Study on mechanical behaviors of interface between gravel soil and concrete with large-scale simple shear test

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Abstract: The mechanical behaviors of interface between gravel soil from three gorges reservoir area and concrete structure had been investigated to by using the large-scale simple shear test. The effect of moisture content or stone content on the interface mechanical behaviors was discussed. The results indicated that the moisture content has a great influence on the deformation and strength of the interface as well as the stone content. The more the moisture content, the less the shear strength of the interface for the gravel soil with the same stone content, while the more the stone content, the more the shear strength of the interface for the gravel soil with the same moisture content.

Introduction

Gravel soil is a special kind of geologic body, and is very different with the general soil because it contains different size, different quantity and different distribution forms of gravel or stone. The contact problems between gravel soil and concrete structure widely exist in the engineering application, such as anti-slide pile in the landslide engineering, pile foundation in the building engineering and the bridge foundation which all involve the contact problems of gravel soil and concrete structure. Gao Jun-he[1] et al. studied the soil-concrete interface problems with fine grained soil using the large size single shear apparatus. Li Deng-hua[2] et al. researched the mechanical properties of interface between concrete face and cushion material in the Concrete Face Rockfill Dam. Zhou Xiao-wen[3] et al. tested the mechanical properties of interface between gravel cushion material and concrete structure. And many scholars[4-10] have studied the interface mechanical properties. The research achievement of interface aspects at present mainly comes from between the concrete structure and other material such as the fine grained soil, the rockfill material and the cushion material. But it is deficient to research on interface properties between the gravel soil and concrete structure. In this paper, a series of experiments are carried out to analysis the interface mechanical properties of gravel soil and concrete structure using the large single shear apparatus.

Experiment Instrument

The experiment instrument adopted in this paper is the large-scale simple shear test (DHJ-50) shown in figure 1, which independently developed by Huaxi geotechnical research institute of sichuan university. The size of the instrument is Φ500x400 mm, and the permissible maximum diameter of gravel soil is 60 mm. The main frame adopts plate frame structure, and the normal load and tangential force is provided by the hydraulic control system. The vertical and horizontal load sensor monitors the vertical and horizontal load, and the vertical and horizontal displacement sensor monitors the vertical and horizontal displacement. The instrument form a complete set of computer automatic data acquisition and processing system. The vertical load、horizontal load and also the shearing velocity can be automatic controlled.

(a) shear box (b) tangential force power (c) control box

Figure 1 experiment instrument

The concrete precast blocks used in the experiment is directly installed on the lower shear box, the shear principle shown in figure 2.

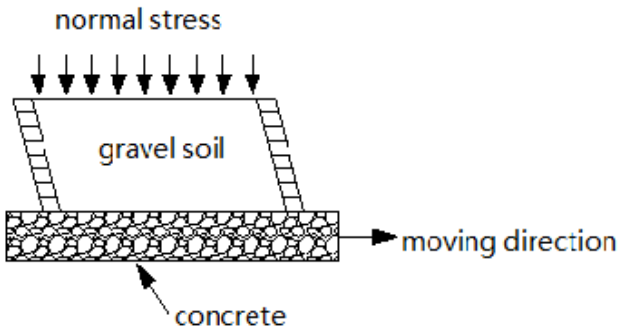


Figure 2 shear principle

Experiment Introduction

The gravel soil used in the experiment is claret-colored silty clay with gravel, and the dry density is 1.89 g/cm^3, the maximum diameter of gravel is 60 mm. The defined particle size of earth-rock is 2 mm, the diameter for gravel is greater than 2 mm and less than or equal to 2 mm diameter for the soil. The large scale shear experiment is carried out with different normal stress (100 kPa、250 kPa、400 kPa) in order to research the interface mechanical characteristics between the concrete structure and gravel soil with different moisture content and stone content.

The experiment of gravel soil with different moisture content

The stone content in the experiment of gravel soil with different moisture content is 65%, and the moisture content proposed is 10%、14%、18%, respectively, to study the effect of moisture content on the interface mechanical properties.

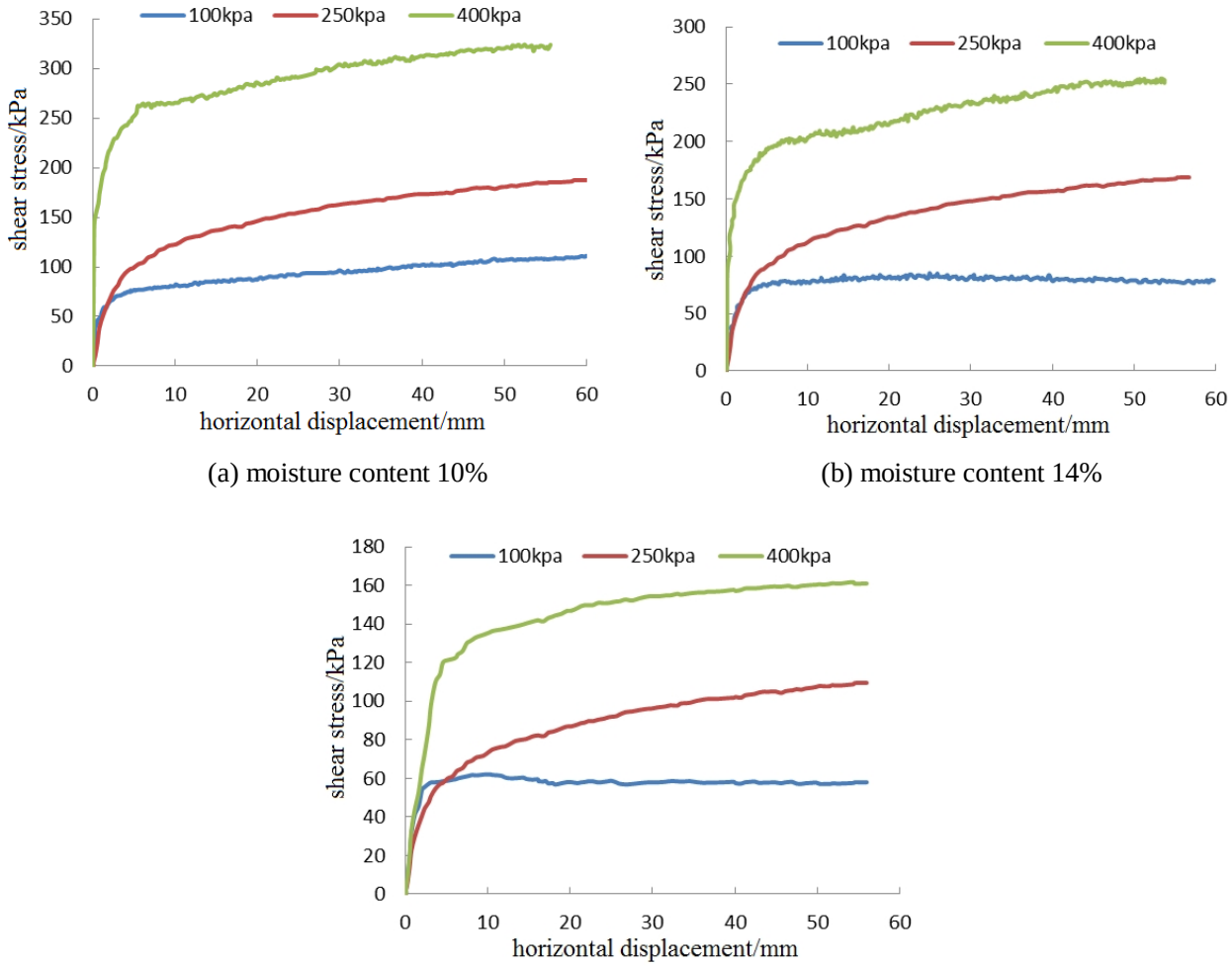
The experiment of gravel soil with different stone content

The moisture content in the experiment of gravel soil with different stone content is 10%, and the stone content proposed is 50%、65%、80%, respectively, to study the effect of stone content on the interface mechanical properties.

The experiment results analysis

The experiment results of gravel soil with different moisture content

The shear stress - horizontal displacement curves are shown in figure 3 of gravel soil with different moisture content, stone content 65%, under the different normal stress (100 kPa、250 kPa、400 kPa). The results show that the more the normal stress, the more the shear strength of the interface between the gravel soil and the concrete structure. The more the moisture content, the less the shear strength of the interface for the gravel soil with the same stone content.



(a) moisture content 10%

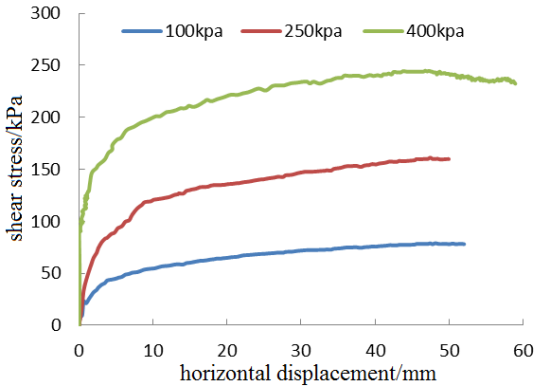
(b) moisture content 14%

(c) moisture content 18%

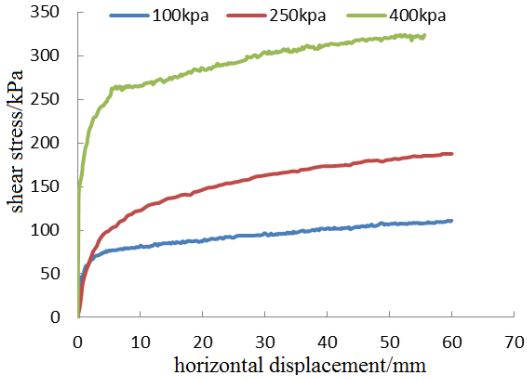
Figure 3 the shear stress - horizontal displacement curves with different moisture content

The experiment results of gravel soil with different stone content

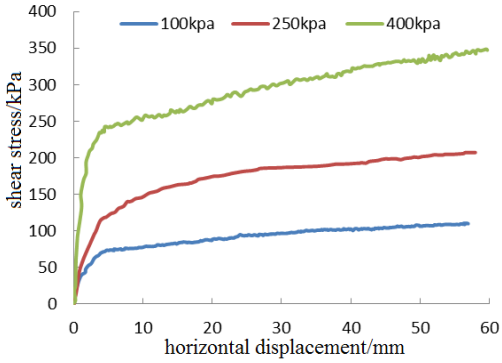
The shear stress - horizontal displacement curves are shown in figure 4 of gravel soil with different stone content, moisture content 10%, under the different normal stress (100 kPa、250 kPa、400 kPa). The more the stone content, the more the shear strength of the interface for the gravel soil with the same moisture content.



(a) stone content 65%



(b) stone content 50%



(c) stone content 80%

Figure 4 The shear stress - horizontal displacement curves with different stone content

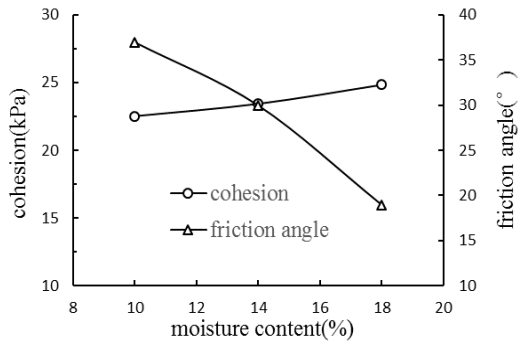


Figure 5 the cohesion and friction angle curves with different moisture content

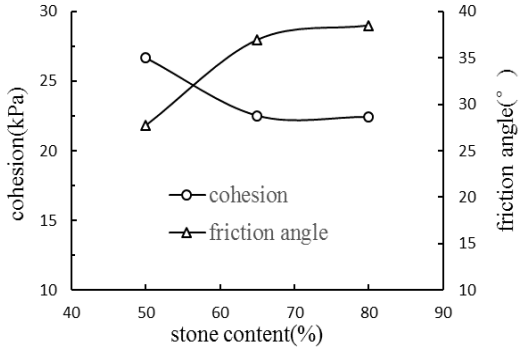


Figure 6 the cohesion and friction angle curves with different stone content

The cohesion and friction angle of gravel soil with different moisture content are shown in figure 5, and the results showed that with the increase of moisture content, the friction angle presents a gradually decreasing trend while the cohesion presents a gradually increasing trend.

The cohesion and friction angle of gravel soil with different stone content are shown in figure 6, and the results showed that with the increase of stone content, the friction angle presents a gradually increasing trend while the cohesion presents a gradually decreasing trend. But as the stone content increasing, the cohesion and friction angle tends to be stable.

Conclusion

It can be seen from the results that the more the normal stress, the more the shear strength of the interface structure with the same moisture content. While results of the gravel soil with different

moisture content indicated that the more the moisture content, the less the shear strength of the interface for the gravel soil with the same stone content. And the friction angle presents a gradually decreasing trend while the cohesion presents a gradually increasing trend.

The experiment results of gravel soil with different stone content indicated that the more the stone content, the more the shear strength of the interface for the gravel soil with the same moisture content. And the results showed that with the increase of stone content, the friction angle presents a gradually increasing trend while the cohesion presents a gradually decreasing trend. But as the stone content increasing, the cohesion and friction angle tends to be stable.

Acknowledgements

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