Technical University of Denmark

Influence of clay content on residual liquefaction in waves

Kirca, V.S. Ozgur; Sumer, B. Mutlu; Fredsøe, Jørgen

Published in:
Abstract Book of the 34th International Conference on Coastal Engineering

Publication date:
2014

INFLUENCE OF CLAY CONTENT ON RESIDUAL LIQUEFACTION IN WAVES

V.S. Ozgur Kirca, Istanbul Technical University, kircave@itu.edu.tr
B.Mutlu Sumer, Technical University of Denmark, bms@mek.dtu.dk
Jørgen Fredsøe, Technical University of Denmark, jf@mek.dtu.dk

INTRODUCTION

Seabed soil may undergo residual liquefaction under the action of water waves where the effective stresses between the individual grains vanish, and therefore the water and sediment mixture acts like a liquid. This phenomenon has been studied quite extensively, especially in the last two decades (see Sumer, 2014 for a detailed review). In those studies on wave-induced residual liquefaction, the seabed has been considered to contain one type of soil such as silt, or sand. However, it is not uncommon that the seabed contains clay, and therefore the seabed soil in these cases behaves as a composite soil such as, for example, clayey silt or clayey sand. This study presents the results of an experimental investigation of the influence of clay content on residual liquefaction of seabed beneath regular progressive waves. An elaborate journal paper on the subject has recently been accepted for publication, which can be consulted for details (Kirca et al., 2014).

EXPERIMENTS

Experiments were conducted in a 26.5 m x 0.6 m wave flume, specifically constructed for liquefaction tests. In the middle of the flume length, a 0.4 m deep and 0.78 m long soil pit was installed beneath the bottom, such that the top level of the soil in the pit became flush with the flume bed (Kirca et al., 2014). Water-surface elevation measurements were conducted on the flume as well as pore-water pressure measurements across the soil depth at five points. These measurements were synchronized with video recording of the liquefaction process from the side. The range of tested wave heights was H = 7.6 - 18.3 cm, whereas a constant wave period T = 1.6 s, and water depth h = 55 cm. was used. Experiments were, for the most part, made with silt (d_{50} = 0.07 mm) and silt-clay mixtures, which were complemented with some tests made with sand-clay mixtures. The clay used was the blue clay, commercially available in Denmark.

RESULTS

The experiments showed that the influence of clay content on wave induced liquefaction is very significant. Susceptibility of silt to liquefaction (i.e. the rate of pore-water pressure buildup) is increased with increasing clay content, CC, up to $CC \approx$ 30% beyond which the mixture of silt and clay is not liquefied (Figure 1). It may be noted that the latter limit, $CC \approx$ 30%, is clay specific. Furthermore, it was seen that when clay is added, the duration during which the soil stayed in liquefied state is significantly extended (Figure 2). In the experiments with sand-clay mixtures, three different sands were used, namely d_{50} = 0.17, 0.4 and 0.9 mm. These tests show that sand may become prone to liquefaction with the introduction of clay, contrary to the general perception that this type of sediment is normally liquefaction resistant under waves. For instance, sand with d_{50} = 0.4 mm was liquefied with a clay content of CC = 10.8% while sand with d_{50} = 0.17 mm was partially liquefied with a clay content as small as CC = 2.9%.

Finally remarks are made as to how to check for liquefaction potential of clayey soils exposed to waves in real life situations.

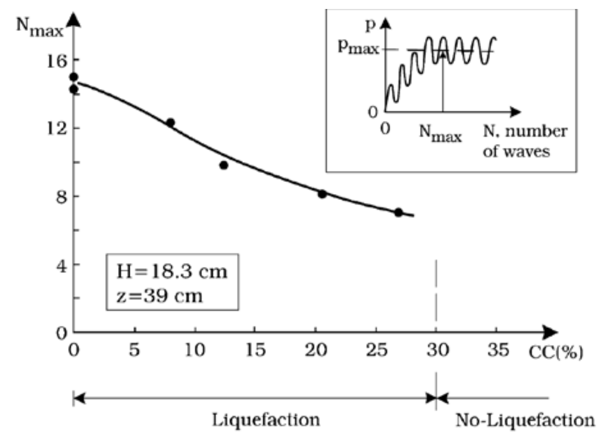

Figure 1 - Number of waves for pressure to reach its maximum value at soil depth 39 cm for H =18.3 cm.

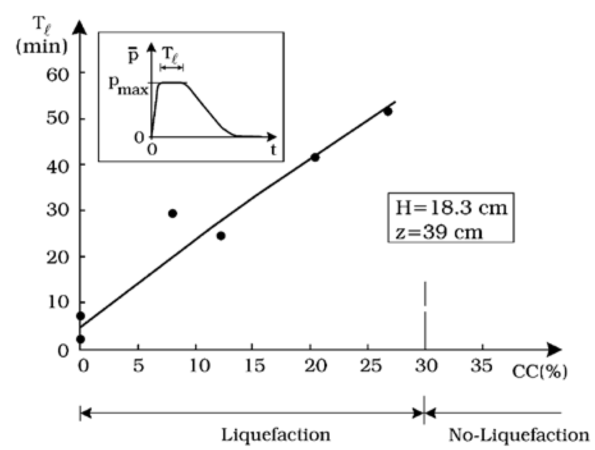

Figure 2 - Time during which the soil remains in the liquefaction state at soil depth 39 cm for H = 18.3 cm.

ACKNOWLEDGEMENT

We acknowledge the support from the EU commission, through the FP-7 project MERMAID (G.A. No. 288710).

REFERENCES

Kirca, Sumer, Fredsøe (2014): Influence of Clay Content on Wave-Induced Liquefaction, J. of Waterway, ASCE (accepted for publication).
Sumer (2014): Liquefaction around Marine Structures, World Scientific, Singapore, 472 pp.