

ICOLD-BW
9th-11th September 2019
MILANO



10th September, 2019

Theme B:

Seismic analysis of Menta Embankment dam

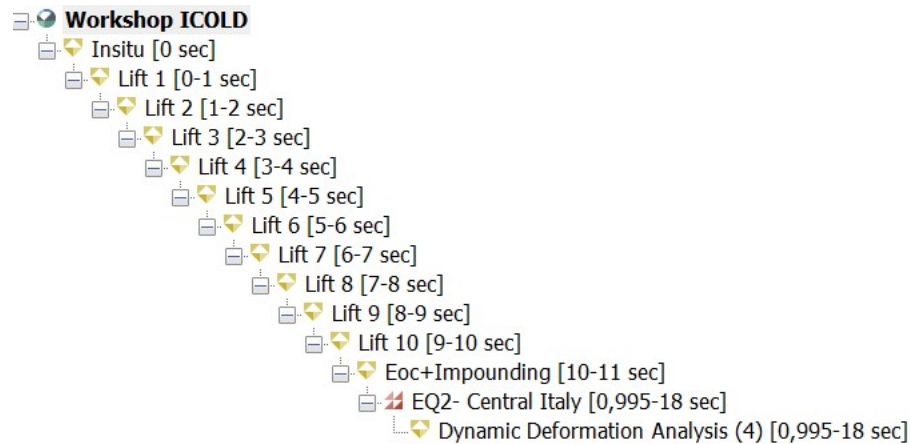
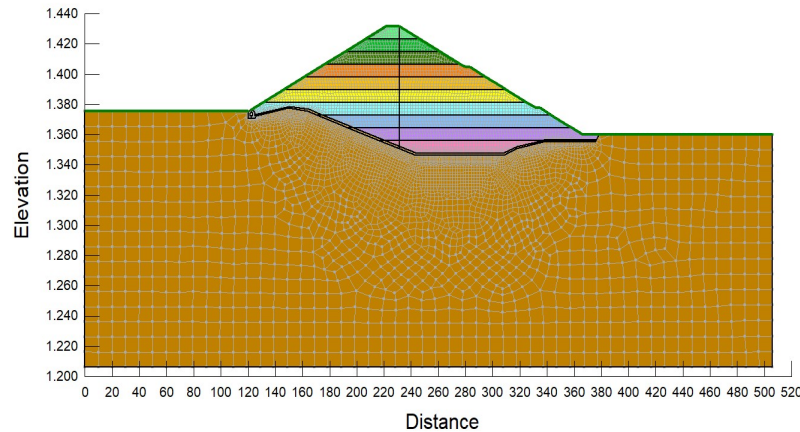
Static and dynamic analysis of a bituminous
faced rockfill dam

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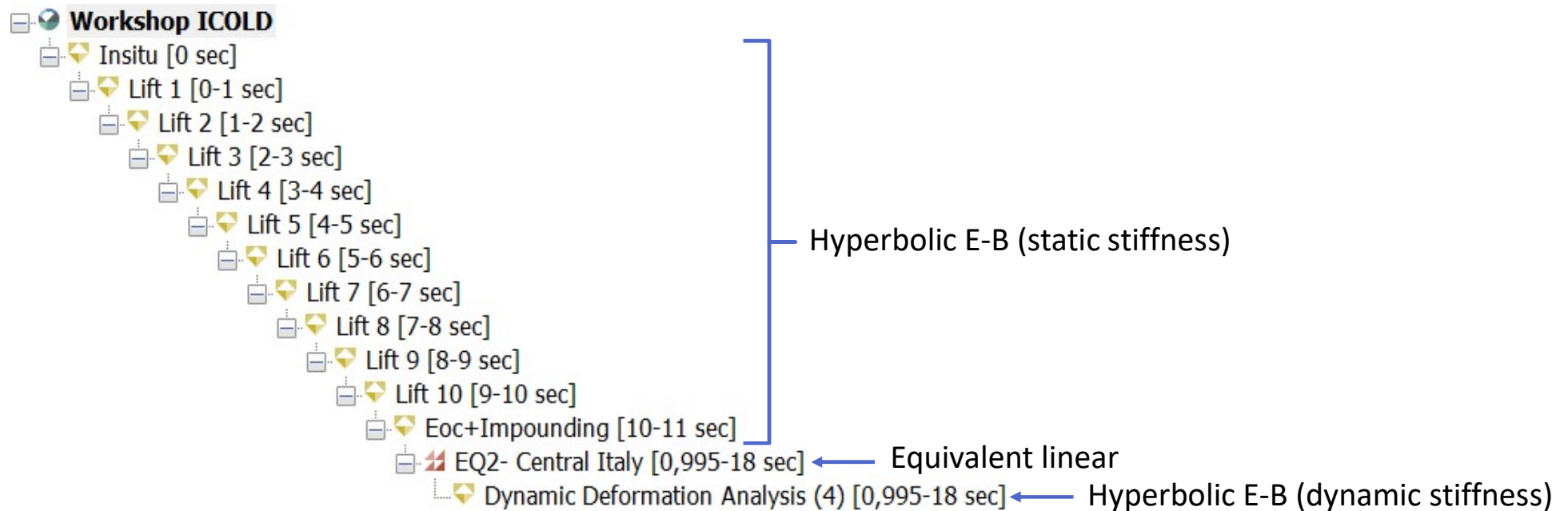
¹ Pöyry Austria Ltd., ² Tschernutter Consulting Ltd.

Performed analysis



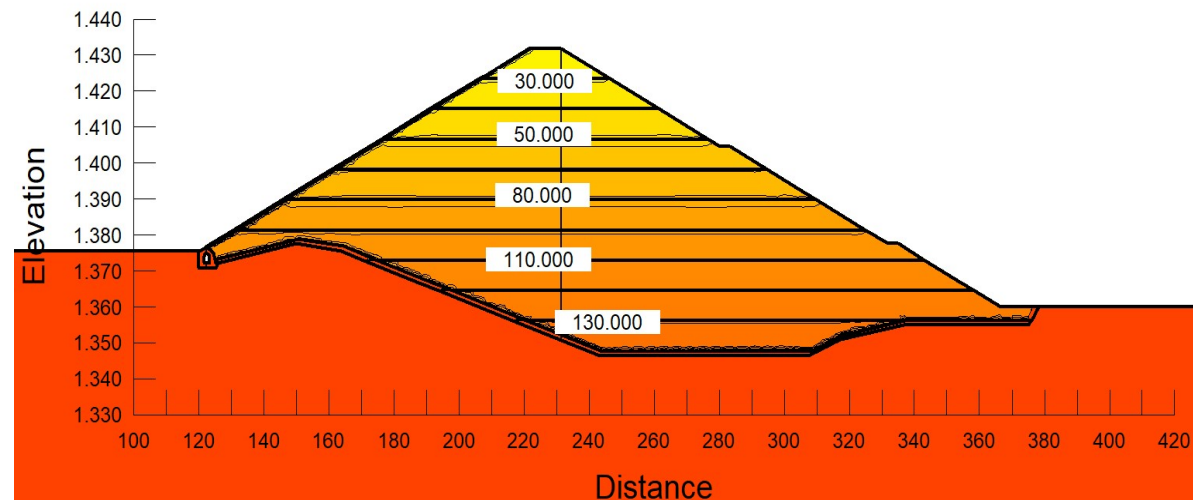
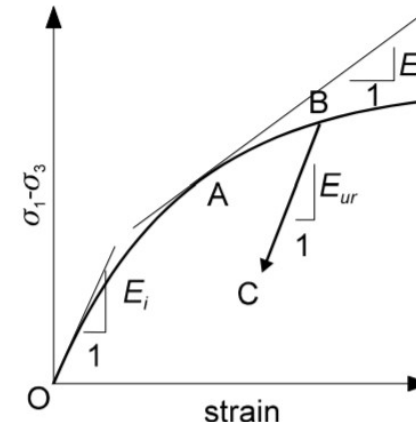
- 2D numerical analysis
 - Seismic behavior of Menta BFED
 - prediction of the stress/strain behavior
 - estimation of the damage potential
-
- Methodological approach - GeoStudio 2019:
 1. Static Load/Deformation Analysis with SIGMA/W
 2. Dynamic Analysis (Equivalent Linear Dynamic Analysis) with QUAKE/W
 3. Dynamic Deformation Analysis with SIGMA/W

Rockfill constitutive model in order to describe cyclic, non-linear behavior



Hyperbolic E-B constitutive model

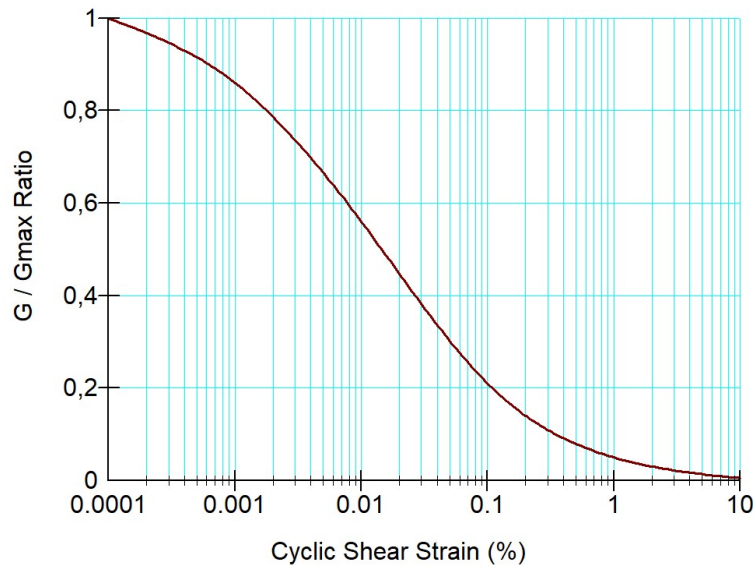
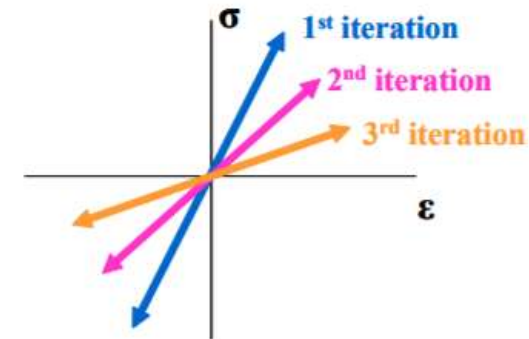
- Described by Duncan et al.
- Bulk modulus (B) is considered to be constant while loading and the elastic modulus (E) varies according to the Duncan and Chang hyperbolic relationship.
- Non-linear stress strain behavior.
- Stress dependent initial Young's modulus (average stress level for each lift)



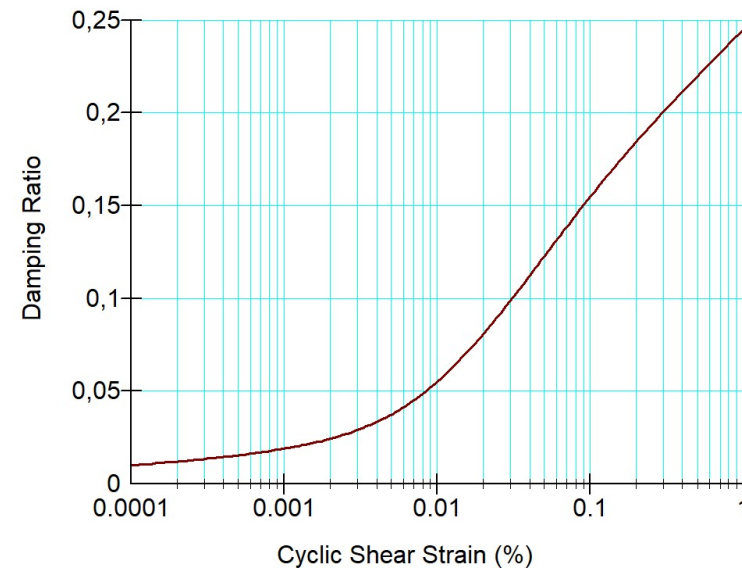
Equivalent linear model

- Considering the modification of the soil stiffness G in response to the computed strains
- Stress dependent shear modulus (average stress level for each lift)

$$G = \frac{E}{2(1 + \nu)}$$



Gravel - Seed et al.

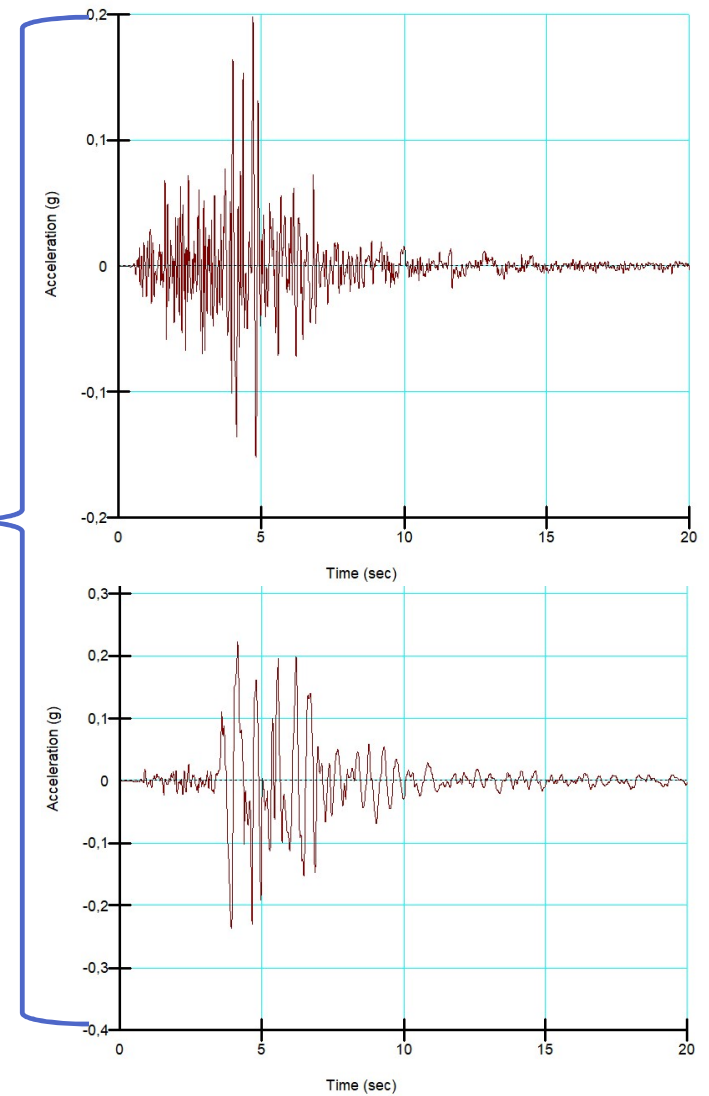
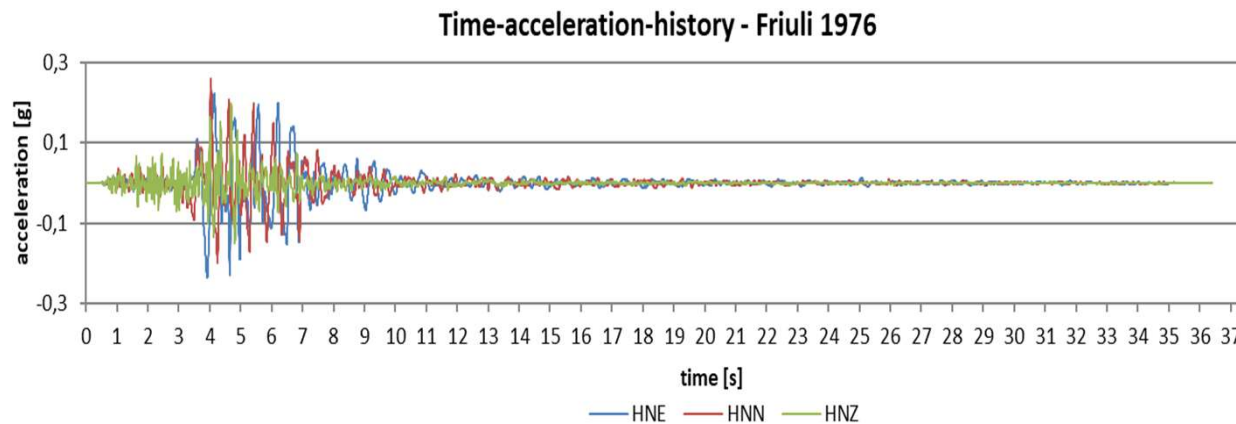


Seed & Idriss (Sand - average)

Seismic input

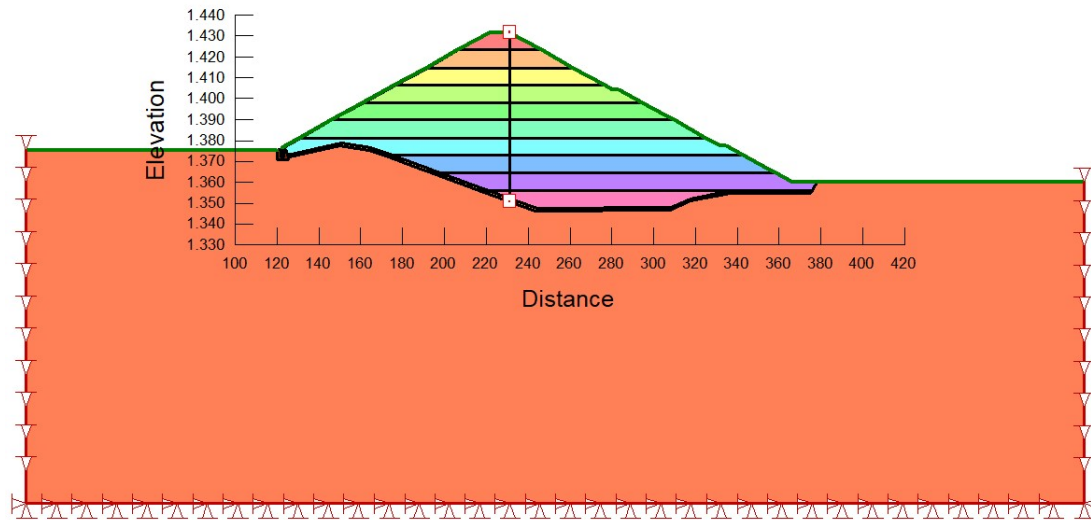
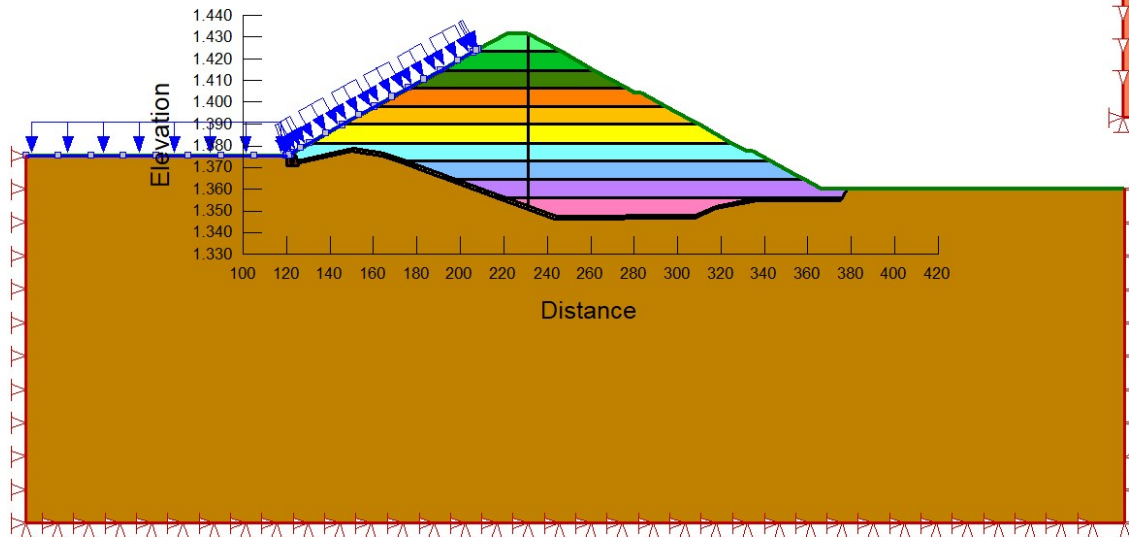
Name	Vertical	Horizontal
EQ1	HNZ Friuli 1976	HNE Friuli 1976
EQ1-0,26g	HNZ Friuli 1976	HNN Friuli 1976
EQ2	HGZ Central Italy 2016	HGN Central Italy 2016
EQ2-0,26g	HGZ Central Italy 2016	HGE Central Italy 2016

Application on the dam footprint



Boundary conditions for numerical model

- Static Load/Deformation Analysis with SIGMA/W



- Dynamic Analysis with QUAKE/W
- Dynamic Deformation Analysis with SIGMA/W

General comments and final remarks

- Construction deformations predominate, impounding has only minor effects on general dam deformation behavior
- Dam shows low risk of damage during the applied earthquake events (calculated post seismic displacements and settlements lower than 10 cm)
- Challenges:
 - Consider hydrodynamic effect in a case of embankment dams
 - Numerical modeling of bituminous concrete facing