320e-04	-3.4454e-03	-3.4313e-03
13	7.3767e-03	7.3766e-03	-9.7258e-04	-9.6985e-04	-1.6778e-03	-1.6777e-03
14	7.2826e-03	7.2840e-03	-8.3203e-04	-8.5231e-04	-2.0344e-03	-2.0362e-03
15	7.2405e-03	7.2220e-03	-6.3295e-04	-8.0226e-04	-2.4181e-03	-2.4190e-03
16	7.1588e-03	7.1065e-03	-3.8351e-04	-7.9373e-04	-2.7775e-03	-2.7707e-03
17	6.4826e-03	6.4827e-03	-8.9779e-04	-8.9649e-04	-1.0052e-03	-1.0056e-03
18	6.3895e-03	6.3900e-03	-7.5870e-04	-7.5746e-04	-1.3964e-03	-1.3971e-03
19	6.3752e-03	6.3568e-03	-5.5132e-04	-7.0365e-04	-1.8160e-03	-1.8266e-03
20	6.3028e-03	6.2382e-03	-2.5546e-04	-7.2155e-04	-2.2081e-03	-2.2134e-03
21	5.5745e-03	5.5749e-03	-8.1265e-04	-8.1069e-04	-4.0769e-04	-4.0827e-04
22	5.4816e-03	5.4820e-03	-6.6447e-04	-6.6249e-04	-8.5525e-04	-8.5586e-04
23	5.5002e-03	5.4813e-03	-4.5177e-04	-6.0748e-04	-1.3133e-03	-1.3365e-03
24	5.4430e-03	5.3598e-03	-1.0332e-04	-6.6213e-04	-1.7408e-03	-1.7636e-03
25	4.5687e-03	4.5687e-03	-6.9867e-04	-6.9864e-04	1.5493e-06	1.6766e-06
26	4.5605e-03	4.5604e-03	-5.5752e-04	-5.5748e-04	-4.6135e-04	-4.6105e-04
27	4.6341e-03	4.6129e-03	-3.4400e-04	-5.1114e-04	-9.2675e-04	-9.6299e-04
28	4.5983e-03	4.4904e-03	6.4011e-05	-6.1577e-04	-1.3595e-03	-1.4117e-03
29	3.7286e-03	3.7284e-03	-5.9851e-04	-5.9846e-04	1.8288e-04	1.8336e-04
30	3.7357e-03	3.7348e-03	-4.5727e-04	-4.5713e-04	-2.3696e-04	-2.3398e-04
31	3.8545e-03	3.8298e-03	-2.3415e-04	-4.3497e-04	-6.5927e-04	-7.1885e-04
32	3.8381e-03	3.6989e-03	2.3389e-04	-5.9811e-04	-1.0649e-03	-1.1584e-03
33	3.0093e-03	3.0092e-03	-5.0544e-04	-5.0540e-04	3.0012e-04	3.0058e-04
34	3.0155e-03	3.0148e-03	-3.6587e-04	-3.6580e-04	-1.0296e-04	-9.9790e-05
35	3.1616e-03	3.1331e-03	-1.2559e-04	-3.8144e-04	-4.7562e-04	-5.6965e-04
36	3.1583e-03	2.9886e-03	3.9158e-04	-6.0409e-04	-8.5510e-04	-1.0070e-03
37	2.3529e-03	2.3534e-03	-4.0946e-04	-4.0947e-04	3.6786e-04	3.6683e-04
38	2.3476e-03	2.3479e-03	-2.7623e-04	-2.7622e-04	-2.7230e-05	-2.7796e-05
39	2.5046e-03	2.4761e-03	-2.5666e-05	-3.3337e-04	-3.4758e-04	-4.8216e-04
40	2.5048e-03	2.3143e-03	5.2304e-04	-6.1241e-04	-7.0880e-04	-9.2564e-04
41	1.7378e-03	1.7384e-03	-3.0544e-04	-3.0453e-04	3.7852e-04	3.7296e-04
42	1.7098e-03	1.7072e-03	-1.8468e-04	-1.8388e-04	-1.6215e-05	-1.4718e-05
43	1.8492e-03	1.8172e-03	6.2201e-05	-2.7716e-04	-2.7006e-04	-4.3387e-04
44	1.8385e-03	1.6360e-03	6.0903e-04	-5.9319e-04	-5.9816e-04	-8.6299e-04
45	1.1400e-03	1.1351e-03	-1.4128e-04	-2.2954e-04	3.1626e-04	3.1231e-04
46	1.0892e-03	1.1003e-03	-9.5428e-05	-8.7298e-05	-3.9506e-05	-9.6675e-05
47	1.1993e-03	1.1598e-03	1.2343e-04	-2.0236e-04	-2.3444e-04	-3.9119e-04
48	1.1206e-03	9.4833e-04	5.9045e-04	-4.9963e-04	-4.5995e-04	-6.8484e-04
49	5.1251e-04	5.1251e-04	-4.8354e-05	-4.8354e-05	1.3260e-04	1.3260e-04
50	5.2314e-04	5.2314e-04	1.1969e-05	1.1969e-05	-1.8047e-04	-1.8047e-04
51	6.5102e-04	6.5102e-04	3.3127e-05	3.3127e-05	-2.3754e-04	-2.3754e-04
52	4.0022e-04	4.0022e-04	7.7555e-05	7.7555e-05	-2.2400e-04	-2.2400e-04

Table 14: Displacements at joint B for winter loading with low order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	1.2736e-02	1.2736e-02	4.9619e-03	4.9619e-03	-4.7956e-03	-4.7956e-03
2	1.2971e-02	1.2971e-02	4.2616e-03	4.2616e-03	-5.0840e-03	-5.0840e-03
3	1.3196e-02	1.3196e-02	3.5811e-03	3.5811e-03	-5.3732e-03	-5.3732e-03
4	1.3425e-02	1.3425e-02	2.9064e-03	2.9064e-03	-5.6767e-03	-5.6767e-03
5	1.2055e-02	1.2055e-02	4.0006e-03	4.0006e-03	-4.5178e-03	-4.5178e-03
6	1.2286e-02	1.2286e-02	3.3624e-03	3.3623e-03	-4.8130e-03	-4.8129e-03
7	1.2542e-02	1.2542e-02	2.6954e-03	2.6954e-03	-5.1197e-03	-5.1196e-03
8	1.2780e-02	1.2780e-02	2.0467e-03	2.0467e-03	-5.4160e-03	-5.4159e-03
9	1.1312e-02	1.1313e-02	3.6863e-03	3.6862e-03	-3.7936e-03	-3.7936e-03
10	1.1539e-02	1.1539e-02	3.0342e-03	3.0342e-03	-4.1834e-03	-4.1834e-03
11	1.1789e-02	1.1789e-02	2.3671e-03	2.3671e-03	-4.5830e-03	-4.5830e-03
12	1.2030e-02	1.2030e-02	1.6969e-03	1.6968e-03	-4.9573e-03	-4.9574e-03
13	1.0243e-02	1.0243e-02	3.6423e-03	3.6423e-03	-2.7952e-03	-2.7952e-03
14	1.0482e-02	1.0482e-02	2.9520e-03	2.9519e-03	-3.3253e-03	-3.3254e-03
15	1.0762e-02	1.0762e-02	2.2431e-03	2.2430e-03	-3.8673e-03	-3.8674e-03
16	1.1019e-02	1.1019e-02	1.5306e-03	1.5305e-03	-4.3754e-03	-4.3754e-03
17	8.8029e-03	8.8029e-03	3.3290e-03	3.3290e-03	-1.8397e-03	-1.8397e-03
18	9.0547e-03	9.0547e-03	2.6157e-03	2.6156e-03	-2.4979e-03	-2.4979e-03
19	9.3664e-03	9.3664e-03	1.9025e-03	1.9024e-03	-3.1786e-03	-3.1787e-03
20	9.6421e-03	9.6421e-03	1.1753e-03	1.1753e-03	-3.8293e-03	-3.8293e-03
21	7.2285e-03	7.2285e-03	2.8325e-03	2.8325e-03	-1.0692e-03	-1.0692e-03
22	7.4858e-03	7.4858e-03	2.1233e-03	2.1232e-03	-1.8233e-03	-1.8234e-03
23	7.8286e-03	7.8286e-03	1.4226e-03	1.4226e-03	-2.6113e-03	-2.6114e-03
24	8.1121e-03	8.1122e-03	7.0941e-04	7.0938e-04	-3.3866e-03	-3.3867e-03
25	5.4374e-03	5.4023e-03	2.0394e-03	2.0949e-03	-4.6691e-04	-5.2962e-04
26	5.6686e-03	5.6686e-03	1.3634e-03	1.3634e-03	-1.3552e-03	-1.3552e-03
27	6.0208e-03	6.0209e-03	7.3047e-04	7.3043e-04	-2.1957e-03	-2.1958e-03
28	6.3326e-03	6.3317e-03	4.3896e-05	4.8383e-05	-3.0212e-03	-3.0774e-03
29	3.7804e-03	3.7870e-03	1.2529e-03	1.2568e-03	-3.1902e-04	-3.4654e-04
30	4.0870e-03	4.0870e-03	6.7563e-04	6.7560e-04	-1.1407e-03	-1.1407e-03
31	4.4687e-03	4.4688e-03	1.1249e-04	1.1245e-04	-1.9492e-03	-1.9493e-03
32	4.7061e-03	4.7109e-03	-4.2858e-04	-4.0901e-04	-2.5799e-03	-2.9398e-03
33	2.3908e-03	2.2283e-03	2.5763e-04	4.2070e-04	-4.7240e-04	-5.6807e-04
34	2.5134e-03	2.5134e-03	-1.7256e-04	-1.7259e-04	-1.2249e-03	-1.2249e-03
35	2.7525e-03	2.7749e-03	-5.3429e-04	-5.2047e-04	-1.7640e-03	-1.8185e-03
36	3.0026e-03	3.1135e-03	-1.0981e-03	-1.0223e-03	-2.4078e-03	-2.7109e-03
37	1.2488e-03	1.2488e-03	-3.9668e-04	-3.9668e-04	-8.9034e-04	-8.9034e-04
38	1.4746e-03	1.4746e-03	-6.9220e-04	-6.9220e-04	-1.2769e-03	-1.2769e-03
39	1.6942e-03	1.6942e-03	-9.7634e-04	-9.7634e-04	-1.7264e-03	-1.7264e-03
40	1.4923e-03	1.4923e-03	-9.5952e-04	-9.5952e-04	-1.6993e-03	-1.6993e-03

Table 15: Displacements at joint B for winter loading with high order elements.

Node	D'x	D"x	D'y	D"y	D'z	D"z
	[m]					
1	3.7986e-03	6.0467e-03	-1.5255e-04	-3.1905e-03	-2.2834e-03	-3.5507e-03
2	3.7397e-03	6.0157e-03	-3.2633e-05	-3.0167e-03	-2.4004e-03	-3.8024e-03
3	3.6809e-03	5.9848e-03	9.0453e-05	-2.8401e-03	-2.5193e-03	-4.0607e-03
4	3.6227e-03	5.9523e-03	2.1152e-04	-2.6689e-03	-2.6326e-03	-4.3097e-03
5	3.4409e-03	5.3399e-03	1.5358e-05	-2.7467e-03	-1.9508e-03	-3.2179e-03
6	3.3843e-03	5.3196e-03	1.2136e-04	-2.5678e-03	-2.0688e-03	-3.4697e-03
7	3.3428e-03	5.3042e-03	2.3482e-04	-2.4005e-03	-2.1891e-03	-3.7283e-03
8	3.2951e-03	5.2722e-03	3.6108e-04	-2.2427e-03	-2.3042e-03	-3.9770e-03
9	3.1392e-03	4.6101e-03	1.1228e-04	-2.4507e-03	-1.3932e-03	-2.5212e-03
10	3.0766e-03	4.5892e-03	2.1568e-04	-2.2569e-03	-1.5248e-03	-2.7948e-03
11	3.0332e-03	4.5756e-03	3.2971e-04	-2.0757e-03	-1.6666e-03	-3.0815e-03
12	2.9830e-03	4.5439e-03	4.6238e-04	-1.9057e-03	-1.8013e-03	-3.3505e-03
13	2.8236e-03	3.8987e-03	1.3945e-04	-2.2246e-03	-8.0864e-04	-1.7590e-03
14	2.7525e-03	3.8867e-03	2.3793e-04	-2.0002e-03	-9.5121e-04	-2.0635e-03
15	2.7204e-03	3.8889e-03	3.5330e-04	-1.8076e-03	-1.1094e-03	-2.3847e-03
16	2.6745e-03	3.8534e-03	5.0728e-04	-1.6322e-03	-1.2599e-03	-2.6821e-03
17	2.4161e-03	3.1685e-03	1.5868e-04	-1.9570e-03	-3.2090e-04	-1.1242e-03
18	2.3649e-03	3.1738e-03	2.4301e-04	-1.6992e-03	-4.7046e-04	-1.4540e-03
19	2.3538e-03	3.2035e-03	3.5289e-04	-1.5029e-03	-6.4026e-04	-1.8045e-03
20	2.3213e-03	3.1651e-03	5.3336e-04	-1.3349e-03	-8.0173e-04	-2.1236e-03
21	2.0275e-03	2.4100e-03	1.7558e-04	-1.6506e-03	6.7409e-05	-6.1784e-04
22	1.9329e-03	2.4695e-03	2.3926e-04	-1.3603e-03	-9.1055e-05	-9.6777e-04
23	1.9503e-03	2.5349e-03	3.3735e-04	-1.1720e-03	-2.7023e-04	-1.3422e-03
24	1.9399e-03	2.4912e-03	5.4918e-04	-1.0263e-03	-4.4197e-04	-1.6790e-03
25	1.5715e-03	1.7538e-03	1.6224e-04	-1.2878e-03	3.8665e-04	-2.0588e-04
26	1.4687e-03	1.7992e-03	2.1865e-04	-9.8484e-04	1.9754e-04	-5.8712e-04
27	1.5164e-03	1.8927e-03	3.0986e-04	-8.2233e-04	2.5156e-06	-9.8615e-04
28	1.5377e-03	1.8344e-03	5.5840e-04	-7.1688e-04	-1.8145e-04	-1.3391e-03
29	1.0002e-03	1.1125e-03	8.7343e-05	-7.7736e-04	4.9565e-04	-4.5473e-06
30	9.7386e-04	1.2008e-03	1.4869e-04	-5.6175e-04	3.1752e-04	-3.6846e-04
31	1.0762e-03	1.3055e-03	2.6142e-04	-4.7741e-04	1.4793e-04	-7.4011e-04
32	1.1334e-03	1.2187e-03	5.5844e-04	-4.3442e-04	-1.6744e-05	-1.0713e-03
33	6.1244e-04	5.5477e-04	4.3726e-05	-4.3839e-04	4.1497e-04	-3.9573e-06
34	5.7291e-04	6.7194e-04	9.0081e-05	-2.3072e-04	2.6947e-04	-2.5314e-04
35	6.8446e-04	7.8682e-04	1.9422e-04	-2.1019e-04	1.7607e-04	-5.2233e-04
36	7.3627e-04	6.7078e-04	5.1063e-04	-2.2416e-04	8.1911e-05	-7.9843e-04
37	1.9834e-04	1.9834e-04	-2.7247e-05	-2.7247e-05	1.0036e-04	1.0036e-04
38	3.0177e-04	3.0177e-04	7.5579e-05	7.5579e-05	-6.3310e-06	-6.3310e-06
39	3.5767e-04	3.5767e-04	1.0666e-04	1.0666e-04	-7.8669e-05	-7.8669e-05
40	2.2967e-04	2.2967e-04	1.3243e-04	1.3243e-04	-9.8974e-05	-9.8974e-05

Table 16: Convergence characteristics for winter loading

Convergence parameter	Mesh 1	Mesh 2
Maximal number of iterations	500	500
Prescribed relative displacement error	0.2 %	0.2 %
Prescribed relative residual error	1.0 %	1.0 %
Prescribed absolute residual error	10.0 %	10.0 %
Number of iterations	26	15

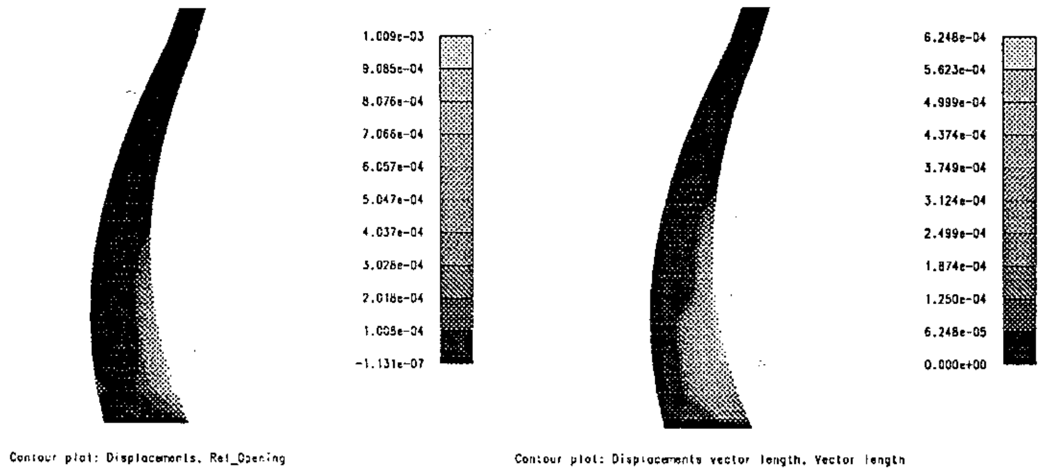

Figure 4: Opening and sliding displacements in joint A for winter loading with low order elements.

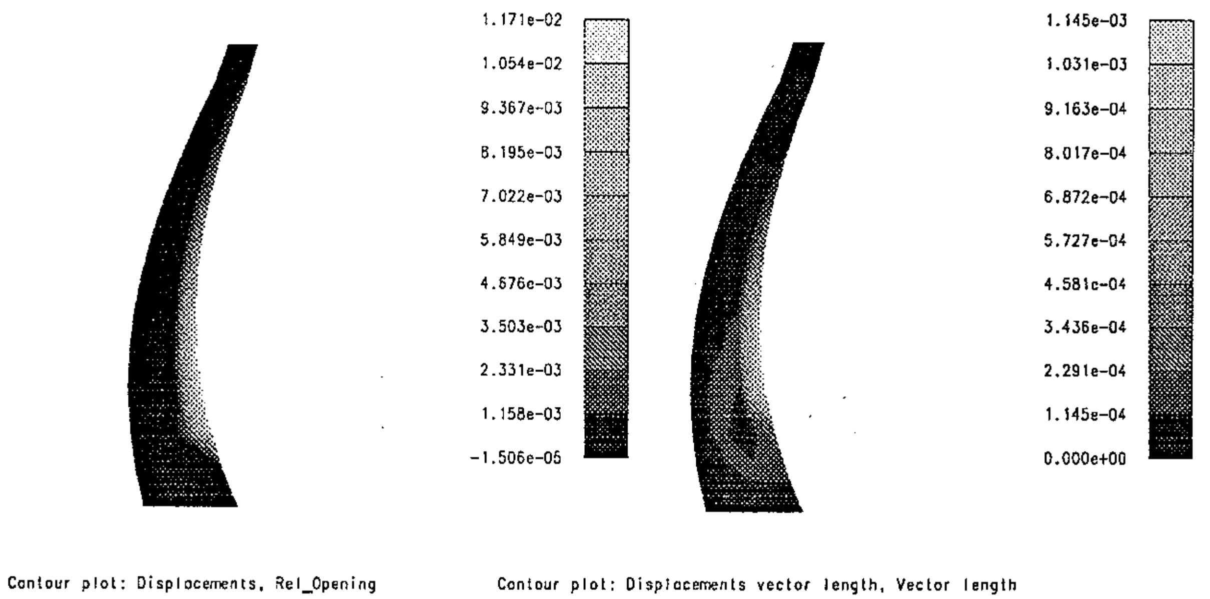

Figure 5: Opening and sliding displacements in joint A for winter loading with higher order elements.

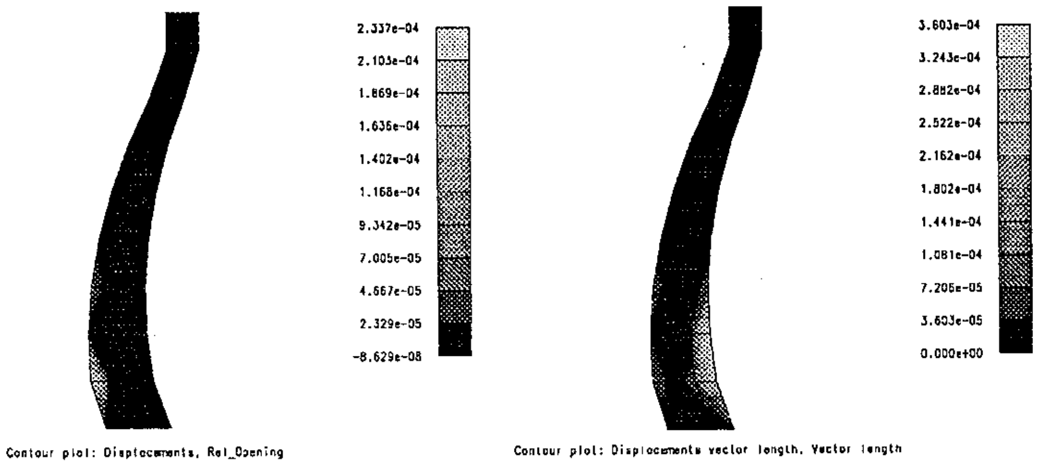

Figure 6: Opening and sliding displacements in joint B for winter loading with low order elements.

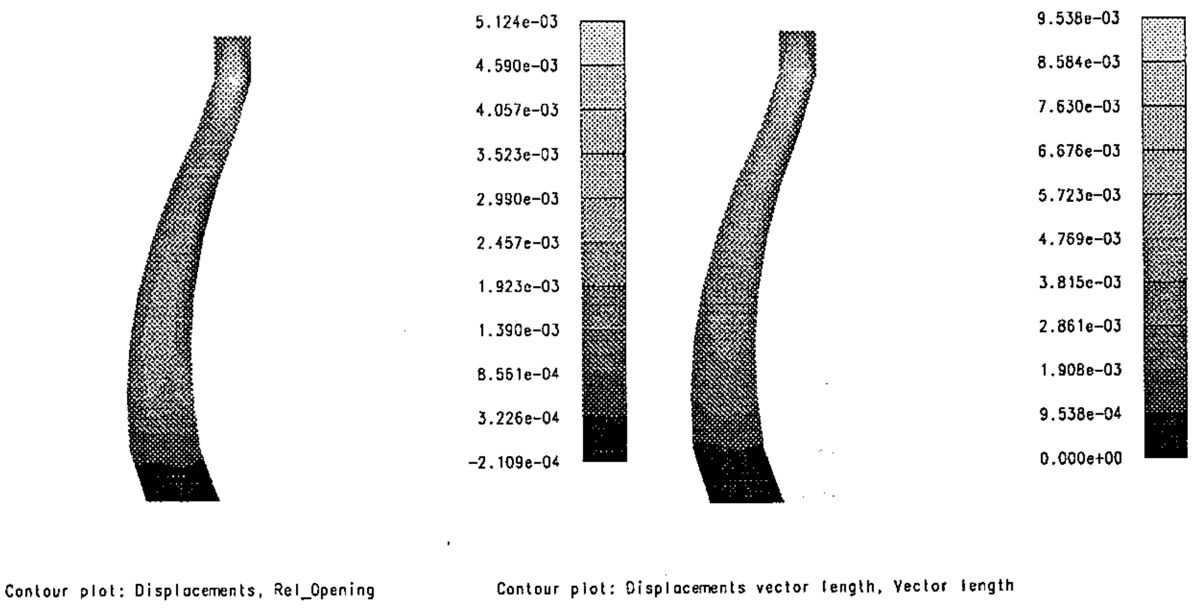

Figure 7: Opening and sliding displacements in joint B for winter loading with higher order elements.

- The maximal joint opening is 10 mm.
- The main cause for the joint openings appears to be the presence of the thermal loading and the thermal gradient between the interior of the dam and its external faces.
- The results show large differencies between the finite element meshes with low order and higher order elements, especially in the case of winter loading. Given the specified mesh size, the low order elements even with improved bending behaviour are not adequate to properly model the arch dam behaviour.

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NOTES

Third Benchmark Workshop on
NUMERICAL ANALYSIS OF DAMS

Paris, France September 29-30, 1994

THEME A1:

NON-LINEAR ANALYSIS OF JOINT BEHAVIOR
UNDER THERMAL AND HYDROSTATIC LOADS
FOR AN ARCH DAM

NON-LINEAR STATIC ANALYSIS OF CONTRACTION JOINTS BEHAVIOR FOR TALVACCHIA ARCH DAM

by

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1. INTRODUCTION

An arch dam is constructed as a system of monolith blocks, i.e., independent consoles with vertical, usually, wrapped contact surfaces. Those surfaces between monoliths are called contraction joints and they enable free shrinkage during the period of concrete cooling . After completion of the dam construction, the contraction joints are grouted so that arch dam acts as an three-dimensional monolithic structure. The grouting is performed when the ambient temperature is such to cause the smallest thermal stresses during summer and winter temperature changes. The contraction joints are constructed with or without shear keys. If they are with shear keys, the full shear transfer across the joints is guaranteed. In the case if shear keys are not provided, shear resistance across the contraction joints is evaluated according to the Coulomb's friction law.

Because of the arch dam construction process, the contraction joints cannot resist any net tensile horizontal arch stress. Therefore appearance of those stresses tends to gradually open joints causing stress redistributions. By this phenomenon, compressive stresses are increased at some parts of the dam and reduced at other parts; at the same time, tensile stresses can be increased or decreased in the monoliths. This joint-opening nonlinear arch dam behavior is the predominant nonlinear structural mechanism for stress redistribution over the dam body. The joint-opening mechanism is considered as a beneficial phenomenon, because it eliminates, physically not possible, tensile arch stresses across the contraction joints and reduces possibility of developing cracks in the concrete monoliths. Therefore, it is obvious why the joint-opening nonlinear mechanism should be included in the arch dam response analysis.

In practice, a linear elastic, static analysis is usually performed because of to two main reasons. First, some design offices are still using the trial load method for arch dam design and analysis which does not permit the nonlinear joint-opening numerical modeling. Second, the current design criteria for arch dams under usual static loads don't let actual tensile stress to be beyond the allowable tensile stress for unreinforced concrete. In fact, this design criteria is not fulfilled for many old, existing arch dams, because the numerical tools, used for design of those dams, were not able to show detail stress distributions, particularly where stress gradients are high and when loads due to temperature changes are considered. On the other hand, even when arch dam designer uses a contemporary analysis tool, like the finite element method, sometimes is not possible to avoid high tensile stresses because of constraints imposed by the canyon shape [1].

To resolve dilemma whether an excessive tensile arch stress across the contraction joints decreases the safety of an arch dam, the nonlinear finite element analysis, capable to simulate the joint-opening mechanism, can supply the necessary answer. ICOLD's Third Benchmark Workshop on Numerical Analysis of Dams is a good opportunity to clarify this phenomenon and to compare the results obtained from different methods and computer codes.

In this work, the finite element discretization is given in Section 2 along with differences with respect to the proposed model by the Scientific Committee [2]. Section 3 gives short description for the nonlinear modeling of the joint-opening mechanism. The results for two load cases are presented in Section 4. Each load case considers three different states of the joint shear resistance. Software used for analysis and other computational details are reported in Section 5; the conclusions are in Section 6.

2. FINITE ELEMENT DISCRETIZATION OF TALVACCHIA ARCH DAM

Mathematical modeling of the Talvacchia arch dam is performed via the finite element method. The ICOLD Scientific Committee [2] suggested a discretization of the dam and surrounding rock foundation by the isoparametric 20-node elements. In this work, instead of the 20-node elements, the 8-node isoparametric element is applied. The coordinates of the element corner nodes are exactly those given in [2].

The applied 8-node isoparametric element has incompatible displacement modes [3] which were modified [4] in order to pass the patch test, while still maintaining high accuracy for elements with parallel sides [6]. This incompatible element arises as particular "compatible" mixed approximations of the enhanced strain field and has recently been re-evaluated within the modified variational formulation [5]. Element stresses are computed at the Gauss-Legendere integration points as a product of the stress-strain matrix, strain-displacement matrix and corresponding nodal displacements. Then, the stresses at the nodes are evaluated by an extrapolation of the stresses at the integration points. Principal stresses at the required nodes are evaluated by averaging stresses at each node taking into account all elements which are connected to the considered node.

Three layers of the 8-node elements are placed through the dam thickness. The elements at the joints have different node numbers, with the same coordinates, on the left and right side of the considered joints. This way of the dam discretization and the element connectivity enables joint-opening during the dam loading history. Because of the dam and loading symmetry only a half, left part of the dam is analyzed, including the joints 1 and 2 (see Fig. 1). The model consists 635 8-node elements, counting 2456 DOF. The physical-mechanical properties of concrete and rock are those given in [2], i.e.: E_c = 36000 MPa, E_r = 12000 MPa, ν_c = 0.2, ν_r =0.16, $\alpha_c = 0.7\times10^{-5}\ {}^{\circ}C^{-1}$, γ_c = 0.024 MN/m^3, and γ_w=0.01 MN/m^3.

3. NON-LINEAR MODELING OF JOINT-OPENING MECHANISM

Numerical modeling of the joint-opening mechanism can be performed by three different joint models: discrete models, smeared models and specially devised models. The discrete models are based on the following elements: node-on-node spring elements, contact elements and joint elements. For all them, the double-noding technique is usually applied, although, the splitting-node technique can be used and, in that case, redefinition of the structural topology is required following the joint opening and closing.

The joint elements require additional relative degrees of freedom and can simulate various nonlinearities within the joints. Their application has been found in the rock mechanics problems [7,8].

The smeared joint models smear out the local opening associated with an integration point into the tributary region of this integration point. This method can capture the global structural behavior but not detail joint behavior [9].

The special joint models have different features to simulate the joint-opening phenomenon but does not posses general applicability and their description can be found elsewhere [10].

In this work, the discrete joint model based on the contact element is applied. Because of the limited paper length, only a brief description of the model is given, without any mathematical derivations. Generally, in the finite element formulation, the contact compatibility can be achieved in two ways: via the Lagrange multiplier [11] or by the penalty functions [12]. In the penalty method, the penalized displacement field appears in the variational formulation. After solving for displacement, an approximate contact stresses are computed by a simple post processing procedure.

The joint-opening of the Talvacchia arch dam is solved applying a mixed finite element approximation using the Lagrange multiplier method. This approach involves the approximation of two independent fields: displacement field and contact stress field, i.e., the contact forces are additional unknowns together with nodal displacements [11]. The resulting set of the simultaneous algebraic equations is nonlinear per boundary conditions, and it is solved by the full Newton method.

In particular, the Talvacchia arch dam, with discretization described in the previous Section, has 84 contact nodes (36 at the

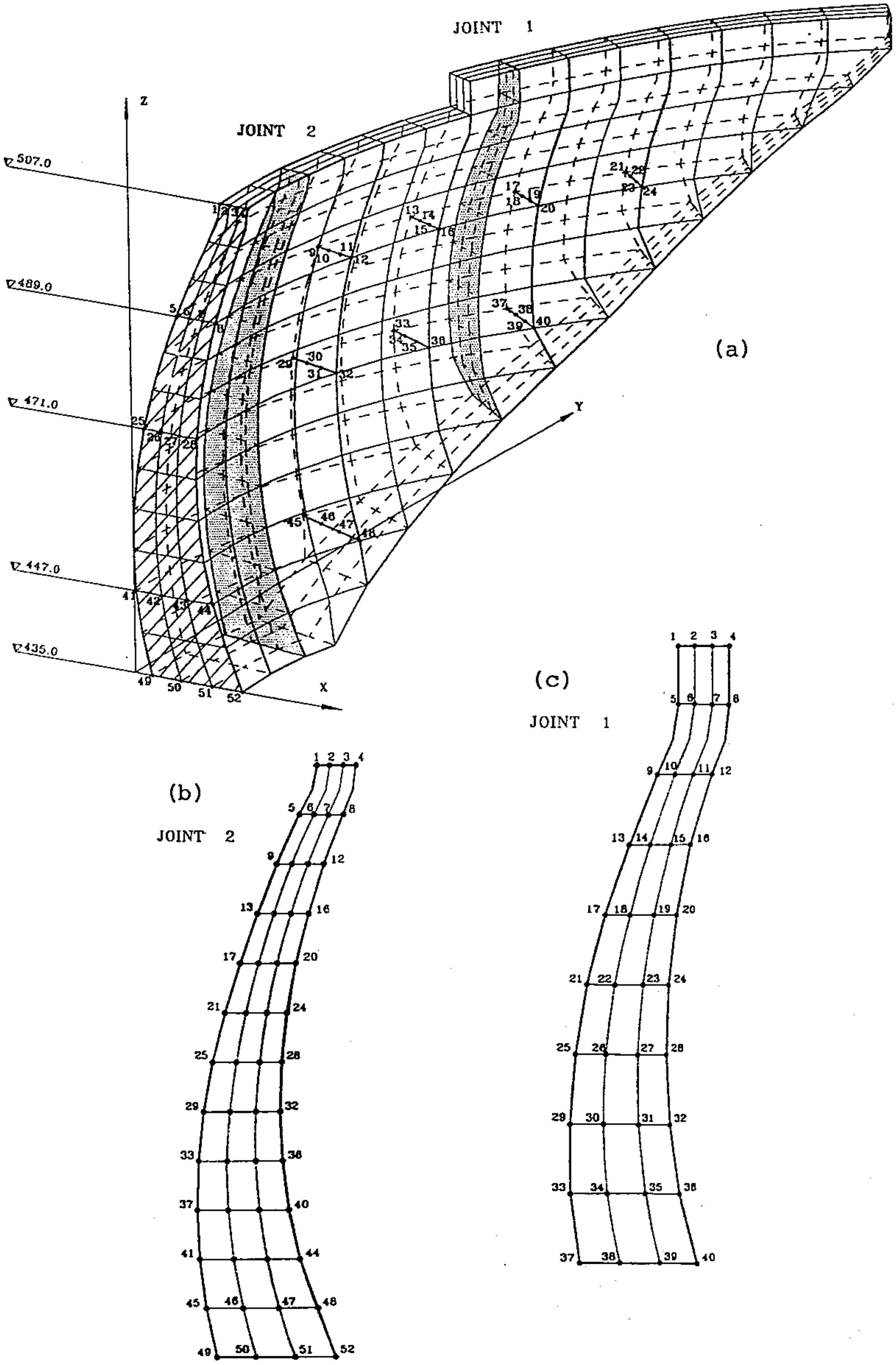

Figure 1. Talvacchia arch dam: (a) symmetric part of the dam with joints and nodes; (b) nodes at joint 2; (c) nodes at joint 1.

joint 1 and 48 at the joint 2) which gives additional 252 equations of unknown contact forces. During loading history, the contraction joints are able to open and to close. When a joint is closed three cases are analyzed: joints are frictionless (f=0); Coulomb's law applies at the joints (f=0.75) and sticking joints (f=∞). Two load cases are considered:

- "summer" load case including: dam self weight applied entirely in a single step, reservoir at 507 m and summer temperature changes; and
- "winter" load case including: dam self weight as above, reservoir at 471 m and winter temperature changes.

Full load amount of each load case is applied in a single step. The dam and foundation stiffness matrix are constant during the entire loading history, whereas the boundary conditions at the contraction joints change until the dam takes final equilibrium configuration.

4. RESULTS

The results are presented in the form of tables, according to the instructions given in [2]. The required displacement and stresses are shown in Tables from 1 to 7 and in Tables from 8 to 17, for the "summer" and for the "winter" load cases, respectively. For each of those loadings, the results are listed for three frictional conditions of the contraction joints: f=0 (hypothetical condition), f=0.75 and f=∞. Also, the results obtained for the dam with no contraction joints are given and compared with results obtained for the dam with joints.

5. APPLIED SOFTWARE

The contact problem of the Talvacchia arch dam is analyzed by the PAK-finite element program for linear and nonlinear structural analysis [13]. The program is installed on IBM RISK working station, operating under AIX with 16 MB of RAM and with HD of 800 MB.

Solution of the nonlinear system of equations is obtained in a few iterations, i.e., the highest number of iterations was 2 for the both:the "summer" load case (hypothetically frictionless condition , f=0), and the "winter" load case (frictional condition, f=0.75).

6. CONCLUSIONS

From the presented results the following conclusions are drawn.

Due to "summer" load case:

- When the contraction joints are hypothetically frictionless (f=0), a slip occurs, the maximum displacements are, almost, doubled, and the stresses undergo significant changes with respect to the results obtained for the dam with no contraction joints (compare Table 1 with Table 2; see Tables 4 and 5).

- For the frictional conditions (f=0.75 and f=∞), the displacements and stresses are identical and they are close to the results obtained for the dam with no contraction joints (compare Table 1 with Table 3). There is no slip or opening of the contraction joints, since they are under compression for this load case (see Table 6 and 7).

Due to "winter" load case:

- For the hypothetically frictionless condition (f=0), the contraction joints undergo slip and opening (see Tables 12 and 13). The displacements and stresses are significantly changed with respect to the results listed for the dam with no contraction joints (compare Table 8 with Table 9).

- For the frictional condition (f=0.75), an opening of the contraction joints occurs (see Tables 14 and 15). The displacements are close to those obtained for the dam with no contraction joints, but differences in stresses are noticeable (compare Table 8 with Table 10).

- For the sticking condition (f=∞), the contraction joints undergo opening (see Tables 16 and 17). The displacements and stresses are closer to those obtained for the dam with no contraction joints than in the previous case (f=0.75), but redistribution of the stresses are evident (compare Table 11 with Table 8).

Generally, the Talvacchia arch dam can be exposed to significant displacement and stress changes depending on stress nature (compression/tension) and on the frictional factor (f) across the contraction joints. Thus, the influence of the non-linear joint-opening phenomenon is proved to be important for displacement and for stress distribution and intensity of this dam.

7. REFERENCES

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TABLE 1. TALVACCHIA ARCH DAM WITH NO CONTRACTION JOINTS; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.012461	0.000000	-0.000102	5.386E-01	2.132E-01	-2.283E+00
2	0.012562	0.000000	0.000146	-3.132E-01	-5.980E-01	-3.488E+00
3	0.012696	0.000000	0.000354	1.304E-02	-1.247E-01	-2.757E+00
4	0.012821	0.000000	0.000546	3.832E-01	3.060E-01	-2.012E+00
5	0.012896	0.000000	-0.000617	-1.355E-01	-1.919E+00	-4.227E+00
6	0.012983	0.000000	-0.000836	-1.272E-01	-4.097E-01	-2.948E+00
7	0.013067	0.000000	-0.001009	1.496E-02	-8.258E-02	-2.771E+00
8	0.013213	0.000000	-0.001165	-2.500E-02	-6.242E-01	-3.666E+00
9	0.008585	-0.001572	-0.000424	-1.417E-01	-1.772E+00	-3.473E+00
10	0.008782	-0.001176	-0.000537	-1.327E-01	-3.544E-01	-2.539E+00
11	0.008984	-0.000764	-0.000607	-1.171E-02	-8.882E-02	-2.806E+00
12	0.009252	-0.000373	-0.000665	-3.461E-02	-7.485E-01	-4.218E+00
13	0.004935	-0.001019	-0.000314	-1.493E-01	-1.664E+00	-2.641E+00
14	0.005180	-0.000650	-0.000334	-1.347E-01	-3.098E-01	-2.036E+00
15	0.005434	-0.000268	-0.000317	-1.680E-02	-1.002E-01	-2.701E+00
16	0.005757	0.000082	-0.000294	-4.697E-02	-8.686E-01	-4.561E+00
17	0.002148	0.000028	-0.000281	-1.555E-01	-1.488E+00	-1.905E+00
18	0.002359	0.000238	-0.000213	-9.110E-02	-1.252E-01	-1.546E+00
19	0.002578	0.000455	-0.000115	1.698E-01	-9.164E-02	-2.470E+00
20	0.002863	0.000628	-0.000018	-5.653E-02	-7.544E-01	-4.632E+00
21	0.000854	0.000759	-0.000324	-1.948E-01	-1.340E+00	-1.676E+00
22	0.000971	0.000801	-0.000225	-1.138E-01	-1.290E-01	-1.306E+00
23	0.001087	0.000829	-0.000104	-1.287E-02	-1.754E-01	-2.191E+00
24	0.001246	0.000805	0.000023	-2.263E-01	-1.091E+00	-4.285E+00
25	0.009768	0.000000	0.000464	-2.986E-01	-2.042E+00	-4.117E+00
26	0.009855	0.000000	-0.000224	-1.457E-01	-3.330E-01	-2.171E+00
27	0.009900	0.000000	-0.000894	-3.508E-02	-3.339E-01	-2.027E+00
28	0.010082	0.000000	-0.001561	-8.483E-02	-2.277E+00	-3.947E+00
29	0.006368	-0.001542	0.000212	-3.125E-01	-1.754E+00	-3.266E+00
30	0.006587	-0.001132	-0.000316	-2.538E-02	-2.907E-01	-1.669E+00
31	0.006773	-0.000699	-0.000833	-2.207E-02	-2.718E-01	-2.015E+00
32	0.007101	-0.000316	-0.001350	-1.085E-01	-2.266E+00	-4.518E+00
33	0.003494	-0.000962	-0.000023	-3.163E-01	-1.468E+00	-2.300E+00
34	0.003765	-0.000590	-0.000406	1.480E-01	-3.124E-01	-1.164E+00
35	0.004004	-0.000194	-0.000779	2.959E-02	-2.449E-01	-2.016E+00
36	0.004391	0.000114	-0.001155	-7.531E-02	-2.357E+00	-5.110E+00
37	0.001474	0.000128	-0.000289	-4.490E-01	-1.185E+00	-1.696E+00
38	0.001664	0.000279	-0.000510	3.151E-01	-1.263E-01	-7.310E-01
39	0.001821	0.000467	-0.000699	3.898E-01	-1.316E-02	-1.692E+00
40	0.002201	0.000555	-0.000928	6.598E-02	-2.711E+00	-5.470E+00
41	0.003903	0.000000	0.000850	-4.883E-01	-1.182E+00	-2.423E+00
42	0.003929	0.000000	-0.000096	4.520E-01	-4.117E-01	-6.321E-01
43	0.003847	0.000000	-0.001050	-9.294E-02	-4.779E-01	-1.131E+00
44	0.004043	0.000000	-0.001883	-1.873E-01	-3.381E+00	-4.849E+00
45	0.001884	-0.000335	0.000075	-4.578E-01	-9.872E-01	-1.714E+00
46	0.002027	0.000025	-0.000600	3.986E-01	-5.880E-02	-6.662E-01
47	0.002064	0.000330	-0.001162	2.971E-01	2.417E-01	-9.773E-01
48	0.002465	0.000538	-0.001706	-2.892E-01	-3.207E+00	-6.193E+00
49	0.001265	0.000000	-0.000078	1.140E+00	7.752E-02	-8.867E-01
50	0.001365	0.000000	-0.000676	6.676E-01	5.375E-01	-2.696E-01
51	0.001341	0.000000	-0.001537	1.333E-02	-3.155E-01	-1.374E+00
52	0.001326	0.000000	-0.001804	-1.343E+00	-3.647E+00	-7.146E+00

TABLE 2. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.021396	0.000000	-0.001190	1.587E-01	-8.272E-02	-3.355E+00
2	0.021499	0.000000	-0.001058	-8.086E-02	-4.522E-01	-4.128E+00
3	0.021620	0.000000	-0.000950	-1.770E-01	-3.188E-01	-3.286E+00
4	0.021746	0.000000	-0.000865	-5.353E-02	-1.231E-01	-3.131E+00
5	0.020182	0.000000	-0.000891	-2.923E-01	-2.457E+00	-4.727E+00
6	0.020261	0.000000	-0.001371	-4.242E-01	-6.970E-01	-3.014E+00
7	0.020306	0.000000	-0.001765	1.618E-01	-4.870E-01	-2.395E+00
8	0.020437	0.000000	-0.002142	-2.430E-01	-2.990E-01	-3.959E+00
9	0.007789	-0.000512	-0.000382	-1.929E-01	-2.140E+00	-3.810E+00
10	0.007941	-0.000274	-0.000401	-2.054E-01	-5.460E-01	-2.630E+00
11	0.008111	0.000056	-0.000377	-8.925E-02	-1.788E-01	-2.640E+00
12	0.008276	0.000111	-0.000301	-1.262E-01	-5.876E-01	-4.068E+00
13	0.005053	-0.000484	-0.000407	3.344E-02	-1.769E+00	-2.874E+00
14	0.005309	-0.000127	-0.000349	1.520E-01	-1.647E-01	-2.264E+00
15	0.005605	0.000300	-0.000252	3.642E-01	2.682E-01	-2.677E+00
16	0.005805	0.000366	-0.000090	3.131E-01	-4.846E-03	-3.570E+00
17	0.001558	0.000946	-0.000436	3.220E-02	-1.264E+00	-2.208E+00
18	0.001656	0.000945	-0.000368	2.076E-01	-1.796E-01	-1.886E+00
19	0.001761	0.000912	-0.000285	3.294E-01	-3.605E-01	-2.742E+00
20	0.002086	0.001114	-0.000260	2.907E-01	-1.694E+00	-3.878E+00
21	0.000795	0.000918	-0.000413	-1.803E-01	-1.065E+00	-1.705E+00
22	0.000905	0.000950	-0.000311	-3.675E-02	-8.469E-02	-1.619E+00
23	0.000978	0.000911	-0.000189	-9.578E-02	-2.031E-01	-2.483E+00
24	0.001113	0.000858	-0.000069	-1.919E-01	-1.136E+00	-3.812E+00
25	0.014433	0.000000	0.001247	-3.936E-01	-2.183E+00	-4.446E+00
26	0.014515	0.000000	0.000077	-3.450E-01	-6.526E-01	-2.132E+00
27	0.014506	0.000000	-0.001064	-1.060E-01	-6.392E-01	-1.434E+00
28	0.014663	0.000000	-0.002197	-3.235E-01	-2.206E+00	-4.053E+00
29	0.006101	-0.000793	0.000189	-3.507E-01	-1.996E+00	-3.755E+00
30	0.006263	-0.000557	-0.000260	-1.149E-01	-3.748E-01	-1.844E+00
31	0.006400	-0.000220	-0.000690	-5.173E-02	-3.423E-01	-1.785E+00
32	0.006630	-0.000084	-0.001123	-1.856E-01	-2.152E+00	-4.171E+00
33	0.003732	-0.000668	-0.000095	-7.351E-02	-1.436E+00	-2.598E+00
34	0.004017	-0.000319	-0.000481	3.336E-01	-7.590E-03	-1.398E+00
35	0.004339	0.000111	-0.000846	4.665E-01	-3.494E-01	-2.152E+00
36	0.004625	0.000188	-0.001223	4.321E-01	-1.900E+00	-3.625E+00
37	0.001346	0.000646	-0.000567	5.967E-02	-1.120E+00	-2.178E+00
38	0.001414	0.000594	-0.000635	2.458E-01	8.141E-02	-1.021E+00
39	0.001453	0.000534	-0.000691	7.154E-01	-1.116E-01	-1.856E+00
40	0.001908	0.000677	-0.000750	1.119E+00	-2.366E+00	-3.756E+00
41	0.005056	0.000000	0.001687	-2.131E-01	-6.638E-01	-2.747E+00
42	0.005071	0.000000	0.000290	7.672E-01	-5.485E-01	-8.698E-01
43	0.004931	0.000000	-0.001120	-7.872E-02	-3.242E-01	-1.610E+00
44	0.005114	0.000000	-0.002347	-2.943E-01	-3.320E+00	-5.926E+00
45	0.001911	-0.000277	0.000100	-3.690E-01	-9.772E-01	-1.988E+00
46	0.002037	0.000048	-0.000551	1.980E-01	-8.725E-02	-1.028E+00
47	0.002010	0.000257	-0.001041	4.723E-01	2.139E-01	-1.050E+00
48	0.002430	0.000535	-0.001585	3.969E-01	-2.864E+00	-5.351E+00
49	0.001403	0.000000	0.000182	2.192E+00	6.509E-01	-6.736E-01
50	0.001537	0.000000	-0.000582	9.988E-01	5.667E-01	-1.284E-01
51	0.001523	0.000000	-0.001737	1.766E-01	-4.121E-01	-1.509E+00
52	0.001488	0.000000	-0.002097	-1.813E+00	-3.787E+00	-9.118E+00

TABLE 3. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75 AND STICKING CONDITION; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.012589	0.000000	-0.000105	1.283E-01	5.056E-02	-2.396E+00
2	0.012690	0.000000	0.000139	4.783E-03	-5.215E-01	-3.400E+00
3	0.012824	0.000000	0.000344	4.159E-02	-3.568E-02	-2.741E+00
4	0.012949	0.000000	0.000533	2.235E-01	1.613E-03	-2.125E+00
5	0.012995	0.000000	-0.000612	-1.453E-01	-1.923E+00	-4.250E+00
6	0.013082	0.000000	-0.000833	-1.238E-01	-4.110E-01	-2.956E+00
7	0.013167	0.000000	-0.001008	1.718E-02	-7.855E-02	-2.773E+00
8	0.013313	0.000000	-0.001167	-3.505E-02	-6.179E-01	-3.665E+00
9	0.008653	-0.001580	-0.000419	-1.513E-01	-1.778E+00	-3.497E+00
10	0.008852	-0.001180	-0.000534	-1.307E-01	-3.560E-01	-2.545E+00
11	0.009055	-0.000764	-0.000604	-1.151E-02	-8.743E-02	-2.810E+00
12	0.009324	-0.000369	-0.000664	-4.442E-02	-7.419E-01	-4.215E+00
13	0.004973	-0.001021	-0.000312	-1.480E-01	-1.656E+00	-2.610E+00
14	0.005220	-0.000647	-0.000331	-1.317E-01	-3.072E-01	-2.056E+00
15	0.005476	-0.000260	-0.000314	-2.490E-02	-1.031E-01	-2.720E+00
16	0.005801	0.000095	-0.000290	-5.536E-02	-8.544E-01	-4.561E+00
17	0.002159	0.000035	-0.000283	-1.524E-01	-1.495E+00	-1.842E+00
18	0.002375	0.000251	-0.000213	-6.902E-02	-1.280E-01	-1.561E+00
19	0.002597	0.000473	-0.000115	1.306E-01	-1.163E-01	-2.558E+00
20	0.002879	0.000646	-0.000013	-8.984E-02	-7.251E-01	-4.555E+00
21	0.000841	0.000757	-0.000330	-2.028E-01	-1.161E+00	-1.453E+00
22	0.000979	0.000827	-0.000230	-1.198E-01	-1.812E-01	-1.427E+00
23	0.001100	0.000865	-0.000107	-1.161E-01	-2.488E-01	-2.376E+00
24	0.001230	0.000813	0.000030	-2.804E-01	-8.919E-01	-4.082E+00
25	0.009844	0.000000	0.000478	-2.894E-01	-2.049E+00	-4.137E+00
26	0.009931	0.000000	-0.000214	-1.479E-01	-3.408E-01	-2.183E+00
27	0.009976	0.000000	-0.000889	-3.513E-02	-3.396E-01	-2.038E+00
28	0.010158	0.000000	-0.001561	-7.610E-02	-2.261E+00	-3.942E+00
29	0.006422	-0.001554	0.000222	-3.057E-01	-1.768E+00	-3.272E+00
30	0.006644	-0.001139	-0.000309	-4.148E-02	-3.031E-01	-1.700E+00
31	0.006831	-0.000702	-0.000829	-8.360E-03	-2.627E-01	-1.994E+00
32	0.007161	-0.000316	-0.001350	-8.554E-02	-2.277E+00	-4.509E+00
33	0.003522	-0.000966	-0.000014	-3.365E-01	-1.508E+00	-2.408E+00
34	0.003797	-0.000589	-0.000404	6.746E-02	-3.438E-01	-1.200E+00
35	0.004032	-0.000199	-0.000777	1.442E-01	-1.731E-01	-1.842E+00
36	0.004437	0.000132	-0.001156	-7.451E-03	-2.429E+00	-5.237E+00
37	0.001483	0.000145	-0.000280	-3.676E-01	-1.267E+00	-1.761E+00
38	0.001669	0.000290	-0.000516	1.458E-01	-2.854E-01	-7.870E-01
39	0.001817	0.000459	-0.000696	3.673E-01	7.937E-02	-1.726E+00
40	0.002246	0.000603	-0.000932	6.205E-01	-2.819E+00	-5.126E+00
41	0.003934	0.000000	0.000868	-4.823E-01	-1.179E+00	-2.430E+00
42	0.003961	0.000000	-0.000087	4.482E-01	-4.181E-01	-6.386E-01
43	0.003877	0.000000	-0.001049	-8.089E-02	-4.554E-01	-1.124E+00
44	0.004074	0.000000	-0.001891	-1.772E-01	-3.416E+00	-4.871E+00
45	0.001892	-0.000360	0.000106	-2.217E-01	-9.648E-01	-1.779E+00
46	0.002051	0.000051	-0.000607	2.019E-01	-5.654E-02	-9.004E-01
47	0.002057	0.000287	-0.001152	3.748E-01	1.924E-01	-1.225E+00
48	0.002520	0.000626	-0.001741	4.360E-01	-3.020E+00	-5.770E+00
49	0.001272	0.000000	-0.000069	1.075E+00	5.831E-02	-8.840E-01
50	0.001372	0.000000	-0.000673	6.596E-01	5.449E-01	-2.500E-01
51	0.001348	0.000000	-0.001542	3.463E-02	-3.152E-01	-1.359E+00
52	0.001335	0.000000	-0.001811	-1.295E+00	-3.704E+00	-7.167E+00

TABLE 4. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS OF SELECTED NODES AT JOINT 1 DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	-0.001030	-0.001359	0.002582	0.001698	0.002023	0.00030
2	-0.000737	-0.001247	0.002949	0.001689	0.002506	0.00076
3	-0.000530	-0.001029	0.003136	0.001878	0.003031	0.00122
4	-0.000340	-0.000821	0.003308	0.002054	0.003583	0.00168
5	0.000510	0.000210	0.001978	0.001480	0.001744	0.00016
6	0.000548	0.000515	0.001888	0.001905	0.002218	0.00055
7	0.000746	0.000711	0.002053	0.002072	0.002727	0.00094
8	0.000974	0.000941	0.002221	0.002238	0.003191	0.00135
9	0.001943	0.001349	0.001256	0.001088	0.000907	-0.00014
10	0.002064	0.001579	0.001347	0.001393	0.001374	0.00001
11	0.002268	0.001771	0.001546	0.001577	0.001815	0.00028
12	0.002523	0.002020	0.001764	0.001769	0.002238	0.00050
13	0.002924	0.001805	0.000487	0.000965	0.000138	-0.00034
14	0.003111	0.001979	0.000720	0.001155	0.000467	-0.00028
15	0.003304	0.002166	0.000948	0.001334	0.000849	-0.00017
16	0.003783	0.002117	0.001711	0.001004	0.001112	0.00004
17	0.003576	0.001957	0.000019	0.000852	-0.000296	-0.00041
18	0.003744	0.002123	0.000223	0.001030	-0.000114	-0.00041
19	0.003910	0.002294	0.000433	0.001213	0.000081	-0.00036
20	0.004391	0.002240	0.001175	0.000857	0.000225	-0.00025
21	0.003706	0.001951	-0.000228	0.000746	-0.000417	-0.00041
22	0.003870	0.002122	-0.000036	0.000935	-0.000448	-0.00044
23	0.004008	0.002282	0.000164	0.001123	-0.000449	-0.00045
24	0.004540	0.002150	0.000970	0.000659	-0.000533	-0.00038
25	0.003336	0.001833	-0.000259	0.000639	-0.000397	-0.00038
26	0.003494	0.001999	-0.000077	0.000816	-0.000629	-0.00043
27	0.003616	0.002130	0.000121	0.001018	-0.000850	-0.00045
28	0.004217	0.001986	0.000966	0.000538	-0.001093	-0.00048
29	0.002615	0.001619	-0.000170	0.000479	-0.000373	-0.00040
30	0.002802	0.001799	0.000059	0.000695	-0.000746	-0.00045
31	0.002924	0.001954	0.000303	0.000917	-0.001108	-0.00053
32	0.003544	0.001667	0.001119	0.000373	-0.001479	-0.00063
33	0.001792	0.001387	0.000120	0.000421	-0.000379	-0.00049
34	0.001987	0.001521	0.000326	0.000542	-0.000841	-0.00059
35	0.002134	0.001564	0.000558	0.000707	-0.001296	-0.00068
36	0.002905	0.001611	0.001326	0.000425	-0.001446	-0.00104
37	0.000999	0.000999	0.000441	0.000441	-0.000573	-0.00057
38	0.001172	0.001172	0.000654	0.000654	-0.000783	-0.00078
39	0.001332	0.001332	0.000928	0.000928	-0.001104	-0.00110
40	0.001339	0.001339	0.000857	0.000857	-0.001205	-0.00120

LEGEND: '_r', right face of joint
'_l', left face of joint

TABLE 5. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS OF SELECTED NODES AT JOINT 2 DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.019775	0.007662	-0.000702	0.000997	-0.000806	0.00083
2	0.019900	0.007790	-0.000522	0.001185	-0.000657	0.00120
3	0.020056	0.007951	-0.000353	0.001364	-0.000537	0.00155
4	0.020233	0.008034	0.000118	0.001174	-0.000464	0.00187
5	0.019965	0.008733	-0.000856	0.000717	-0.001155	0.00024
6	0.020058	0.008831	-0.000679	0.000904	-0.001152	0.00046
7	0.020161	0.008951	-0.000477	0.001118	-0.001085	0.00073
8	0.020329	0.009012	0.000062	0.000861	-0.001030	0.00109
9	0.019679	0.009247	-0.001013	0.000438	-0.001158	-0.00007
10	0.019770	0.009342	-0.000861	0.000601	-0.001324	0.00001
11	0.019863	0.009463	-0.000654	0.000819	-0.001442	0.00013
12	0.020043	0.009523	-0.000054	0.000483	-0.001546	0.00033
13	0.018823	0.009250	-0.001096	0.000256	-0.000801	-0.00006
14	0.018915	0.009346	-0.000959	0.000406	-0.001226	-0.00014
15	0.018995	0.009455	-0.000765	0.000612	-0.001585	-0.00018
16	0.019188	0.009498	-0.000065	0.000169	-0.001925	-0.00015
17	0.017395	0.008847	-0.001116	0.000136	-0.000233	0.00011
18	0.017486	0.008941	-0.000986	0.000277	-0.000914	-0.00011
19	0.017551	0.009032	-0.000804	0.000472	-0.001552	-0.00030
20	0.017758	0.009064	-0.000029	-0.000040	-0.002163	-0.00045
21	0.015505	0.008155	-0.001092	0.000047	0.000411	0.00037
22	0.015594	0.008245	-0.000956	0.000188	-0.000519	0.00001
23	0.015639	0.008311	-0.000776	0.000379	-0.001415	-0.00031
24	0.015862	0.008327	0.000069	-0.000188	-0.002296	-0.00062
25	0.013300	0.007266	-0.001028	-0.000026	0.000978	0.00063
26	0.013386	0.007351	-0.000882	0.000121	-0.000151	0.00016
27	0.013409	0.007390	-0.000691	0.000315	-0.001271	-0.00028
28	0.013651	0.007392	0.000204	-0.000280	-0.002375	-0.00073
29	0.010936	0.006251	-0.000937	-0.000092	0.001376	0.00083
30	0.011016	0.006332	-0.000768	0.000069	0.000100	0.00027
31	0.011018	0.006342	-0.000563	0.000265	-0.001186	-0.00028
32	0.011282	0.006334	0.000364	-0.000328	-0.002449	-0.00084
33	0.008551	0.005169	-0.000815	-0.000147	0.001548	0.00092
34	0.008622	0.005240	-0.000624	0.000023	0.000185	0.00030
35	0.008605	0.005222	-0.000396	0.000230	-0.001203	-0.00033
36	0.008891	0.005211	0.000524	-0.000347	-0.002537	-0.00098
37	0.006270	0.004071	-0.000666	-0.000193	0.001475	0.00090
38	0.006327	0.004125	-0.000454	-0.000012	0.000090	0.00022
39	0.006288	0.004080	-0.000213	0.000197	-0.001313	-0.00046
40	0.006582	0.004060	0.000684	-0.000336	-0.002632	-0.00117
41	0.004207	0.003002	-0.000500	-0.000220	0.001173	0.00072
42	0.004248	0.003036	-0.000269	-0.000025	-0.000158	0.00003
43	0.004163	0.002931	-0.000021	0.000185	-0.001510	-0.00068
44	0.004452	0.002929	0.000760	-0.000302	-0.002620	-0.00139
45	0.002435	0.002043	-0.000297	-0.000197	0.000716	0.00043
46	0.002434	0.002030	-0.000086	-0.000018	-0.000556	-0.00031
47	0.002385	0.001914	0.000123	0.000173	-0.001605	-0.00099
48	0.002703	0.001863	0.000888	-0.000346	-0.002433	-0.00165
49	0.001042	0.001042	-0.000034	-0.000034	-0.000076	-0.00007
50	0.001135	0.001135	0.000128	0.000128	-0.000676	-0.00067
51	0.001144	0.001144	0.000332	0.000332	-0.001602	-0.00160
52	0.001188	0.001188	0.000281	0.000281	-0.001827	-0.00182

TABLE 6. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75 AND STICKING CONDITION; DISPLACEMENTS OF SELECTED NODES AT JOINT 2 DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	-0.000745	-0.000745	0.002243	0.002243	0.001277	0.00127
2	-0.000486	-0.000486	0.002506	0.002506	0.001811	0.00181
3	-0.000220	-0.000220	0.002769	0.002769	0.002358	0.00235
4	0.000041	0.000041	0.003022	0.003022	0.002877	0.00287
5	0.000821	0.000821	0.001609	0.001609	0.000974	0.00097
6	0.001027	0.001027	0.001872	0.001872	0.001455	0.00145
7	0.001259	0.001259	0.002136	0.002136	0.001954	0.00195
8	0.001510	0.001510	0.002374	0.002374	0.002444	0.00244
9	0.002274	0.002274	0.000747	0.000747	0.000278	0.00027
10	0.002475	0.002475	0.001000	0.001000	0.000630	0.00063
11	0.002703	0.002703	0.001268	0.001268	0.001011	0.00101
12	0.002972	0.002972	0.001516	0.001516	0.001401	0.00140
13	0.003087	0.003087	-0.000039	-0.000039	-0.000159	-0.00015
14	0.003316	0.003316	0.000254	0.000254	0.000018	0.00001
15	0.003558	0.003558	0.000547	0.000547	0.000242	0.00024
16	0.003851	0.003851	0.000814	0.000814	0.000476	0.00047
17	0.003392	0.003392	-0.000499	-0.000499	-0.000284	-0.00028
18	0.003632	0.003632	-0.000199	-0.000199	-0.000253	-0.00025
19	0.003883	0.003883	0.000116	0.000116	-0.000192	-0.00019
20	0.004203	0.004203	0.000392	0.000392	-0.000128	-0.00012
21	0.003296	0.003296	-0.000696	-0.000696	-0.000248	-0.00024
22	0.003551	0.003551	-0.000381	-0.000381	-0.000357	-0.00035
23	0.003805	0.003805	-0.000052	-0.000052	-0.000445	-0.00044
24	0.004141	0.004141	0.000218	0.000218	-0.000533	-0.00053
25	0.002908	0.002908	-0.000645	-0.000645	-0.000174	-0.00017
26	0.003165	0.003165	-0.000343	-0.000343	-0.000401	-0.00040
27	0.003401	0.003401	-0.000023	-0.000023	-0.000606	-0.00060
28	0.003778	0.003778	0.000245	0.000245	-0.000824	-0.00082
29	0.002346	0.002346	-0.000462	-0.000462	-0.000152	-0.00015
30	0.002610	0.002610	-0.000150	-0.000150	-0.000444	-0.00044
31	0.002863	0.002863	0.000179	0.000179	-0.000757	-0.00075
32	0.003177	0.003177	0.000351	0.000351	-0.001040	-0.00104
33	0.001696	0.001696	-0.000062	-0.000062	-0.000207	-0.00020
34	0.001919	0.001919	0.000178	0.000178	-0.000579	-0.00057
35	0.002068	0.002068	0.000410	0.000410	-0.000870	-0.00087
36	0.002560	0.002560	0.000631	0.000631	-0.001220	-0.00122
37	0.001034	0.001034	0.000344	0.000344	-0.000433	-0.00043
38	0.001225	0.001225	0.000554	0.000554	-0.000678	-0.00067
39	0.001410	0.001410	0.000853	0.000853	-0.001064	-0.00106
40	0.001438	0.001438	0.000830	0.000830	-0.001208	-0.00120

LEGEND: '_r', right face of joint
'_l', left face of joint

TABLE 7. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75 AND STICKING CONDITION; DISPLACEMENTS OF SELECTED NODES AT JOINT2 DUE TO "SUMMER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.011056	0.011056	-0.000478	-0.000478	0.000080	0.00008
2	0.011191	0.011191	-0.000233	-0.000233	0.000352	0.00035
3	0.011360	0.011360	0.000008	0.000008	0.000587	0.00058
4	0.011522	0.011522	0.000251	0.000251	0.000806	0.00080
5	0.011781	0.011781	-0.000729	-0.000729	-0.000422	-0.00042
6	0.011888	0.011888	-0.000479	-0.000479	-0.000283	-0.00028
7	0.012010	0.012010	-0.000219	-0.000219	-0.000098	-0.00009
8	0.012164	0.012164	0.000033	0.000033	0.000093	0.00009
9	0.012025	0.012025	-0.000996	-0.000996	-0.000643	-0.00064
10	0.012138	0.012138	-0.000747	-0.000747	-0.000647	-0.00064
11	0.012260	0.012260	-0.000487	-0.000487	-0.000621	-0.00062
12	0.012429	0.012429	-0.000233	-0.000233	-0.000569	-0.00056
13	0.011778	0.011778	-0.001158	-0.001158	-0.000550	-0.00055
14	0.011900	0.011900	-0.000901	-0.000901	-0.000741	-0.00074
15	0.012022	0.012022	-0.000633	-0.000633	-0.000886	-0.00088
16	0.012207	0.012207	-0.000375	-0.000375	-0.001016	-0.00101
17	0.011107	0.011107	-0.001219	-0.001219	-0.000279	-0.00027
18	0.011235	0.011235	-0.000962	-0.000962	-0.000639	-0.00063
19	0.011351	0.011351	-0.000689	-0.000689	-0.000968	-0.00096
20	0.011551	0.011551	-0.000429	-0.000429	-0.001280	-0.00128
21	0.010113	0.010113	-0.001207	-0.001207	0.000070	0.00007
22	0.010243	0.010243	-0.000946	-0.000946	-0.000447	-0.00044
23	0.010348	0.010348	-0.000672	-0.000672	-0.000936	-0.00093
24	0.010562	0.010562	-0.000414	-0.000414	-0.001422	-0.00142
25	0.008897	0.008897	-0.001130	-0.001130	0.000405	0.00040
26	0.009025	0.009025	-0.000874	-0.000874	-0.000241	-0.00024
27	0.009114	0.009114	-0.000599	-0.000599	-0.000871	-0.00087
28	0.009341	0.009341	-0.000350	-0.000350	-0.001500	-0.00150
29	0.007546	0.007546	-0.001008	-0.001008	0.000664	0.00066
30	0.007670	0.007670	-0.000754	-0.000754	-0.000085	-0.00008
31	0.007739	0.007739	-0.000487	-0.000487	-0.000827	-0.00082
32	0.007977	0.007977	-0.000248	-0.000248	-0.001565	-0.00156
33	0.006136	0.006136	-0.000845	-0.000845	0.000806	0.00080
34	0.006249	0.006249	-0.000602	-0.000602	-0.000018	-0.00001
35	0.006296	0.006296	-0.000341	-0.000341	-0.000840	-0.00084
36	0.006543	0.006543	-0.000129	-0.000129	-0.001647	-0.00164
37	0.004734	0.004734	-0.000654	-0.000654	0.000805	0.00080
38	0.004827	0.004827	-0.000425	-0.000425	-0.000062	-0.00006
39	0.004847	0.004847	-0.000181	-0.000181	-0.000922	-0.00092
40	0.005087	0.005087	0.000006	0.000006	-0.001754	-0.00175
41	0.003401	0.003401	-0.000450	-0.000450	0.000652	0.00065
42	0.003472	0.003472	-0.000231	-0.000231	-0.000216	-0.00021
43	0.003436	0.003436	-0.000017	-0.000017	-0.001079	-0.00107
44	0.003673	0.003673	0.000123	0.000123	-0.001834	-0.00183
45	0.002204	0.002204	-0.000222	-0.000222	0.000372	0.00037
46	0.002213	0.002213	-0.000055	-0.000055	-0.000510	-0.00051
47	0.002173	0.002173	0.000143	0.000143	-0.001228	-0.00122
48	0.002398	0.002398	0.000233	0.000233	-0.001856	-0.00185
49	0.001083	0.001083	0.000000	0.000000	-0.000171	-0.00017
50	0.001187	0.001187	0.000132	0.000132	-0.000702	-0.00070
51	0.001187	0.001187	0.000284	0.000284	-0.001459	-0.00145
52	0.001205	0.001205	0.000257	0.000257	-0.001691	-0.00169

TABLE 8. TALVACCHIA ARCH DAM WITH NO CONTRACTION JOINTS; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.013560	0.000000	-0.006569	-6.798E-02	-1.749E-01	-1.418E+00
2	0.013463	0.000000	-0.007039	1.000E-01	-7.273E-02	-1.126E+00
3	0.013361	0.000000	-0.007522	1.081E-01	-7.057E-02	-8.726E-01
4	0.013259	0.000000	-0.007992	-7.492E-02	-1.835E-01	-6.767E-01
5	0.008679	0.000000	-0.003278	8.526E-01	1.314E-01	-1.237E-02
6	0.008565	0.000000	-0.003857	2.263E-02	-6.283E-01	-8.614E-01
7	0.008486	0.000000	-0.004472	2.305E-02	-6.139E-01	-8.632E-01
8	0.008365	0.000000	-0.005065	9.184E-01	2.015E-01	-2.434E-03
9	0.006447	-0.001879	-0.002726	1.095E+00	6.520E-01	-1.437E-02
10	0.006395	-0.001631	-0.003265	1.779E-02	-4.209E-01	-6.918E-01
11	0.006382	-0.001387	-0.003842	2.017E-02	-4.258E-01	-1.009E+00
12	0.006331	-0.001135	-0.004404	9.325E-01	-5.141E-04	-4.151E-02
13	0.004396	-0.002057	-0.002181	1.373E+00	1.121E+00	-1.889E-02
14	0.004383	-0.001779	-0.002671	1.544E-02	-9.495E-02	-6.223E-01
15	0.004417	-0.001510	-0.003199	1.275E-02	-1.853E-01	-1.161E+00
16	0.004414	-0.001228	-0.003717	1.093E+00	-2.199E-03	-3.392E-01
17	0.002445	-0.001762	-0.001619	1.725E+00	1.477E+00	-2.288E-02
18	0.002455	-0.001499	-0.002025	2.743E-01	3.548E-03	-5.502E-01
19	0.002513	-0.001254	-0.002465	1.409E-01	2.517E-03	-1.289E+00
20	0.002541	-0.000991	-0.002901	1.426E+00	4.995E-03	-6.436E-01
21	0.000864	-0.001169	-0.001095	2.236E+00	1.790E+00	1.393E-01
22	0.000877	-0.000949	-0.001373	7.443E-01	1.322E-01	-4.190E-01
23	0.000944	-0.000747	-0.001680	5.512E-01	9.063E-02	-1.412E+00
24	0.000987	-0.000528	-0.001986	1.900E+00	1.685E-01	-8.071E-01
25	0.004569	0.000000	-0.001179	9.107E-01	-2.690E-01	-2.820E-01
26	0.004519	0.000000	-0.001759	1.016E-01	-8.283E-01	-1.081E+00
27	0.004514	0.000000	-0.002364	7.816E-03	-7.107E-01	-1.371E+00
28	0.004386	0.000000	-0.002935	2.036E+00	5.353E-01	3.965E-02
29	0.002886	-0.000976	-0.001068	1.111E+00	2.205E-01	-2.767E-01
30	0.002904	-0.000747	-0.001558	7.901E-02	-6.032E-01	-9.769E-01
31	0.002973	-0.000531	-0.002063	-2.984E-03	-5.268E-01	-1.534E+00
32	0.002929	-0.000279	-0.002538	2.024E+00	2.337E-01	3.290E-02
33	0.001482	-0.000784	-0.000947	1.251E+00	7.188E-01	-2.919E-01
34	0.001529	-0.000560	-0.001339	5.940E-02	-3.688E-01	-9.597E-01
35	0.001632	-0.000365	-0.001727	-8.132E-03	-3.530E-01	-1.733E+00
36	0.001628	-0.000120	-0.002081	2.049E+00	4.852E-02	-1.250E-01
37	0.000496	-0.000341	-0.000842	1.142E+00	8.149E-01	-2.304E-01
38	0.000508	-0.000194	-0.001054	-2.250E-01	-3.315E-01	-1.076E+00
39	0.000568	-0.000075	-0.001277	-1.821E-01	-5.371E-01	-1.908E+00
40	0.000527	0.000114	-0.001496	2.168E+00	9.375E-02	-9.880E-01
41	0.001557	0.000000	-0.000701	6.595E-01	6.190E-01	-2.201E-01
42	0.001490	0.000000	-0.001023	-1.823E-01	-9.149E-01	-1.351E+00
43	0.001525	0.000000	-0.001330	-5.289E-02	-4.478E-01	-1.526E+00
44	0.001354	0.000000	-0.001668	2.788E+00	1.040E+00	5.458E-02
45	0.000731	-0.000273	-0.000809	9.540E-01	3.936E-01	-2.660E-01
46	0.000690	-0.000098	-0.000996	-6.423E-01	-7.672E-01	-1.272E+00
47	0.000736	-0.000004	-0.001160	-3.421E-01	-6.605E-01	-1.514E+00
48	0.000584	0.000161	-0.001328	2.651E+00	8.251E-02	-8.684E-02
49	0.000612	0.000000	-0.000595	1.131E+00	6.488E-01	1.531E-01
50	0.000628	0.000000	-0.000964	6.045E-02	-5.960E-01	-1.198E+00
51	0.000638	0.000000	-0.001080	2.224E-01	1.458E-01	-1.147E+00
52	0.000424	0.000000	-0.000872	2.635E+00	2.909E-01	-6.713E-01

TABLE 9. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.017688	0.000000	-0.007762	-2.044E-02	-5.980E-02	-1.173E+00
2	0.017588	0.000000	-0.008390	-3.806E-02	-9.550E-02	-9.750E-01
3	0.017483	0.000000	-0.009034	-3.178E-02	-1.168E-01	-7.745E-01
4	0.017380	0.000000	-0.009660	1.268E-04	-5.549E-02	-7.653E-01
5	0.010964	0.000000	-0.003690	1.054E+00	4.677E-01	9.456E-04
6	0.010848	0.000000	-0.004469	4.558E-02	-5.904E-01	-6.721E-01
7	0.010773	0.000000	-0.005300	5.027E-02	-6.581E-01	-9.515E-01
8	0.010656	0.000000	-0.006108	7.704E-01	3.389E-02	3.692E-03
9	0.005772	-0.001300	-0.002700	1.307E+00	6.652E-01	-1.527E-02
10	0.005703	-0.001106	-0.003226	6.732E-03	-3.518E-01	-6.768E-01
11	0.005673	-0.000925	-0.003795	1.058E-02	-5.603E-01	-1.008E+00
12	0.005613	-0.000716	-0.004355	7.000E-01	1.314E-02	-1.058E-01
13	0.004245	-0.001659	-0.002568	1.328E+00	9.277E-01	-3.905E-02
14	0.004194	-0.001470	-0.003090	-4.757E-02	-3.499E-01	-7.157E-01
15	0.004193	-0.001276	-0.003651	-5.913E-02	-4.818E-01	-1.318E+00
16	0.004170	-0.001045	-0.004210	7.460E-01	-5.097E-02	-5.857E-01
17	0.002051	-0.000706	-0.001272	1.511E+00	1.052E+00	-4.446E-02
18	0.002017	-0.000518	-0.001553	-5.695E-02	-1.306E-01	-4.674E-01
19	0.002014	-0.000365	-0.001861	-6.249E-02	-2.242E-01	-9.655E-01
20	0.001965	-0.000218	-0.002157	1.172E+00	-1.421E-02	-4.928E-02
21	0.000857	-0.000657	-0.001073	1.976E+00	1.404E+00	1.336E-01
22	0.000834	-0.000490	-0.001276	5.652E-01	1.320E-01	-5.295E-01
23	0.000871	-0.000328	-0.001509	2.500E-01	1.074E-01	-1.398E+00
24	0.000860	-0.000172	-0.001710	1.856E+00	1.536E-01	-2.811E-01
25	0.005405	0.000000	-0.001209	1.317E+00	1.850E-01	-5.679E-02
26	0.005351	0.000000	-0.001961	1.023E-01	-7.105E-01	-9.958E-01
27	0.005364	0.000000	-0.002755	1.214E-01	-9.792E-01	-1.581E+00
28	0.005252	0.000000	-0.003518	1.727E+00	9.955E-02	4.228E-02
29	0.002353	-0.000673	-0.001176	1.230E+00	2.375E-01	-1.016E-01
30	0.002359	-0.000474	-0.001605	-3.626E-03	-6.514E-01	-9.771E-01
31	0.002419	-0.000301	-0.002050	1.951E-02	-8.295E-01	-1.464E+00
32	0.002377	-0.000059	-0.002468	1.668E+00	3.132E-01	4.076E-02
33	0.001200	-0.000597	-0.001238	7.683E-01	3.302E-01	-2.784E-01
34	0.001181	-0.000483	-0.001599	-2.089E-01	-3.006E-01	-1.141E+00
35	0.001238	-0.000335	-0.001939	-1.916E-01	-3.949E-01	-1.961E+00
36	0.001242	-0.000080	-0.002249	1.263E+00	-1.476E-01	-5.462E-01
37	0.000443	-0.000145	-0.000627	6.900E-01	1.993E-01	-5.321E-01
38	0.000446	0.000011	-0.000761	2.211E-01	-4.257E-01	-7.781E-01
39	0.000459	0.000113	-0.000909	3.027E-01	-6.055E-01	-1.152E+00
40	0.000326	0.000231	-0.001106	1.619E+00	1.027E-01	-4.674E-01
41	0.001533	0.000000	-0.000828	9.725E-01	8.170E-01	-2.604E-01
42	0.001458	0.000000	-0.001216	-1.018E-01	-9.105E-01	-1.277E+00
43	0.001527	0.000000	-0.001579	7.370E-02	-1.006E+00	-1.724E+00
44	0.001386	0.000000	-0.001957	2.189E+00	5.452E-01	9.869E-02
45	0.000599	-0.000231	-0.000930	8.681E-01	1.002E-01	-5.512E-01
46	0.000570	-0.000040	-0.001051	-4.690E-01	-6.786E-01	-1.168E+00
47	0.000623	0.000029	-0.001170	-3.806E-01	-5.093E-01	-1.334E+00
48	0.000468	0.000190	-0.001305	2.302E+00	2.921E-01	-1.681E-01
49	0.000559	0.000000	-0.000760	1.080E+00	6.143E-01	-4.437E-02
50	0.000563	0.000000	-0.001170	-2.715E-02	-6.416E-01	-1.342E+00
51	0.000590	0.000000	-0.001305	1.672E-01	-1.268E-01	-1.276E+00
52	0.000391	0.000000	-0.001057	2.293E+00	3.435E-01	-1.032E+00

TABLE 10. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.013926	0.000000	-0.006776	1.003E-02	-2.743E-02	-1.334E+00
2	0.013828	0.000000	-0.007279	1.282E-02	-1.217E-01	-1.087E+00
3	0.013726	0.000000	-0.007802	2.156E-02	-6.754E-02	-8.303E-01
4	0.013623	0.000000	-0.008303	-4.217E-03	-6.125E-02	-5.714E-01
5	0.008646	0.000000	-0.003322	1.003E+00	2.861E-01	1.876E-02
6	0.008533	0.000000	-0.003936	7.183E-02	-6.447E-01	-8.082E-01
7	0.008460	0.000000	-0.004605	8.744E-02	-5.948E-01	-8.023E-01
8	0.008341	0.000000	-0.005248	1.013E+00	1.379E-01	4.229E-02
9	0.006303	-0.001793	-0.002779	1.200E+00	7.598E-01	-1.678E-02
10	0.006249	-0.001546	-0.003353	2.122E-02	-3.397E-01	-6.314E-01
11	0.006238	-0.001304	-0.003961	1.829E-02	-4.999E-01	-1.111E+00
12	0.006196	-0.001028	-0.004564	8.706E-01	3.086E-02	-1.025E-01
13	0.004336	-0.001972	-0.002466	1.203E+00	9.810E-01	-3.125E-02
14	0.004309	-0.001727	-0.002973	-1.119E-02	-2.461E-01	-5.983E-01
15	0.004341	-0.001460	-0.003506	-5.285E-02	-4.040E-01	-1.268E+00
16	0.004342	-0.001166	-0.004041	1.143E+00	-2.891E-02	-2.261E-01
17	0.002273	-0.000984	-0.001309	1.744E+00	1.040E+00	-5.637E-02
18	0.002240	-0.000791	-0.001693	-6.752E-02	-1.670E-01	-4.326E-01
19	0.002239	-0.000637	-0.002121	-7.621E-02	-3.252E-01	-1.292E+00
20	0.002203	-0.000480	-0.002538	1.237E+00	-4.120E-02	-8.314E-01
21	0.000964	-0.000872	-0.001009	1.993E+00	1.630E+00	1.251E-01
22	0.000951	-0.000689	-0.001269	5.750E-01	1.310E-01	-3.694E-01
23	0.001006	-0.000504	-0.001572	2.119E-01	9.401E-02	-1.487E+00
24	0.001012	-0.000330	-0.001839	1.841E+00	1.380E-01	-6.174E-01
25	0.004298	0.000000	-0.001225	1.162E+00	5.434E-02	-4.344E-02
26	0.004249	0.000000	-0.001808	1.277E-01	-6.731E-01	-1.089E+00
27	0.004262	0.000000	-0.002439	1.333E-01	-9.505E-01	-1.406E+00
28	0.004145	0.000000	-0.003029	1.842E+00	4.037E-01	8.843E-02
29	0.002581	-0.000905	-0.001156	1.296E+00	3.443E-01	-8.493E-02
30	0.002599	-0.000672	-0.001643	1.631E-02	-6.558E-01	-9.820E-01
31	0.002676	-0.000456	-0.002140	2.762E-02	-8.413E-01	-1.547E+00
32	0.002650	-0.000179	-0.002613	1.608E+00	1.133E-01	3.076E-02
33	0.001227	-0.000784	-0.001153	1.007E+00	5.383E-01	-1.939E-01
34	0.001247	-0.000609	-0.001538	-1.454E-01	-7.051E-01	-1.029E+00
35	0.001328	-0.000442	-0.001903	-1.513E-01	-7.039E-01	-1.855E+00
36	0.001333	-0.000192	-0.002242	1.419E+00	-8.410E-02	-4.197E-01
37	0.000473	-0.000036	-0.000699	9.001E-01	3.089E-01	-4.120E-01
38	0.000449	0.000073	-0.000844	-8.312E-02	-3.695E-01	-9.105E-01
39	0.000471	0.000164	-0.000996	-6.106E-02	-5.650E-01	-1.353E+00
40	0.000359	0.000295	-0.001191	1.646E+00	-6.870E-02	-4.215E-01
41	0.001332	0.000000	-0.000854	9.194E-01	8.067E-01	-2.112E-01
42	0.001265	0.000000	-0.001142	-7.177E-02	-9.576E-01	-1.237E+00
43	0.001331	0.000000	-0.001424	5.347E-02	-9.175E-01	-1.512E+00
44	0.001181	0.000000	-0.001732	2.109E+00	9.561E-01	7.069E-02
45	0.000618	-0.000212	-0.000941	9.220E-01	1.957E-01	-5.342E-01
46	0.000594	-0.000019	-0.001088	-4.703E-01	-7.545E-01	-1.182E+00
47	0.000654	0.000071	-0.001224	-4.168E-01	-4.986E-01	-1.390E+00
48	0.000504	0.000238	-0.001380	2.163E+00	8.994E-02	-2.447E-01
49	0.000530	0.000000	-0.000709	1.060E+00	5.199E-01	-1.305E-01
50	0.000531	0.000000	-0.001077	-2.751E-02	-5.816E-01	-1.236E+00
51	0.000555	0.000000	-0.001164	2.071E-01	-1.276E-01	-1.132E+00
52	0.000361	0.000000	-0.000924	2.375E+00	4.311E-01	-5.352E-01

TABLE 11. TALVACCHIA ARCH DAM WITH STICKING CONTRACTION JOINTS; DISPLACEMENTS AND PRINCIPAL STRESSES AT SELECTED NODES DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx [m]	Dy [m]	Dz [m]	P1 [MPa]	P2 [MPa]	P3 [MPa]
1	0.013697	0.000000	-0.006614	9.278E-03	-4.805E-02	-1.337E+00
2	0.013600	0.000000	-0.007096	1.360E-02	-1.031E-01	-1.114E+00
3	0.013498	0.000000	-0.007594	1.823E-02	-8.308E-02	-8.587E-01
4	0.013396	0.000000	-0.008074	1.181E-03	-5.253E-02	-6.070E-01
5	0.008667	0.000000	-0.003261	9.297E-01	2.649E-01	1.230E-02
6	0.008554	0.000000	-0.003853	6.170E-02	-6.148E-01	-8.413E-01
7	0.008480	0.000000	-0.004487	6.729E-02	-6.607E-01	-8.798E-01
8	0.008361	0.000000	-0.005110	9.431E-01	2.269E-01	5.085E-02
9	0.006362	-0.001843	-0.002712	1.138E+00	6.771E-01	-5.165E-03
10	0.006312	-0.001586	-0.003257	1.275E-02	-4.535E-01	-6.973E-01
11	0.006301	-0.001340	-0.003852	2.505E-02	-4.335E-01	-9.790E-01
12	0.006262	-0.001049	-0.004408	9.129E-01	1.356E-02	-1.154E-01
13	0.004171	-0.002000	-0.002169	1.465E+00	9.678E-01	-2.831E-02
14	0.004167	-0.001698	-0.002653	-8.137E-02	-3.018E-01	-8.030E-01
15	0.004198	-0.001417	-0.003213	-1.431E-02	-4.495E-02	-9.889E-01
16	0.004227	-0.001054	-0.003694	1.093E+00	-9.384E-02	-5.370E-01
17	0.002387	-0.001537	-0.001594	1.522E+00	1.276E+00	-6.000E-02
18	0.002376	-0.001306	-0.001999	9.690E-02	-5.482E-02	-4.674E-01
19	0.002416	-0.001081	-0.002406	1.365E-01	-1.231E-01	-1.442E+00
20	0.002387	-0.000898	-0.002871	1.459E+00	-4.385E-02	-6.031E-01
21	0.000916	-0.001108	-0.001087	2.051E+00	1.755E+00	1.265E-01
22	0.000909	-0.000914	-0.001365	7.850E-01	1.367E-01	-3.687E-01
23	0.000983	-0.000703	-0.001679	3.795E-01	7.986E-02	-1.581E+00
24	0.001001	-0.000513	-0.001972	1.924E+00	1.427E-01	-6.718E-01
25	0.004467	0.000000	-0.001168	1.040E+00	1.384E-02	-5.713E-02
26	0.004416	0.000000	-0.001750	1.203E-01	-7.298E-01	-1.068E+00
27	0.004429	0.000000	-0.002360	1.423E-01	-9.377E-01	-1.378E+00
28	0.004311	0.000000	-0.002955	1.934E+00	5.075E-01	1.108E-01
29	0.002777	-0.000927	-0.001071	1.169E+00	3.177E-01	-1.005E-01
30	0.002798	-0.000684	-0.001559	1.681E-02	-6.086E-01	-9.441E-01
31	0.002874	-0.000467	-0.002066	3.349E-02	-6.864E-01	-1.563E+00
32	0.002848	-0.000179	-0.002526	1.906E+00	2.536E-01	5.586E-02
33	0.001350	-0.000728	-0.000986	9.987E-01	4.426E-01	-2.519E-01
34	0.001372	-0.000533	-0.001372	-1.577E-01	-2.665E-01	-7.876E-01
35	0.001466	-0.000317	-0.001736	-2.068E-01	-4.475E-01	-1.857E+00
36	0.001482	-0.000018	-0.002014	2.018E+00	-5.784E-03	-1.281E-01
37	0.000480	-0.000231	-0.000872	6.849E-01	2.571E-01	-4.909E-01
38	0.000491	-0.000073	-0.001035	5.732E-02	-4.219E-01	-1.003E+00
39	0.000521	0.000039	-0.001211	3.151E-02	-6.147E-01	-1.473E+00
40	0.000428	0.000187	-0.001483	1.629E+00	-4.334E-01	-6.892E-01
41	0.001447	0.000000	-0.000739	9.143E-01	7.804E-01	-2.639E-01
42	0.001372	0.000000	-0.001057	-8.863E-02	-8.265E-01	-1.260E+00
43	0.001436	0.000000	-0.001352	1.060E-01	-8.674E-01	-1.445E+00
44	0.001286	0.000000	-0.001692	2.372E+00	9.216E-01	9.552E-02
45	0.000677	-0.000224	-0.000835	8.976E-01	2.831E-01	-5.795E-01
46	0.000651	-0.000011	-0.001009	-4.836E-01	-6.535E-01	-1.131E+00
47	0.000708	0.000072	-0.001167	-3.863E-01	-4.691E-01	-1.425E+00
48	0.000566	0.000255	-0.001337	2.306E+00	1.493E-01	-2.377E-01
49	0.000556	0.000000	-0.000630	1.122E+00	6.057E-01	5.091E-02
50	0.000562	0.000000	-0.001004	1.775E-02	-5.764E-01	-1.235E+00
51	0.000585	0.000000	-0.001113	2.028E-01	-1.137E-01	-1.144E+00
52	0.000387	0.000000	-0.000894	2.409E+00	4.153E-01	-5.729E-01

TABLE 12. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS OF SELECTED NODES AT JOINT 1 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.009452	0.006059	-0.004178	-0.002454	-0.005923	-0.00386
2	0.009418	0.006030	-0.004004	-0.002282	-0.006419	-0.00416
3	0.009377	0.005993	-0.003836	-0.002116	-0.006931	-0.00447
4	0.009321	0.005974	-0.003711	-0.001922	-0.007426	-0.00477
5	0.007971	0.005258	-0.003487	-0.001797	-0.005594	-0.00349
6	0.007941	0.005239	-0.003334	-0.001628	-0.006087	-0.00381
7	0.007915	0.005224	-0.003194	-0.001468	-0.006599	-0.00413
8	0.007907	0.005179	-0.002989	-0.001338	-0.007099	-0.00443
9	0.006424	0.004327	-0.002724	-0.001311	-0.004607	-0.00264
10	0.006380	0.004300	-0.002575	-0.001137	-0.005131	-0.00300
11	0.006348	0.004289	-0.002432	-0.000966	-0.005680	-0.00336
12	0.006310	0.004261	-0.002272	-0.000797	-0.006213	-0.00371
13	0.004834	0.003463	-0.002237	-0.000832	-0.003471	-0.00181
14	0.004828	0.003390	-0.001998	-0.000730	-0.004035	-0.00214
15	0.004829	0.003367	-0.001804	-0.000591	-0.004624	-0.00249
16	0.004788	0.003341	-0.001647	-0.000407	-0.005195	-0.00286
17	0.003399	0.002646	-0.001766	-0.000500	-0.002614	-0.00120
18	0.003401	0.002570	-0.001507	-0.000390	-0.003154	-0.00149
19	0.003433	0.002557	-0.001297	-0.000268	-0.003730	-0.00182
20	0.003407	0.002531	-0.001122	-0.000084	-0.004288	-0.00215
21	0.002207	0.001981	-0.001389	-0.000246	-0.002008	-0.00079
22	0.002244	0.001864	-0.001066	-0.000193	-0.002485	-0.00103
23	0.002306	0.001866	-0.000856	-0.000079	-0.003008	-0.00131
24	0.002273	0.001865	-0.000718	0.000142	-0.003496	-0.00159
25	0.001342	0.001369	-0.000975	-0.000168	-0.001547	-0.00050
26	0.001356	0.001275	-0.000706	-0.000053	-0.001973	-0.00073
27	0.001442	0.001296	-0.000524	0.000046	-0.002423	-0.00098
28	0.001423	0.001279	-0.000385	0.000253	-0.002810	-0.00121
29	0.000694	0.000781	-0.000534	-0.000139	-0.001269	-0.00042
30	0.000849	0.000682	-0.000226	-0.000176	-0.001603	-0.00063
31	0.000947	0.000756	-0.000160	-0.000072	-0.001943	-0.00080
32	0.000818	0.000892	-0.000248	0.000301	-0.002198	-0.00096
33	0.000300	0.000475	-0.000288	-0.000085	-0.001121	-0.00062
34	0.000387	0.000407	-0.000145	-0.000012	-0.001237	-0.00071
35	0.000474	0.000477	-0.000154	0.000122	-0.001435	-0.00081
36	0.000349	0.000437	-0.000198	0.000408	-0.001620	-0.00096
37	0.000215	0.000215	-0.000040	-0.000040	-0.000636	-0.00063
38	0.000248	0.000248	0.000055	0.000055	-0.000810	-0.00081
39	0.000263	0.000263	0.000075	0.000075	-0.000841	-0.00084
40	0.000134	0.000134	0.000084	0.000084	-0.000723	-0.00072

LEGEND: '_r', right face of joint
'_l', left face of joint

TABLE 13. TALVACCHIA ARCH DAM WITH FRICTIONLESS CONTRACTION JOINTS, f=0; DISPLACEMENTS OF SELECTED NODES AT JOINT 2 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.017135	0.011685	-0.001637	-0.000831	-0.007745	-0.00592
2	0.017046	0.011596	-0.001556	-0.000744	-0.008365	-0.00638
3	0.016953	0.011505	-0.001466	-0.000648	-0.009002	-0.00685
4	0.016865	0.011398	-0.001317	-0.000640	-0.009626	-0.00730
5	0.014867	0.010047	-0.001398	-0.000673	-0.006539	-0.00493
6	0.014776	0.009958	-0.001312	-0.000578	-0.007207	-0.00542
7	0.014692	0.009877	-0.001222	-0.000479	-0.007900	-0.00593
8	0.014600	0.009776	-0.001104	-0.000423	-0.008569	-0.00642
9	0.012709	0.008519	-0.001209	-0.000593	-0.005069	-0.00377
10	0.012611	0.008422	-0.001115	-0.000488	-0.005793	-0.00429
11	0.012531	0.008345	-0.001022	-0.000384	-0.006563	-0.00484
12	0.012429	0.008248	-0.000935	-0.000267	-0.007303	-0.00538
13	0.010626	0.007076	-0.001020	-0.000544	-0.003792	-0.00280
14	0.010519	0.006978	-0.000939	-0.000408	-0.004558	-0.00332
15	0.010452	0.006912	-0.000843	-0.000299	-0.005376	-0.00389
16	0.010343	0.006820	-0.000791	-0.000130	-0.006166	-0.00444
17	0.008658	0.005772	-0.000908	-0.000443	-0.002747	-0.00203
18	0.008552	0.005663	-0.000781	-0.000339	-0.003519	-0.00254
19	0.008507	0.005618	-0.000680	-0.000227	-0.004362	-0.00310
20	0.008396	0.005535	-0.000667	-0.000006	-0.005175	-0.00364
21	0.006868	0.004607	-0.000764	-0.000396	-0.001904	-0.00142
22	0.006758	0.004495	-0.000636	-0.000278	-0.002695	-0.00193
23	0.006740	0.004474	-0.000533	-0.000166	-0.003533	-0.00247
24	0.006629	0.004406	-0.000566	0.000109	-0.004335	-0.00299
25	0.005212	0.003520	-0.000617	-0.000339	-0.001374	-0.00105
26	0.005182	0.003489	-0.000505	-0.000226	-0.002116	-0.00152
27	0.005209	0.003512	-0.000405	-0.000120	-0.002899	-0.00200
28	0.005099	0.003462	-0.000491	0.000208	-0.003639	-0.00246
29	0.003901	0.002703	-0.000505	-0.000297	-0.001150	-0.00092
30	0.003886	0.002687	-0.000394	-0.000189	-0.001765	-0.00128
31	0.003955	0.002749	-0.000301	-0.000094	-0.002441	-0.00168
32	0.003840	0.002717	-0.000449	0.000290	-0.003078	-0.00205
33	0.002903	0.002110	-0.000417	-0.000272	-0.001020	-0.00085
34	0.002887	0.002091	-0.000308	-0.000170	-0.001547	-0.00114
35	0.002974	0.002167	-0.000222	-0.000085	-0.002102	-0.00145
36	0.002846	0.002149	-0.000439	0.000357	-0.002625	-0.00174
37	0.002126	0.001648	-0.000342	-0.000252	-0.000938	-0.00079
38	0.002106	0.001622	-0.000236	-0.000155	-0.001383	-0.00104
39	0.002211	0.001710	-0.000162	-0.000086	-0.001828	-0.00128
40	0.002069	0.001704	-0.000448	0.000406	-0.002251	-0.00151
41	0.001527	0.001261	-0.000219	-0.000273	-0.000874	-0.00076
42	0.001485	0.001227	-0.000169	-0.000133	-0.001241	-0.00096
43	0.001586	0.001306	-0.000108	-0.000077	-0.001575	-0.00114
44	0.001422	0.001301	-0.000471	0.000453	-0.001924	-0.00134
45	0.001035	0.000958	-0.000189	-0.000167	-0.000806	-0.00072
46	0.000964	0.000869	-0.000101	-0.000094	-0.001111	-0.00093
47	0.001000	0.000905	-0.000153	0.000046	-0.001327	-0.00103
48	0.000791	0.000813	-0.000436	0.000492	-0.001537	-0.00119
49	0.000552	0.000552	-0.000049	-0.000049	-0.000655	-0.00065
50	0.000578	0.000578	0.000003	0.000003	-0.000995	-0.00099
51	0.000607	0.000607	0.000043	0.000043	-0.001027	-0.00102
52	0.000388	0.000388	0.000063	0.000063	-0.000816	-0.00081

TABLE 14. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75; DISPLACEMENTS OF SELECTED NODES AT JOINT 1 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.007876	0.007876	-0.004564	-0.004564	-0.004835	-0.00483
2	0.007890	0.007890	-0.004299	-0.004299	-0.005269	-0.00526
3	0.007895	0.007895	-0.004047	-0.004047	-0.005723	-0.00572
4	0.007898	0.007898	-0.003802	-0.003802	-0.006166	-0.00616
5	0.006727	0.006773	-0.003558	-0.003440	-0.004679	-0.00433
6	0.006772	0.006772	-0.003240	-0.003240	-0.005082	-0.00482
7	0.006795	0.006798	-0.002994	-0.002996	-0.005521	-0.00530
8	0.006820	0.006812	-0.002715	-0.002758	-0.005937	-0.00577
9	0.005641	0.005331	-0.002766	-0.002462	-0.004012	-0.00319
10	0.005631	0.005344	-0.002518	-0.002233	-0.004430	-0.00374
11	0.005650	0.005370	-0.002242	-0.002015	-0.004818	-0.00435
12	0.005671	0.005368	-0.001946	-0.001802	-0.005291	-0.00486
13	0.004436	0.004003	-0.002400	-0.001447	-0.003169	-0.00207
14	0.004474	0.003928	-0.002069	-0.001351	-0.003626	-0.00258
15	0.004542	0.003887	-0.001726	-0.001253	-0.004094	-0.00315
16	0.004513	0.003910	-0.001512	-0.001008	-0.004571	-0.00371
17	0.003259	0.002855	-0.001975	-0.000756	-0.002421	-0.00135
18	0.003291	0.002771	-0.001651	-0.000664	-0.002913	-0.00176
19	0.003340	0.002768	-0.001391	-0.000539	-0.003442	-0.00221
20	0.003350	0.002732	-0.001125	-0.000389	-0.003930	-0.00269
21	0.002179	0.002022	-0.001584	-0.000297	-0.001857	-0.00092
22	0.002226	0.001906	-0.001239	-0.000246	-0.002320	-0.00122
23	0.002313	0.001896	-0.000977	-0.000157	-0.002832	-0.00158
24	0.002300	0.001891	-0.000790	0.000042	-0.003308	-0.00193
25	0.001305	0.001372	-0.001185	-0.000064	-0.001413	-0.00061
26	0.001364	0.001242	-0.000837	-0.000010	-0.001852	-0.00088
27	0.001464	0.001262	-0.000626	0.000075	-0.002316	-0.00115
28	0.001442	0.001265	-0.000482	0.000290	-0.002715	-0.00141
29	0.000664	0.000764	-0.000662	-0.000018	-0.001152	-0.00052
30	0.000758	0.000734	-0.000448	0.000038	-0.001509	-0.00071
31	0.000878	0.000795	-0.000340	0.000112	-0.001870	-0.00090
32	0.000826	0.000856	-0.000291	0.000369	-0.002147	-0.00106
33	0.000264	0.000481	-0.000378	0.000019	-0.001044	-0.00067
34	0.000381	0.000390	-0.000175	0.000041	-0.001175	-0.00075
35	0.000473	0.000464	-0.000166	0.000164	-0.001394	-0.00084
36	0.000344	0.000443	-0.000214	0.000465	-0.001601	-0.00099
37	0.000206	0.000206	-0.000032	-0.000032	-0.000639	-0.00063
38	0.000236	0.000236	0.000062	0.000062	-0.000812	-0.00081
39	0.000255	0.000255	0.000088	0.000088	-0.000846	-0.00084
40	0.000131	0.000131	0.000102	0.000102	-0.000729	-0.00072

LEGEND: '_r', right face of joint
'_l', left face of joint

TABLE 15. TALVACCHIA ARCH DAM WITH FRICTIONAL CONTRACTION JOINTS, f=0.75; DISPLACEMENTS OF SELECTED NODES AT JOINT 2 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.013139	0.013139	-0.001699	-0.001699	-0.006549	-0.00654
2	0.013057	0.013057	-0.001571	-0.001571	-0.007046	-0.00704
3	0.012972	0.012972	-0.001433	-0.001433	-0.007562	-0.00756
4	0.012885	0.012885	-0.001302	-0.001302	-0.008058	-0.00805
5	0.011353	0.011353	-0.001445	-0.001445	-0.005509	-0.00550
6	0.011270	0.011270	-0.001303	-0.001303	-0.006043	-0.00604
7	0.011195	0.011195	-0.001160	-0.001160	-0.006603	-0.00660
8	0.011106	0.011106	-0.001016	-0.001016	-0.007135	-0.00713
9	0.009672	0.009672	-0.001283	-0.001283	-0.004274	-0.00427
10	0.009583	0.009583	-0.001127	-0.001127	-0.004847	-0.00484
11	0.009513	0.009513	-0.000974	-0.000974	-0.005457	-0.00545
12	0.009414	0.009426	-0.000840	-0.000788	-0.006065	-0.00602
13	0.008075	0.008075	-0.001126	-0.001126	-0.003222	-0.00322
14	0.007982	0.007982	-0.000960	-0.000960	-0.003813	-0.00381
15	0.007922	0.007928	-0.000801	-0.000800	-0.004473	-0.00442
16	0.007816	0.007848	-0.000706	-0.000559	-0.005096	-0.00503
17	0.006610	0.006611	-0.000975	-0.000975	-0.002384	-0.00237
18	0.006511	0.006511	-0.000805	-0.000805	-0.002957	-0.00295
19	0.006469	0.006478	-0.000659	-0.000631	-0.003646	-0.00355
20	0.006360	0.006408	-0.000606	-0.000343	-0.004272	-0.00417
21	0.005286	0.005285	-0.000827	-0.000827	-0.001694	-0.00168
22	0.005182	0.005182	-0.000657	-0.000657	-0.002282	-0.00228
23	0.005162	0.005177	-0.000539	-0.000469	-0.002967	-0.00286
24	0.005052	0.005121	-0.000535	-0.000140	-0.003582	-0.00345
25	0.004043	0.004043	-0.000670	-0.000670	-0.001257	-0.00125
26	0.004021	0.004021	-0.000519	-0.000519	-0.001809	-0.00180
27	0.004046	0.004061	-0.000426	-0.000336	-0.002452	-0.00233
28	0.003933	0.004025	-0.000490	0.000043	-0.003014	-0.00285
29	0.003091	0.003091	-0.000538	-0.000538	-0.001087	-0.00108
30	0.003082	0.003082	-0.000401	-0.000401	-0.001526	-0.00152
31	0.003145	0.003163	-0.000345	-0.000219	-0.002083	-0.00195
32	0.003025	0.003142	-0.000478	0.000201	-0.002564	-0.00238
33	0.002385	0.002385	-0.000431	-0.000431	-0.000974	-0.00097
34	0.002373	0.002373	-0.000308	-0.000308	-0.001346	-0.00134
35	0.002448	0.002472	-0.000299	-0.000116	-0.001810	-0.00167
36	0.002314	0.002458	-0.000492	0.000334	-0.002207	-0.00200
37	0.001829	0.001825	-0.000337	-0.000337	-0.000894	-0.00088
38	0.001807	0.001807	-0.000229	-0.000229	-0.001202	-0.00120
39	0.001894	0.001923	-0.000263	-0.000038	-0.001582	-0.00144
40	0.001745	0.001914	-0.000514	0.000435	-0.001916	-0.00169
41	0.001368	0.001365	-0.000249	-0.000249	-0.000822	-0.00081
42	0.001334	0.001334	-0.000155	-0.000155	-0.001075	-0.00107
43	0.001413	0.001443	-0.000216	0.000022	-0.001371	-0.00123
44	0.001247	0.001422	-0.000501	0.000486	-0.001666	-0.00145
45	0.001003	0.000994	-0.000158	-0.000156	-0.000745	-0.00075
46	0.000917	0.000917	-0.000083	-0.000083	-0.000983	-0.00098
47	0.000939	0.000966	-0.000153	0.000071	-0.001176	-0.00107
48	0.000716	0.000890	-0.000464	0.000542	-0.001370	-0.00122
49	0.000558	0.000558	-0.000042	-0.000042	-0.000627	-0.00062
50	0.000581	0.000581	-0.000003	-0.000003	-0.000952	-0.00095
51	0.000605	0.000605	0.000029	0.000029	-0.000964	-0.00096
52	0.000384	0.000384	0.000058	0.000058	-0.000765	-0.00076

TABLE 16. TALVACCHIA ARCH DAM WITH STICKING CONTRACTION JOINTS; DISPLACEMENTS OF SELECTED NODES AT JOINT 1 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.007902	0.007902	-0.004656	-0.004656	-0.004777	-0.00477
2	0.007914	0.007914	-0.004398	-0.004398	-0.005210	-0.00521
3	0.007918	0.007918	-0.004151	-0.004151	-0.005661	-0.00566
4	0.007924	0.007924	-0.003907	-0.003907	-0.006101	-0.00610
5	0.006751	0.006751	-0.003716	-0.003716	-0.004444	-0.00444
6	0.006765	0.006765	-0.003474	-0.003474	-0.004888	-0.00488
7	0.006785	0.006785	-0.003236	-0.003236	-0.005339	-0.00533
8	0.006798	0.006798	-0.002995	-0.002995	-0.005778	-0.00577
9	0.005451	0.005484	-0.002935	-0.002879	-0.003528	-0.00353
10	0.005474	0.005474	-0.002660	-0.002660	-0.004012	-0.00401
11	0.005497	0.005497	-0.002413	-0.002413	-0.004509	-0.00450
12	0.005512	0.005498	-0.002145	-0.002184	-0.005019	-0.00496
13	0.004125	0.004264	-0.002407	-0.002139	-0.002580	-0.00253
14	0.004195	0.004195	-0.002015	-0.002015	-0.003044	-0.00304
15	0.004232	0.004232	-0.001757	-0.001757	-0.003563	-0.00356
16	0.004242	0.004242	-0.001486	-0.001508	-0.004129	-0.00402
17	0.002901	0.003145	-0.001917	-0.001459	-0.001887	-0.00180
18	0.002952	0.003098	-0.001559	-0.001297	-0.002361	-0.00224
19	0.003074	0.003074	-0.001177	-0.001177	-0.002794	-0.00279
20	0.003079	0.003102	-0.000924	-0.000906	-0.003360	-0.00321
21	0.001900	0.002243	-0.001505	-0.000889	-0.001441	-0.00131
22	0.001988	0.002140	-0.001076	-0.000812	-0.001837	-0.00170
23	0.002131	0.002131	-0.000710	-0.000710	-0.002209	-0.00220
24	0.002129	0.002174	-0.000490	-0.000428	-0.002733	-0.00253
25	0.001169	0.001503	-0.001074	-0.000523	-0.001082	-0.00099
26	0.001243	0.001413	-0.000694	-0.000403	-0.001475	-0.00132
27	0.001410	0.001410	-0.000350	-0.000350	-0.001779	-0.00177
28	0.001383	0.001471	-0.000204	-0.000044	-0.002227	-0.00201
29	0.000653	0.000848	-0.000563	-0.000276	-0.000944	-0.00083
30	0.000798	0.000798	-0.000252	-0.000252	-0.001177	-0.00117
31	0.000910	0.000910	-0.000126	-0.000126	-0.001460	-0.00146
32	0.000867	0.001005	-0.000036	0.000168	-0.001826	-0.00155
33	0.000362	0.000504	-0.000275	-0.000086	-0.000951	-0.00091
34	0.000458	0.000458	-0.000047	-0.000047	-0.001040	-0.00104
35	0.000548	0.000548	0.000042	0.000042	-0.001206	-0.00120
36	0.000404	0.000587	0.000003	0.000390	-0.001505	-0.00130
37	0.000242	0.000242	-0.000008	-0.000008	-0.000726	-0.00072
38	0.000283	0.000283	0.000092	0.000092	-0.000927	-0.00092
39	0.000317	0.000317	0.000128	0.000128	-0.000973	-0.00097
40	0.000195	0.000195	0.000141	0.000141	-0.000833	-0.00083

LEGEND: '_r', right face of joint
'_l', left face of joint

TABLE 17. TALVACCHIA ARCH DAM WITH STICKING CONTRACTION JOINTS; DISPLACEMENTS OF SELECTED NODES AT JOINT 2 DUE TO "WINTER" LOAD CASE.

NODE NUM.	Dx_r [m]	Dx_l [m]	Dy_r [m]	Dy_l [m]	Dz_r [m]	Dz_l [m]
1	0.012922	0.012922	-0.001715	-0.001715	-0.006398	-0.00639
2	0.012841	0.012841	-0.001586	-0.001586	-0.006872	-0.00687
3	0.012756	0.012756	-0.001453	-0.001453	-0.007362	-0.00736
4	0.012670	0.012670	-0.001323	-0.001323	-0.007835	-0.00783
5	0.011233	0.011233	-0.001462	-0.001462	-0.005393	-0.00539
6	0.011150	0.011150	-0.001329	-0.001329	-0.005902	-0.00590
7	0.011074	0.011074	-0.001186	-0.001186	-0.006433	-0.00643
8	0.010986	0.010986	-0.001049	-0.001049	-0.006941	-0.00694
9	0.009643	0.009643	-0.001293	-0.001293	-0.004196	-0.00419
10	0.009553	0.009553	-0.001150	-0.001150	-0.004744	-0.00474
11	0.009482	0.009482	-0.001001	-0.001001	-0.005327	-0.00532
12	0.009384	0.009392	-0.000868	-0.000834	-0.005900	-0.00587
13	0.008123	0.008123	-0.001132	-0.001132	-0.003164	-0.00316
14	0.008029	0.008029	-0.000978	-0.000978	-0.003734	-0.00373
15	0.007971	0.007971	-0.000828	-0.000828	-0.004348	-0.00434
16	0.007865	0.007889	-0.000736	-0.000599	-0.004955	-0.00491
17	0.006719	0.006714	-0.000958	-0.000996	-0.002330	-0.00232
18	0.006617	0.006617	-0.000817	-0.000817	-0.002889	-0.00288
19	0.006576	0.006576	-0.000668	-0.000668	-0.003517	-0.00351
20	0.006465	0.006505	-0.000621	-0.000384	-0.004142	-0.00409
21	0.005423	0.005418	-0.000811	-0.000842	-0.001632	-0.00162
22	0.005316	0.005316	-0.000665	-0.000665	-0.002215	-0.00221
23	0.005301	0.005301	-0.000520	-0.000520	-0.002837	-0.00283
24	0.005188	0.005247	-0.000532	-0.000183	-0.003460	-0.00340
25	0.004182	0.004182	-0.000668	-0.000668	-0.001184	-0.00118
26	0.004160	0.004160	-0.000524	-0.000524	-0.001738	-0.00173
27	0.004191	0.004191	-0.000390	-0.000390	-0.002318	-0.00231
28	0.004076	0.004156	-0.000466	-0.000005	-0.002901	-0.00282
29	0.003220	0.003220	-0.000537	-0.000537	-0.001002	-0.00100
30	0.003212	0.003212	-0.000403	-0.000403	-0.001448	-0.00144
31	0.003283	0.003283	-0.000286	-0.000286	-0.001945	-0.00194
32	0.003162	0.003266	-0.000436	0.000151	-0.002457	-0.00236
33	0.002502	0.002502	-0.000433	-0.000433	-0.000882	-0.00088
34	0.002489	0.002489	-0.000309	-0.000309	-0.001264	-0.00126
35	0.002573	0.002573	-0.000207	-0.000207	-0.001673	-0.00167
36	0.002436	0.002569	-0.000438	0.000285	-0.002112	-0.00199
37	0.001957	0.001915	-0.000247	-0.000438	-0.000796	-0.00079
38	0.001910	0.001910	-0.000229	-0.000229	-0.001128	-0.00112
39	0.002002	0.002002	-0.000145	-0.000145	-0.001457	-0.00145
40	0.001851	0.002005	-0.000451	0.000391	-0.001843	-0.00170
41	0.001452	0.001431	-0.000207	-0.000296	-0.000732	-0.00073
42	0.001405	0.001405	-0.000149	-0.000149	-0.001017	-0.00101
43	0.001493	0.001493	-0.000086	-0.000086	-0.001267	-0.00126
44	0.001317	0.001503	-0.000466	0.000485	-0.001636	-0.00145
45	0.001035	0.001031	-0.000168	-0.000143	-0.000673	-0.00067
46	0.000953	0.000953	-0.000074	-0.000074	-0.000937	-0.00093
47	0.000972	0.001009	-0.000146	0.000091	-0.001141	-0.00105
48	0.000753	0.000930	-0.000422	0.000540	-0.001350	-0.00122
49	0.000569	0.000569	-0.000039	-0.000039	-0.000575	-0.00057
50	0.000595	0.000595	0.000003	0.000003	-0.000907	-0.00090
51	0.000621	0.000621	0.000039	0.000039	-0.000940	-0.00094
52	0.000400	0.000400	0.000068	0.000068	-0.000751	-0.00075

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