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Development of a new T-bar for the geotechnical centrifuge at TU Delft

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An accurate estimation of undrained shear strength of clay seabed is important for interpreting lateral pile-soil interaction response. The cylindrical T-bar is a widely used site investigation tool for profiling the undrained strength (su) of soft soils. As such, a new miniature T-bar penetrometer is designed and fabricated at TU Delft for characterization of the undrained shear strength profile of clay layer in centrifuge models, and OCR profile can be then derived from undrained shear strength profile with known pre-consolidation stress level. The miniature T-bar penetrometer head is a cylinder of 5 mm in diameter and 20 mm in length and the miniature T-bar penetrometer head is connected with a rigid shaft (Figure 1(a)). The T-bar penetration resistance along the depth of clay sample can be obtained and further interpreted into the undrained shear strength profile.

Rate of penetration is one of the key parameters that govern the drainage behaviour of soil response around the T-bar and the resulting penetration resistance. A very low rate of penetration leads to partial pore water dissipation and thus partial drainage condition. When a very large rate of penetration is applied, the fully undrained condition is achieved. However, the effect of T-bar penetration rate has not previously been fully examined for normally consolidated and over consolicated clay in the centrifuge. In this paper, the tip resistance profile of T-bar penetration tests under different rates of penetration is analyzed to obtain undrained shear strength profile of clay soils.

A series of T-bar tests are conducted in both normally consolidated and slightly over consolidated clay samples at 100 g. The sample drainage state is tested by varying the rate of penetration from 0.01 mm/s to 5 mm/s. The results are interpreted by two methods: (i) the conventional method by converting the measured penetration resistance to soil strength using a single bearing factor, indicating a full-flow mechanism at failure [1]; and (ii) an approach considering soil buoyancy and a reduced bearing factor arising from the shallow failure mechanism, indicating the shallow correction procedure has a significant influence on the soil strength profile inferred from a T-bar penetrometer test [2]. The interpreted undrained shear strength profile provides soil property and OCR information for further monopile tests in the centrifuge, allowing a comprehensive study of the soil-structure interaction on soft soils.

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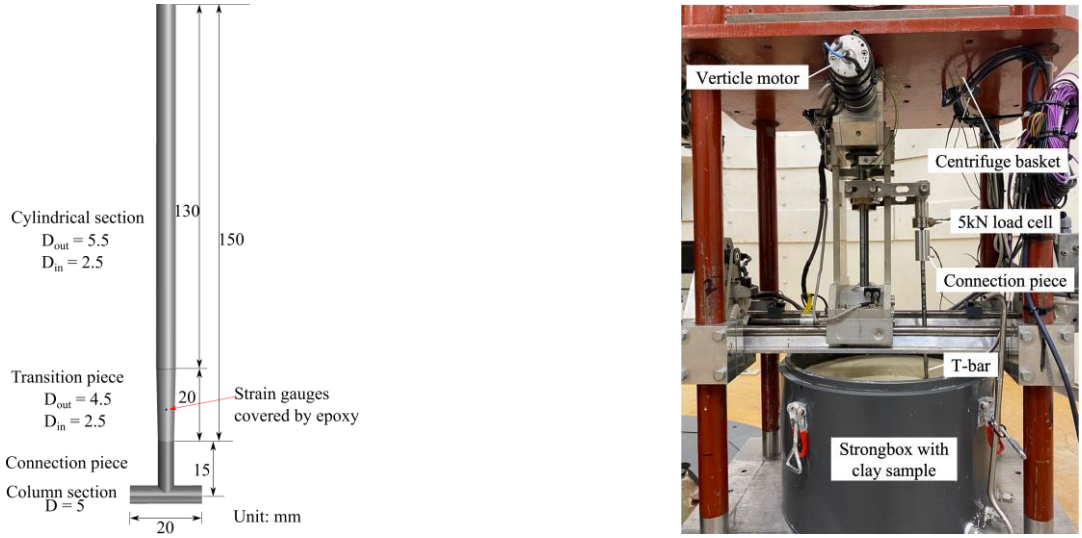

Figure 1: (a) Sketch of T-bar; (b) T-bar test setup in the centrifuge.

Contributor statement

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