

論文 / 著書情報  
Article / Book Information

題目(和文)	
Title(English)	Experimental investigation on internal erosion and its impact on mechanical responses of gap-graded and well-graded sandy soils
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出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第12135号, 授与年月日:2021年9月24日, 学位の種別:課程博士, 審査員:高橋 章浩,北詰 昌樹,竹村 次朗,鼎 信次郎,田村 修次
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第12135号, Conferred date:2021/9/24, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

## Thesis outline

The internal erosion and its impact on mechanical responses on gap-graded and well-graded soils are investigated.

A modified triaxial erosion apparatus is proposed with a newly developed seepage control system to investigate the internal erosion initiation and progress. The main modification part of the apparatus is a revised seepage control system, which is based on the hydraulic head control concept. A novel seepage control system allows the capability of an internal erosion experiment with a high back-pressure under a pressure-controlled seepage condition. The calibrations of transducers, accuracy, precision, and resolution of the measurements are also discussed. Specimen preparation, saturation, consolidation, seepage testing, and triaxial compression testing are all part of the testing procedure.

The triaxial erosion tests on the gap-graded soils having different amounts of finer fraction content are conducted. The gap-graded soils with different fines content exhibit different microstructure, i.e., underfilled and overfilled, which significantly influences erosion initiation and progress. The characterizations of erosion progress, i.e., self-filtering, suffusion, suffosion, seepage-induced failure, and an internally stable state, are described by eroded mass, volume change, and hydraulic conductivity. The erosion progress of the underfilled soils exhibits self-filtering and suffusion initiated at a low hydraulic gradient. Depending on the initial fines content contributing to soil microstructure, the erosion progress of the overfilled soils can be suffosion, seepage-induced failure, or internally stable initiated at a large hydraulic gradient. The seepage results highlight the importance of the combination of eroded mass, volume change, and hydraulic conductivity for evaluating erosion initiation and progress. The internal erosion identification diagram is proposed for accessing erosion initiation and progress and possible soil microstructure.

The triaxial erosion tests on the underfilled gap-graded soil with multiple hydraulic loadings are conducted. Suffusion dominates the erosion progress of the soils. The number of hydraulic loadings significantly affects erosion progress. With increasing the hydraulic loading cycle, the eroded mass and hydraulic conductivity increase, resulting in an increasing void ratio.

Additional triaxial erosion tests on the well-graded soils at varying densities and gradation are conducted. The erosion progress of the soils is dominated by self-filtering and suffusion. The initial density, shape of gradation, and hydraulic loading have essential effects on erosion initiation and progress. The amount of eroded mass tends to decrease with larger density, narrower gradation, and smaller hydraulic loading. The hydraulic gradient initiating erosion increases with increased density and narrower particle-size distribution for well-graded soils, but this is not the case for gap-graded soils.

Factor influencing the internal erosion of gap-graded and well-graded soils is explored. The constriction-size distribution of the soils appears to be one of the primary factors affecting erosion characteristics. Initial hydraulic conductivity increases while hydraulic gradient initiating erosion decreases considerably with increasing constriction diameters.

The undrained triaxial compression tests are then conducted on the eroded gap-graded and well-graded soils to investigate the impact of internal erosion on mechanical responses. The results show that suffusion makes the eroded soils looser and more contractive than non-eroded soils, while suffusion makes the eroded soil more dilative at the large strain level. The post-suffusion shear strength consistently decreases with increasing the amounts of eroded mass and void ratio. The void ratio may be used in predicting the post-suffusion mechanical behavior. Suffusion creates a loose material structure, as demonstrated by sudden drops in shear stress and stiffness with a sharp increase in pore water pressure. As the eroded soil is already unstable, the disturbance caused by cyclic loading produces the collapse of the soil, leading to smaller resistance to liquefaction.

Finally, internal erosion will be a severe problem in the internal stability state of sandy soils, based on the observed reduction in strength, stiffness, and liquefaction resistance. The author highlights the importance of conducting laboratory testing to determine the impact of internal erosion on shear strength to assess the internal stability state of an earthen structure.