邊坡傾角對膠結不良砂岩淺基礎承載行為之影響

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摘要

本文旨在探討淺基礎位於不同邊坡角度(坡角為 10°、20°及 30°) 膠結不良砂岩層的坡頂(crest)之承載行為。本研究藉由室內模型基礎承載試驗觀察膠結不良砂岩層之承載行為與破壞機制，並檢討現有於邊坡坡頂之基礎位承載力方法的適用性分析。

本研究主要工作包含試體製作及模型承載試驗，模型材料以模擬地層(頭嵙山層)之砂塊攪拌後通過 30 號篩之岩屑粒料為主，經濕篩後含細粒料水溶液為膠結材，然後依照配比混合攪拌以高壓力壓密方式製作試體。待試體氣乾後，以人工削磨方式製作試驗條件之邊坡，而後進行承載試驗，並經由基礎試驗箱前方之強化玻璃視窗進行觀察拍照記錄試體之破壞過程。

研究結果顯示，位於邊坡坡頂膠結不良砂岩淺基礎的模型，其承載曲線和基礎位於水平地表膠結不良砂岩淺基礎的模型雷同，可略分為四個階段，即應力調整階段、線性階段、非線性階段及破壞階段。承載曲線的尖峰值即為試體的極限承載力，承載能力隨邊坡角提高而下降；傾斜地表 10 度的承載力約為水平地表的 91％，傾斜地表 20 度的承載力約為水平地表的 79％，傾斜地表 30 度承載力約為水平地表承載力的 63％。

實驗過程中，應力調整階段試體外觀無明顯變化，線性階段先於模型基腳邊緣因應力集中產生裂縫並隨荷重增加而生長。非線性階段中，開始發展剪裂破壞面，當剪裂破壞面發展完全時，此時為承載曲線之極限承載力，破壞階段中主動區往坡面滑動，承載力因而下降。試驗完成後，觀察試體並劃分主動區、被動區、輻射應力區與完整區等不同型態區域。

關鍵字：人造膠結不良砂岩、邊坡傾角、淺基礎模型承載試驗、極限承載力、破壞機制

Effect of Slope Inclination on the Loading Behavior of Shallow Foundation In a Poorly Cemented Sandstone

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ABSTRACT

This thesis aims to investigate the loading behavior of shallow foundation in poorly cemented sandstone slope where the slope angle is 10 degree,20degree and 30 degree .　In this thesis, an artificial weak rock was developed as the foundation material.　The mechanical behavior of the artificial rock is analogous to the natural sandstone.　A set of laboratory loading equipments for foundation model was assembled.

The samples were prepared and loaded in a steel box with the dimension of 60 cm x 30 cm x 65 cm.　To observe the fracturing of the specimen during test, a observed window was made on the upper and central part of one of the wall of the box using high strength glasses .　Then, twelve sets of model loading tests were performed in the laboratory.　Base on these tests, not only the bearing capacity but also the mechanisms of progressive failure are investigated by image processing analysis.　We explore the behavior of the shallow foundation of poorly cemented sandstone by the progressive failure and the analyzed results.

To prepare the model material the sandstone was first gently crushed and ground by a rubber hammer in order to appropriately represent actual grain size distribution of the natural sandstone.　After grinding, the rock grains passing #30 sieve and retaining on the #200 sieve were adopted as the basic model

material. The solution passing #200 sieve was used as the cementing material for producing the artificial soft rock model. The particles and the solution with fines were mixed thoroughly with the ratio of 1:1 by volume. After that, their mixture was poured into a model container with 300 mm in width, 600 mm in length and 70 mm in height. The load on the specimen was slowly increased up to 250 tons step by step. After the consolidation stage completed, the specimen was extruded from the container and was exposed to an electric fan for three weeks to produce an air-dried specimen; and the specimen was ready for a load bearing tests.

The results of model bearing test indicate that a load-settlement curve can be roughly divided into the incipient stage, the linear stage, the non-linear stage, and the final stage. The peak point of the load-settlement curve is the ultimate stress that decreases varies with slope angles. Generally speaking, the bearing capacity of 10 degree slope is approximately about 91 percent of horizontal specimens; the bearing capacity of 20 degree slope is approximately about 79 percent of horizontal specimens; the bearing capacity of 30 degree slope is approximately about 63 percent of horizontal specimens.

At the incipient stage, the specimens have no obvious cracks. And at the linear stage , cracks just beneath both edges of footing could be observed, these cracks were likely due to the stress concentration near both footing edges and extended outward with the increasing bearing load. At the non-linear stage, as the cracks grows completely, it reaches the peak point of the load-settlement curve and an active zone right under the foundation base was clearly formed. At the failure stage, the active zone slide toward the slope faces and the bearing stress decreases. After tests, the failure zones and mechanism were also identified. Failure zones were divided into the active zone, the transitional zone, and the passive zone. It was found that the bearing behavior on poorly cemented sandstone is distinct from the cases on hard rock or soil, with both

plasticity and brittle characteristics. The bearing capacity formulas commonly used for soil or hard rock is not necessarily suitable for the case of poorly cemented soft sandstone.

Key words：artificial poorly cemented sandstone、slope angle、shallow foundation、ultimate bearing capacity, load-bearing behavior.