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Type(English)	Summary

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論文要旨

THESIS SUMMARY

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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This thesis describes the hypothesis behind the mechanical behavior of cantilever type large diameter steel tubular pipe (CSTP) retaining walls embedded in soft rock. Cantilever type retaining wall has several advantages, it can be constructed in very simple process in a limited space, which is a common condition in highly populated urban area. However, the applications of cantilever type retaining walls are limited to a moderate retained height of earth in relatively soft foundation conditions. Limitations arises from large displacements caused by the flexural bending and wall deflection as well as less redundancy of the structure without additional reinforcing mechanisms, such as tie-back plates or ground anchors in soft grounds. On the other hand, the wall deflection can be significantly reduced in relatively hard mediums such as soft to hard rocks. Hence the excessive deformation of large height cantilever wall could be untangled by large diameter cantilever steel tubular pipe (CSTP) walls embedded in hard mediums, even with relatively small embedment depths. For the application of these CSTP walls in to relatively hard mediums no specific design guidelines are available up to date.

Current design practices adopted from the concept of beams on elastic foundation requires minimum embedment depth (d_e) of $'3/\beta'$ for the application of CSTP walls, where $'\beta'$ is a characteristic value related to the subgrade reaction of the embedded medium and flexural stiffness (EI) of the wall. Attributing to the assumptions made in this design method, required minimum embedment depth increases with increasing EI value, regardless of the retained height. This phenomenon yields unrealistically large embedment depths even for relatively short cantilevered walls even in hard mediums, this is the major drawback of this design method. It causes difficulties in the pile installation, especially for the large diameter piles into the ground with considerable strength and stiffness, such as soft rock. Therefore, if this type of retaining wall can be constructed with a rational embedment depth in the soft rock type ground with an additional safety margin over the ultimate loads, its applicability can be increased, which could contribute in the reduction of construction time and cost. For the reduction of the embedment depth smaller than the one determined by the current design practice, both the survivability limit and ultimate limit should be reasonably examined in the design. Therefore, the process from the design conditions to the failure should be well studied by physical means, such as a physical modelling. To understand the mechanical behavior of CSTP walls embedded in soft rock and to investigate the influence of $'d_e/\beta'$ values on the deformation and failure behavior of the walls, a series of model tests were conducted using TIT-Mark-III geotechnical centrifuge under static loading conditions. Dynamic stability of a specific prototype also investigated using a centrifuge model.

Deformation and failure behavior of CSTP walls were investigated by using a simplified rectangular wall model with the simulation of excavation and additional loading inflight. A centrifuge modelling system has been developed, in which the loading process from design condition to the ultimate failure conditions can be simulated on a simplified rectangular wall embedded in soft rock at a constant centrifugal (50g) acceleration. For the stiff model grounds, two different artificial soft rock models namely sand rock and mud rock were developed using sand-cement-clay mixture. In-flight excavation and additional lateral loading processes were simulated by means of draining water from the wall front and feeding water to the retained soil side respectively. Outcomes reveal that, wall can stand in the design condition with relatively small embedment depth ($1/\beta$), and poses reasonable safety margin against ultimate loading conditions. Also a small increment in the embedment depth e.g., 0.5 m, can significantly increase the stability of the wall in rock type grounds.

As the observation of simplified wall models reveal the possibility of optimization, further investigations are necessary to develop a rational design concept. Therefore, the influential factors were investigated through a series of lateral load tests on large diameter steel tubular piles and steel tubular pile walls embedded in different soil profiles such as soft rock and soft rock overlain by sand. Similar to the

observation in simplified models, a small increment of embedment depth (1m) significantly increase the lateral resistance and highly controlled the deformation and failure modes of laterally loaded large diameter steel tubular piles embedded in stiff ground. Unlike soft mediums, a load bearing mechanism of shallow rock layers, provides large lateral resistance at relatively small pile top displacements ($1\% \Phi$), which diminish the influence of embedment depths. Observed deformation and failure modes reveals that, there is an optimum embedment depth from which the ultimate failure changes from ground failure to structural failure. Different failure modes were observed for the single pile and tubular pile wall with the identical embedment ($d_e=2\Phi$) and loading conditions in single soft rock layer. The former exhibited structural buckling and the latter was a clear wedge type ground failure. It reveals that the optimum embedment depth is deeper for the tubular pile wall than single pile. It also indicates that the rational embedment for cantilever tubular pile wall is larger than single pile with same cross section. Both, wall model and single pile with the $d_e=1.5\Phi$ in single rock layer showed the ground failure as an ultimate failure condition. However, the normalized ultimate resistance for single pile is about 1.6 times that of wall model and the wall model exhibited a clear wedge type ground failure, while the single pile showed more confined deformations. The difference in the observed ground failures at the ultimate condition of single pile and wall model embedded in single rock layer is highly influenced by the wall or pile width and thereby the mobilized subgrade reaction. Attributing to the 2-dimensional condition, the influence zone, which contribute to the lateral resistance for a unit width of the wall is much narrower compare to an isolated single pile. This phenomenon causes an increased stress level or strain in the shallow layer of the rock and resulting significant reduction in subgrade reaction. This mechanism causing large deflection of the wall compare to the condition of an isolated single pile. Eventual deterioration of subgrade reaction in the embedded zone causing a wedge type ground failure at the ultimate resistance of the embedded medium.

As the retaining walls are mostly associated to the lifelines and the residential areas, dynamic stability of CSTP wall is a major concern especially when we call for a short embedment depth than the current design practice. Stability of a specific prototype, CSTP wall with a retained height of 12m was investigated under dry and submerged backfill conditions with an embedment depth of $1.2/\beta$. Based on the deformations under dynamic loads, and the creep deformation characteristics of the CSTP wall it can be confirmed that the wall exhibits reasonable safety margin against the ultimate collapse even in a dynamic loading event. The imposed maximum load in the dynamic loading was about 1.2 times the ultimate load applied by static loading in the simplified wall model.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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