

Geotechnical aspects of the M8.8 2010 Maule, Chile earthquake

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Acknowledgments

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(PIs: Jon Bray, Ellen Rathje, David Frost)
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- ◆ National Science Foundation RAPID program



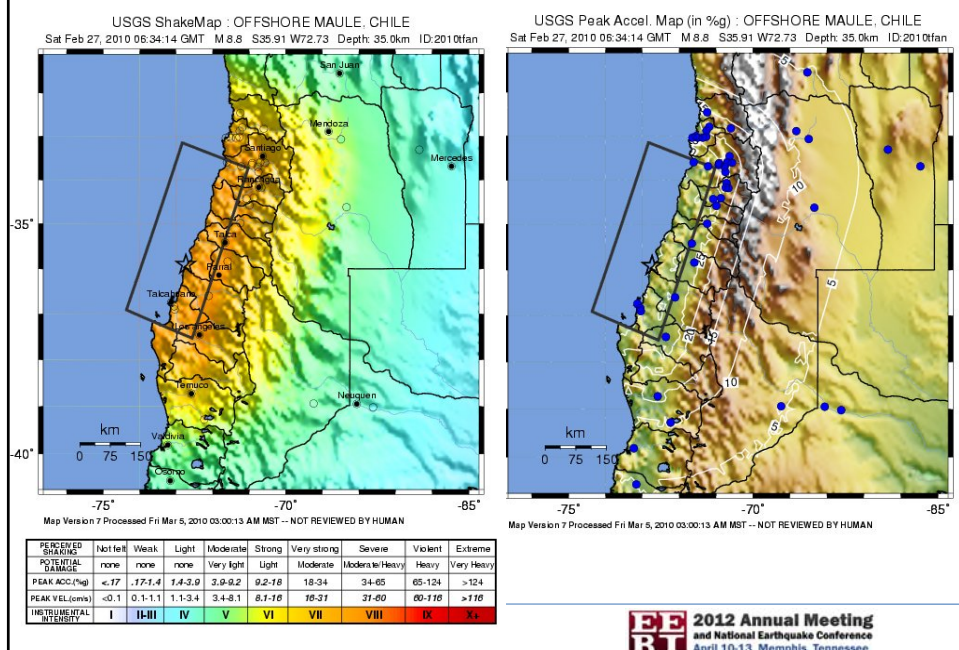
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M8.8 February 27, 2010 Maule, Chile earthquake

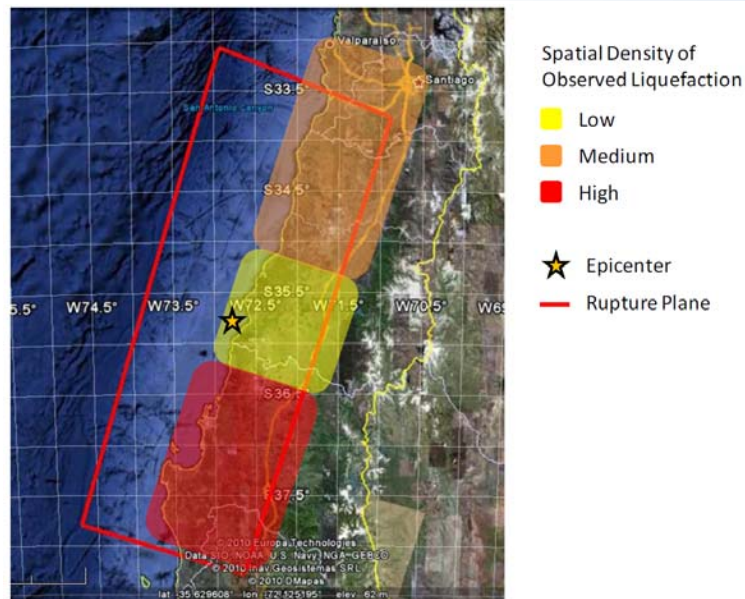
- 7th largest earthquake since 1900
- 370,000 residences; 4,000 schools; 79 hospitals; 4,200 boats damaged or destroyed
- 200 bridges damaged including 20 with one or more collapsed spans
- 1.8 million people (1/8 of population) affected by earthquake, with 800,000 displaced
- Fault rupture 500 km long and 100 km wide
- ~ \$30B in economic losses – 15% of GDP



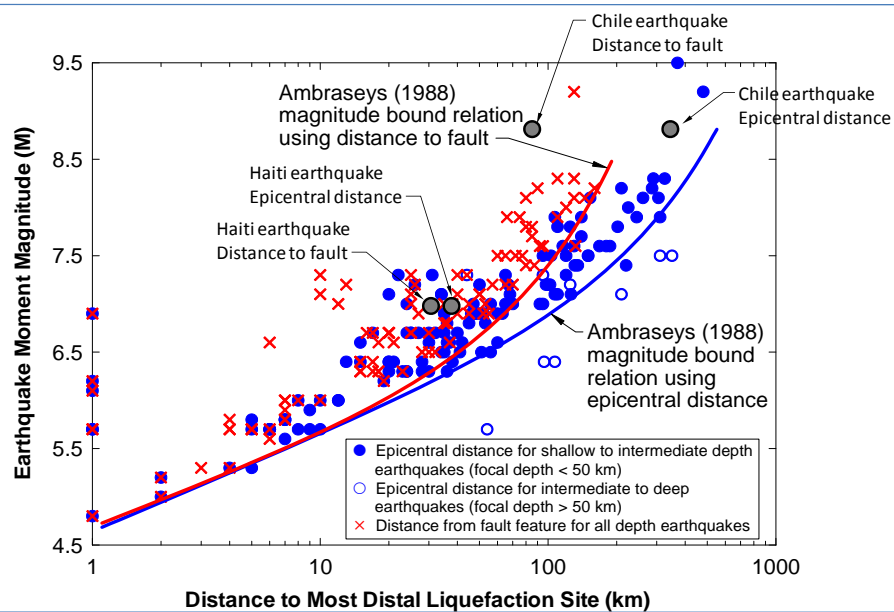
Shaking intensities



Distribution of liquefaction effects



Distribution of liquefaction effects



Effects of liquefaction on bridges

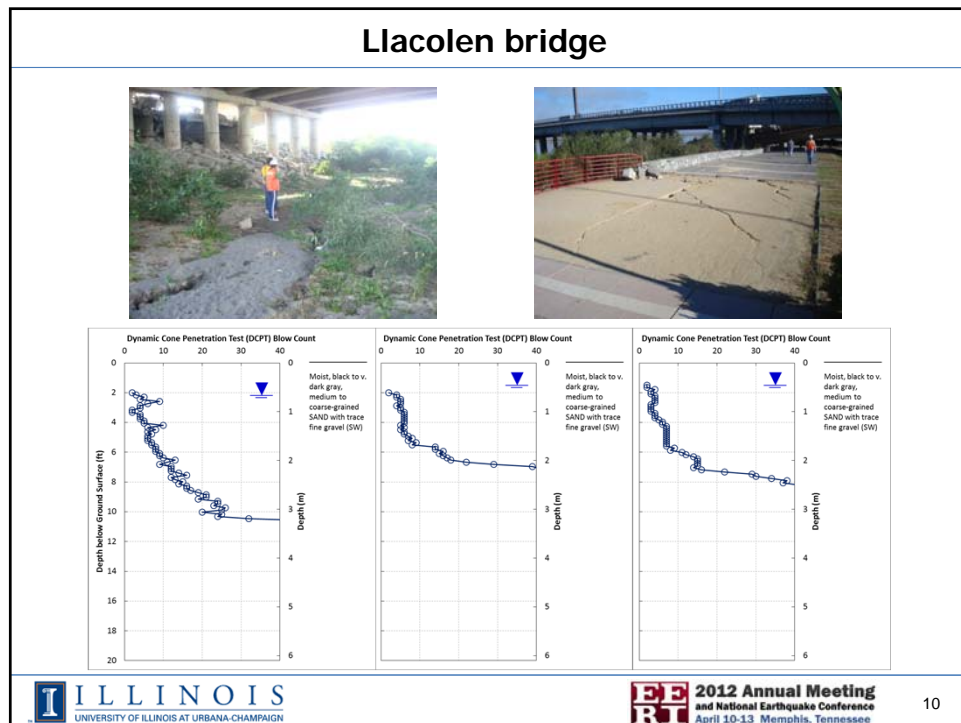
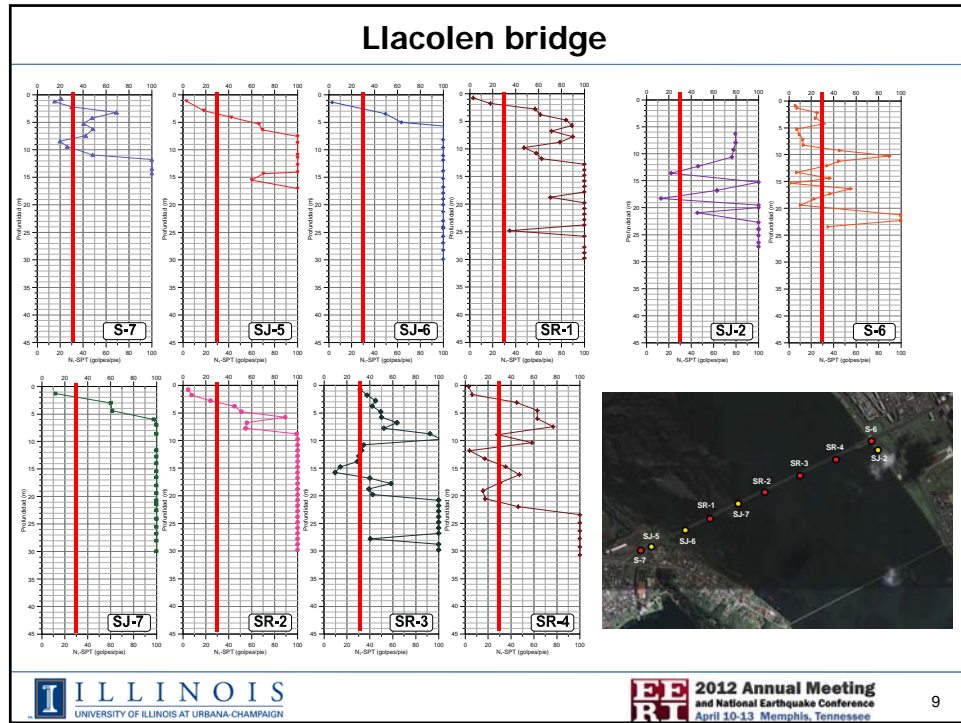
- Many bridges damaged by liquefaction and lateral spreading were located along the Bio-bio River

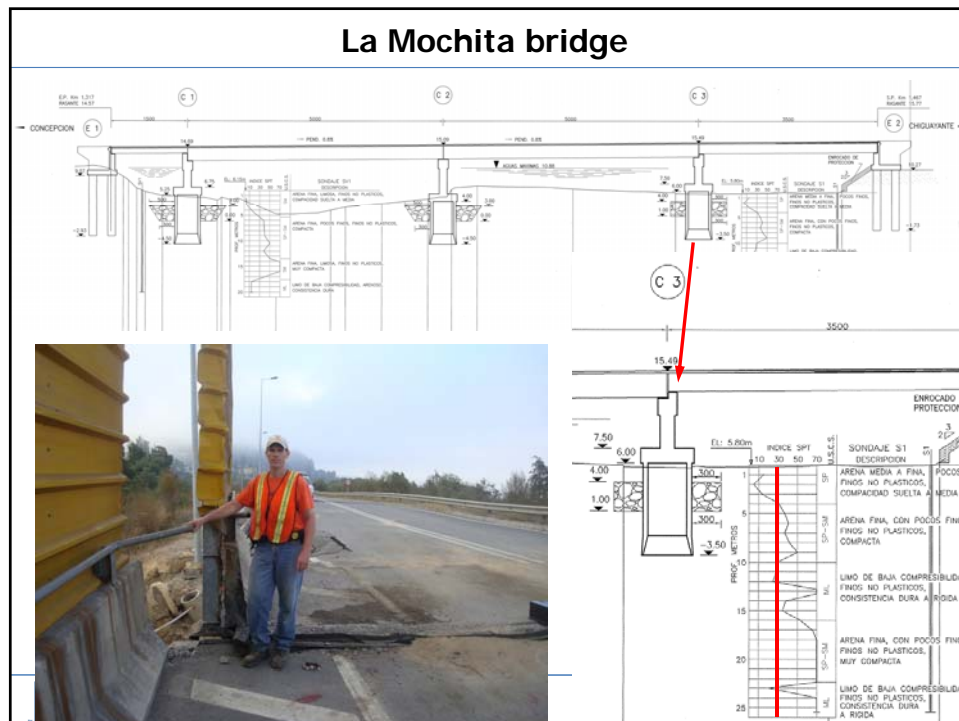


Llacolén bridge



- Measured $p_{ga} \sim 0.4g$ (downtown Concepción)

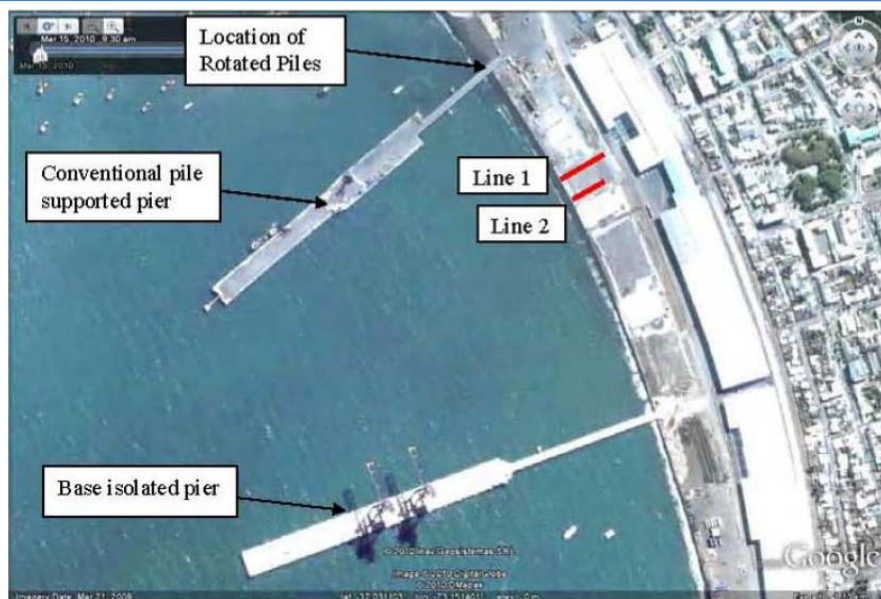




Effects of liquefaction at ports

- ◆ Several ports and wharfs damaged by liquefaction and lateral spreading, particularly Port of Coronel and Port of Concepcion
- ◆ Conversely, several ports suffered little to no damage, particularly Port of Valparaiso and Port of San Antonio

Port of Coronel



Port of Coronel



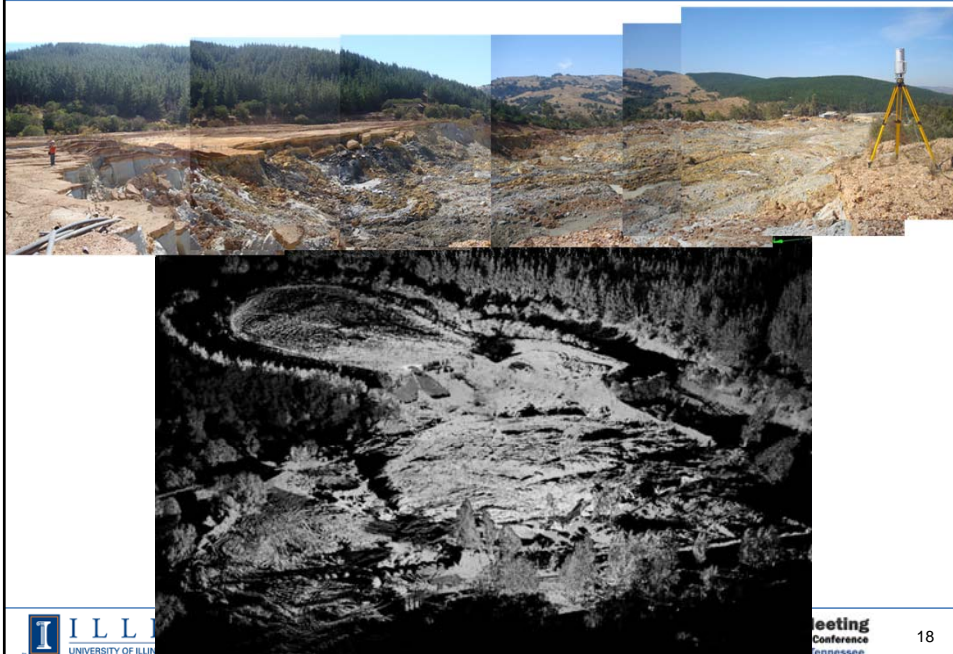
Port of Coronel

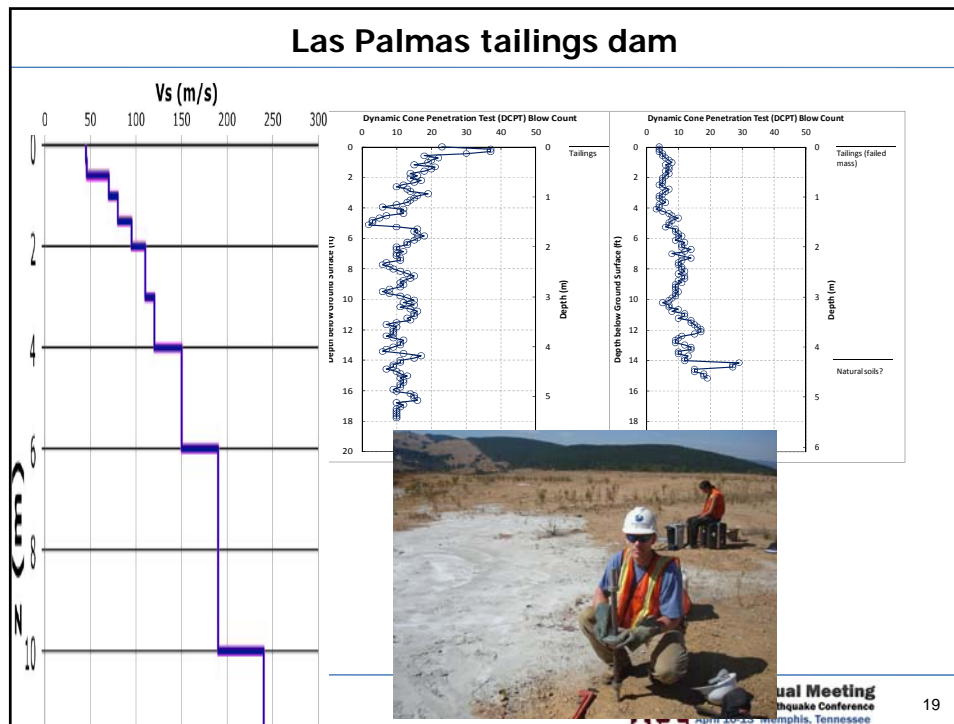


Dams & tailings facilities

- ◆ Overall, dams and tailings facilities performed well
- ◆ However, Las Palmas tailings dam suffered a massive liquefaction flow failure, killing a family of four (the facility operator)


Las Palmas tailings dam






Building performance

- ◆ Overall, well-engineered buildings performed adequately
- ◆ However, GEER investigated two notable sites where buildings settled and tilted as a result of liquefaction



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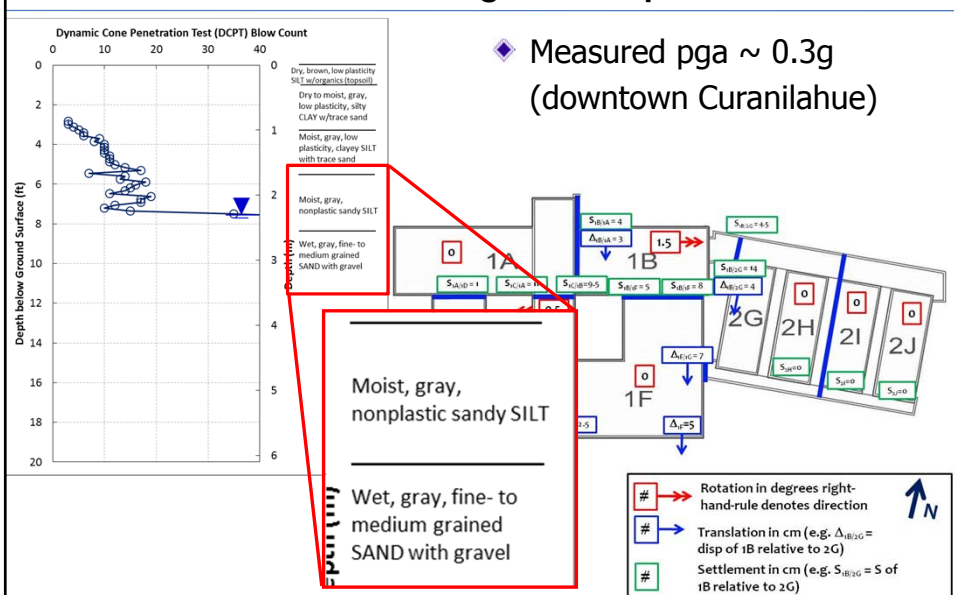
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Curanilahue regional hospital



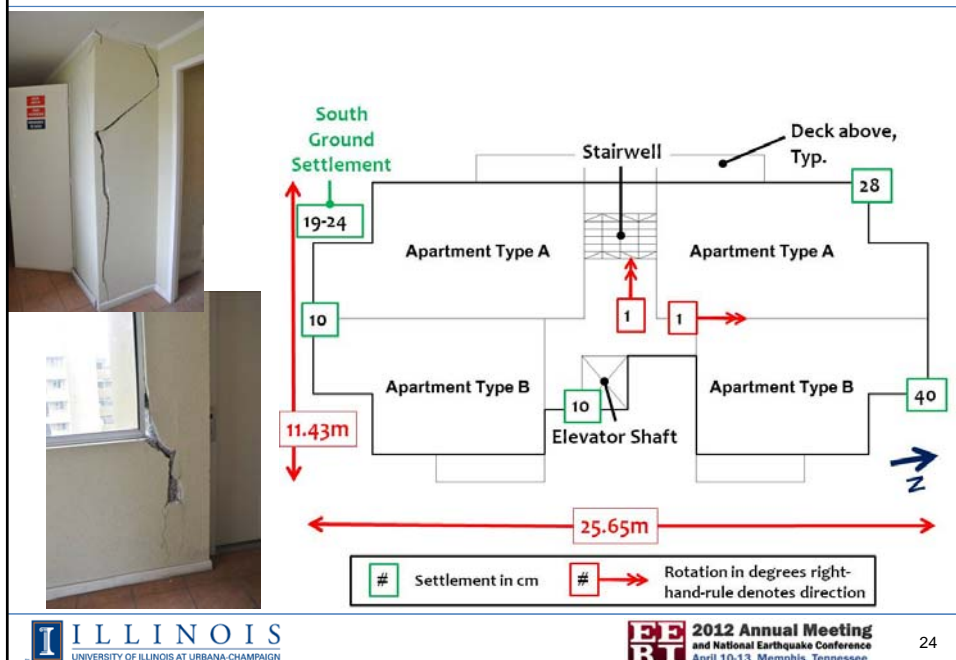
Curanilahue regional hospital

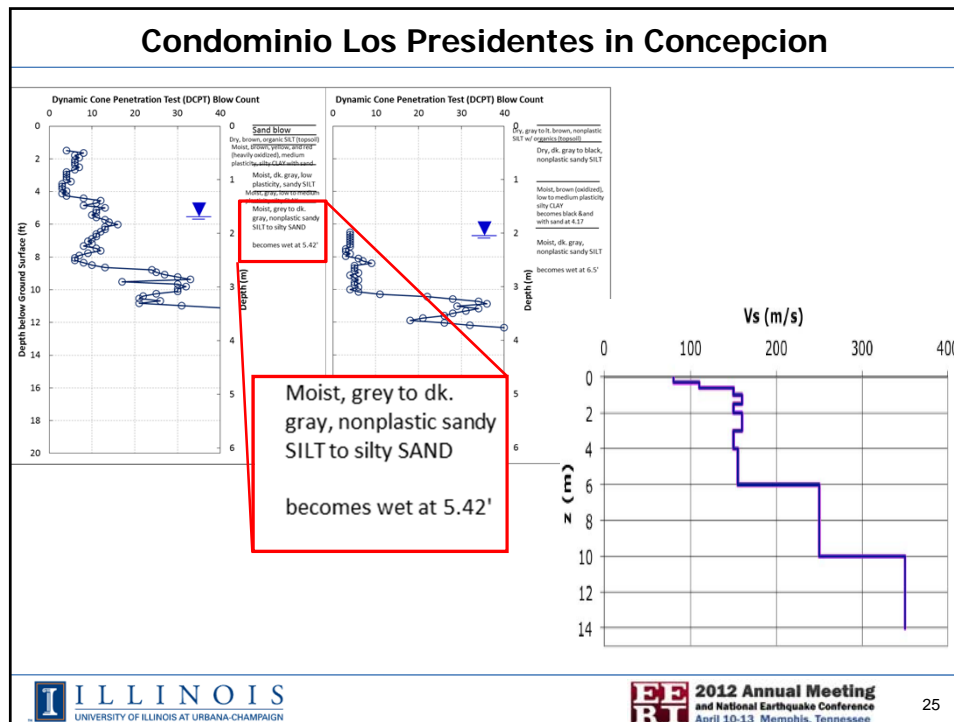


Condominio Los Presidentes in Concepcion



Condominio Los Presidentes in Concepcion





Conclusions

- ◆ Widespread liquefaction in alluvial deposits and artificial fill consisting of clean sands to sandy silts
- ◆ Bridges along Bio-bio River near Concepcion suffered significant damage, leaving no bridges fully functional
- ◆ Important ports closest to epicenter suffered significant liquefaction and lateral-spreading induced damage
- ◆ Particularly important liquefaction flow failure occurred at large tailings facility
- ◆ Liquefaction-induced building settlement and tilting occurred in silty soils