Liquefaction Susceptibility of Reclaimed Calcareous Sand Deposits

MAKING WAVES IN GEOTECHNICAL ENGINEERING

Celebrating the career and achievements of V.P. Drnevich

Purdue University – May 1st, 2010

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Alaa K. Ashmawy

School of Engineering

Land Reclamation Projects in Dubai

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Construction-Geotechnical Challenges

- Reclamation done by rainbowing seabed dredge material
- Deposits consisting mainly of calcareous sand with shell fragments
- Post-fill densification by vibrocompaction
- Surface layer of compacted fill

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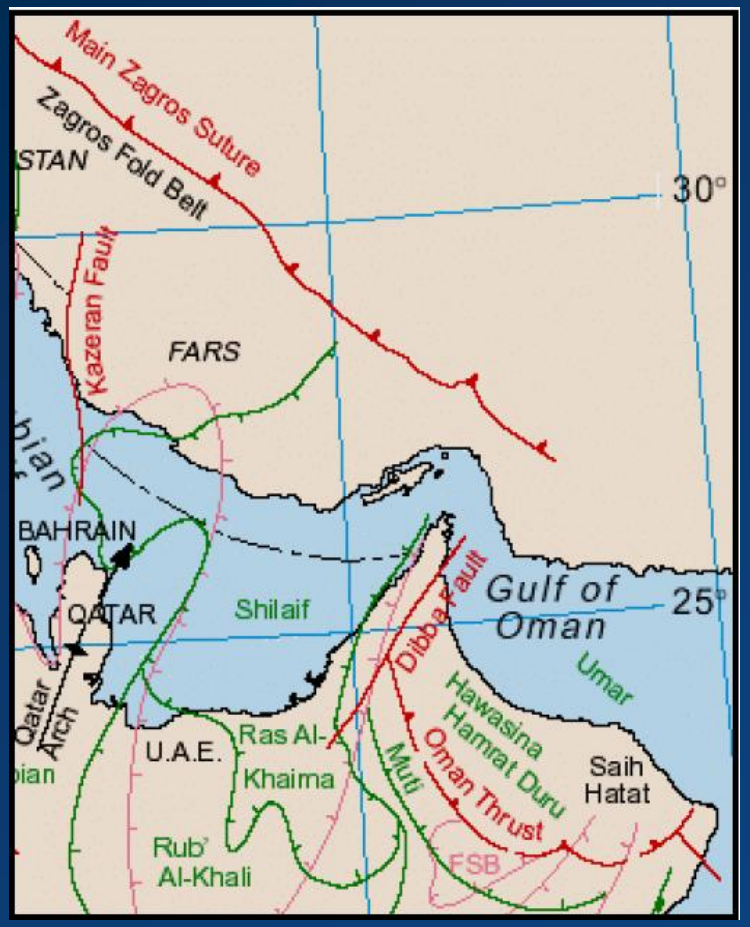
Seismic risk

- Dubai falls in low seismic hazard zone
- Seismographic data – limited to none
- Seismic geology data – abundant but proprietary
- Design PGA = 0.25 g (under revision)
- Cyclic test data on local sand – very limited
- Liquefaction behavior of calcareous sand – limited

Geologic Faults - UAE



Source: Ziegler (2001) GeoArabia, Vol. 6, No. 3.

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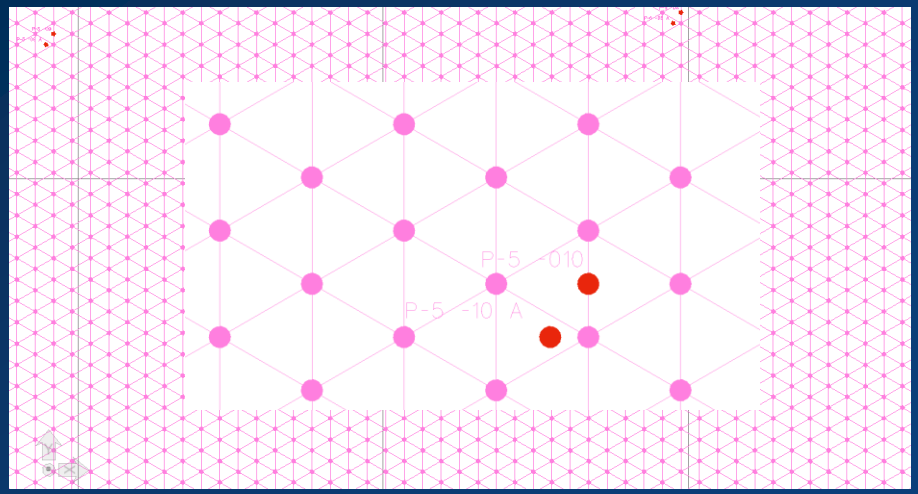
Vibrocompaction Data

- Information collected from six reclaimed land sites in the UAE
- Data includes site layout, as well as locations of CPT and SPT before and after vibrocompaction
- Data can be used to evaluate soil profile vis-à-vis liquefaction resistance, as well as spatial variability

Geotechnical Data

- Dense vibrocompaction grid
- Hundreds of CPT profiles, both pre and post densification
- Post densification CPT taken at fixed locations relative to the vibrocompaction grid



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Liquefaction susceptibility of calcareous sand

- Calcareous sands are much more susceptible to particle crushing. As a result, CPT values are low
- Need for undrained cyclic testing to properly define CSR required to cause liquefaction
- Discrete element modeling and image analysis of grain shape can assist in evaluating liquefaction susceptibility of calcareous sand

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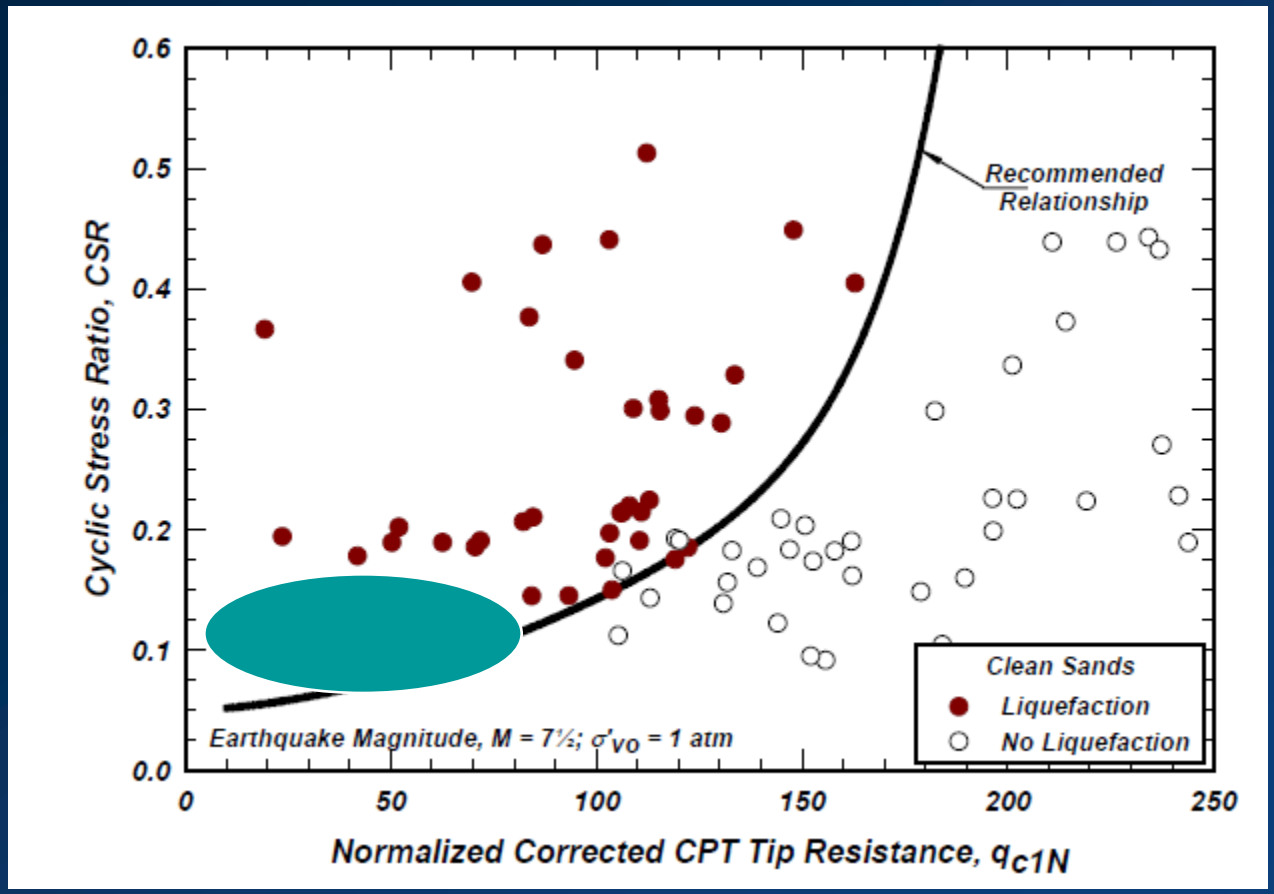
Liquefaction Potential Assessment from CPT



Robertson & Wride, 1998

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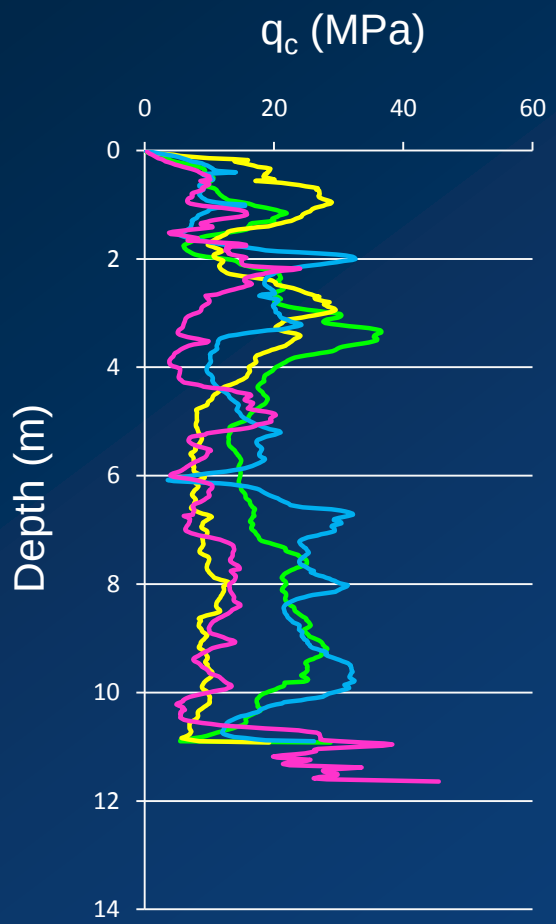
Spatial Variability Pre and Post Densification



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Quantification of Spatial Variability

- Cross correlation of CPT soundings results in cross-correlation functions of different characteristics
- Similarity descriptors are obtained from the cross-correlation function (Rabens 2000)
- Technique used to determine best location for subsequent CPT soundings
- Can be extended to define spatial variability of site

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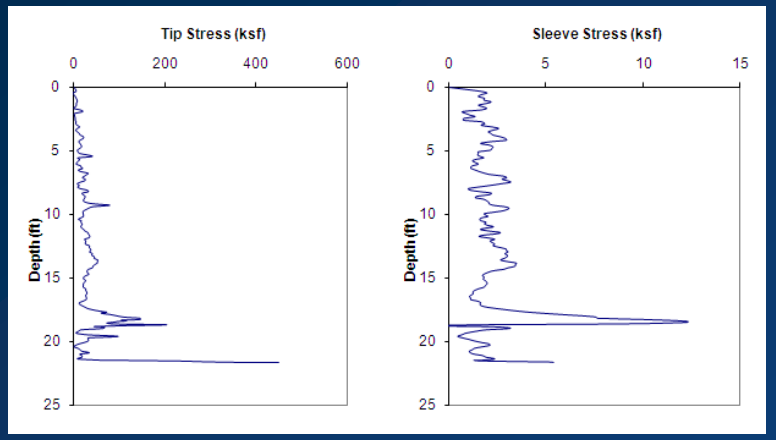
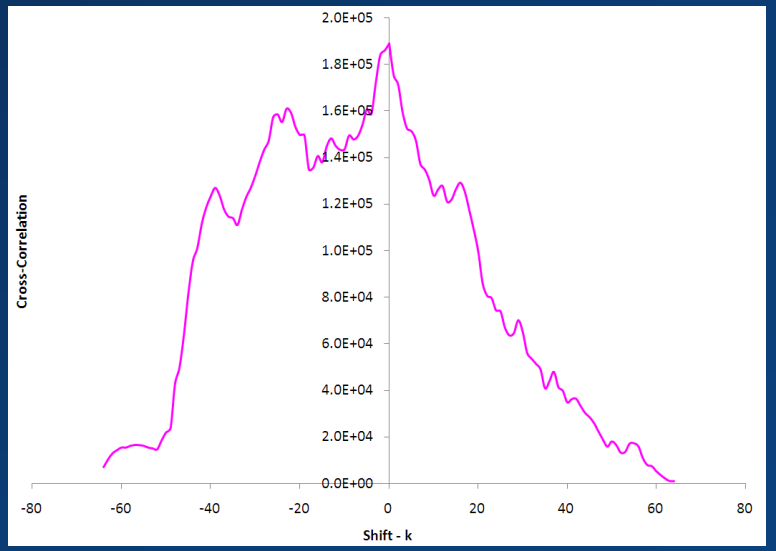
Implementation at Site A – Palm Jumeirah

- Area
- Mean
- Mode
- Standard Deviation
- Skewness





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Acknowledgements

- Shad Khan, Guido Freitag (Keller Grundbau)
- Kathryn Gunberg, Russell Green (Virginia Tech)
- Guy H. Rabens (UES Florida)

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