

**EFFECT OF SOIL COMPRESSIBILITY ON SAND  
RESPONSE TO LIQUEFACTION AND LATERAL SPREADING**

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## ABSTRACT

This thesis focuses on sand liquefaction and associated lateral spreading in the free field, and explores the possibility of correlating them to the compressibility of the soil. For that purpose, various parameters associated to the sand compressibility are first compared for one sand (Ottawa F#55), and then one of these parameters (Constrained Modulus,  $M$ ) is correlated to the lateral spreading (lateral displacement) measured during liquefaction in centrifuge model tests in the same sand.

The compressibility parameters are obtained in normally and overconsolidated sand from regular consolidation tests, as well as from settlement measurements during centrifuge spinning of sand-filled rigid and laminar boxes. Dry pluviation, water sedimentation, and hydraulic fill methods of deposition are used in these consolidometer and centrifuge tests, so as to evaluate the effect of sand fabric on compressibility. Liquefaction and lateral spreading responses of the normally consolidated and overconsolidated sand, are studied by subjecting inclined centrifuge model deposits in the laminar box to base shaking.

Specifically, the following centrifuge and laboratory tests on Ottawa F#55 sand are conducted:

- three liquefaction centrifuge tests of inclined sand deposits in a laminar box, using dry pluviation technique as deposition method. Settlements were also measured in these tests;

- two centrifuge tests with settlement measurements in a rigid container using dry pluviation and hydraulic fill deposition techniques; and
- eighteen consolidometer tests .

The results of these tests are reported throughout the thesis, including a study of sand compressibility for different deposition methods, and the relation between sand compressibility and lateral spreading during liquefaction. The results of the centrifuge and consolidometer tests are also compared with results of previous tests performed by other researchers using Ottawa F#55, Nevada, and Scaled sands. It is found that: (i) the author's results are comparable to those of the other researchers; (ii) sand deposited by hydraulic fill tends to be more compressible than the same sand deposited by dry pluviation of the same density; (iii) other things being equal, the constrained modulus,  $M$ , decreases in all tests when the void ratio of the sand,  $e$ , increases; (iv) in terms of liquefaction effects, the centrifuge results show that a soil deposit with low relative density that has been significantly overconsolidated, may behave like a NC deposit of significantly higher density; and (v) a consistent correlation is established from the three liquefaction centrifuge tests, between lateral displacement,  $D_H$ , and constrained modulus,  $M$ , with the lateral displacement decreasing as the modulus increases.