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Centrifuge experiment on the slurry trench stability in the clay ground.

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Introduction: This paper reports on the centrifuge experiment on the slurry trench stability in the clay ground. The modeled trench was 15x12x1.1m (depth/length/width) in the prototype scale and the aim of the experiment was to observe the deformation and failure mechanism during the lowering of the slurry. This is an extension to the work already performed (Katagiri et al., 1996), in which the trench was 15x6x1.1 m (depth/length/width) and 15 m deep under 2D condition, respectively.

Soil and preparation method: The model ground was made from Kawasaki clay with following properties: ρ_s=2.704 (g/cm^3), w_L=52.8% and w_P=29.0%. The clay ground was prepared in the strong box in five layers, the height of the bottom layer was 7.5 cm and 5 cm for each next one, in total 27.5 cm of model multi-layer ground. The clay mud of water content of 80% was poured into the strong-box to create a layer, covered by filter paper and loading plate, and the pre-consolidation loading was applied. Sufficiently long time was allowed to complete the consolidation. The pre-consolidation loading (Fig. 1a) was designed to be greater than the geostatic pressure developed in the prototype. This results in model ground being slightly over-consolidated with OCR of 1.2~2.0, except for the top layer, which was highly over-consolidated (Fig. 1).

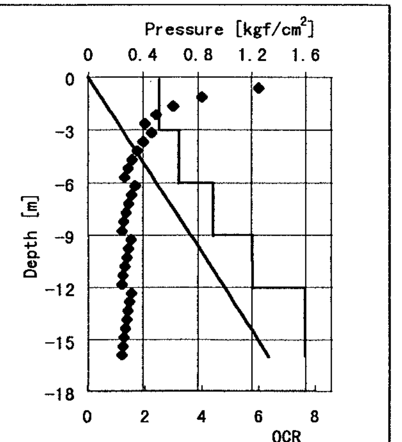

Fig. 1 Geostatic and loading pressure, OCR

Figure 2 gives the results from the unconfined compression tests carried out after the centrifuge experiment together with the values obtained from the previous tests. It is seen that the model ground was prepared with comparable strength properties with the previous experiment.

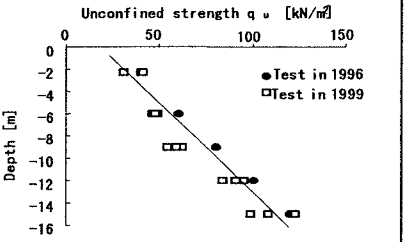

Fig. 2 Unconfined compression test results

Experiment description: The strong container (800x400x250 mm) was divided into two parts. The slurry controlling system was inserted into the one part. The model ground was put on the 2.5 cm high sand layer into the other one. The trench was cut to be 25 cm deep, 10 cm long and 0.9 cm wide in model scale. A thin rubber bag was inserted into the trench in order to keep the shape of the slurry in the trench. The density of the slurry was 10.5 kNm^{-3}. A 5 mm thick sand layer was rained on the clay ground for drainage purpose. Prepared container was put in to the centrifuge and accelerated on 60G. The underground water level was maintained at the ground surface. The model was left flying for about 60 min. to allow a reconsolidation. When the settlement approached the asymptotic value, the process of the slurry lowering has begun.

Key words: centrifuge test, slurry trench, stability

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Results of the centrifuge experiment: Figures 3, 4 and 5 show the measured values of the settlement, the underground water and the slurry levels. (If not indicated otherwise, the height refers to the bottom of trench in prototype scale.) It was intended to set the clay surface at +15m, however due to the swelling and re-compression process during flying, the clay surface settled at +15.39m and the ground level at +15.69m (including the drainage sand layer). A point of significant importance was found when the ground water level exhibited a sudden decrease at 89.35 min. of time. The change in the underground level indicates a motion of soil into the space of trench. This turning point was defined as the critical or yield point, as it was introduced in the previous work. However, it is questionable if this point represents a failure point, as far as it is extremely difficult to clearly define the failure in the clay ground. The Figure 4 shows the measured settlement at two points, close to the trench and fairer. It is seen that the critical (yield) point divides the curve into two parts where the settlement increases non-linearly (before) and almost linearly (after the point) to the slurry lowering process. Figure 5 shows the relationship between subtracted settlement and the underground water level. This curve sensitively captures for the change in the soil behaviour and the critical point may be easily found. Another point, called point *I*, indicates the beginning of settlement due to the slurry lowering.

The comparison between this experiment and those already performed is given in Figure 6. The critical point was defined at the slurry level -0.9 m under the clay surface, what fits well with the previous experiments. Evidently, the relationship between the ratio L/B (length/width) and ΔH, difference between the slurry level and the clay surface is not linear. The 3D effect is remarkable in the case of L=6m while L=12m case is closer to 2D condition.

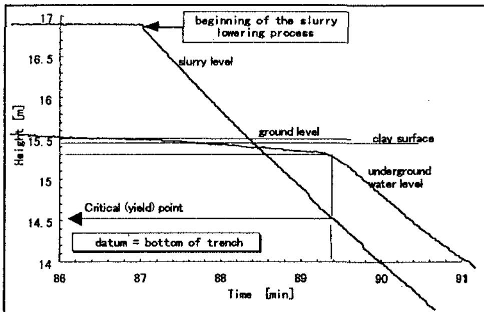

Fig. 3 Underground water and slurry level during the lowering process

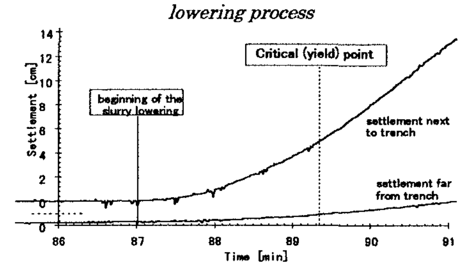

Fig. 4 Measured settlement

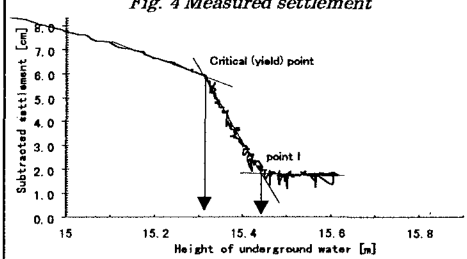

Fig. 5 Relationship between settlement and underground water level

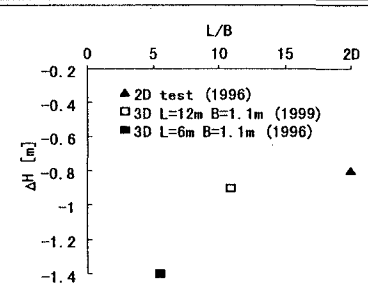

Fig. 6 Critical point versus the length ratio

Conclusions: The critical (yield) point was found when the slurry level decreased at -0.9 m under the clay surface. This result is in very good agreement with previously performed experiments (Fig. 6). The accompanied settlement was as large as 5.4 cm, what is tolerable deformation on the building site.

Reference: Katagiri, M. et al. 1997 "Behaviour of slurry trench wall constructed in multi clay layers during lowering of slurry water level", Proc. of 32nd Japan National Conference on Geotechnical Engineering. Vol. 1: 1821-1822 (in Japanese)