Volume III
Proceedings of the Specialty Conference on

## PERFORMANCE OF EARTH AND EARTH-SUPPORTED STRUCTURES

June 11-14, 1972 Purdue University • Lafayette, Indiana

Jointly sponsored by School of Civil Engineering Purdue University and Soil Mechanics and Foundations Division ASCE



Published by American Society of Civil Engineers 345 East 47th Street New York, N.Y. 10017

© 1973 - American Society of Civil Engineers

## **CONTENTS**

FOREWORD	vii
PROGRAM	ix
ROSTER	xiii
OPENING REMARKS by G. A. Leonards	xxxi
INTRODUCTION OF LAURITS BJERRUM FOR	
TERZAGHI AWARD by Elio D'Appolonia	
by Elio D'Appolonia	xxxvii
SPECIAL EVENTS: DEMONSTRATION OF PILE DRIVING AND LOAD TESTING	
FIELD DEMONSTRATION: RESPONSE OF INSTRU- MENTED PILES TO DRIVING AND LOAD TESTING	
by George G. Goble, William D. Kovacs, and Frank Rausche	3
SESSION I — EMBANKMENTS ON SOFT GROUND	
PANEL DISCUSSION by Victor Milligan	41
REPORTER'S SUMMARY by William H. Perloff	49
EMBANKMENTS ON SOFT GROUND by Laurits Bjerrum	
DISCUSSION by Robert D. Holtz and Jan Wennerstrand	59
GENERAL DISCUSSION	
by Gerald P. Raymond	61
(Addendum) by Robert D. Holtz and Gote Lindskog	71
LONG-TERM LOADING TESTS AT SKA-EDEBY,	
SWEDEN (Errata) by Robert D. Holtz and Bengt Broms	73
SESSION II — EARTH AND EARTH-ROCK DAMS	
REPORTER'S SUMMARY by James L. Sherard	77
VI Junios E. Diicidiu	- //

	ANALYSIS OF FAILURE OF BALDWIN HILLS RESER- VOIR by Thomas M. Leps
91	THE BALDWIN HILLS RESERVOIR FAILURE IN RETROSPECT by Arthur Casagrande, Stanley D. Wilson, and E. Douglas Schwantes, Jr. DISCUSSION by Robert O. Castle and T. Leslie Youd
100	CLOSURE
103	by Thomas M. Leps by Arthur Casagrande, Stanley D. Wilson, and E. Douglas Schwantes, Jr.
	PIPING IN EARTH DAMS OF DISPERSIVE CLAY by James L. Sherard, Rey S. Decker, and Norman L. Ryker
105	DISCUSSION by Edward D. Graf and Harpal S. Arora
107	by Aldo R. Reginatto
111	by O. G. Ingles
	HYDRAULIC FRACTURING IN LOW DAMS OF DIS- PERSIVE CLAY by James L. Sherard, Rey S. Decker, and Norman L. Ryker
	DISCUSSION
119	by O. G. Ingles DISCUSSION OF "DISPERSIVE CLAY" PAPERS
127	by Gordon L. Bell
131	by R. A. Rallings
135	by Aurelio Bemassini Vizcaino and Vicente Casales Lattuada CLOSURE TO "DISPERSIVE CLAY" PAPERS
143	by James L. Sherard, Rey S. Decker, and Norman L. Ryker
157	by C. F. Lee
159	CLOSURE by Daniel Resendiz and Miguel P. Romo
137	LATERAL DEFORMATION OF A DAM EMBANKMENT (Addendum)
161	by Richard Catanach and Thomas N. McDaniel
	SESSION III - SHALLOW FOUNDATIONS
165	PANEL PRESENTATION by Carl B. Crawford
	GENERAL DISCUSSION by Laurits Bjerrum
167	by G. A. Leonards
169	
	LOAD TESTS ON SMALL FOUNDATIONS IN SOFT CLAY by Edward W. Brand, Chai Muktabhant, and Anan Taechatummarak
174	DISCUSSION by feech Feld
1/4	by Jacob Feld

SETTLEMENT DUE TO CHEMICAL ATTACK OF SOILS by Robert G. Lukas and Robert J. Gnaedinger, Jr.	
DISCUSSION by Howard P. Thomas	176
FOUNDATIONS IN THE CRUST OF SENSITIVE CLAY DEPOSITS (Errata)	
by R. J. Mitchell, D. A. Sangrey, and G. S. Webb	178
SESSION IV - DEEP FOUNDATIONS	
PANEL PRESENTATIONS	
SETTLEMENTS OF PILE GROUPS by Bengt B. Broms	181
AXIAL CAPACITY by Lymon C. Reese	201
CONSTRUCTION OF DEEP FOUNDATIONS by W. F. Swiger	207
REPORTER'S SUMMARY by P. Girault	211
DESIGN AND PERFORMANCE OF DEEP FOUNDATIONS by Bramlette McClelland	
DISCUSSION by George G. Goble and Frank Rausche by C. P. Wroth	227 231
GENERAL DISCUSSION by B. Ladanyi	235
LATERAL LOAD TESTS ON FULL-SCALE PILE GROUPS by J. B. Kim, R. J. Brungraber, and C. H. Kindig	
DISCUSSION by M. B. Jamiolkowski and S. Marchetti	237
CONSOLIDATION EFFECTS AROUND DRIVEN PILES by D. Joseph Hagerty and John E. Garlanger	
DISCUSSION by M. Appendino	241
SESSION V - SOIL STRUCTURE INTERACTION	
REVIEW OF SESSION	247
OPENING REMARKS by Raiph B. Peck	249
DESIGN OF TEMPORARY EARTH RETAINING STRUCTURES FOR THE WASHINGTON SUBWAY	
SYSTEM by James P. Gould	251
PREDICTING PERFORMANCE OF BRACED EXCAVATIONS	
by T. William Lambe	259

PERFORMANCE OF BRACED EXCAVATIONS IN LONDON CLAY	
by William H. Ward	257
PERFORMANCE OF TIE-BACK SUPPORT SYSTEMS by G. Wayne Clough	259
USE OF THE FINITE ELEMENT METHOD IN ANALY- SIS OF SOIL-STRUCTURE INTERACTION	18
by James M. Duncan	265
ADDITIONAL PAPERS	
PERFORMANCE OF A BRACED EXCAVATION IN GRANULAR AND COHESIVE SOILS	
by K. R. Chapman, E. J. Cording, and H. Schnabel, Jr.	271
CONSTRUCTION PORE PRESSURE DISSIPATION IN EARTH DAMS by Edward W. Gray	295
LANDSLIDE AT SILVER JACK DAM	
by Malcolm H. Logan and Fred J. Davis	315
STRESS-STRAIN RELATIONSHIPS FOR PARTICULATE MATERIALS AT EQUILIBRIUM	
by P. W. Rowc	327
INDEXES	
SUBJECT INDEX	361
AUTHOR INDEX	381

## **FOREWORD**

In February of 1958 the Executive Committee of the Soil Mechanics and Foundations Division, ASCE, appointed a Task Committee—with W. J. Turnbull as chairman—to organize a national conference on the shear strength of cohesive soils. A series of "Specialty Conferences" ensued, as follows:

- 1960 UNIV. OF COLORADO
  Research Conference on Shear Strength of
  Cohesive Soils
- 1964 NORTHWESTERN UNIV.

  Design of Foundations for Control
  of Settlement
- 1966 UNIV. OF CALIF. AT BERKELEY Stability and Performance of Slopes and Embankments
- 1968 MIT
  Placement and Improvement of Soil
  to Support Structures
- 1970 CORNELL Lateral Stresses in the Ground and Design of Earth-Retaining Structures

A Task Committee consisting of M. S. Kapp, R. I. Kaufman, G. A. Leonards, S. D. Wilson and T. W. Lambe (subsequently F. E. Richart) was appointed in February 1969 to plan a conference on the "Performance of Earth Structures and Earth-Supported Structures" to be held at Purdue University in June of 1972. Early in the planning process the Committee decided to emphasize observed behavior of full-scale structures, and papers reporting the results of field measurements were solicited. Papers accepted for the Conference were preprinted in Volume I.

Five half-day technical sessions were held:

- Embankments on Soft Ground
- II. Earth and Earth-Rockfill Dams
- III. Shallow Foundations
- IV. Deep Foundations
- V. Soil-Structure Interaction

Session leaders were appointed to prepare reports on each session topic, focusing on a critical analysis of the papers in relation to the present state of

the art. The session leaders' reports were printed in Volume II.

Panels were appointed to discuss the session leaders' reports, establish areas of agreement, and debate conflicting viewpoints. Reporters were assigned to synthesize panel deliberations and discussions from the floor.

This, the third and final volume of proceedings is arranged as follows:

- a. A list of participants, the Program (including a limited photographic record), and a Paper describing and interpreting the demonstration on Wednesday afternoon of pile driving and load testing.
- b. A record of oral and written discussions, in the following sequence: formal remarks by panel members that were submitted later in written form, the Reporter's synthesis of panel deliberations and discussions from the floor, and written discussions to papers or Session Leaders' reports.
- c. Papers accepted for the Conference but received too late to be printed in Volume I of Proceedings.