Visualization of Soil Data for Seismic Hazard Analysis

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ABSTRACT

Seismic hazards such as the earthquake-induced liquefaction of soils often cause significant damage to infrastructures and pose tremendous adverse social and economical impacts. Evaluation of earthquake-induced liquefaction requires extensive amount of soil data over extended area. The research goal of this work is to understand the effects of spatially correlated soil properties on the predicted liquefaction potential over certain region. Aiming at this research goal, the objective of this visualization project is to develop 2D and 3D visualization models of soil properties to gain insights of collected soil information on the evaluation of regional seismic hazards. Field data of selected regions, such as the Charleston of South Carolina and the Marina district in San Francisco, was used to generate visualization of soil profile in the region. A Python-based program was developed to filter data and convert it into a readable file format for ParaView, a visualization tool. The generated file is used as input to ParaView where 2D and 3D models are rendered. These models can then be manipulated by applying filters such as slice, clip and glyph. The visualization of soil data can support the analysis and estimation of variables that constitute the evaluation of seismic hazards in selected regions.

BACKGROUND

Ground shaking such as earthquakes can induce liquefaction of soils, which is referred to as the process where soil deposits lose strength and act as a fluid causing damage to infrastructures, systems, or other entities, as shown in Figure 1. Evaluation of seismic hazard such as liquefaction requires information on soil properties over certain region.

Figure 1. Soil liquefaction 1964 Niigata Earthquake

OBJECTIVES

- Develop 2D and 3D visualization models of liquefaction-related soil properties
- Apply to the Marina District in San Francisco and Charleston, South Carolina region

METHODOLOGY

- Collect field data using Cone Penetration Test (CPT)
- Generate random field realization of CPT-based soil properties
- Develop Python program to convert data into a single VTK file
- Render visualization models using ParaView

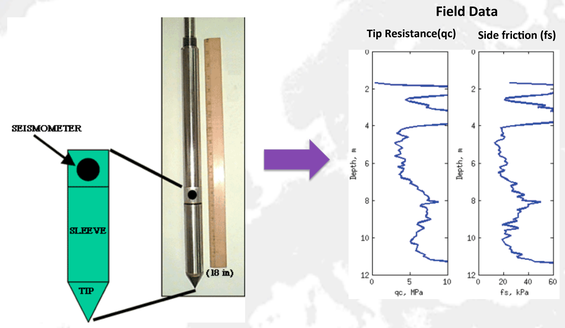

Figure 2. Cone Penetration Test (CPT)

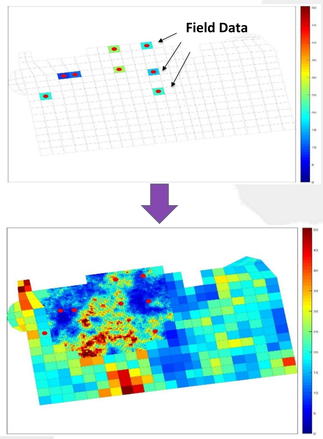

Figure 3. Random Field Realization of Tip Resistance

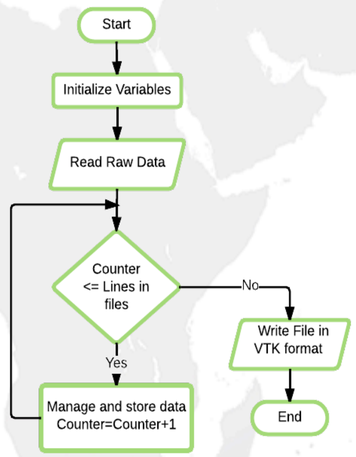

Figure 4. Python Program Flow Chart

RESULTS AND CONCLUSIONS

- 2D and 3D visualizations of tip resistance of the Marina District in San Francisco: weaker soil in blue and stronger soil in red
- 2D and 3D visualizations of tip resistance of Charleston, South Carolina: weaker soil in blue and stronger soil in red

RESULTS AND CONCLUSIONS

Figure 5. Marina District in San Francisco

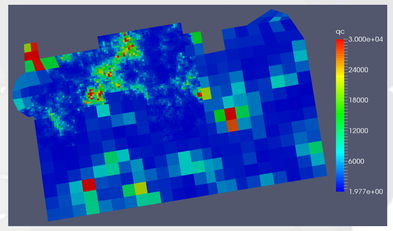

Figure 6. 2D Visualization of Tip Resistance

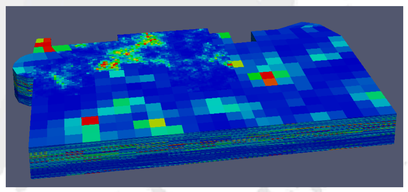

Figure 7. 3D Visualization of Tip Resistance

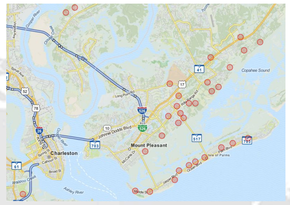

Figure 8. Charleston, SC

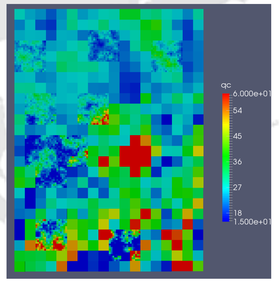

Figure 9. 2D Visualization of Tip Resistance

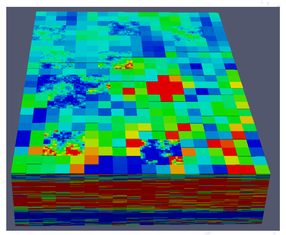

Figure 10. 3D Visualization of Tip Resistance

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Figure 2. http://earthquake.usgs.gov/research/cpt/
Figure 3. Q. Chen, C. Wang and C.H. Juang. (2015). Probabilistic assessment of CPT-based liquefaction risk accounting for spatial variability at multiple scales. *Journal of Geotechnical and Geoenvironmental Engineering*, in review.
Figure 5 & 8. http://earthquake.usgs.gov/research/cpt/data/

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