Influence of liquefaction on scour around offshore monopile foundations

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Scour hole formation around offshore monopile foundations is a threat for the structure's stability. Large uncertainty leads to conservatism in design codes and hence to high construction costs. Under the same hydrodynamic loading as for scour hole formation the soil can liquefy due to structural vibrations or waves. The aim of this study is to investigate the effect of liquefaction from vibrations of offshore monopile foundations on scour by performing scaled flume experiments, where liquefaction is induced by a monotonic excess pore water pressure (EPWP) gradient.

Liquefaction is known to be caused by EPWP build up under cyclic loading and normally last for limited time, because the built up pore water pressure drains off to the bed surface. Therefore, monotonic EPWP is introduced at the bottom of a pile, which is placed in a flume filled with fine sand. During the experiments a current is used to induce scour, while the EPWP is used as independent variable.

In the experiments the EPWP gradient is observed to take some time to bring the sediment into liquefaction. First the soil is lifted, but as soon as the vertical resistance of the sand is lost a current brakes trough. Subsequently, the flow concentrates in one feeder and sediment is transported as if it is in suspension. When this occurs depends on the magnitude of the EPWP. During the scour experiments this resulted in a sudden collapse of the scour hole. The scour depth decreased and a new balance arises between slope sliding and erosion due to the horseshoe and lea-wake vortices.

It is concluded that under liquefaction the equilibrium scour depth decreases for a larger negative excess pore water pressure gradient. Furthermore, the angle of repose is decreased. The equalising effect of liquefaction on the scour hole is also expected in field situations, but the degree is unknown. The potential gain of the decreased scour depth to the structure's stability is limited, since the liquefied area may not be expected to provide any contribution to the stability of the structure.

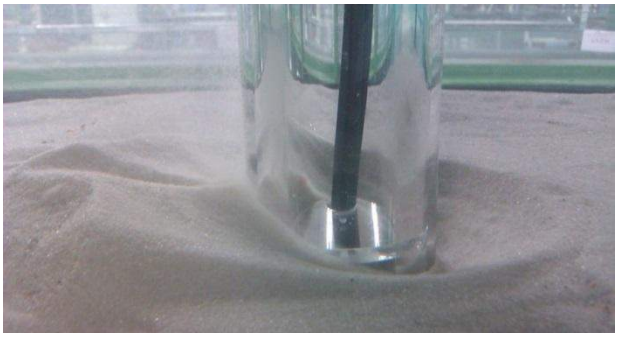

Figure 1. Initiation of scour hole formation during experiment