GeoEngineering Centre at Queen's—RMC, Queen's University
Ellis Hall, 58 University Avenue, Kingston ON K7L 3N6, Canada
613 533 3160 info@geoeng.ca

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ALEX BURNETT, MSC (2015)

RESEARCH SUMMARY

- LARGE SCALE TEST FACILITY PREPARED WITH WINDOWS TO OBSERVE SAND MOVEMENTS AROUND PIPE DISPLACED LATERALLY
- TEXTURE OF OLIVINE TEST SAND TRACKED USING DIGITAL CAMERAS
- TESTS ON 250MM AND 600 MM OIL PIPELINES, AND AT DIFFERENT BURIAL DEPTH RATIOS
- IDENTIFICATION OF FAILURE ZONES AND BANDS OF LOCALIZED SHEAR FAULURE
- DATA BEING USED BY COLLABORATORS TO EVALUATE THEIR FINITE ELEMENT ANALYSES

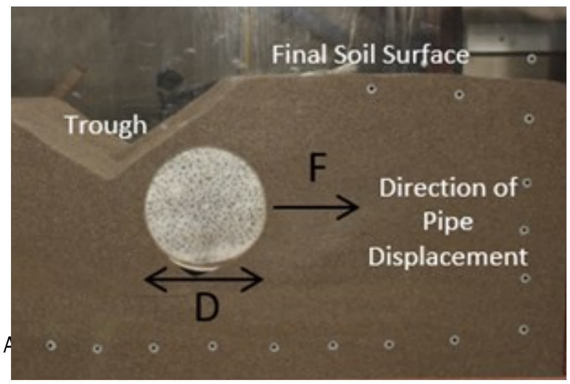
HIGHLIGHTS

- **Collaboration with Drs. Kenny and Hawlader at Carleton University and the Memorial University of Newfoundland**
- **Collaborative Research and Development project with the Wood Group (Aberdeen/Houston)**
- **Soil deformation and strain data of greatly improved quality compared to previous test programs**

INVESTIGATION OF FULL SCALE HORIZONTAL PIPE-SOIL INTERACTION AND LARGE STRAIN BEHAVIOUR OF SAND

Situations arise when buried oil and gas pipelines are subjected to ground movements. These include deformations imposed by iceberg keels over submarine pipelines off the coast of Newfoundland, and for transmission pipelines passing across slopes experiencing down-slope movements. Work is underway to develop nonlinear computer models to capture details of the soil-pipe interaction, including passive and active soil zones, and regions of localized failure (shear bands). Research by Alex Burnett has provided high quality experimental data for use in evaluating and calibrating those computer models.

Firstly, a new test chamber 5.5m long, 0.9m wide, and 1.8m deep was defined within the West test pit of the GeoEngineering Laboratory. The new chamber was fitted with four windows, through which pipe and soil deformations were monitored. A series of experiments were then conducted where pipe segments were pulled horizontally through the soil, examining the effect of different pipe diameters, burial depths, and soil densities. Tests provided detailed evidence of the lateral forces that develop on the pipe, lateral and vertical movements of the test pipes, and the soil response monitored during the test using digital photography. Post-test analysis was then used to calculate soil velocities and strains.

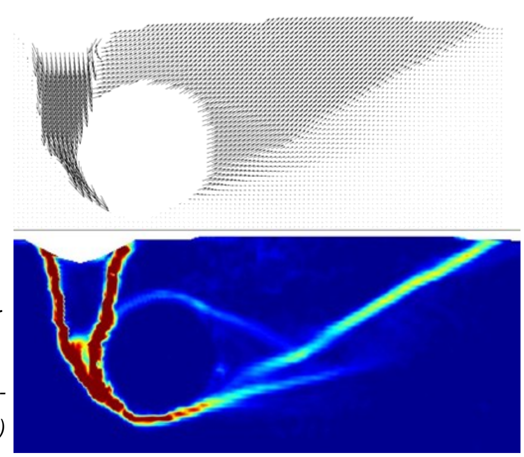


View of moving pipeline through the window part-way through a lateral pulling experiment showing the pipe, and changes in the geometry of the ground surface.

Supervisors:
W. Andy Take, PhD, PEng
Associate Professor and Canada Research Chair in Geotechnical Engineering
andy.take@queensu.ca tel: 613 533 3124
Ian D. Moore, PhD, PEng, FCAE, FEIC , FCSCE
Professor and Canada Research Chair in Infrastructure Engineering
ian.moore@queensu.ca tel: 613 533 3160
Sponsors: The Wood Group, NSERC and CFI

DIGITAL IMAGE CORRELATION

Dr Andy Take and his graduate students have been at the forefront of developing Digital Image Correlation techniques for use in monitoring soil deformations, and calculating strains from those displacements. Recent improvements to his GeoPIV software provide better treatment of particle rotation and substantial reductions in noise associated with displacement gradients (for strain estimates). Alex used the latest software to analyze soil movements, and to identify and interpret the different soil zones in front of, above, and behind the moving pipe. Plots of shear strain provide clear evidence of location and evolution of shear bands not previously available.



Shear strain distributions (right) calculated from particle displacements (above)