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Depth Beyond Knowledge™

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RESEARCH SUMMARY

EXPERIMENTAL RESPONSE OF A PILE IN SAND UNDER STATIC AND CYCLIC LATERAL LOADS

3.5M LONG INSTRUMENTED TEST PILE

TESTING IN SAND UNDER ONE-WAY AND TWO-WAY CYCLIC LOADING

MEASUREMENT OF AXIAL STRAINS & LATERAL EARTH PRESSURES

OBSERVATIONS OF ELASTIC AND PLASTIC SHAKE-DOWN

EARTH PRESSURE MEASUREMENTS DIFFER FROM CONVENTIONAL DESIGN MODELS

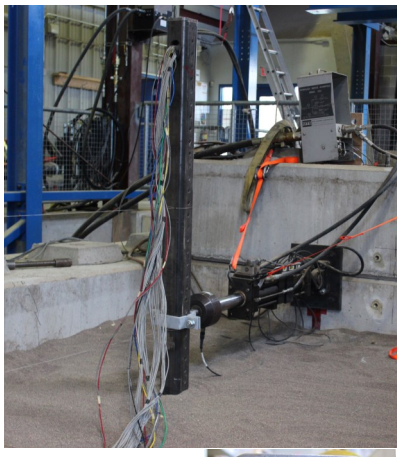
FUTURE PROJECTS MAY INVESTIGATE PILE GROUP EFFECTS ON LATERAL PRESSURES

Piled foundations under offshore structures are often subject to cyclic lateral loads due to wind, wave, ice or ship impacts. Design of these structures generally employs simplified lateral earth pressure distributions inferred from pile tests. Direct measurement of earth pressure is difficult, particularly under cyclic loading, so field & laboratory studies have used strain to calculate pile curvature and bending moment, and then calculus to estimate lateral forces. New contact pressure sensors (see below) are now available, and these have been used to make direct measurements of lateral earth pressure on a vertical test pile subject to cyclic lateral loading. Tests conducted using the large scale buried infrastructure test facilities at Queen's included 'one-way' (loading between the test load & zero) and 'two-way' (loading from +load to –load) lateral cyclic loading histories, featuring a range of lateral force magnitudes.

The test results showed that lateral earth pressures at low levels of applied force are dominated by elastic response with earth pressures that decrease linearly with depth for two-way load cycles, transitioning at higher loads into nonlinear earth pressures that feature a 'parabolic' distribution down to the point of rotation of the pile. One-way load cycles, however, adopt nonlinear earth pressures even at low load levels.

Comparisons show that distributed loads inferred from moment are almost the same as direct earth pressure measurements for most of the pile, but distributed load from moment is inaccurate near the ground surface.

Instrumented pile installed in the test pit loaded laterally using actuator.



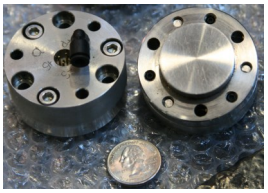
HIGHLIGHTS

- **Novel use of 'nulling' pressure sensors to obtain high quality earth pressure data on the test pile**
- **Testing showed differences between one-way and two-way cyclic lateral loading**
- **Pegah is now working for SPL, Toronto**

USE OF TALESNICK 'NULLING' SENSORS

The test pile was fabricated from a rectangular hollow steel section cut into two pieces, milled to have overlapping flanges, and then fastened together using countersunk screws. This provides ready access to the inside of the test pile so that strain gages and contact pressure sensors can be installed. The 'null' sensors used to measure contact pressures are the active earth pressure cells developed by Talesnick which use internal pressures within the sensor to 'null' the strain (restore it to zero). This makes the sensor essentially rigid, with unit calibration factor that is independent of soil stiffness, and the same whether the soil is loading, unloading or reloading. These sensors provide performance that is superior to conventional earth pressure sensors that deform under load and provide readings that are strongly affected by changes in soil stiffness.

Test pile cross-section Talesnick sensors



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