膠結不良砂岩在不同應力路徑下之力學行為

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中文摘要

為了能夠進一步瞭解台灣中北部麓山帶地區出露之『極軟弱至軟弱』岩石之力學行為，本研究使用適用於此類材料之三軸試驗裝置。此裝置之試驗能量在一般硬岩與土壤三軸試驗儀器之間，以充分滿足軟弱岩石試驗之需求，並具有飽和試體及量測孔隙水壓之裝置。三軸試體之變形採用三軸室內局部應變、傳統三軸室外之變形量測，可以量得微應變下試體之線彈性乃至於大應變下材料之屈服行為。並在試體頂蓋及底座加裝剪力波元件以量得剪力波在試驗過程中的變化，並求得在 10^{-3}%應變下之彈性模數並配合微應變所量測之彈性模數相互驗證。

三軸室壓與軸向壓力可以用電腦做伺服控制，以進行應力歷史控制之試驗。本研究使用此一試驗裝置對所取得之軟弱岩石試體進行了一系列之壓密不排水，不同應力路徑下三軸試驗。

由研究結果顯示，軟岩試體，三軸試驗中在小應變下確實呈現線彈性之行為，且隨著有效圍壓的增加，其楊氏模數會有遞增情形發生。從應力應變行為來看，飽和試體都缺乏一般硬岩所常有之脆性力學行為，軟岩遇水軟化，影響強度勝鉅，試驗時引發之超額孔隙水壓，在低有效圍壓試驗條件下會顯現類似緊砂或過壓密黏土之膨脹性行為。在高有效圍壓試驗條件下，則呈現類似鬆砂或正常壓密黏土之壓縮性行為，其門檻值為有效圍壓 3MPa。不同應力路徑下強度與行為有明顯的變化，所以在工程應用上，應就其不同條件考慮個別參數分析以免錯估。本研究配合王慧蓉 (2001) 漸進降伏面模式進行模擬，結果可以合理描述軟岩的應力應變行為。

關鍵字：軟弱岩石, 三軸實驗, 應力應變關係, 降伏行為，應力路徑

Mechanical Behavior of Different Stress Path in a Poorly Cemented Sandstone

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ABSTRACT

A triaxial device was specifically built for the soft rock, and used to enhance our understanding of the weak and young rock formations in the central and northern regions of Western Taiwan. The triaxial cell was equipped with local strain measurement devices capable of monitoring strains less than 10^{-3} %, as well as external displacement sensors so that the behavior of soft rock from small strain, linear elastic state to yielding could all be observed. In order to confirm the measurements of E_{max}, the triaxial cell was also equipped with bender elements.

The axial and cell pressure were servo-controlled independently to enable stress path controlled tests to be performed. A series of consolidated undrained, stress path controlled triaxial tests have been conducted using this test device.

The results showed a linear elastic behavior of the soft rock during the small strain triaxial loading. As the effective confining stress increased the non-linear stress-strain relationship occurred at smaller strains. And from the observation of the stress-strain behavior of soft rock, that saturated specimens have less brittle behavior than typical hard rock.Based on its lithifation, the strength of soft rock reduces greatly. During these tests, the pore water pressure was generated in most cases. For the sandstone specimens, and the range of effective confining stress applied in the triaxial tests, the excess pore pressure changed from negative to positive as the effective confining stress increased. In low effective confining stress, the specimens showed more swelling behavior that similar to dense sand or OC-clay. In high effective confining stress, the specimens showed more compressive behavior that similar to loose sand or NC-clay. The liminal effective confinement between the two behaviors is about 3MPa.The strength and behavior has obvious changes under the series of consolidated undrained, the stress path controlled triaxial tests, so when using these parameters in the engineering problems, the parameter should always be considered in different situations. This research also adopted for modeling the mechanical behavior of soft rock in the presented work.A 3-surface model, a special version of the generalized transitional yielding approach by Huijung Wang (2001) was used, the result showed that the proposed model is capable of modeling the stress-strain behavior of soft rock.

Keywords: Weak Rock, Triaxial Test, Stress-strain relationships, Yield behavior, Stress path

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