



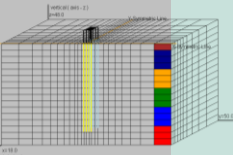
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Software:

VERSAT-S2D

VERSAT-D2D

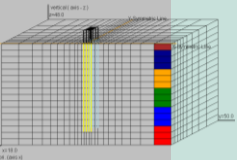
VERSAT-P3D





OUR MISSION

- **We ought to provide the computing tools for you to deliver the best solutions for your geotechnical assignments in an efficient and cost-effective manner.**

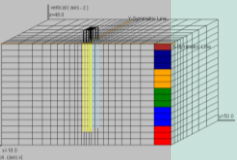




SOFTWARE FEATURE

- Advanced Technology
- Easy to Use
- Low Cost
- World Wide Access

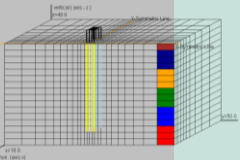
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VERSAT-S2D

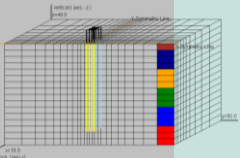
- A computer program for static 2D plane-strain finite element analyses of stresses, deformations, and soil-structure interactions.
- Easy to use with its advanced mesh-generation, interactive windows and intuitive modelling technique.





VERSAT-D2D

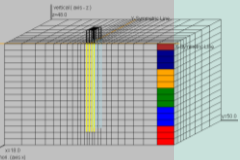
- A computer program for 2D time-history finite element analyses of earth structures subjected to dynamic loads from earthquakes, machine vibration, waves or ice actions.
- Nonlinear hysteretic soil model, and effective stress analysis





VERSAT-D2D

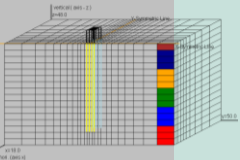
- Computing very fast with a typical run-time of 4 hours for a model of 6000 elements and an input motion of 50 sec
- Significantly increase the confidence limits of calculation by running more comparable analyses





VERSAT-P3D.stiffness

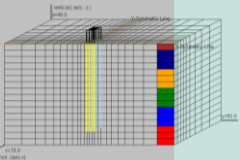
- Computing stiffness (static) and impedance (dynamic) for a single pile, a large-diameter caisson, or a pile group





VERSAT-P3D.loading

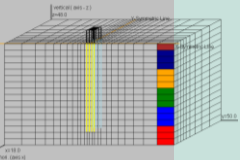
- Computing pile response (shear, bending moment) subjected to lateral loads for a single pile or a pile group





VERSAT-P3D.shaking

- Computing pile response subjected to ground shaking (earthquake) for a single pile or a pile group,
- Using the 3D finite element method and a self-generated mesh, for - P3D.all
- Using strain-compatible equivalent-linear method of analysis, for – P3D.all

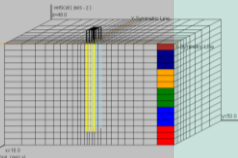




Features of Our Software

Wutec Geotechnical International

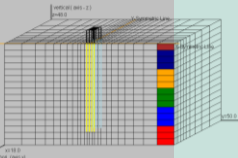
- Uses advanced .NET technology for software development
- Does not require a hardware key
- Be run in any desktop or laptop computer being connected to the Internet.
- Cost significantly less to the user as a lump sum purchase is not required, and the license is granted on a yearly basis





Geotechnical Calculation Library

- The library is created to provide geotechnical engineers easily accessible and reliable solutions to some of the most common geotechnical problems including
 - Ground settlements due to soil consolidation,
 - Consolidation time corresponding to certain degree of consolidation,
 - Static and dynamic soil pressures on retaining walls,
 - Calculation for mechanically stabilized earth structures, lock blocks, retaining walls, etc.

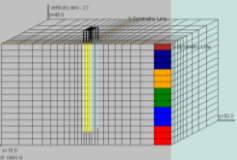




Geotechnical Calculation Library

- continued...

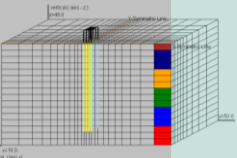
- World wide access through <http://www.wutecgeo.com> and it is free





SITE CLASS F - NBCC 2005

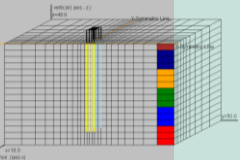
- Liquefiable soils, or other sensitive soils;
- peat and/or highly organic clays greater than 3 m in thickness;
- highly plastic clays ($PI > 75$) more than 8 m in thickness;
- soft to medium stiff clays more than 30 m thick.





SITE CLASS F: EARTHQUAKE RESPONSE ANALYSIS USING VERSAT-D2D

- Having problems with SHAKE or FLAC for the assignment?
- VERSAT-D2D can help you deliver solutions in a simple but consistent & unified manner.

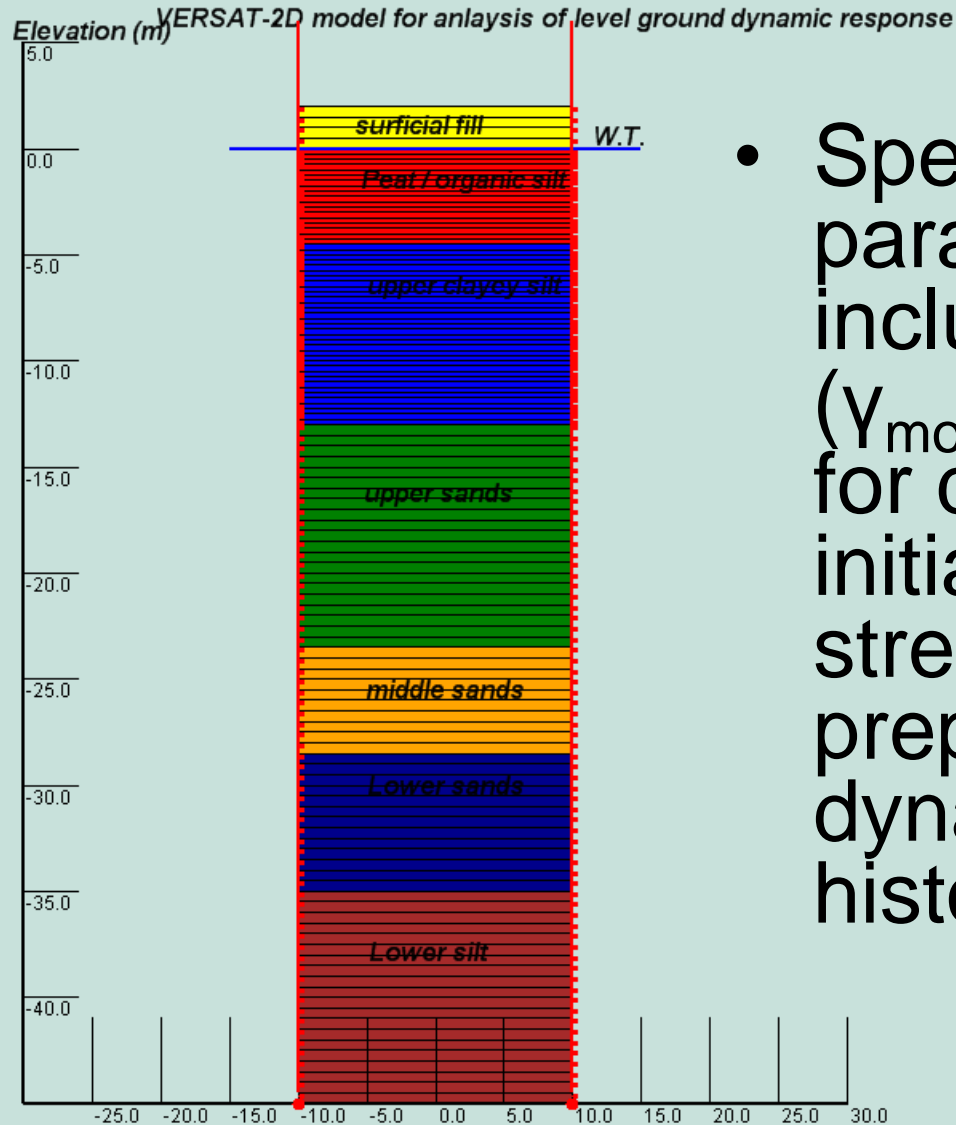




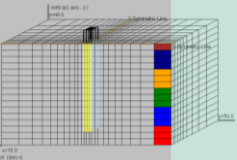
SITE CLASS F : VERSAT-D2D Analysis

Step 1:

Model Setup and static analysis (30 minutes required)



- Specify soil parameters including γ_{sat} (γ_{moist} above W.T.) for determining initial vertical stresses in preparation for a dynamic time-history analysis





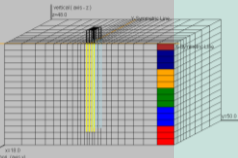
SITE CLASS F : VERSAT-D2D Analysis

Step 2: Conduct a Dynamic Time-history Analysis
(60 minutes required)

- Specify parameters K_g and m for soil shear modulus, G

$$G = K_g P_a \left(\frac{\sigma'_m}{P_a} \right)^m$$

- For cohesionless soils, $K_g=21.7K2\max$, and $m=0.5$
- For linearly increase G with depth, $m=1.0$
- For constant G with depth, $m=0$
- Specify parameters (c, Φ) for soil shear strengths.

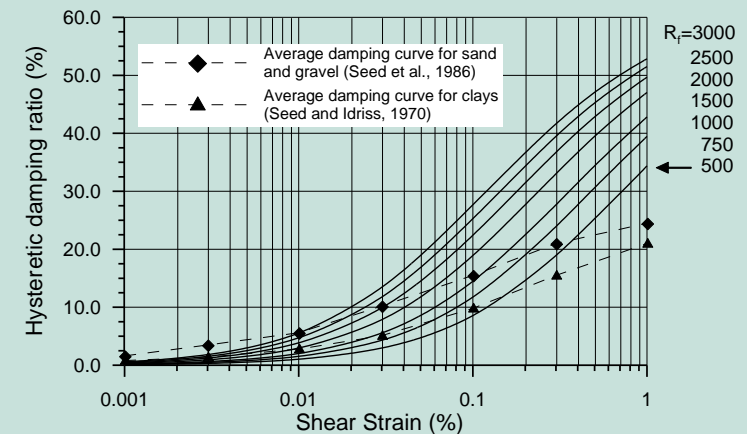
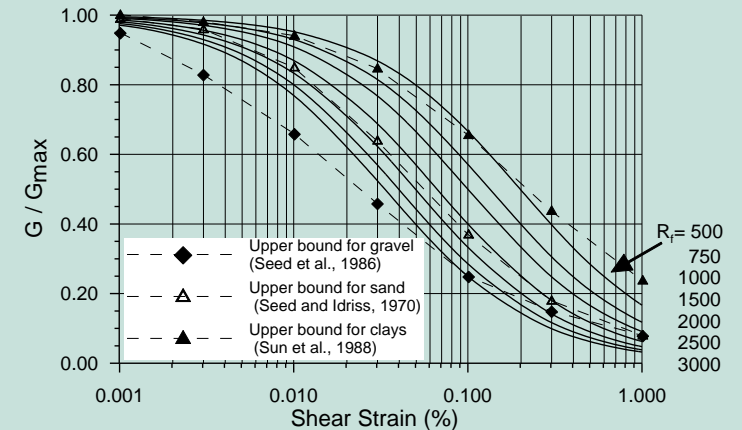




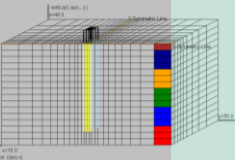
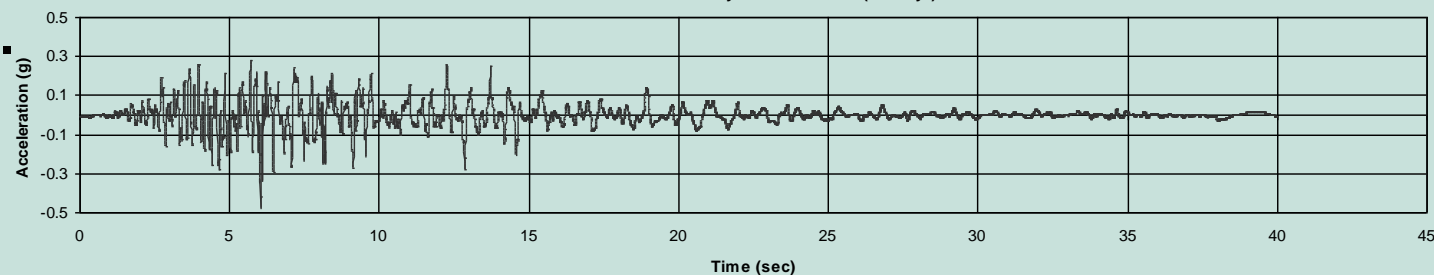
SITE CLASS F : VERSAT-D2D Analysis

Step 2: continued...

- Specify modulus reduction factor R_f to match the desired G/G_{max} and λ curves, optional.
- Specify pore water pressure parameters such as $(N_1)_{60}$ if liquefaction is of concern.
- Specify an acceleration time-history as input at the base.
- Start the dynamic time-history analysis using the option of Gravity Off.



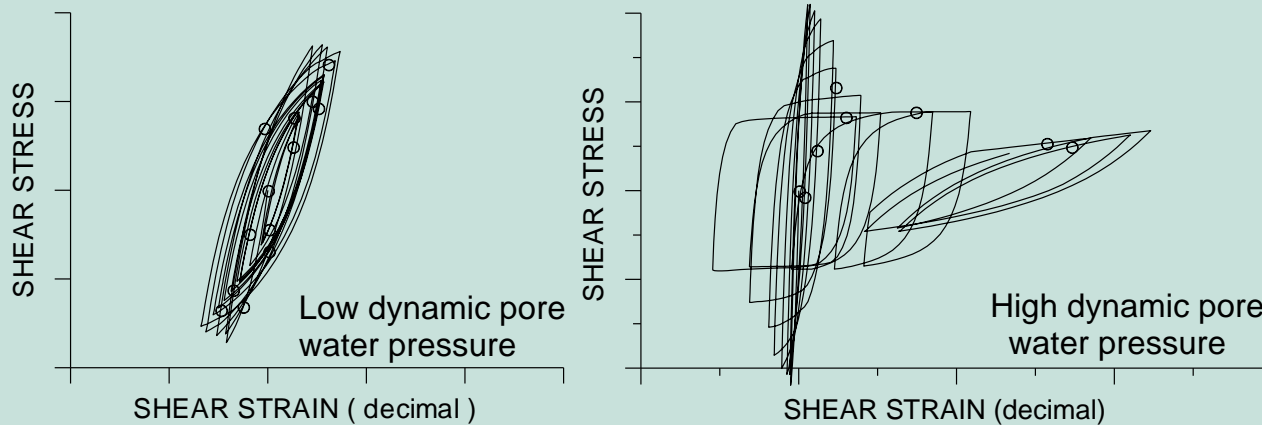
An Acceleration Time History at Firm-Ground (1:2475yr)





SITE CLASS F : VERSAT-D2D Analysis

- VERSAT-2D nonlinear hysteretic soil model



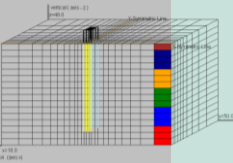
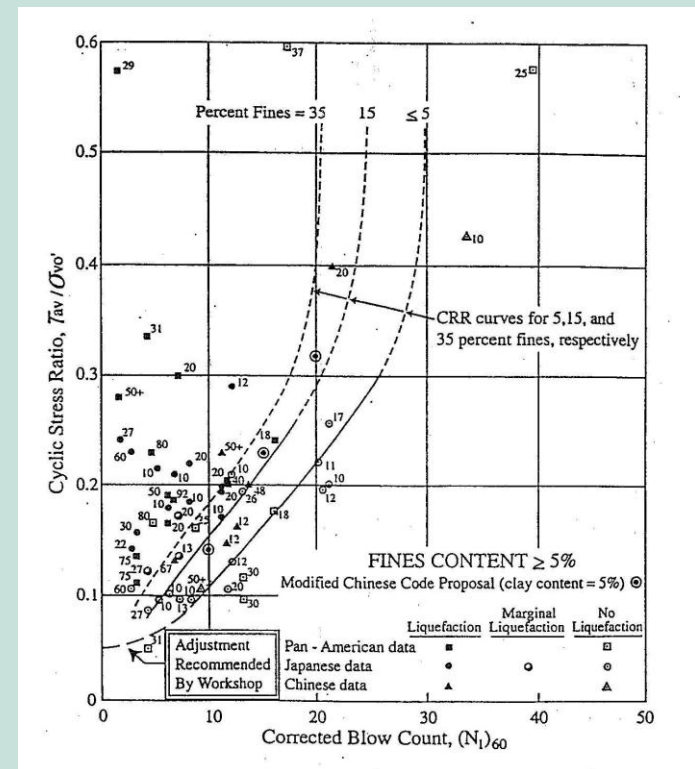
- Three pore water pressure models

- Martin-Finn-Seed model (MFS)
- Modified MFS Pore Water Pressure Model

$$E_r = M \cdot (\sigma_{v0}' - u)$$

- Seed's Pore Water Pressure Model

$$u / \sigma_{v0}' = \frac{2}{\pi} \arcsin\left(\frac{N_{15}}{N_l}\right)^{\frac{1}{2\theta}}$$

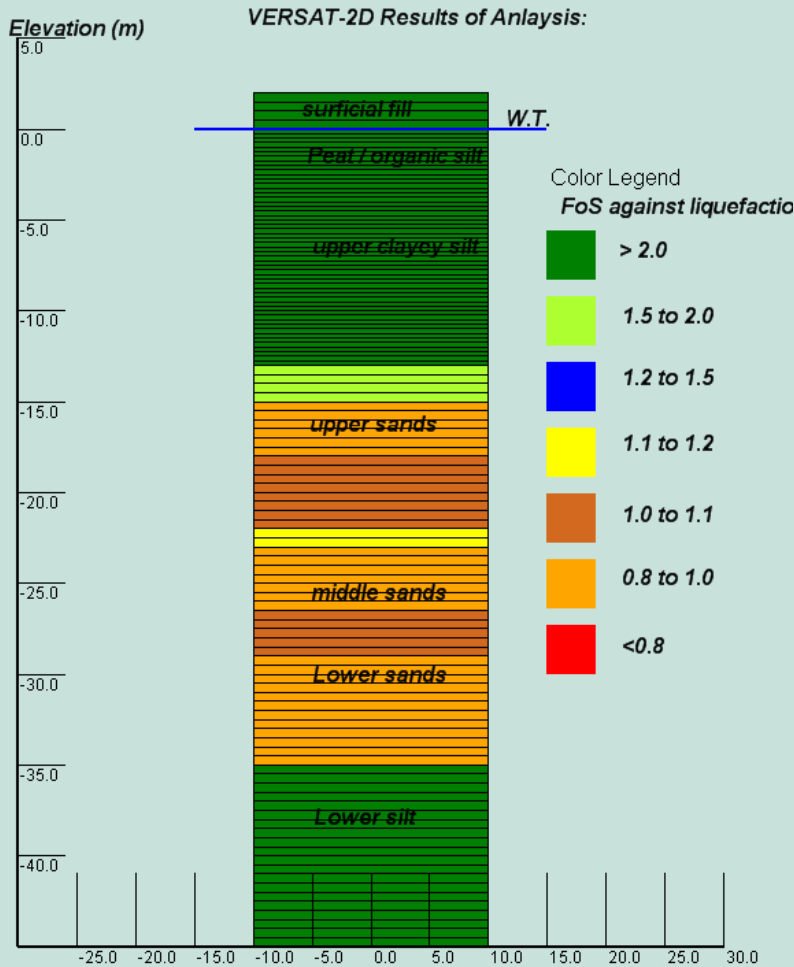




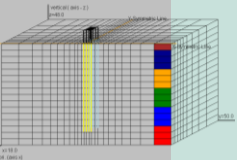
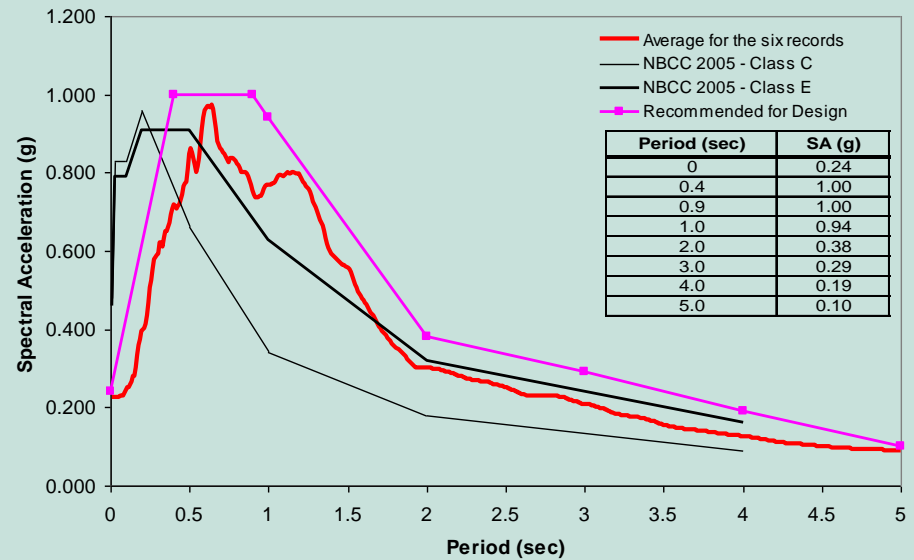
SITE CLASS F : VERSAT-D2D Analysis

Step 3: Process Results

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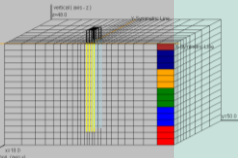
- The nonlinear hysteretic soil model and an effective stress analysis, that are built-ins of VERSAT-2D, can help you overcome problems related to shear strains exceeding the limit of application, shear stress exceeding the shear strength, & effect of dynamic pore water pressures. It can be done in an efficient but consistent fashion.





Other Projects: VERSAT-2D application Selected

- BC Hydro's John Hart Dam seismic deficiency investigation
- BC Hydro's Cheakumas Dam
- BC Hydro's Ruskin Dam in Mission BC
- Golder Associates, Seismic upgrade design of the 3D box/pile foundations of the Pattullo Bridge in British Columbia
- Golder Associates, Seismic design of the Hwy. 15 North Serpentine River Bridge in Surrey, B.C. Proceedings of the 59th Canadian Geotechnical Conference, Vancouver, pp. 596-601.
- Metro Vancouver's First Narrows and Port Mann water supply crossings seismic vulnerability assessment
- BGC Engineering, Dynamic analyses of Pueblo Viejo Mine Dam
- EBA Engineering, Design of the Russ Baker Way Overpass on liquefiable sand - Vancouver Airport, Richmond, BC. Proceedings of the 6th International Conference on Short and Medium Span Bridges, Vancouver, pp. 579-586
- EBA Engineering, Earthquake-deformation analyses of east abutment soil slope, Cleveland Dam, Vancouver
- EBA Engineering, Geotechnical design of foundations for Skytrain Millennium Line, Vancouver, Canada
- Klohn-Crippen Consultants, Earthquake analysis of L-L tailings dam in Highland Valley, B.C., Canada

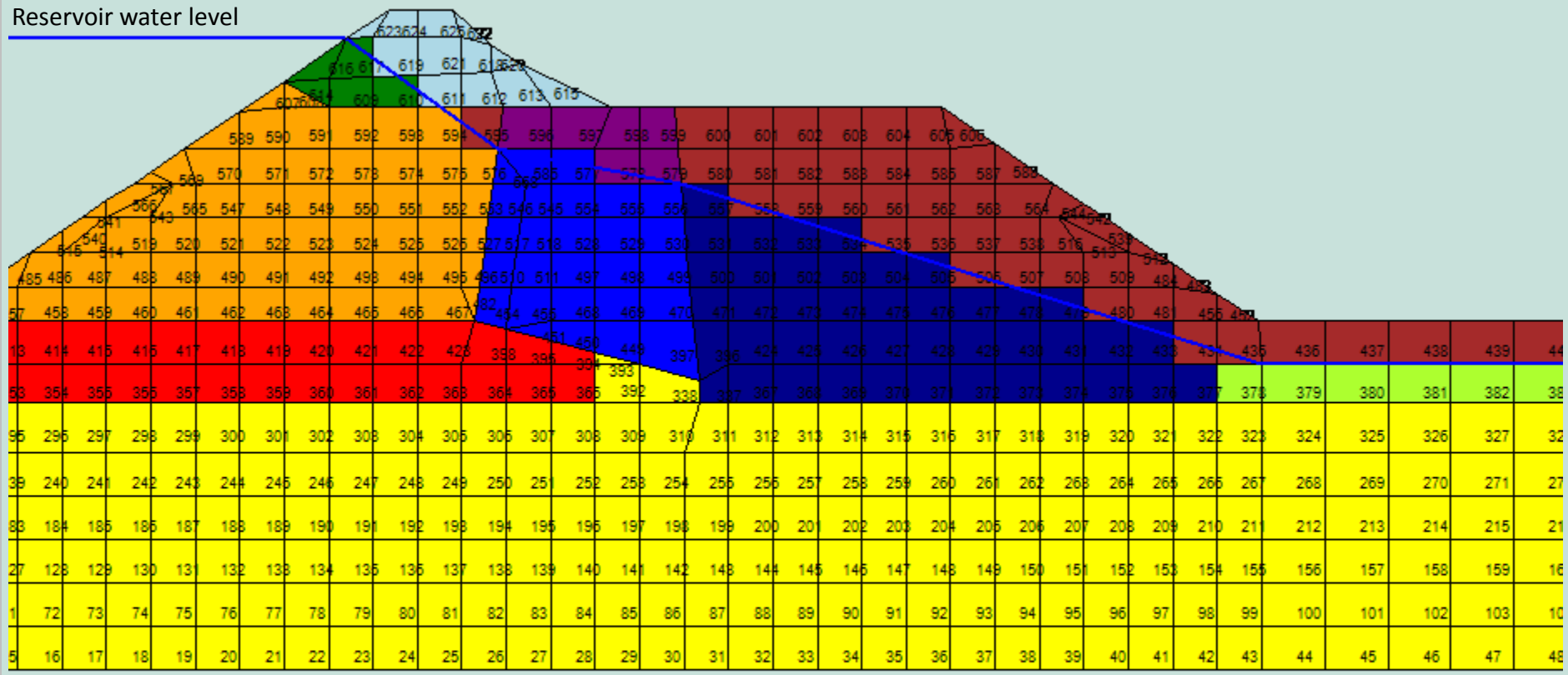




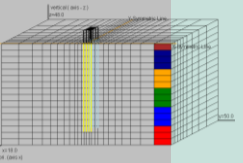
Upper San Fernando Dam: VERSAT-2D application

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Reservoir water level

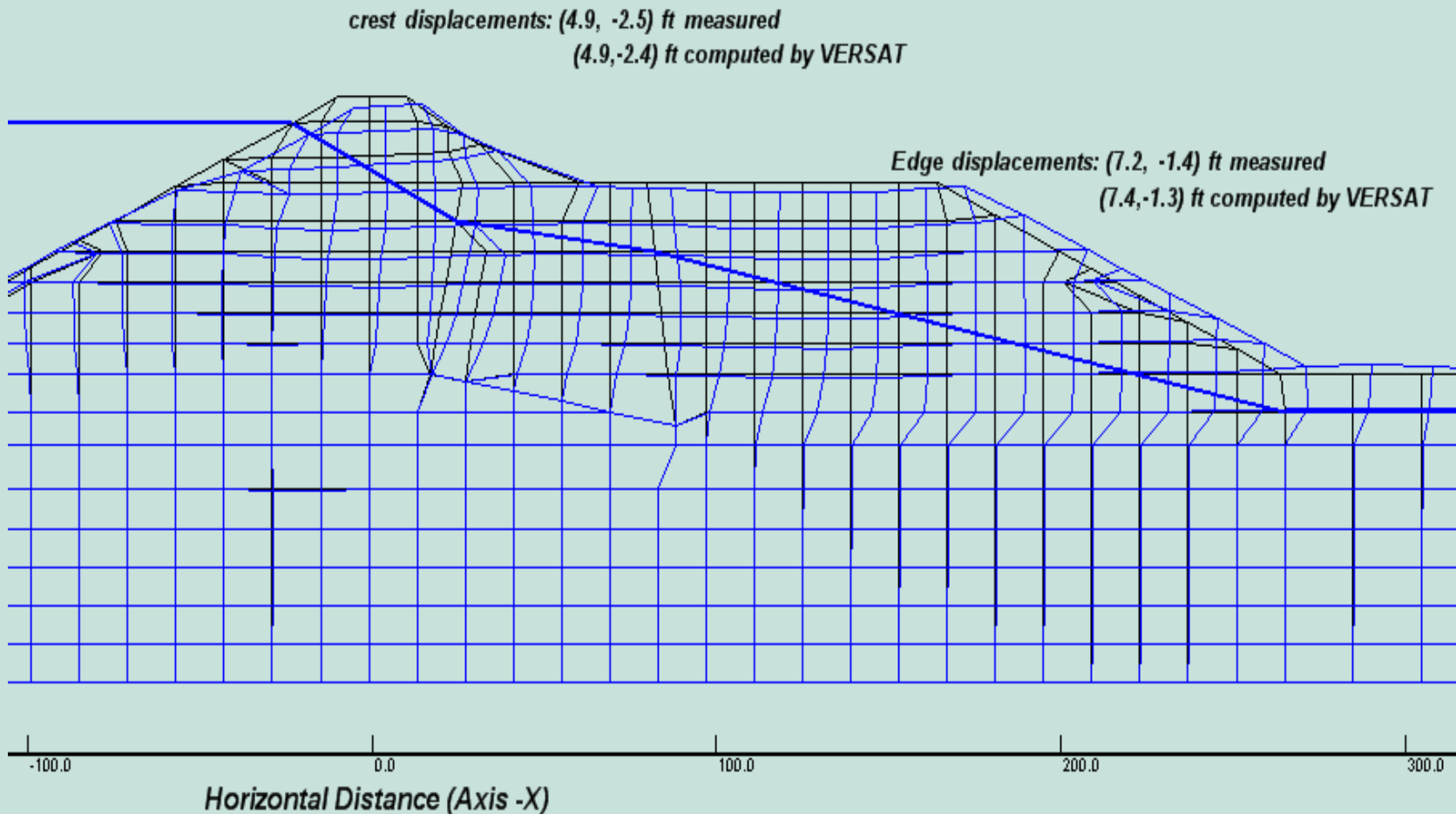


- 1971 San Fernando Earthquake 0.6g at the dam site
- Foundation: Alluvial sand, dense not liquefiable.
- Dam: Hydraulic sand fill with an average $(N_1)_{60} = 14$
- Clayey core, reservoir and phreatic surface within the dam as shown.

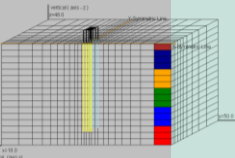




Upper San Fernando Dam: VERSAT-2D application



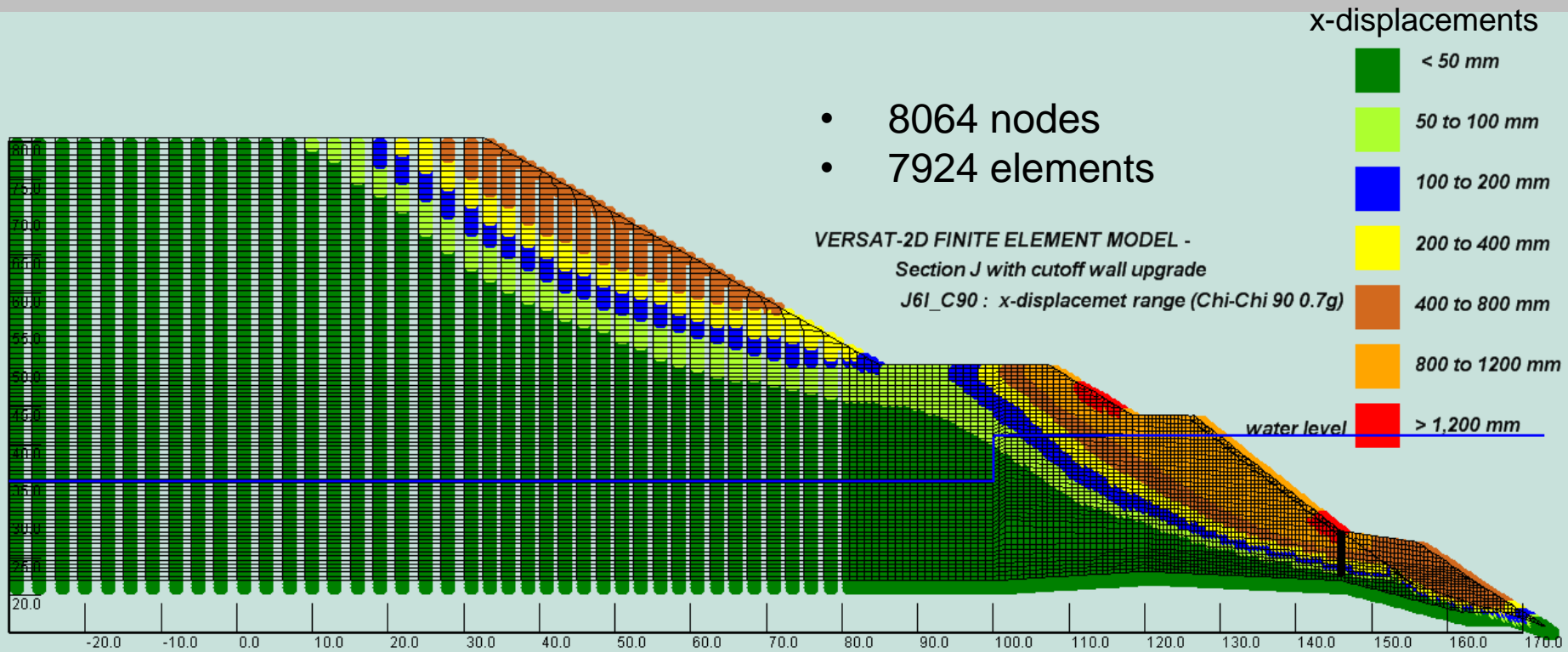
- Post Earthquake Deformations Predicted Using VERSAT-D2D
- Source: G. Wu, "Dynamic analyses of the Upper San Fernando dam", Canadian Geotechnical Journal, 2001, Vol. 38: 1-15.





Seismic Upgrade of a BC Hydro Dam: VERSAT-2D application

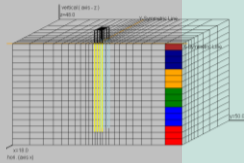
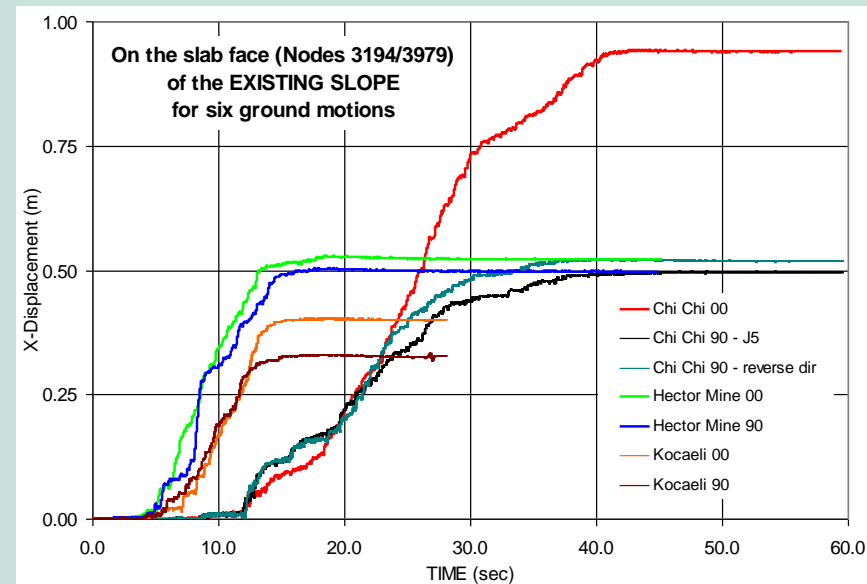
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- 8064 nodes
- 7924 elements

VERSAT-2D FINITE ELEMENT MODEL -
Section J with cutoff wall upgrade
J6I_C90 : x-displacement range (Chi-Chi 90 0.7g)

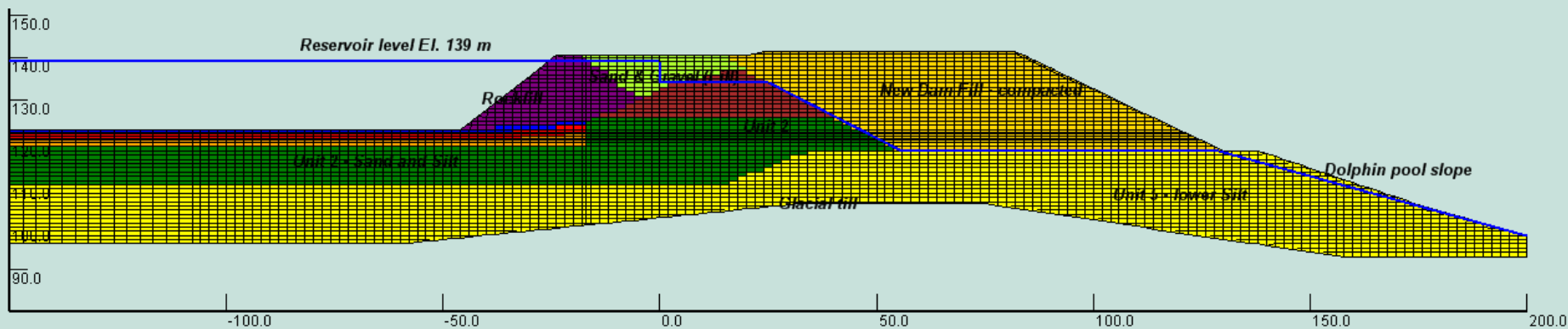
VERSAT-2D Results:
End-of-earthquake horizontal displacements (above), and time histories of x-displacements (right) under various input ground motions.



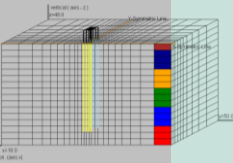
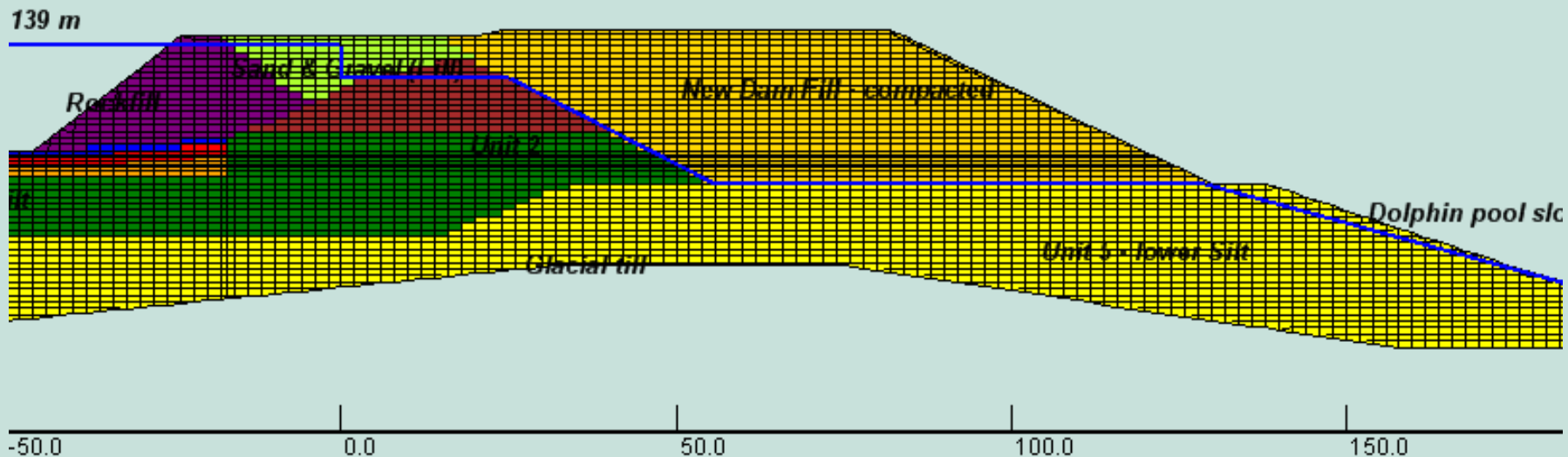


2009 Deficiency Investigation: VERSAT-2D Model

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Slurry trench

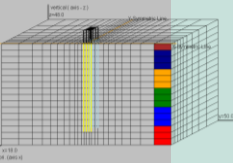
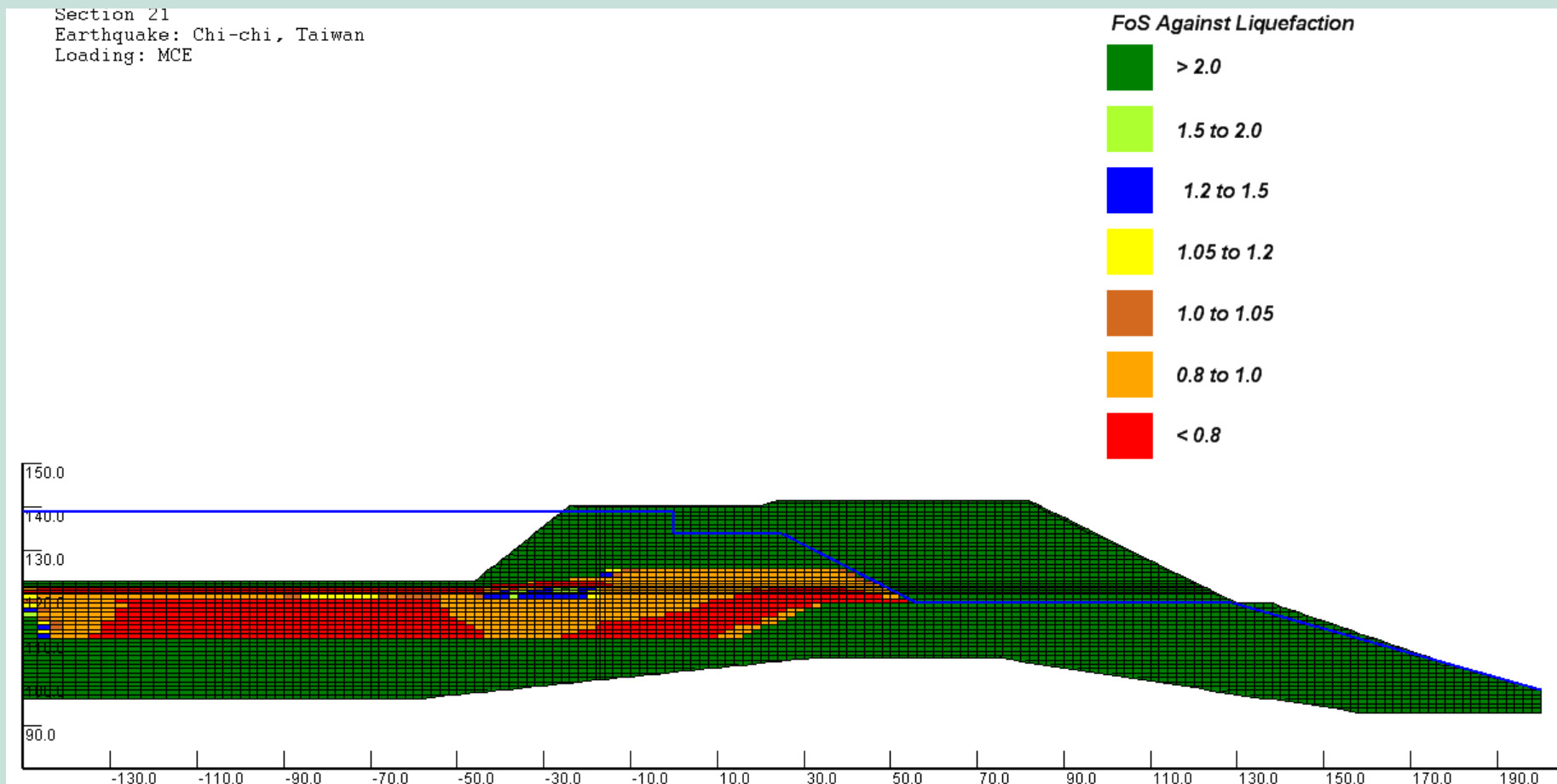




2009 Deficiency Investigation: VERSAT-2D Model

Wutec Geotechnical International

Factor of Safety Against Liquefaction: 1/10,000 (Chi Chi record)





2009 Deficiency Investigation: VERSAT-2D Model

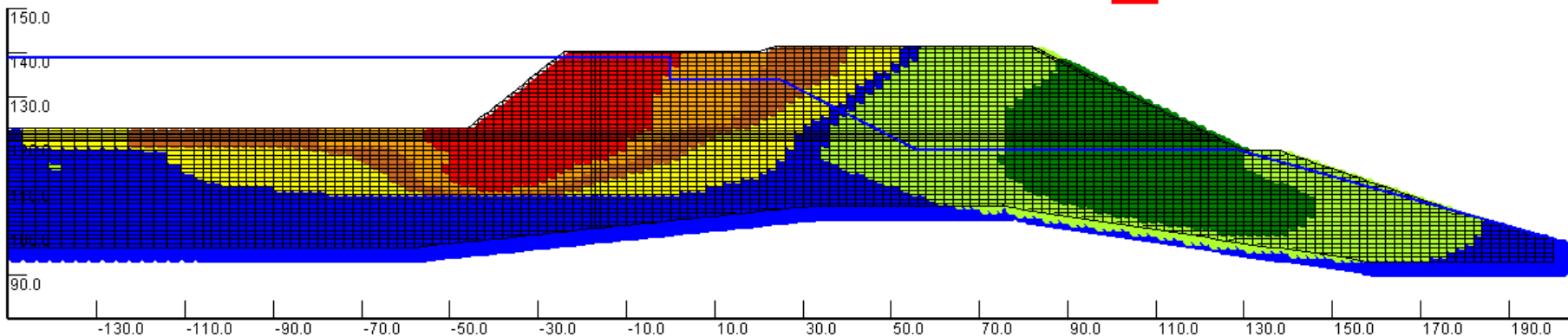
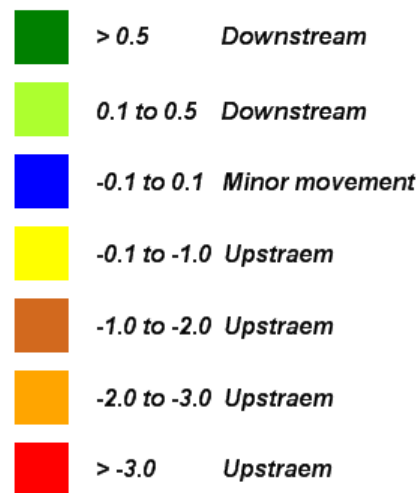
HORIZONTAL DISPLACEMENT CONTOURS: 1/10,000 (Chi Chi record)

Section 21
 Earthquake: Chi-Chi, Taiwan
 Loading: MCE

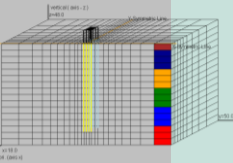
Max horizontal displacement at U/S: 5.54 m
 Max horizontal displacement at D/S: 0.67 m

Horizontal displacement at Cutoff: -3.10 m
 Horizontal displacement at US Crest: -5.16 m
 Horizontal displacement at DS Crest: 0.49 m

Horizontal displacement (m)



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2009 Deficiency Investigation: VERSAT-2D Model

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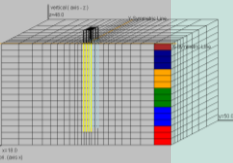
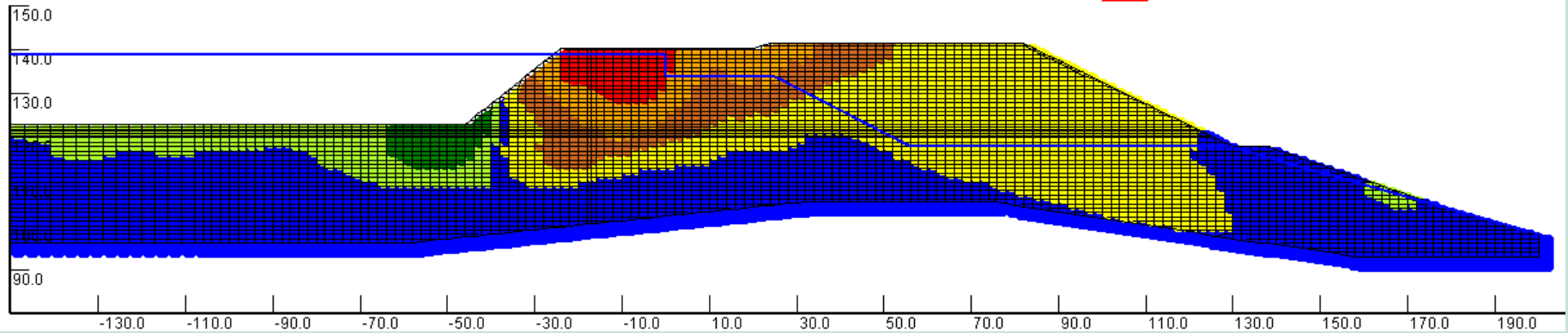
VERTICAL DISPLACEMENT CONTOURS: 1/10,000 (Chi Chi record)

Section 21
 Earthquake: Chi-Chi, Taiwan
 Loading: MCE

Max y-displacement in Up direction: 2.83 m
 Max y-displacement in Down direction: 2.14 m

Y-displacement at US Crest: -1.82 m
 Y-displacement at DS Crest: -0.26 m
 Y-displacement at Cutoff: -1.72 m

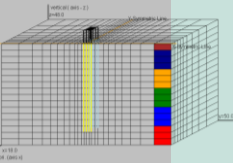
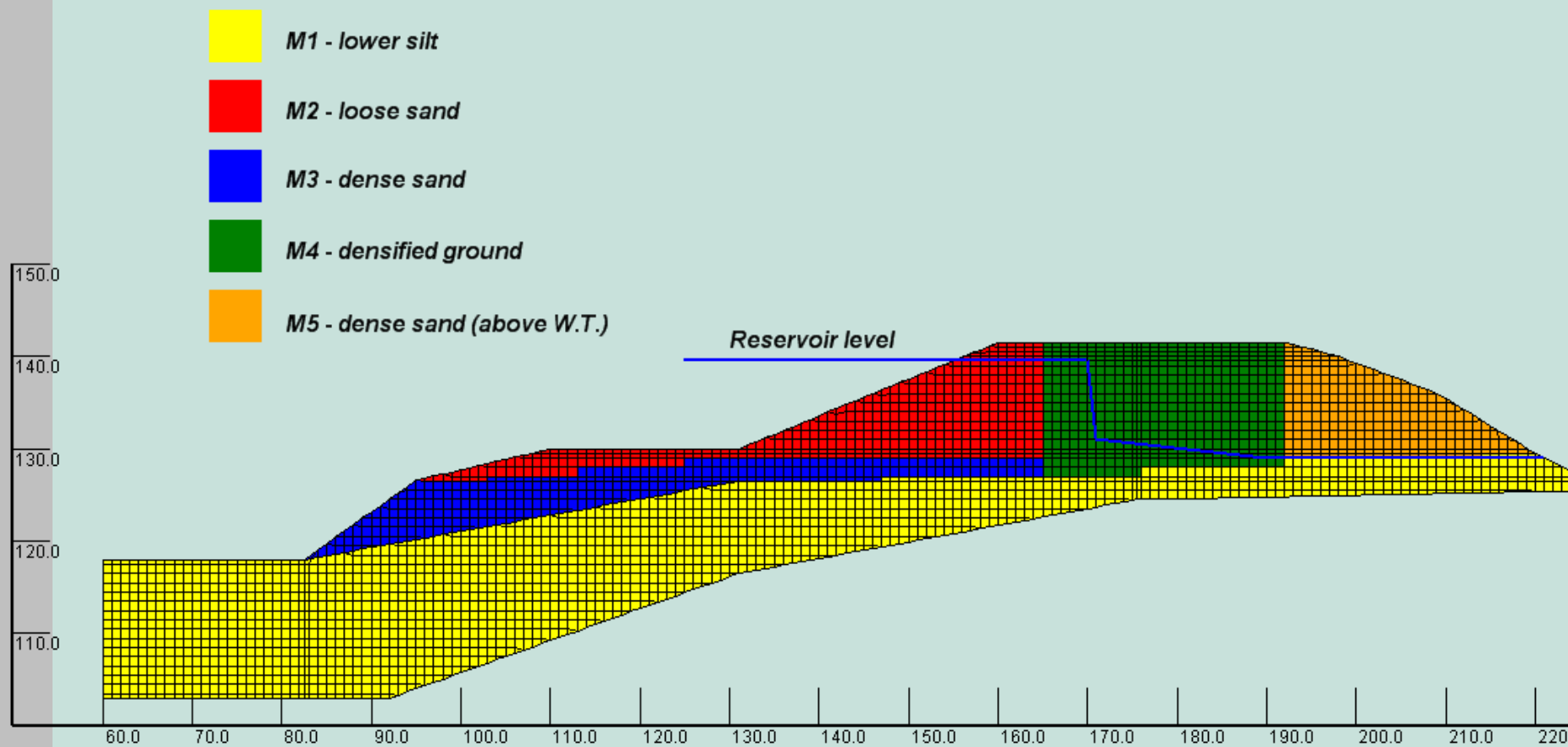
Vertical Displacement (m)





2010 Deficiency Investigation: VERSAT-2D Model

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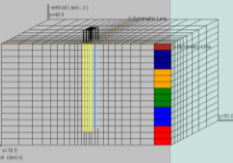
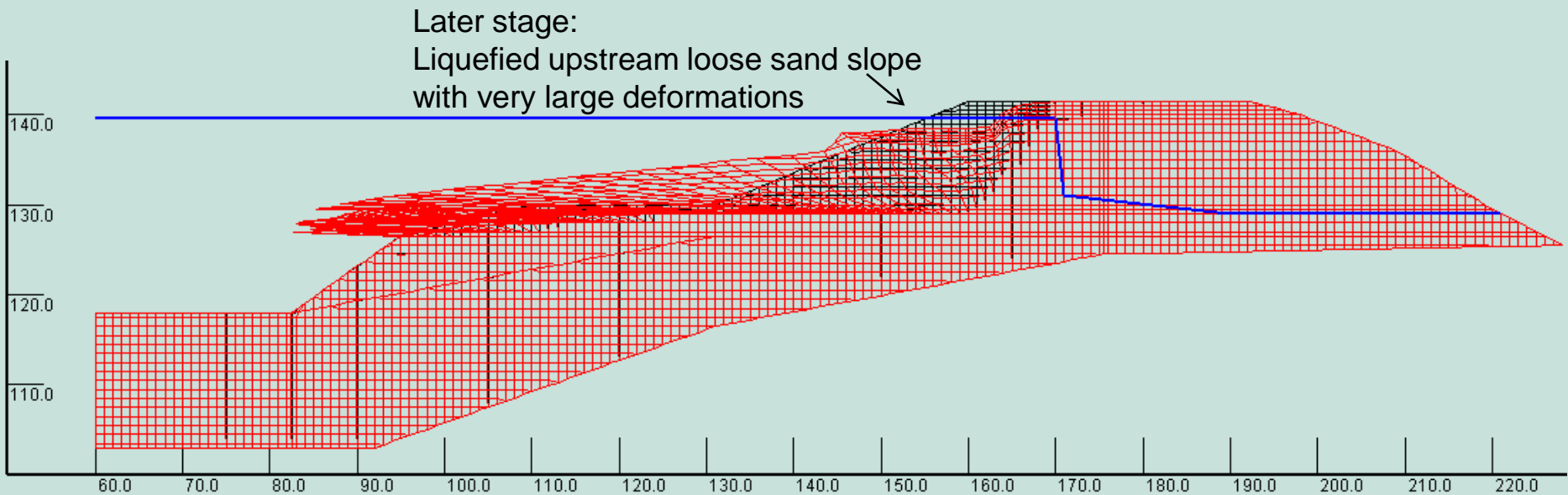
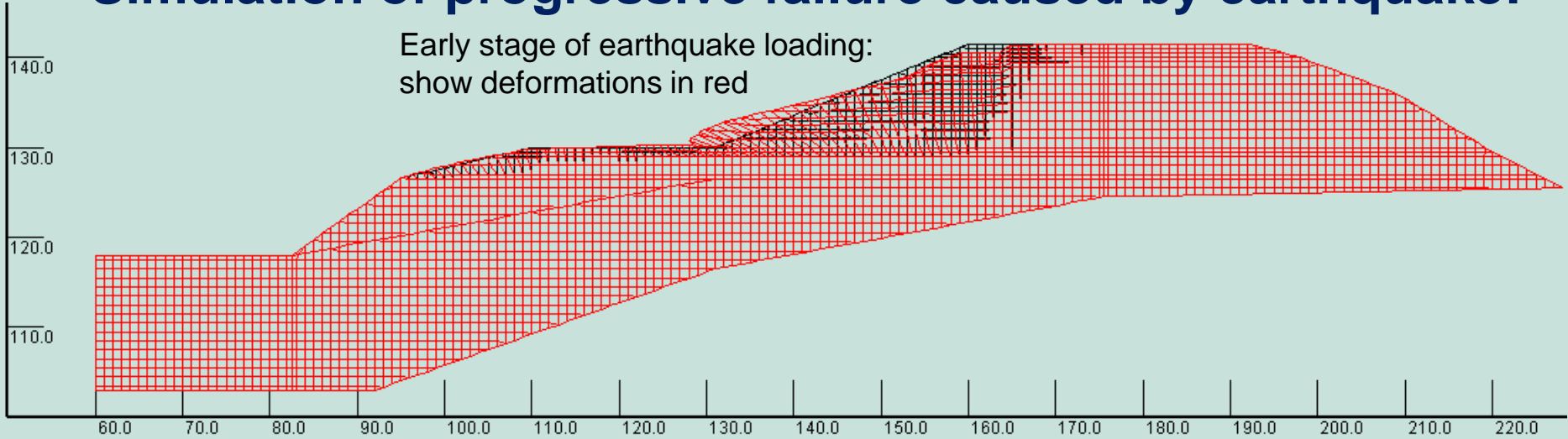




2010 Deficiency Investigation: VERSAT-2D Model

Simulation of progressive failure caused by earthquake:

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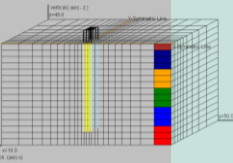
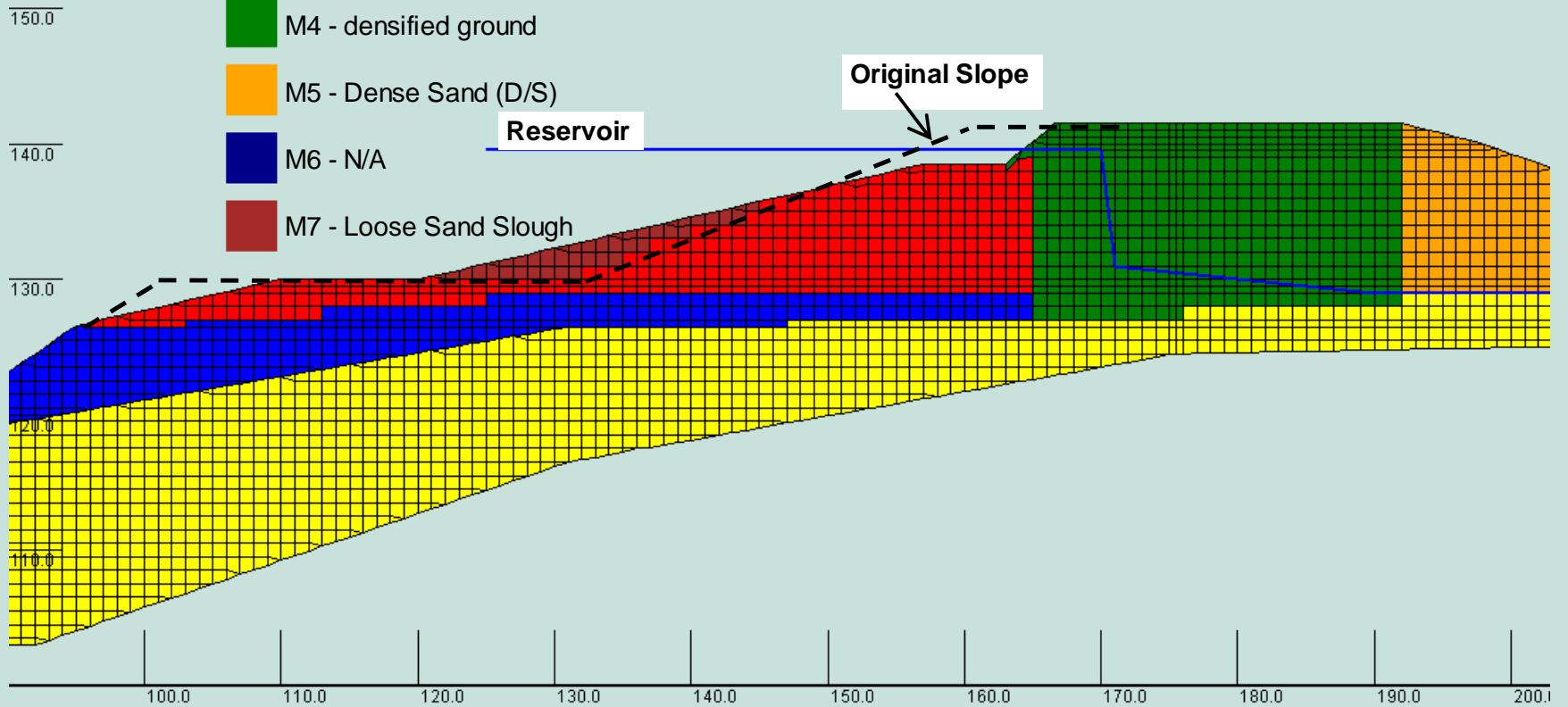


2010 Deficiency Investigation: STAGE 1 DEFORMED SLOPE

Wutec Geotechnical International

Deformed Slope at end of quake

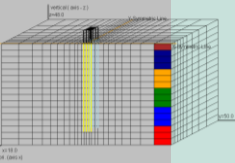
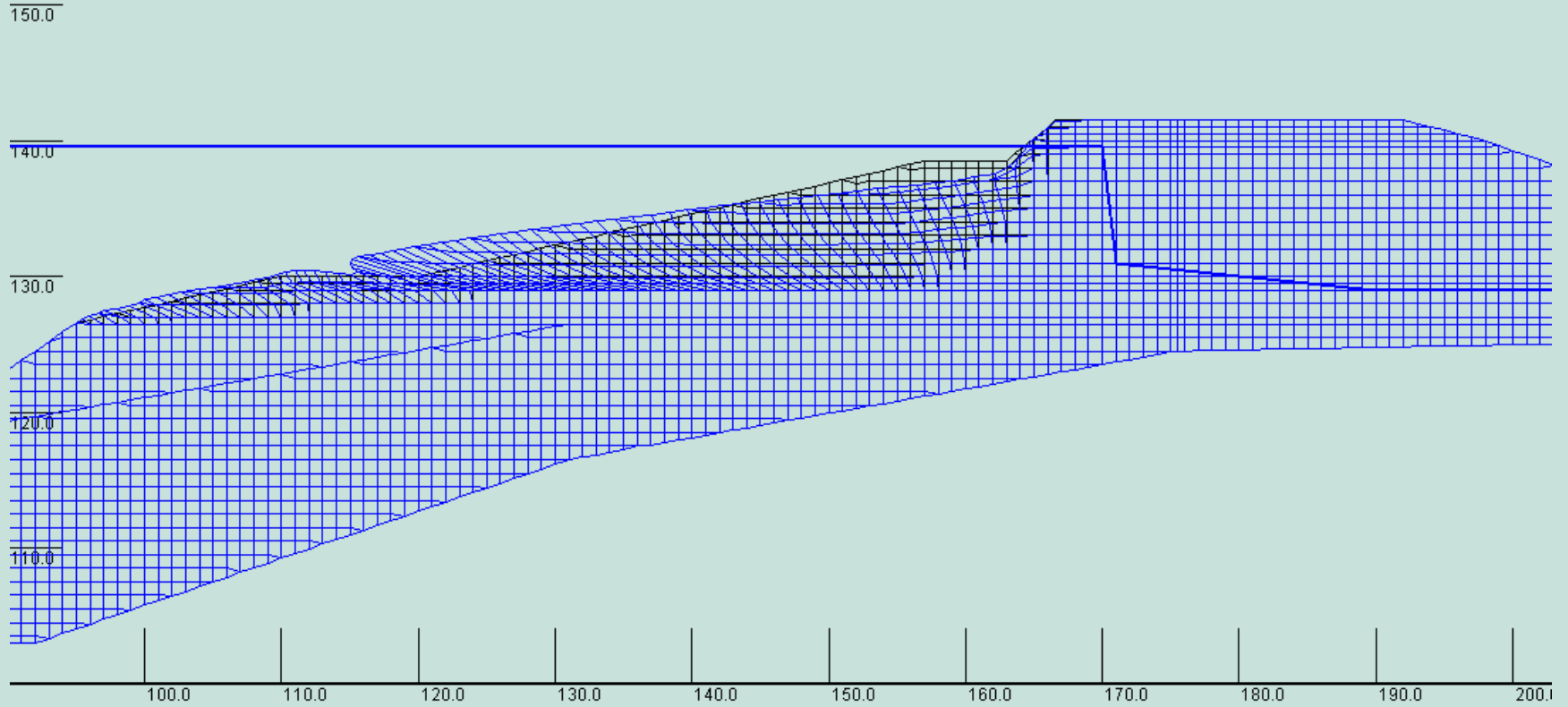
- M1 - Lower Silt
- M2 - Loose Sand
- M3 - Dense Sand
- M4 - densified ground
- M5 - Dense Sand (D/S)
- M6 - N/A
- M7 - Loose Sand Slough





2010 Deficiency Investigation: STAGE 1 DEFORMED SLOPE

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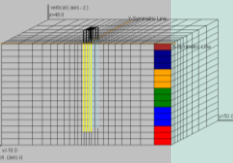
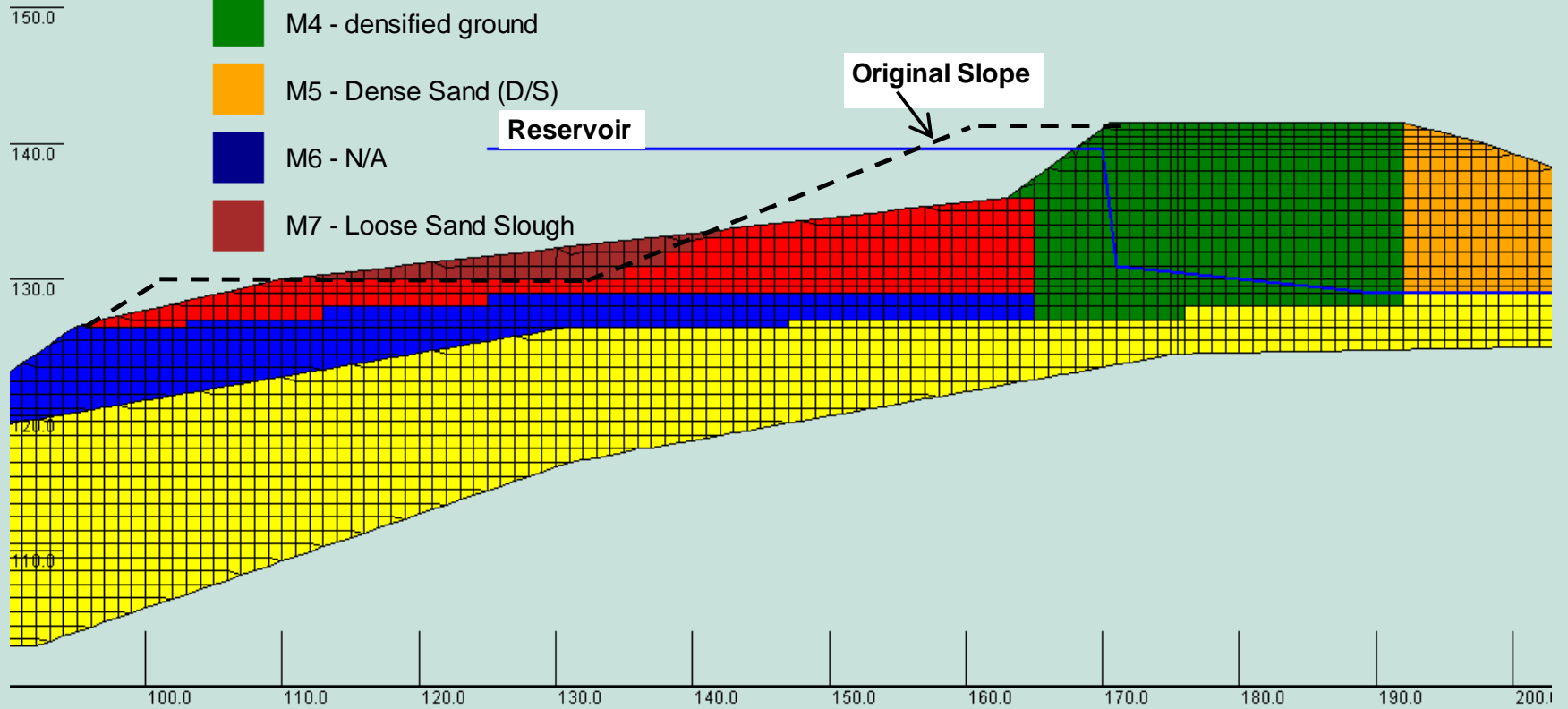


2010 Deficiency Investigation: STAGE 2 DEFORMED SLOPE

Wutec Geotechnical International

Deformed Slope at end of quake

- M1 - Lower Silt
- M2 - Loose Sand
- M3 - Dense Sand
- M4 - densified ground
- M5 - Dense Sand (D/S)
- M6 - N/A
- M7 - Loose Sand Slough



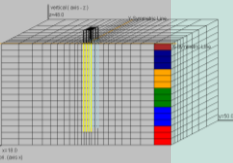
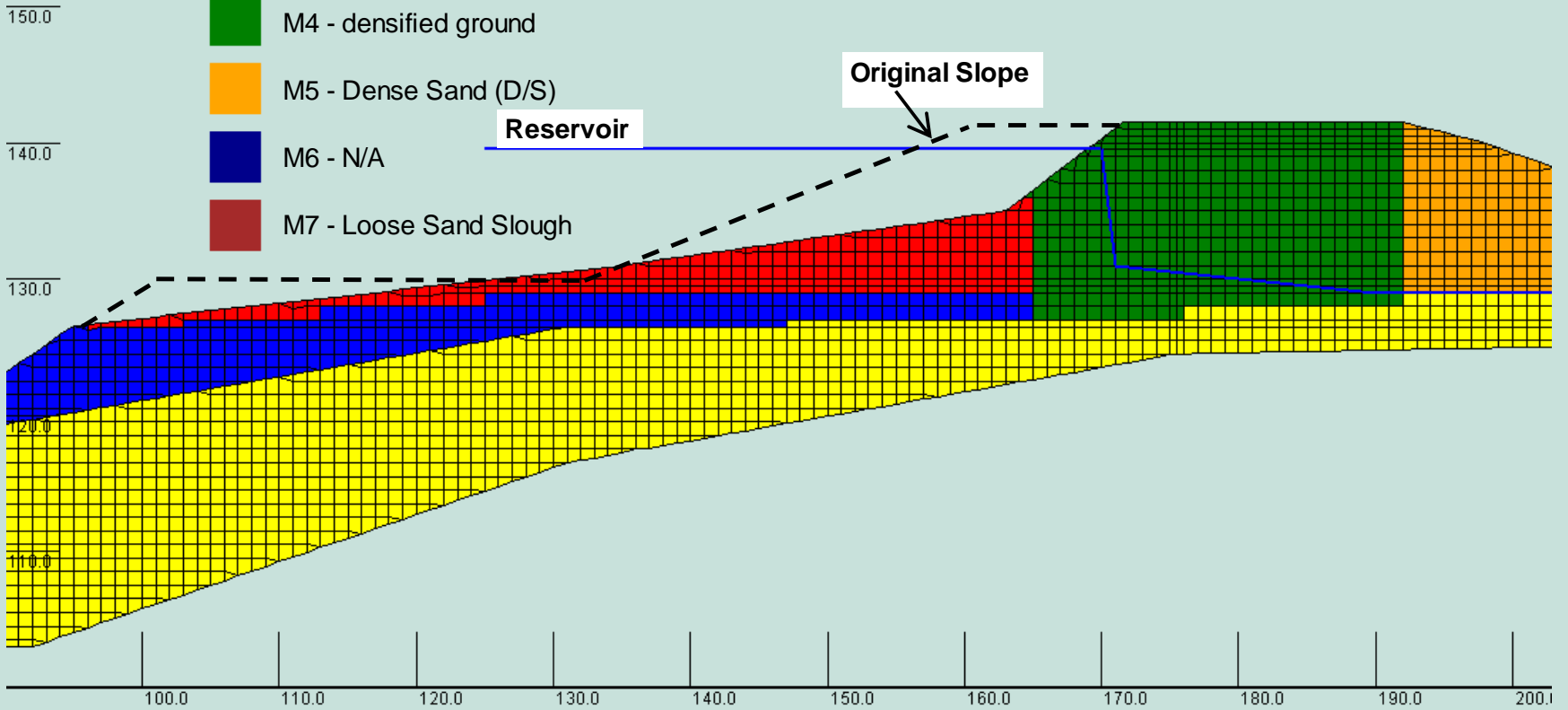


2010 Deficiency Investigation: STAGE 3 DEFORMED SLOPE

Wutec Geotechnical International

Deformed Slope at end of quake

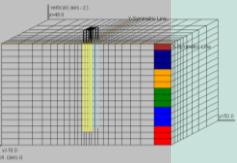
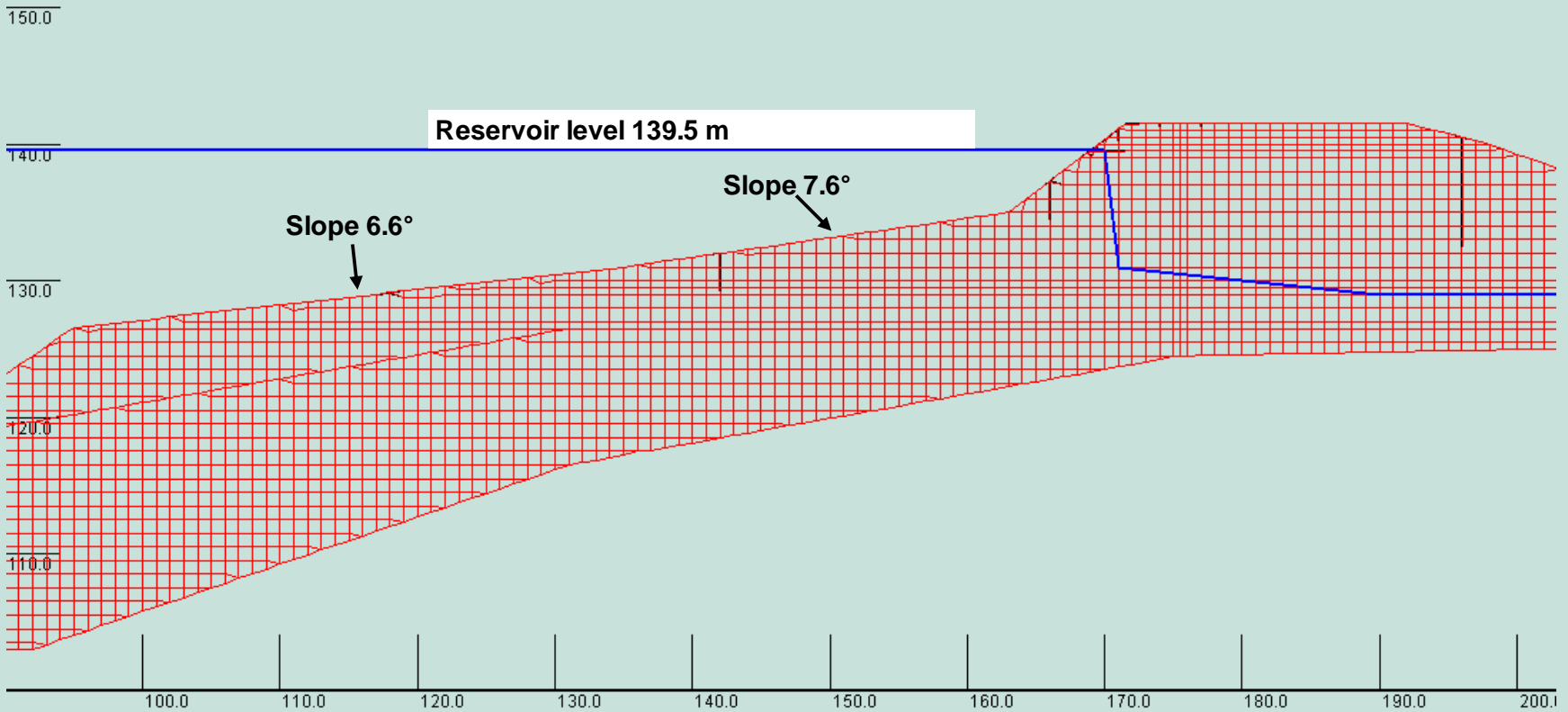
- M1 - Lower Silt
- M2 - Loose Sand
- M3 - Dense Sand
- M4 - densified ground
- M5 - Dense Sand (D/S)
- M6 - N/A
- M7 - Loose Sand Slough





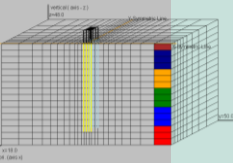
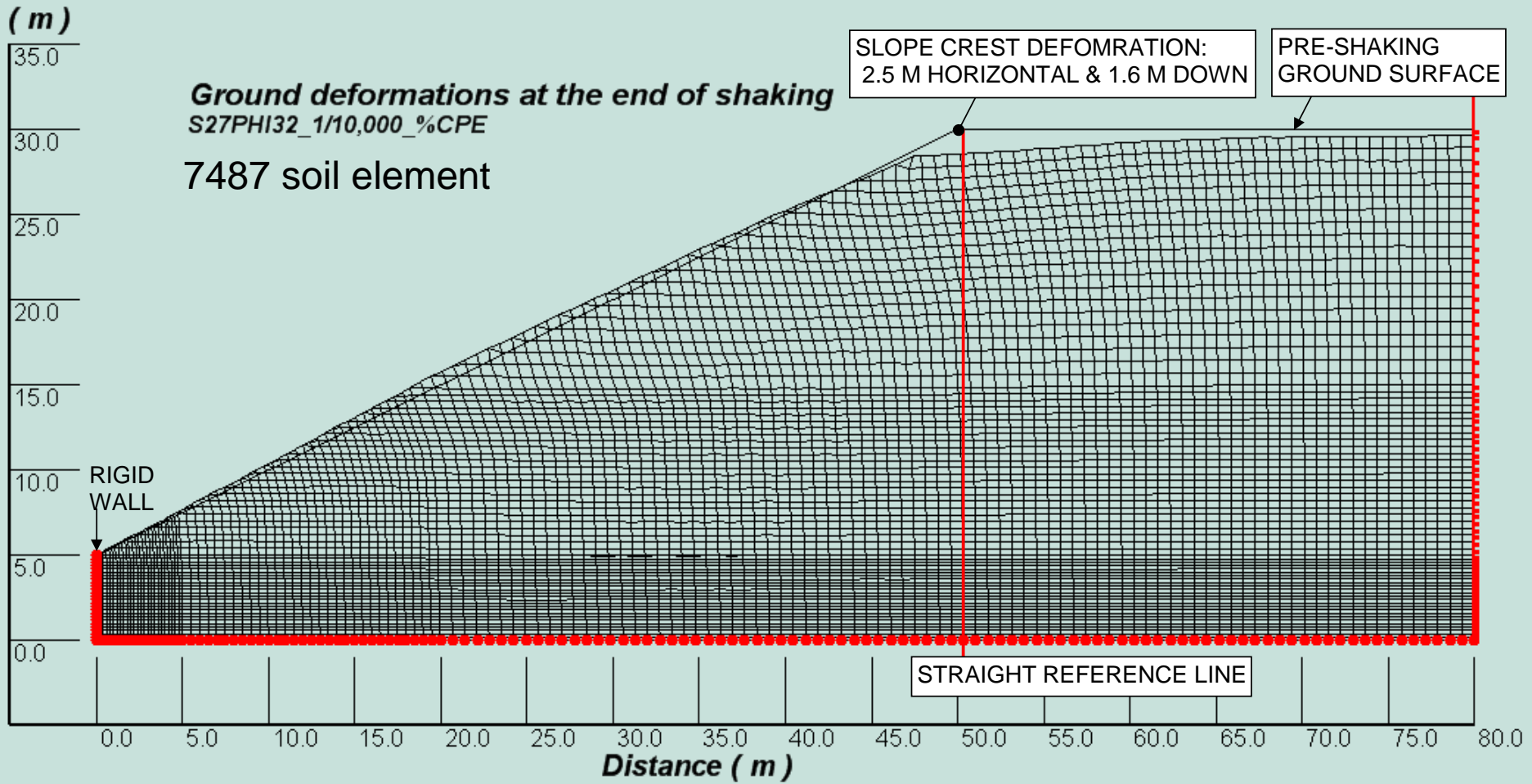
2010 Deficiency Investigation: Final stable slope

Wutec Geotechnical International



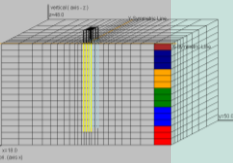
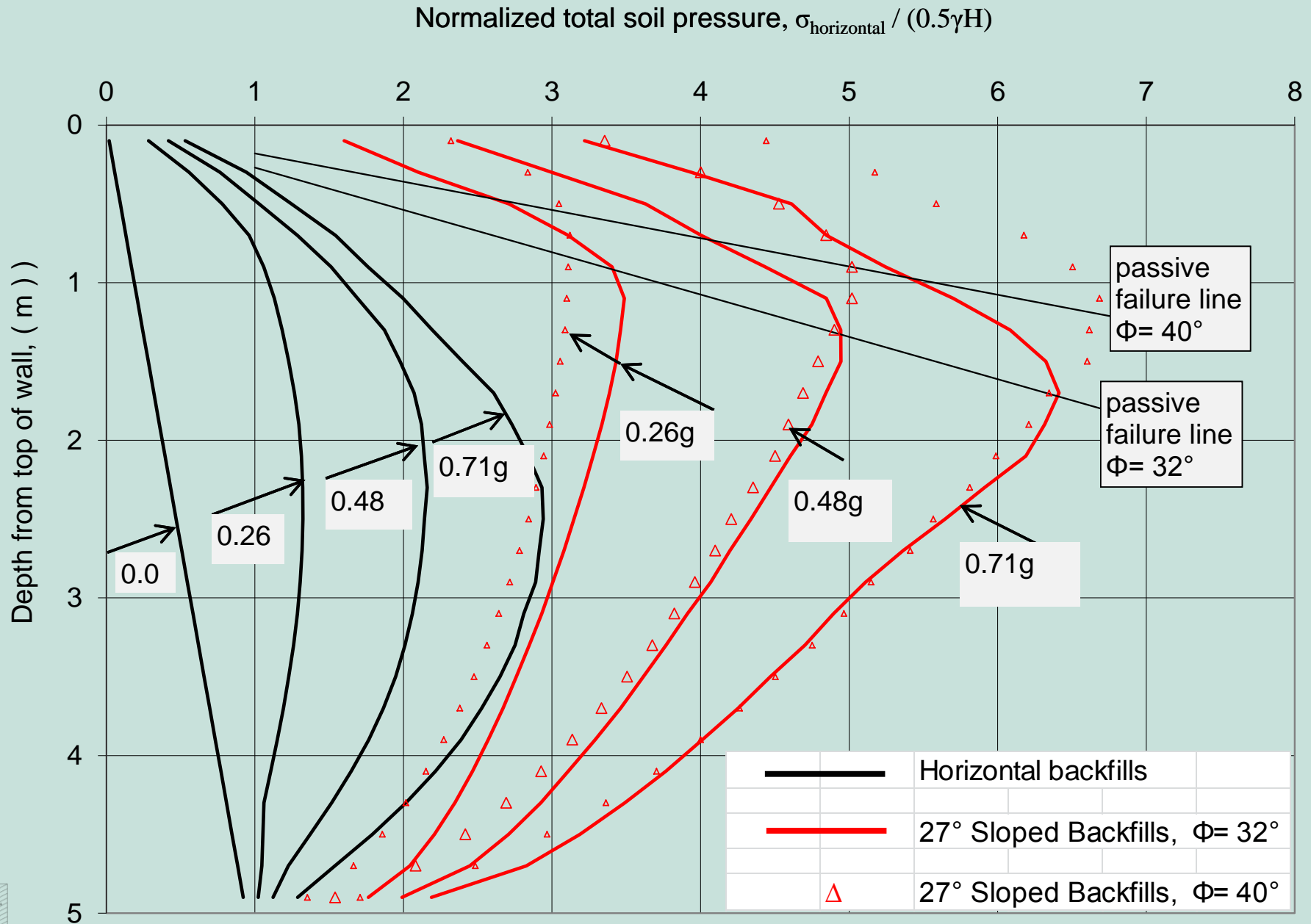


Seismic Soil Pressures: VERSAT-2D analysis



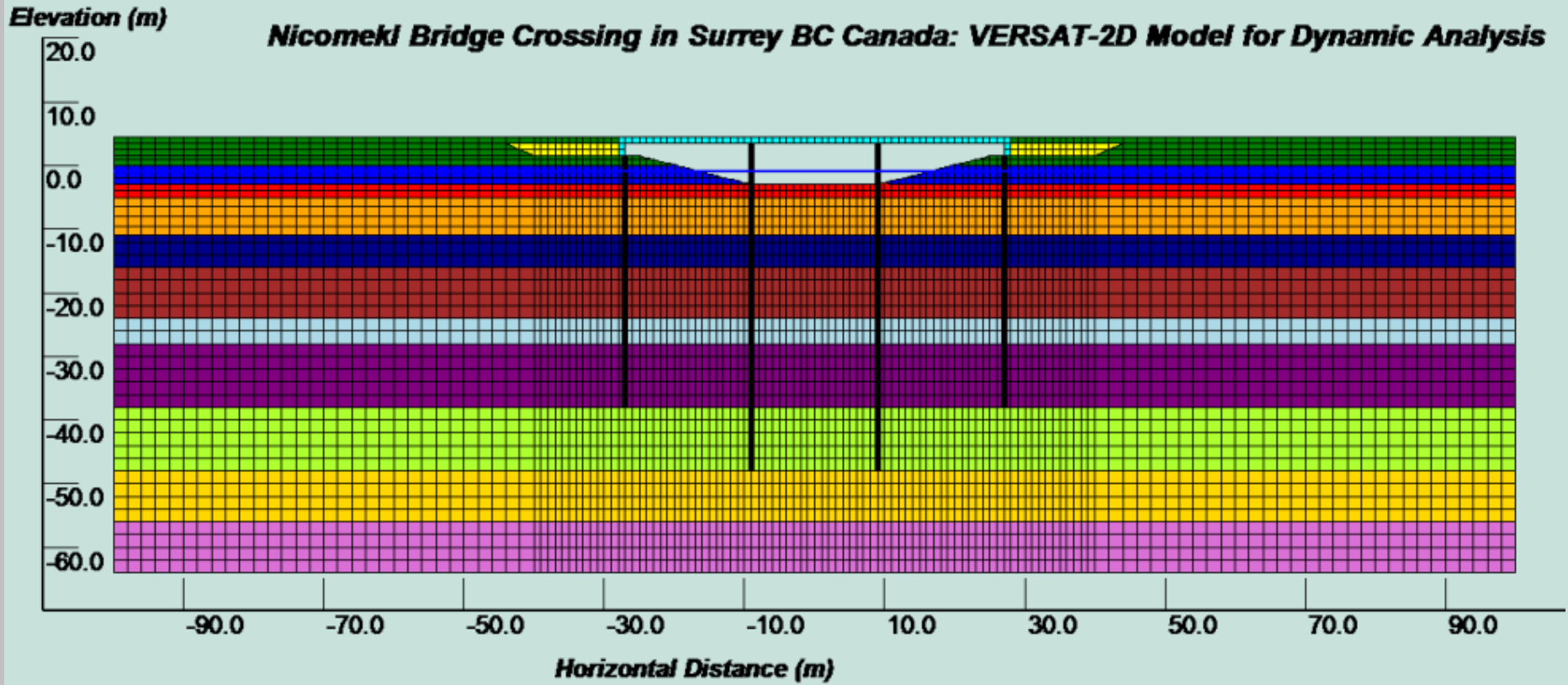


Seismic Soil Pressures: VERSAT-2D analysis

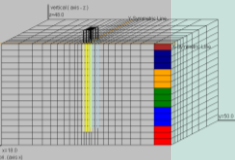




New Serpentine River Bridge: VERSAT-2D application



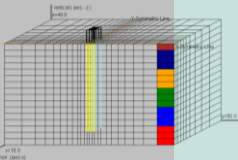
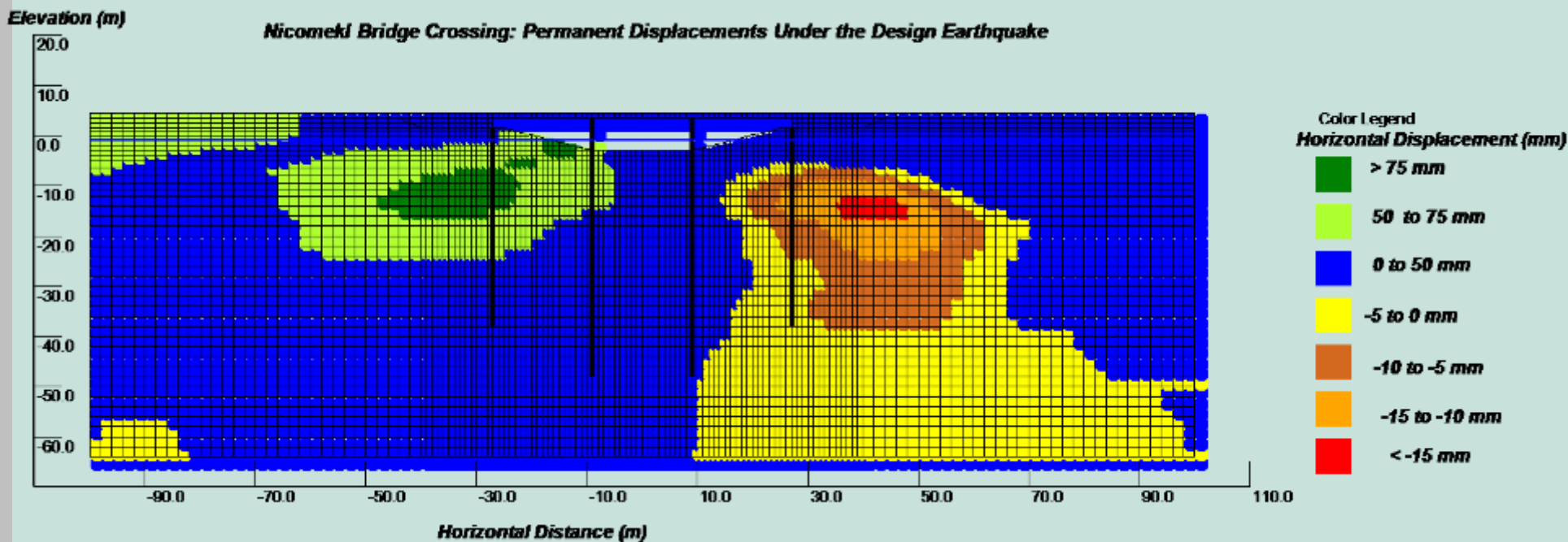
- Single Span Bridge on Soft Soils (24 m long, 14 m wide)
- 4716 nodes, 4572 elements, including bridge deck and abutment walls (Source: 2006 59th Can. Geot. Conference)





New Serpentine River Bridge: VERSAT-2D application

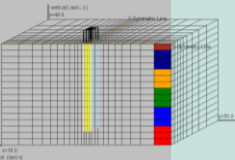
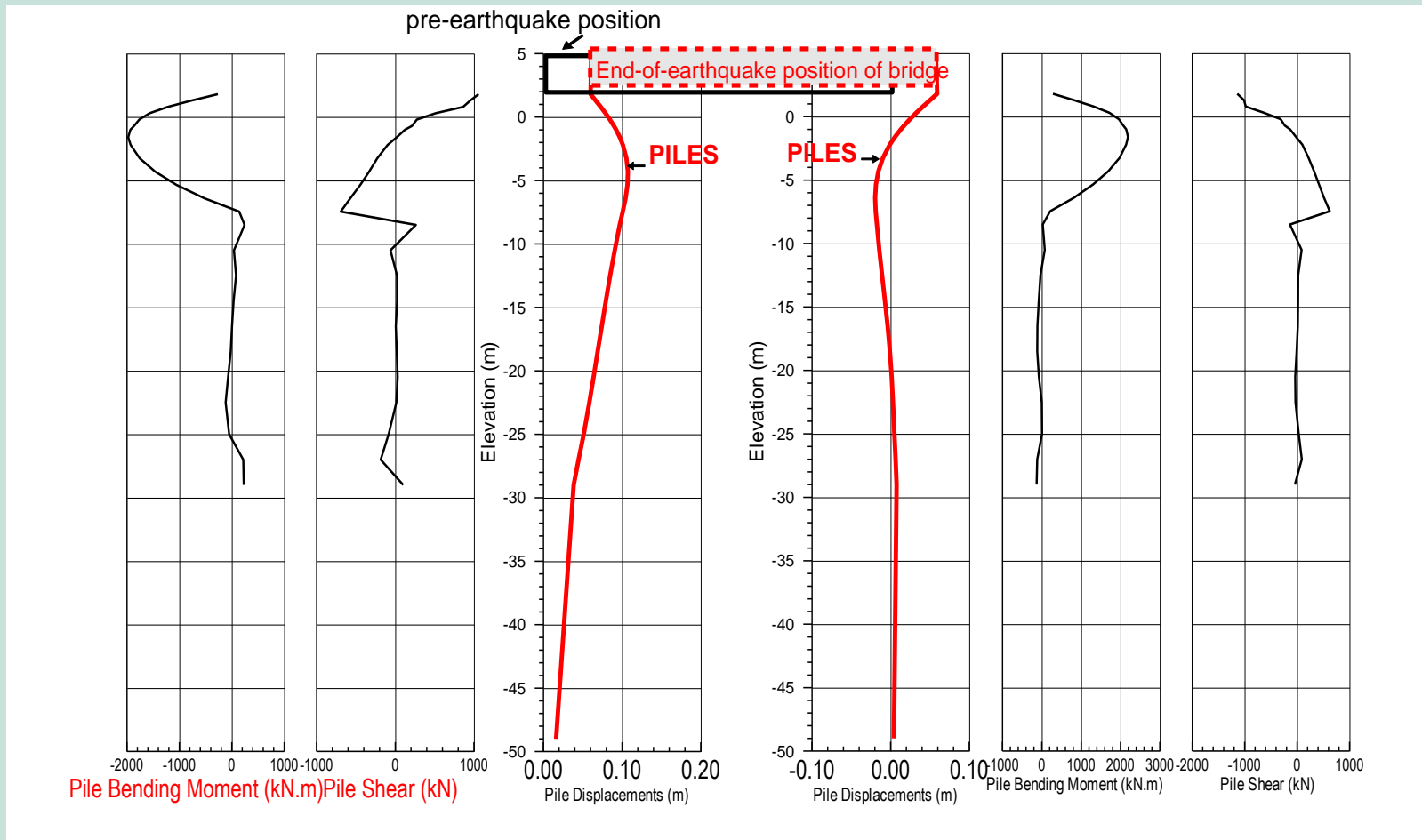
- End-of-earthquake horizontal displacement contours





new Serpentine River Bridge: VERSAT-2D application

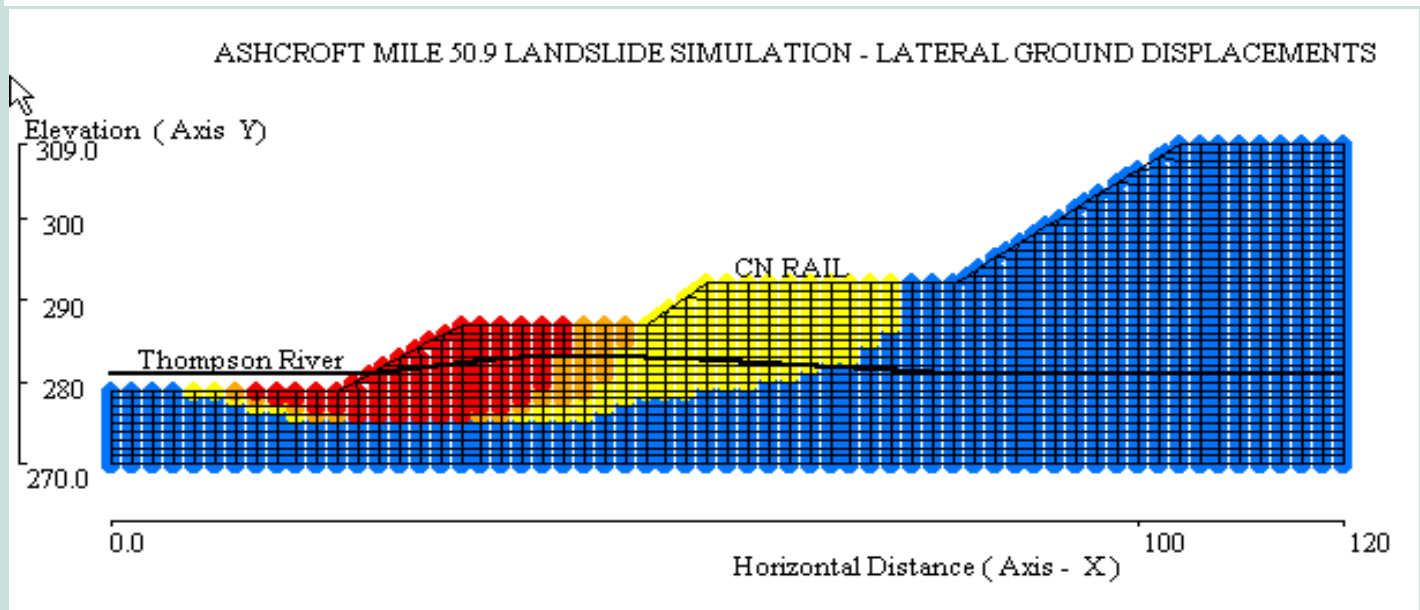
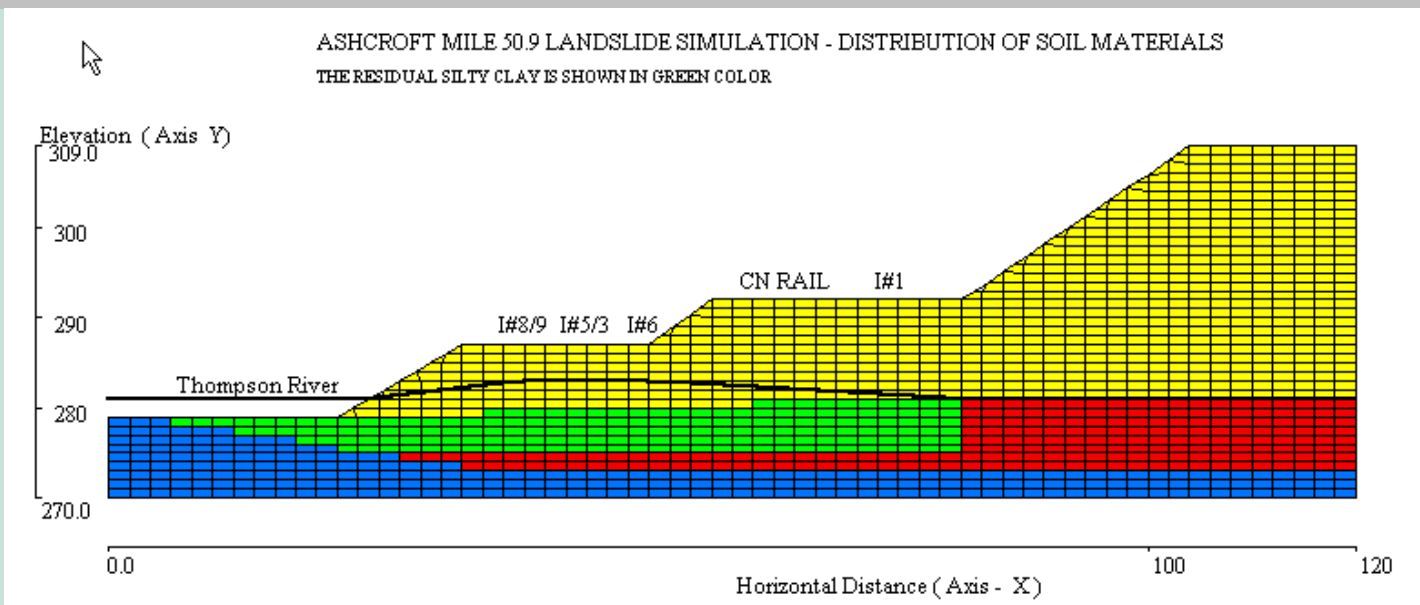
- End-of-earthquake displacements of piles and bridge





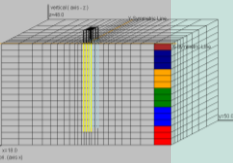
The ASHCROFT LANDSLIDE: VERSAT-2D application

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Legend: Ranges of lateral ground movements (mm)

- < 5
- 5 to 25
- 25 to 100
- > 100





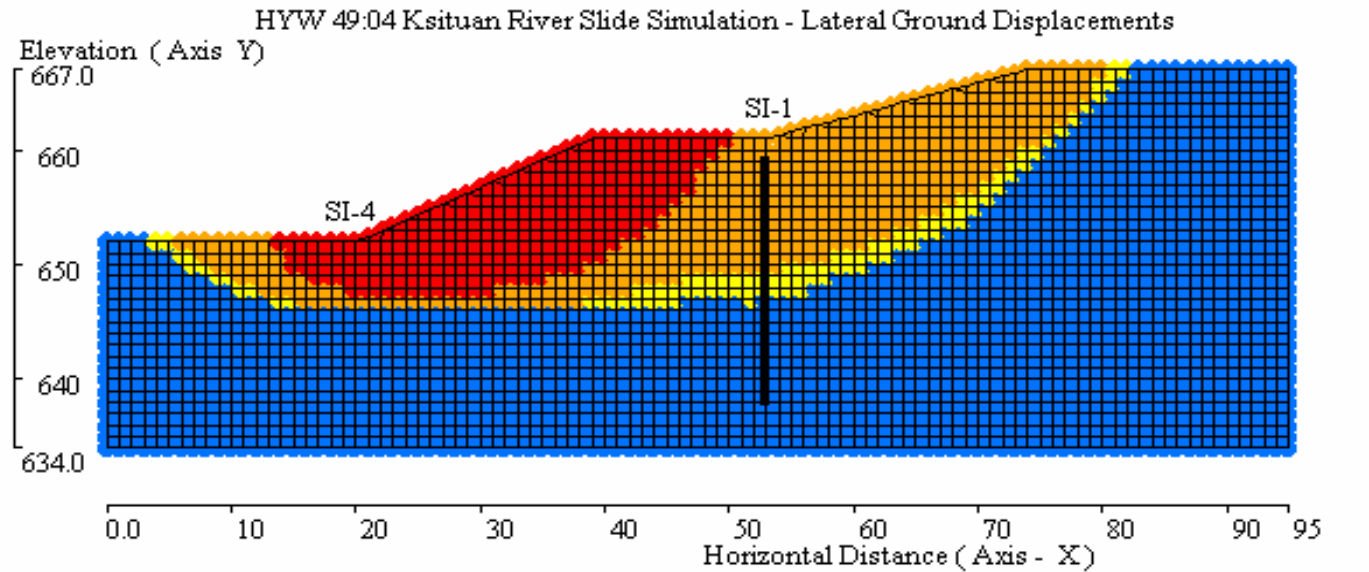
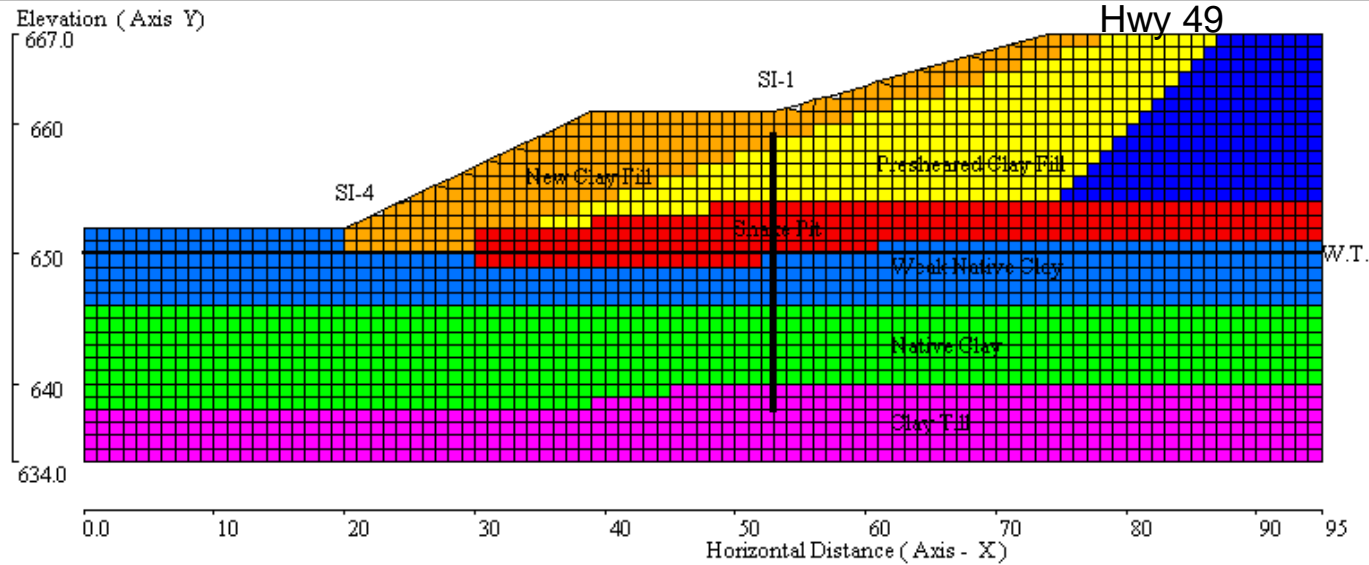
Hwy 49 Remediation: VERSAT-2D application

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Landslide deformations was observed on one side of Hwy 49.

Driving piles was selected as remediation.

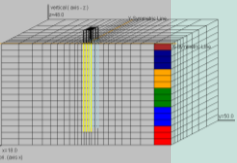
VERSAT-2D analysis was carried out for pile design.



LEGEND
Lateral Ground Disp. (mm)

Blue	< 100
Yellow	100 to 200
Orange	200 to 1000
Red	> 1000

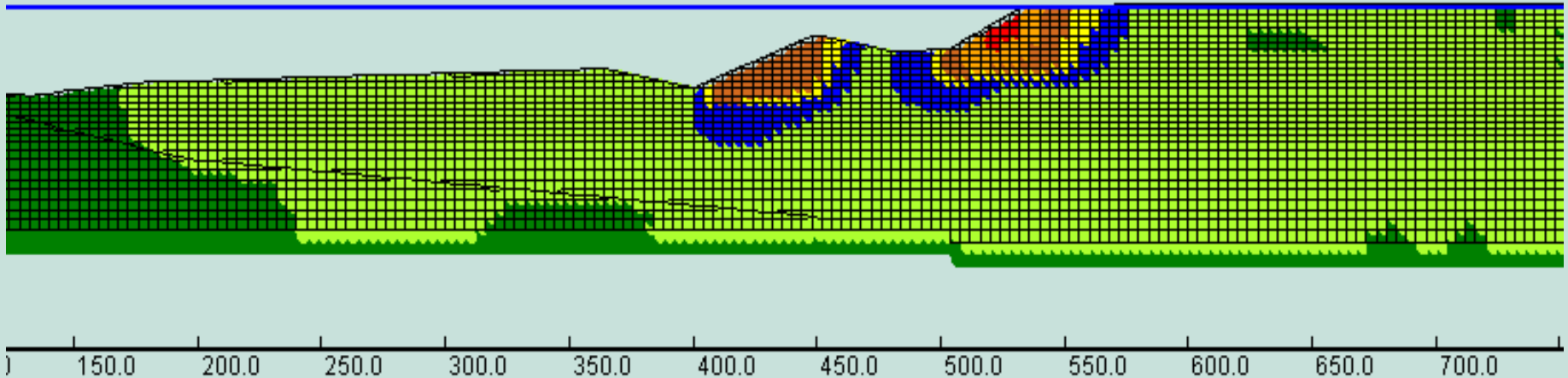
Maximum Shear in piles = (414, -508) kN
Maximum Moment in Piles = 3414 kN.m



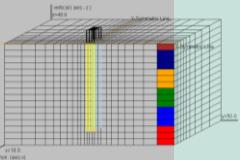
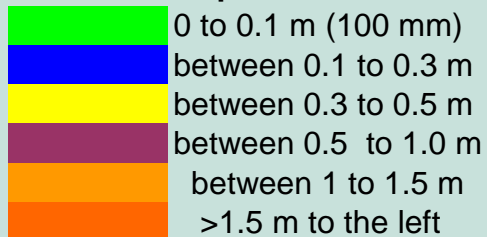


A Bridge Seismic Upgrade: VERSAT-2D Application

- **VERSAT-2D results: End-of-earthquake lateral ground displacements of Pier 6 soil slope and as-is ground conditions**



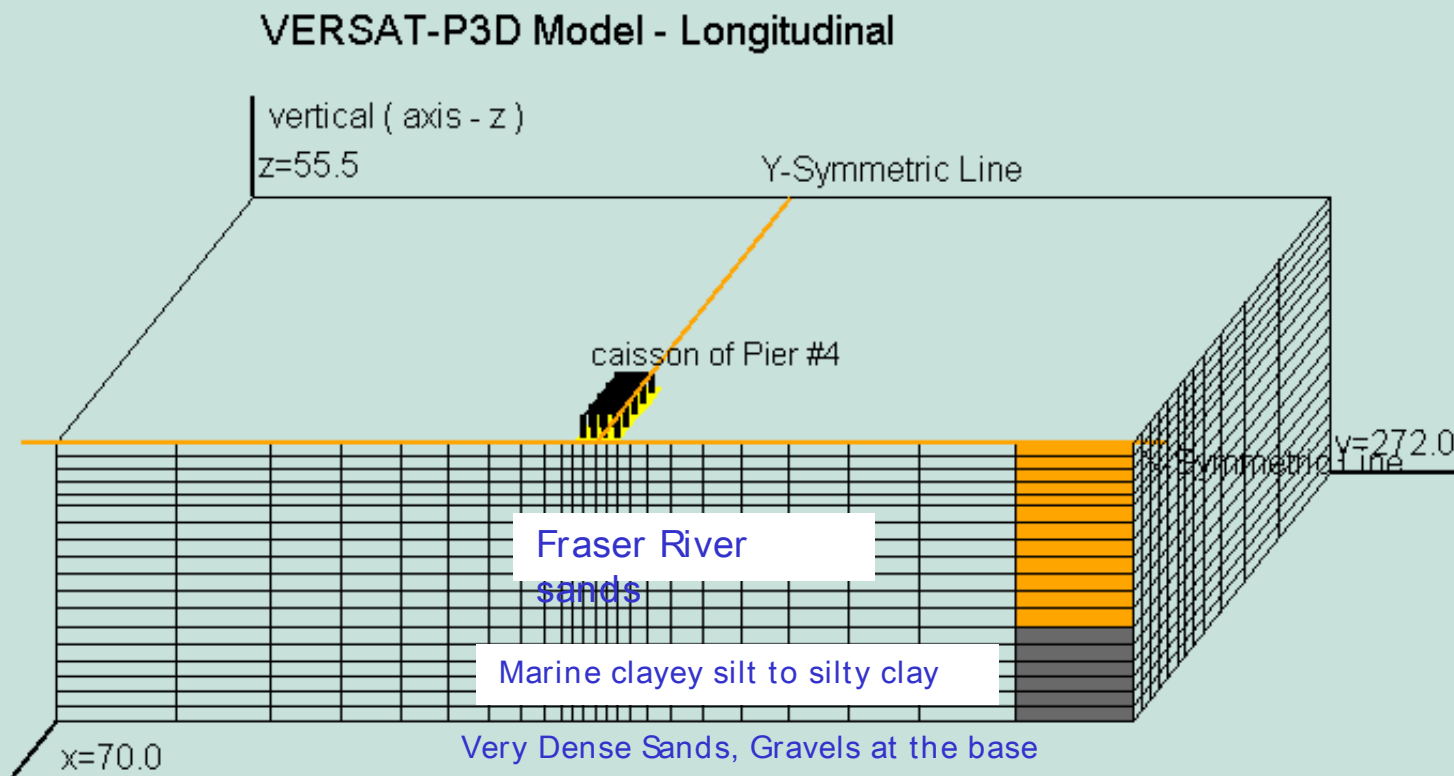
Ground X-displacements end of 475-year earthquake



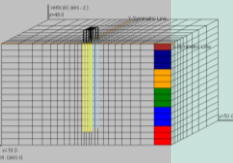


A Bridge Seismic Upgrade: VERSAT-2D Application

VERSAT-P3D MODEL OF PIER 4 CAISSON - Longitudinal to Bridge Alignment



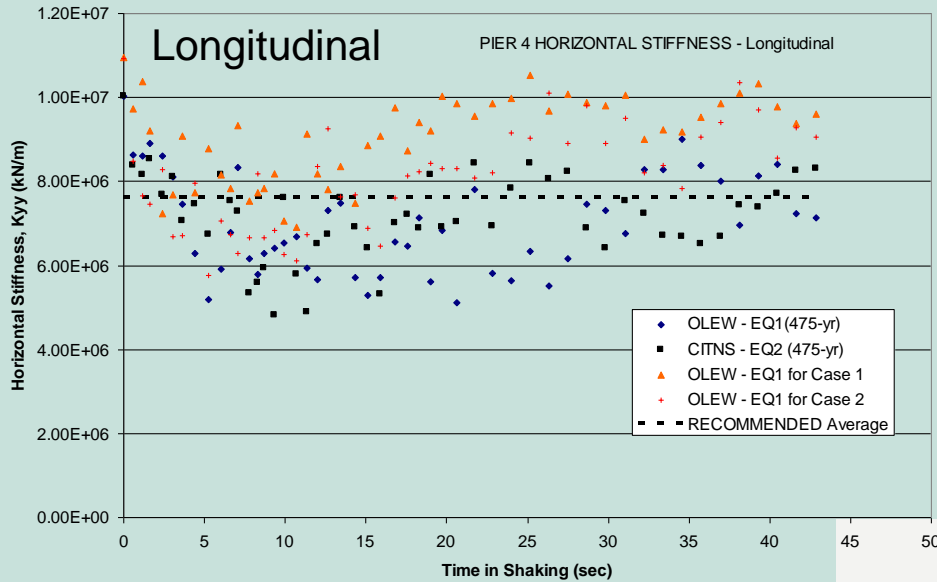
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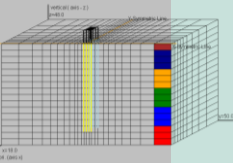
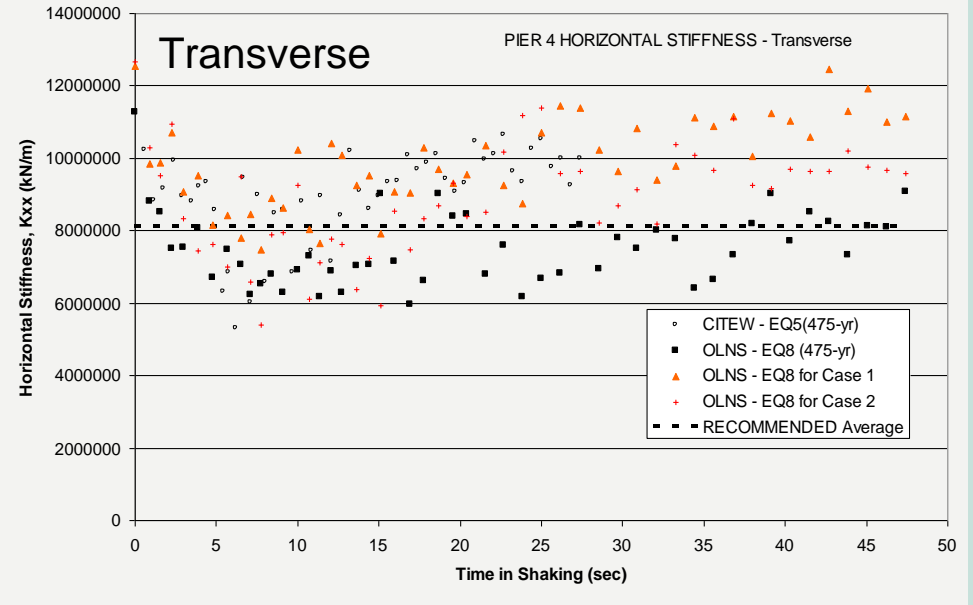


a Bridge Seismic Upgrade: VERSAT-2D Application

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VERSAT-P3D Results: Horizontal Stiffness Time-history of Pier 4 Caisson





A CAISSON Study: VERSAT-P3D Application

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point of interest

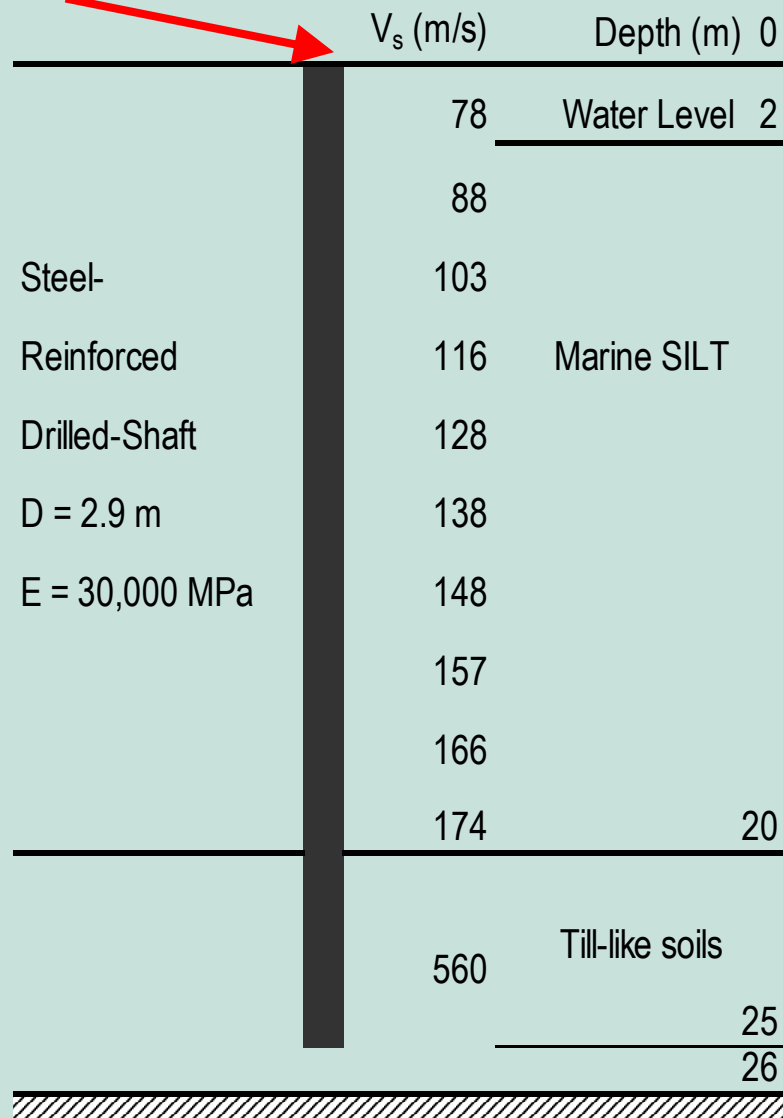
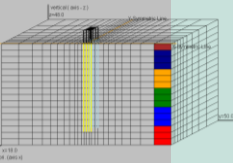


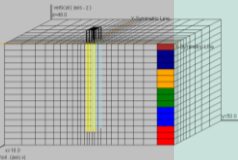
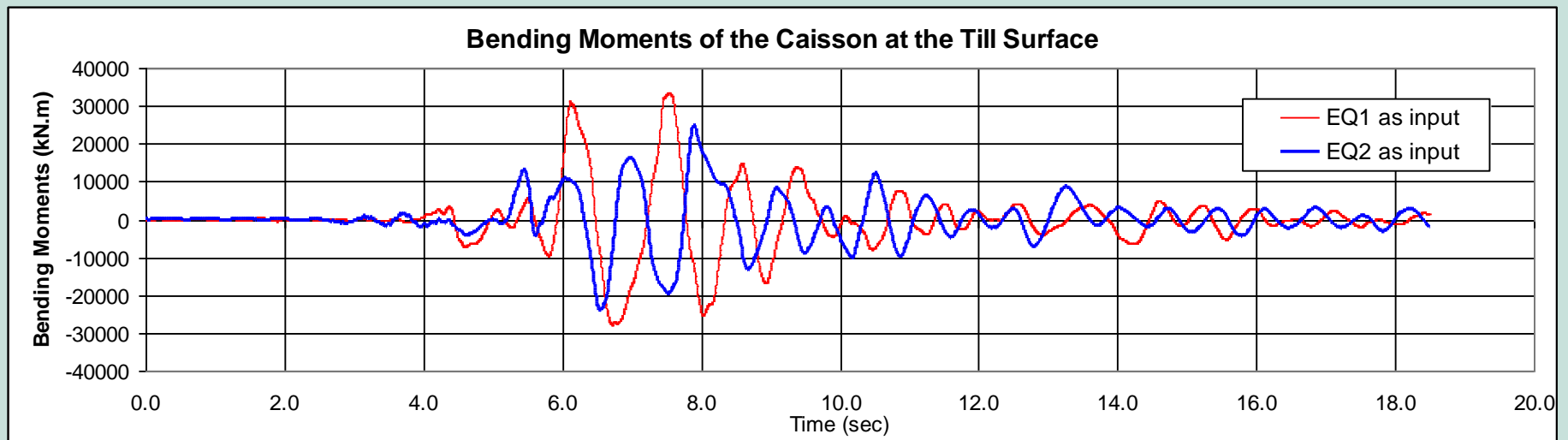
Figure 3 A Drilled-Shaft Embedded in Marine Silts and Till-Like Soils





A CAISSON Study: VERSAT-P3D Application

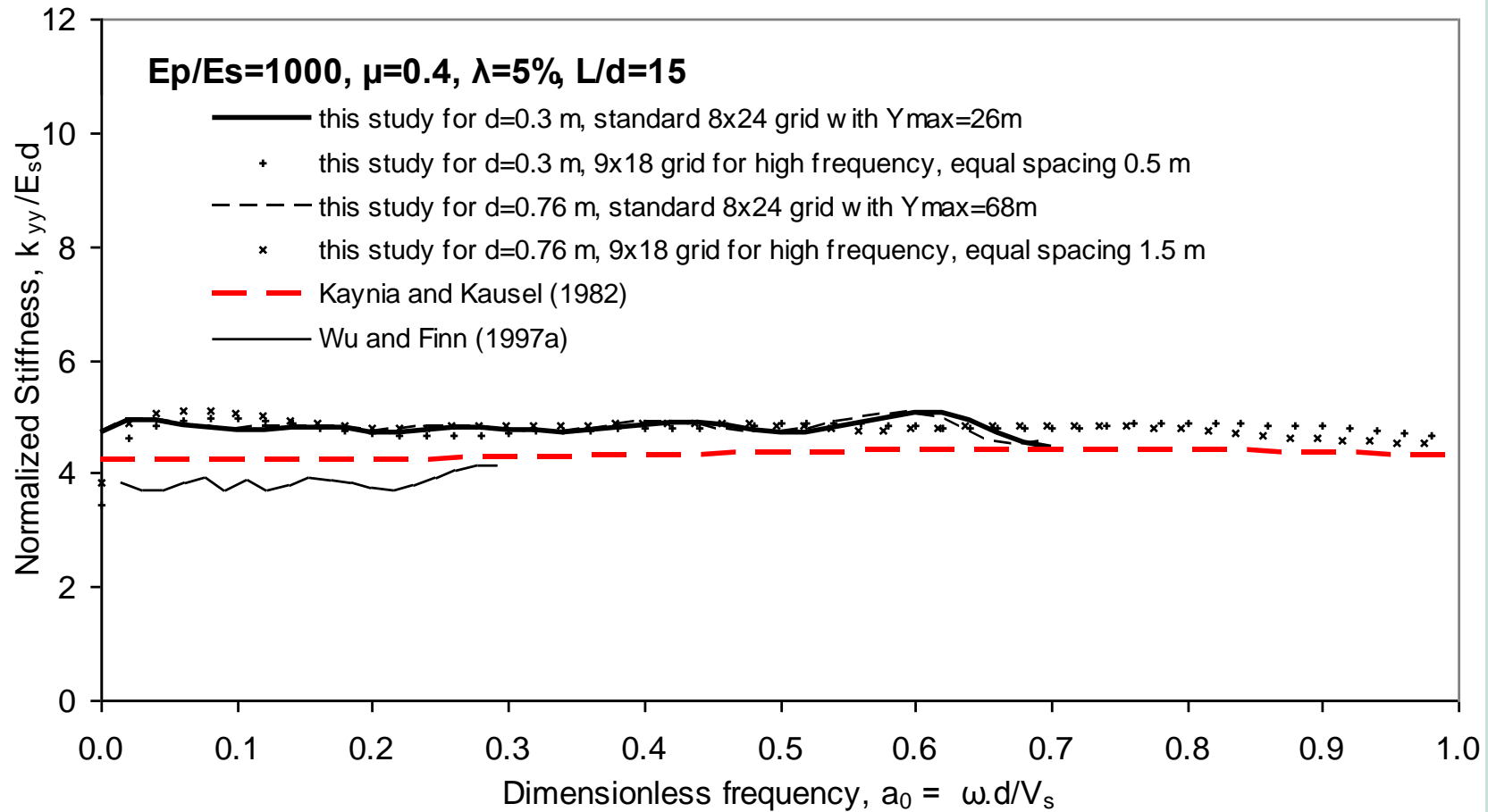
VERSAT-P3D Results: Bending moments at the till surface surface (source: 7th GeoChina Conference in Beijing)



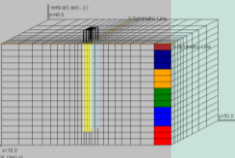


VERSAT-P3D Verification Study

Normalized horizontal stiffness of single piles



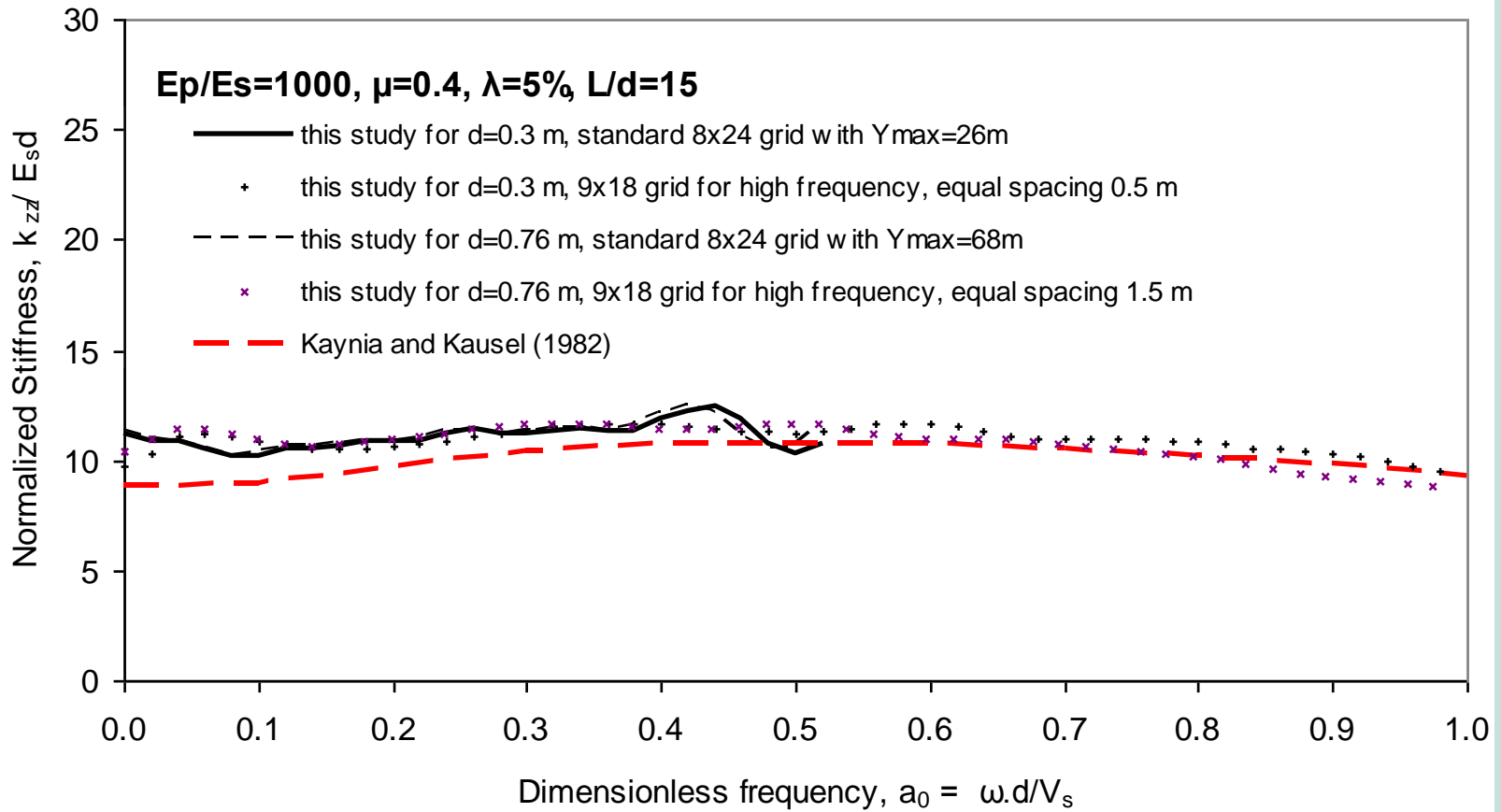
Note: The results are not affected by element size vs. pile size (Source: 2007 60th Can. Geot. Conference)



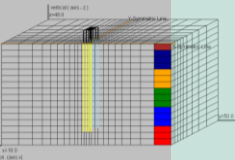


VERSAT-P3D Verification Study

Normalized vertical stiffness of single piles



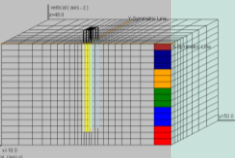
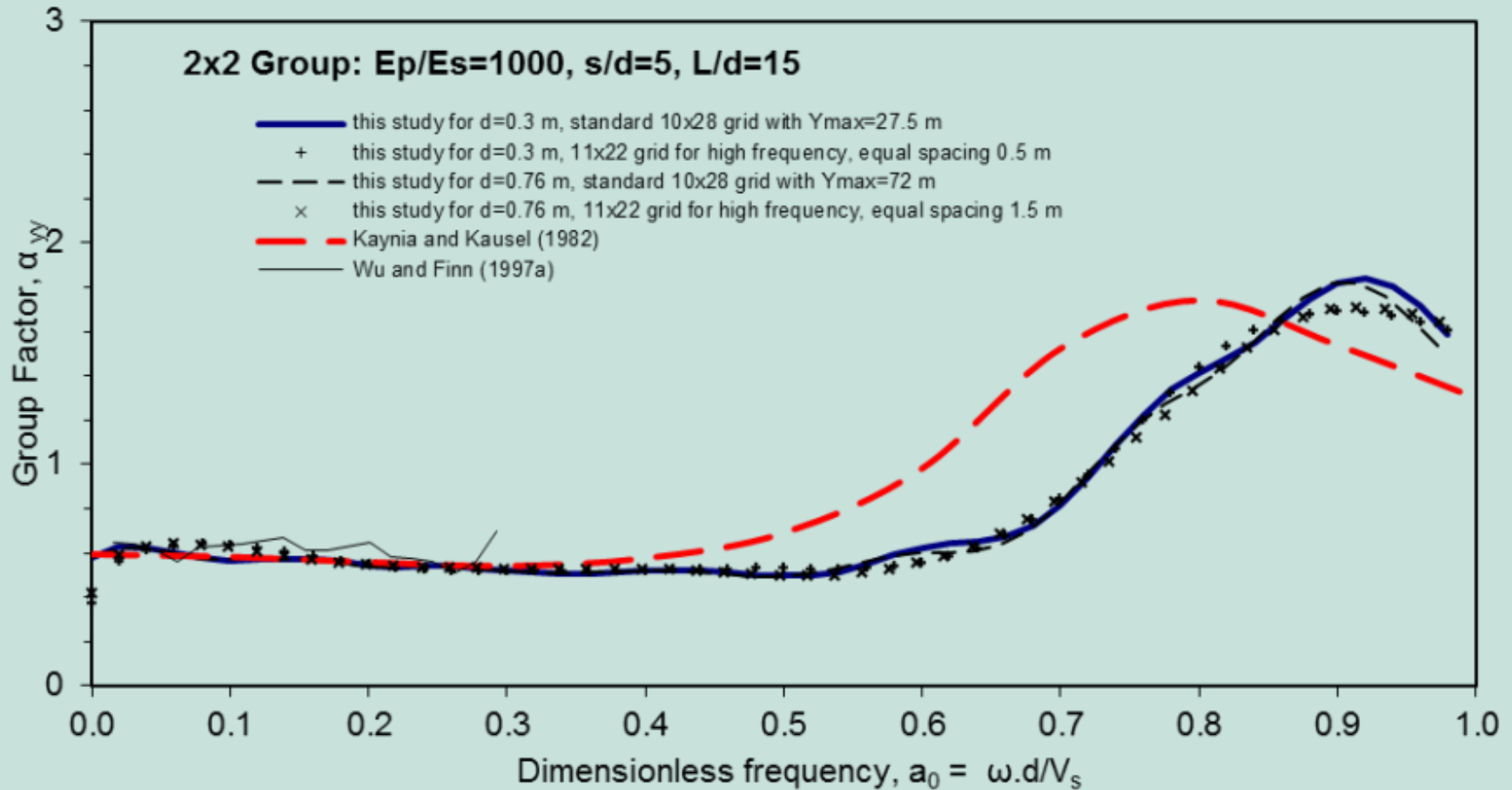
Note: The results are not affected by element size vs. pile size





VERSAT-P3D Verification Study

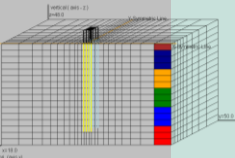
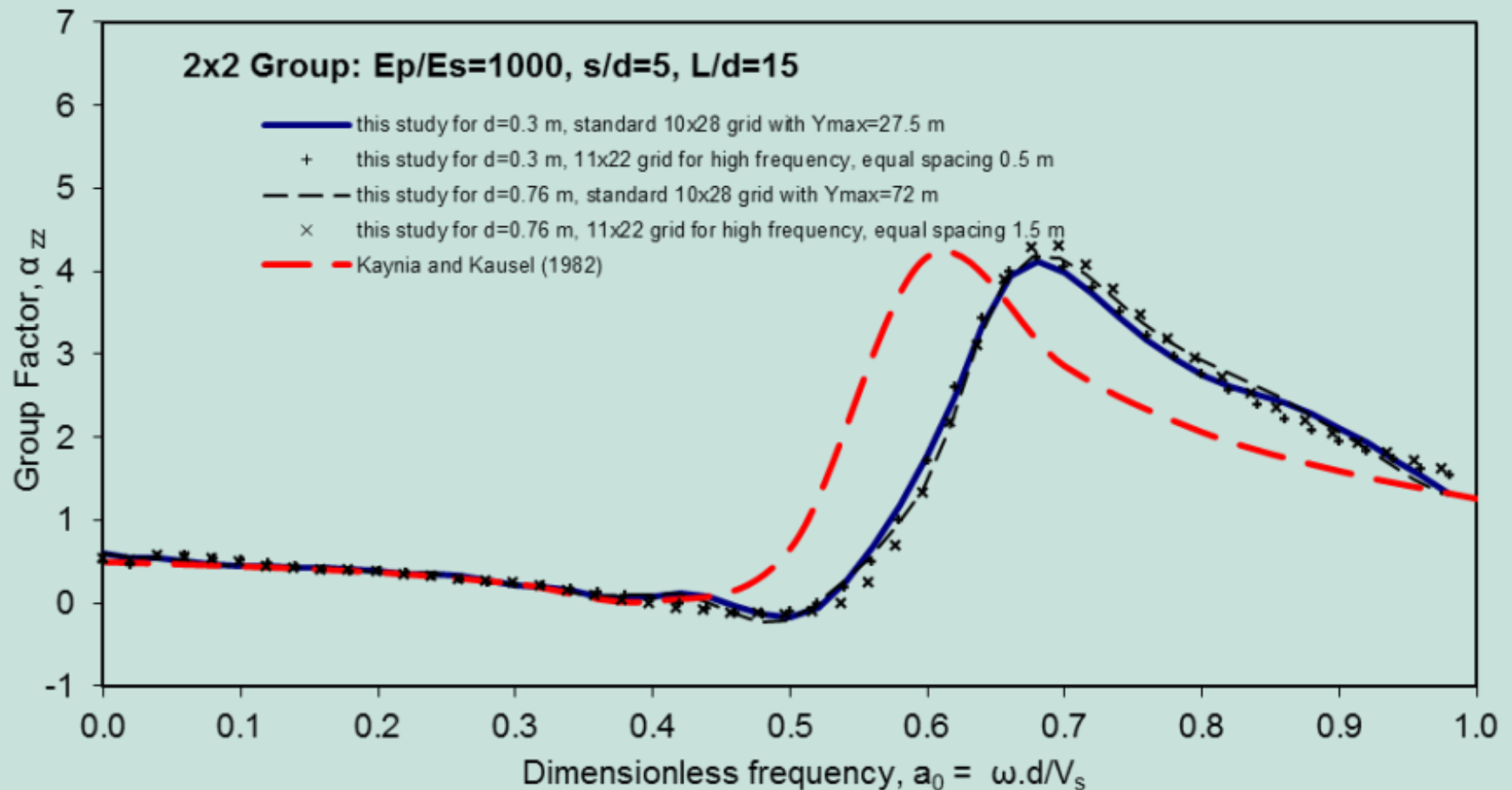
- 2x2 pile group: Horizontal stiffness
- The results are reliable over high-frequency range





VERSAT-P3D Verification Study

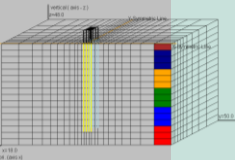
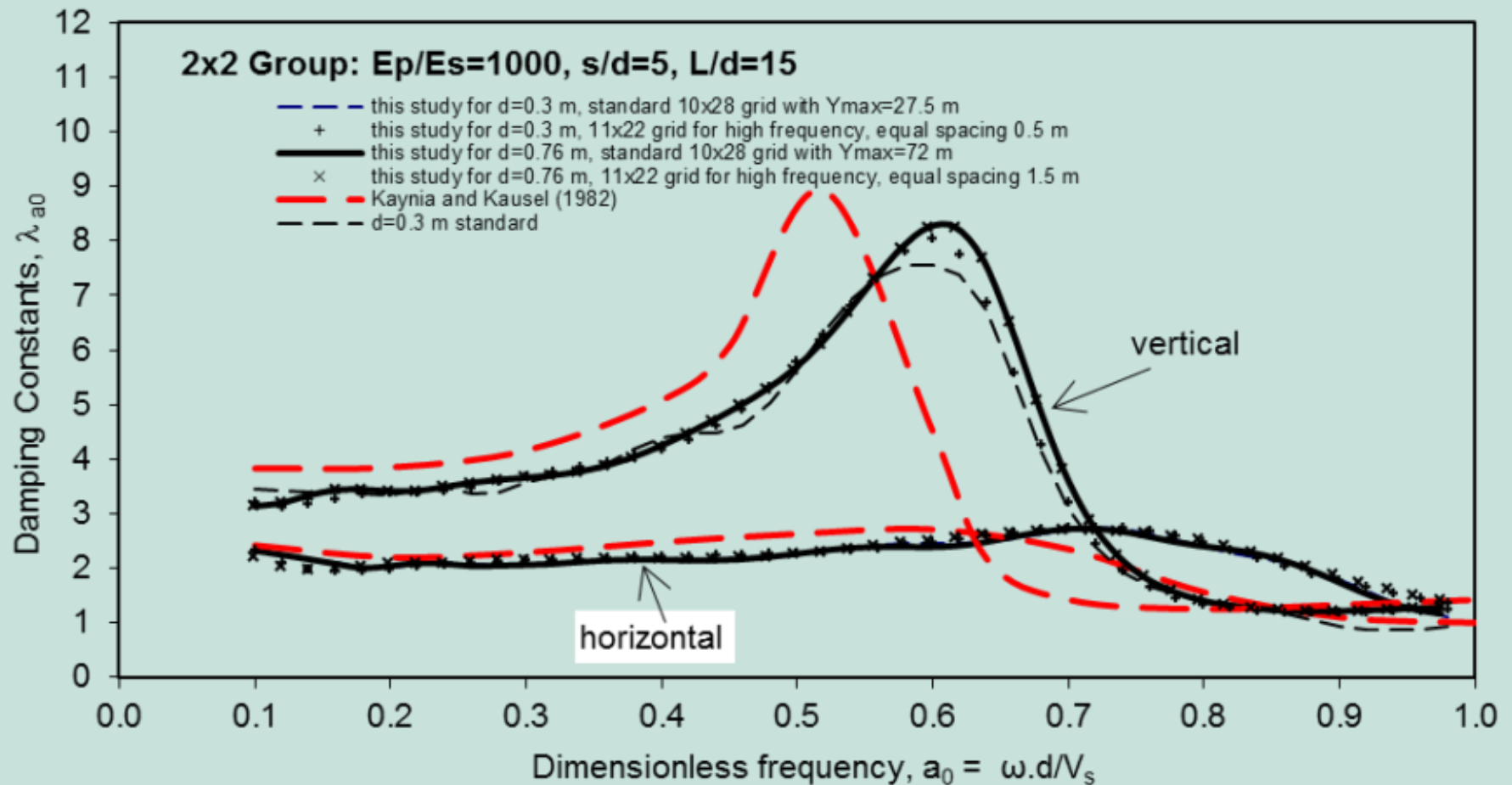
- 2x2 pile group: vertical stiffness
- The results are reliable over high-frequency range





VERSAT-P3D Verification Study

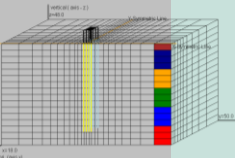
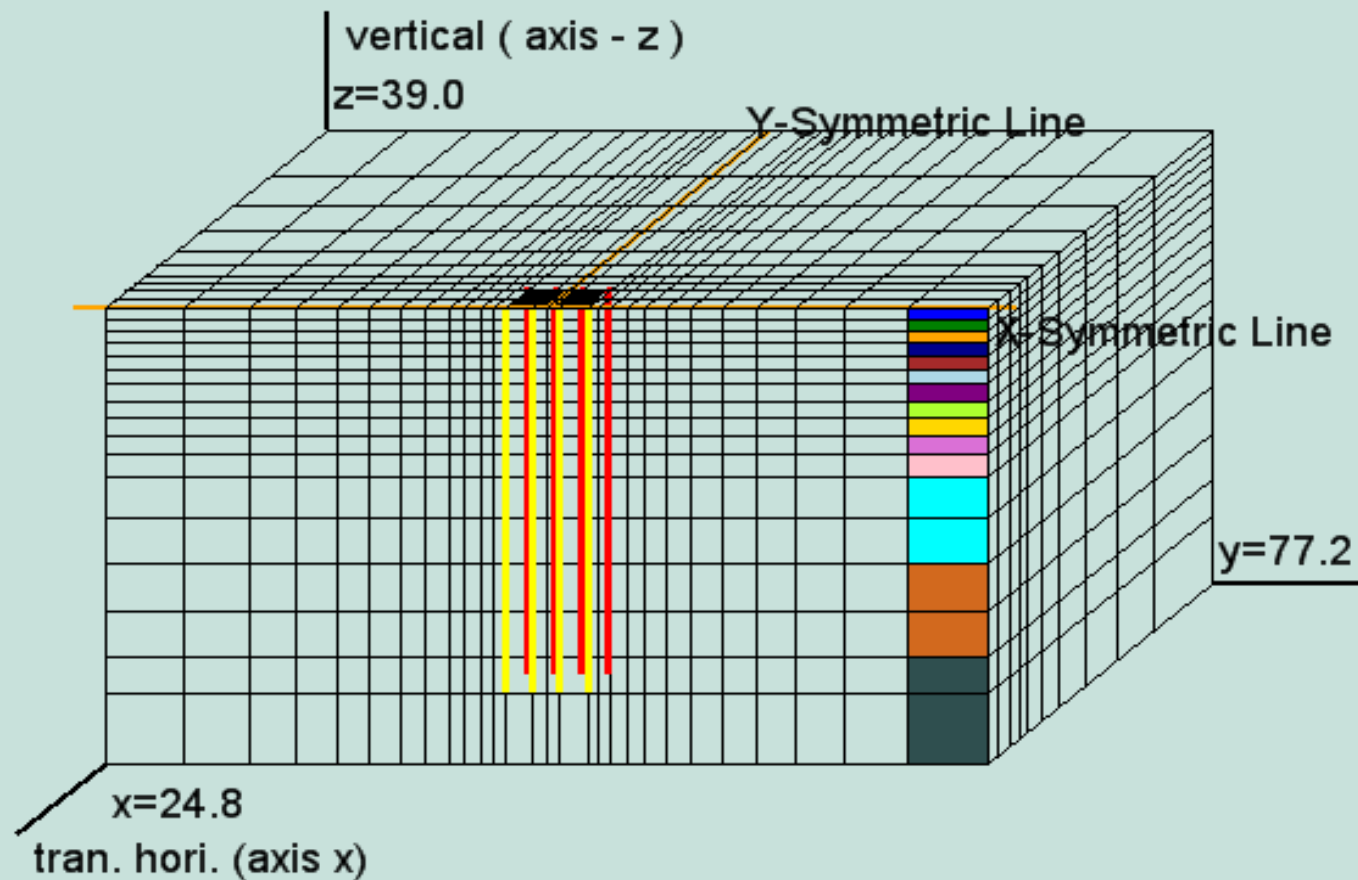
- 2x2 pile group: Horizontal and vertical damping
- The results are reliable over high-frequency range





VERSAT-P3D Verification Study

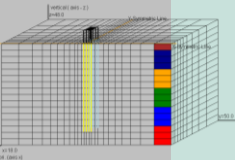
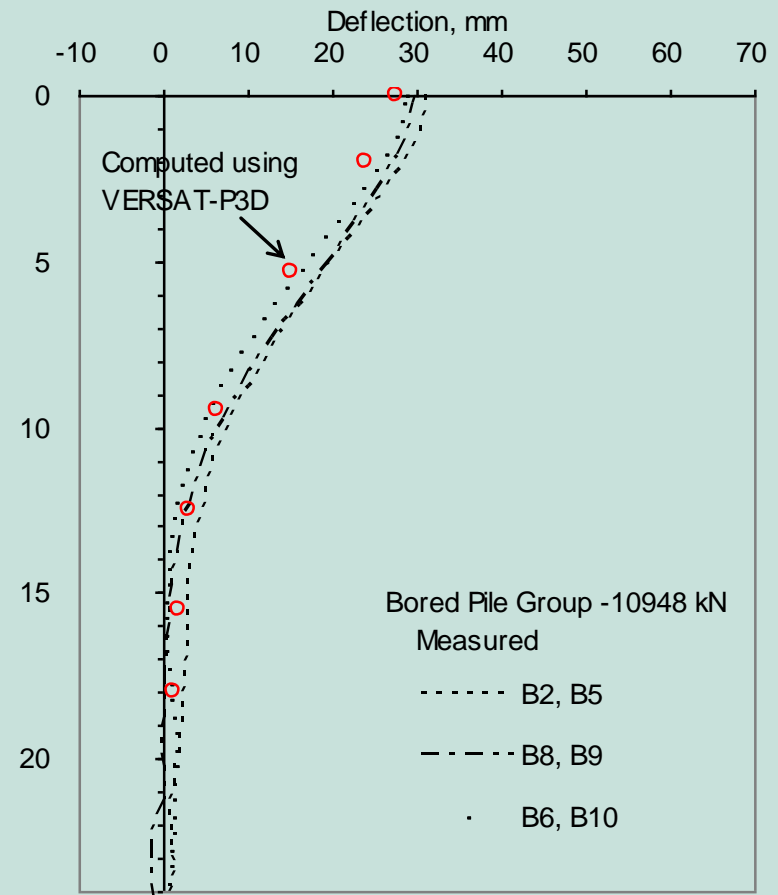
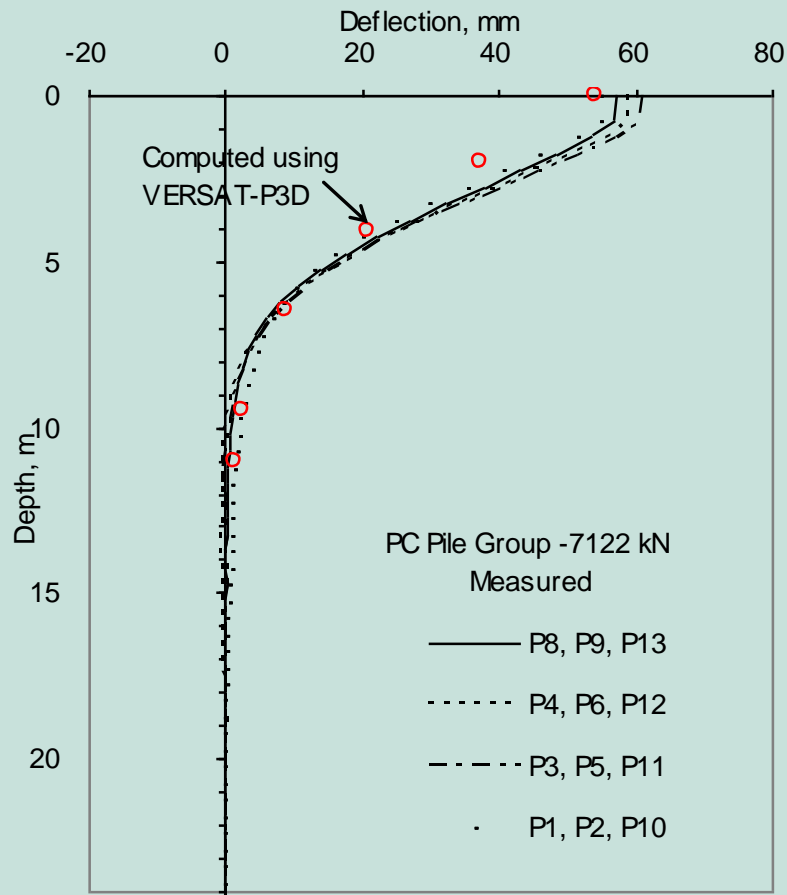
- Analysis of Full-scale Tests (Huang et al., ASCE 2001)
- Quasi-3D finite element model used for the analysis of a 3x4 PC pile group





VERSAT-P3D Verification Study

- Analysis of Full-scale Tests:
- Comparison of pile deflection profile versus depth for pile groups





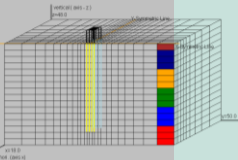
VERSAT-P3D Verification Study

Quasi-3D Method:

- A newly proposed method
- a more fundamental and straight forward approach in solving problems of pile-soil interactions.
- This approach uses only the fundamental parameters of the pile-soil system such as the size and stiffness of the pile, and stiffness and strength of the surrounding soils.

Conventional p-y Approach:

- A popular method
- p-y curve and p-multiplier are highly dependent on pile size, pile stiffness, soil nonlinearity, etc
- complex to be quantified reliably and accurately in practice





*Vancouver Convention Centre
Under Construction in 2005*



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Website: <http://www.wutecgeo.com>

THANK YOU !! 谢谢 !!

