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The study of reinforced soil and modeling test

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ABSTRACT: Based on the shear test in the laboratory, The authors suggest the right method of measuring friction coefficient between soil and reinforcement in reinforced earth retaining wall. Considering other information and present the reasonable value of friction coefficient, it is also pointed out that for sake of safety, friction coefficient should be considered carefully in the design of reinforced earth retaining wall.

1 INTRODUCTION

Since French Engineer H. Vidal first put forward the conception of reinforced soil, and built the first reinforced soil engineering in the world in 1966. So this kind engineering has been welcomed all over the world, it is conformed that this construction of reinforced soil engineering be simple in construction, good-looking in outline and good adjustment for different foundation, and brings great benefit. It is well known that the internal stability of the reinforced soil main rely on the frictional force between reinforcement and soil. If we can affirm this friction propery, we are able to explain the mechanism of the friction. In order to make reinforced soil contruction be safety, economy and reasonable, the friction character between reinforcement and soil should be studied. In light of the information, the friction coefficient is computered according to the formula: $f=tg\varphi$ =shear stress(τ) /normal stress(σ). We may ask the question: How can we measure the friction coefficient well? What value can we give the fricion coefficient? Some people suggest that the direct shear test can be used to measure the coefficient, and there are several kinds placements of reinforcement in the direct shear apparatus and which placement may we choose? The friction coefficient value of 0.4 is considered safer by some people, and more dangerous by other people. For the problems above, thorough carrying out the direct shear test and considering other information, we did the study on the friction charater of reinforced soil, and we believe that the thing which we did should give good advice to engineering application.

2 DIRECT SHEAR TEST IN LABORATORY

2.1 Experimental material's physical characteristics

The physical characteristics of soil and reinforcemental materials is as following: Reinforcement mateal is consisted of ployester fiber and copper, their thickness is 0.07mm and 0.05mm respectively.

2.2 Test method

In order to research the effecting of the location of reinforcement in direct shear apparatus on the friction coefficient to

Table 1 physical aspects of Loess

specific gravity	liquid limit %	plastic limit	plasticity index	dry unit weight KN/m³	optimum water content %
2.75	30	17	13	17.2	12.5
2.75	30	17	13	15.3	12.5

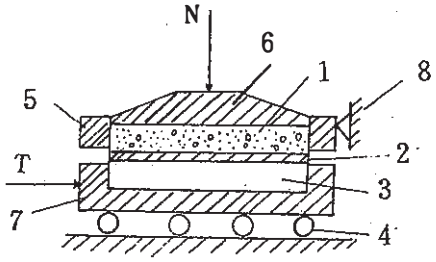


Figure 1 equipment of friction test

1-soil sample 2-reinforcement material
3-copper plate 4-rolling ball
5-downbox 6-upbox
7-bearing block 8-trestle

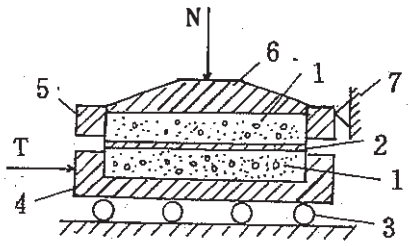


Figure 2 equipment of friction test

1-soil sample 2-reinforcement material
3-rolling ball 4-downbox
5-upbox 6-bearing block
7-trestle

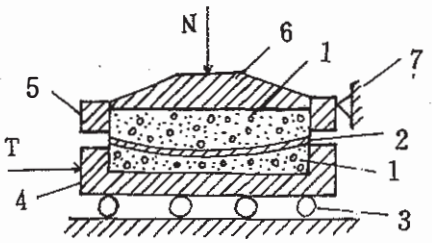
be measured,and the friction property between these kinds reinforcement material and soil,we chose three kinds material to be as reinforcement.There are two kinds location of reinforcement in direct shear apparatus which we called methodl and method2 respectively.Methodl:At frist,the specialized copper plate made is placed in the downbox;second,reinforcement material is fastened on the copper plate by iron wire;third,put the upbox on the copper plate which is covered by reinforcement material;fourth,press the soil into the upbox,put the pressure plate on the soil. If all the thing above is finished,we can carry out shear test,the equipment is shown in Figure 1. Method2:At first,press soil into downbox,and second,using reinforcement material to cover the soil surface,third,put upbox on the downbox,press the soil into upbox,and then cover pressure plate,so we can do direct shear test, the equipment is shown in Figure 2.We also did consolidated fast direct shear test so as to explore consolidation affecting on the friction coefficient. To understand it easily,we call reinforced soil soil-reinforcement according to methodl,and that soil-reinforcement-soil according to method2.

2.3 Test results and analysis

The results is following in Table 2 and Figure 3,we can find that the shear stress -norm stress relationship is in accord with Colomb-Mohr theory.It is said that the relationship could be expressed by $\tau = \sigma \operatorname{tg}\varphi + c$,where $\operatorname{tg}\varphi$ is friction coefficient,σ is norm stress and c is cohesion. From Table 2,we find that friction coefficient value in coloumn No.1 and No.2 increases from 0.22 to 0.33,and increases

Table 2 The results of direct shear test

Name	Soil-Polyester fibre		Soil-Polyester fibre		Soil-Polyester fibre-Soil	
Compacting parameter	0.9	0.8	0.9	0.8	0.9	0.8
Friction coefficient	0.22	0.30	0.30	0.24	0.53	0.60
Cohesion KPa	14.05	2.96	28.4	20.8	22.7	5.38
Cosolidation			√	√		
No.	1	2	3	4	5	6



Fidure 3 deformation of reinforced material

more than 14%,c value changes from 14.05 kPa to 2.96kPa,it descends 11.09kPa,we can conclude that in light of method1,the larger is compacting factor,the less is friction coefficient,the larger is cohesion.The friction coefficient from consolidated fast direct shear test is the same as that from direct shear test almostly except the cohesion changing,and c value from consolidated fast direct shear test is much bigger than that from direct shear test.We may use direct shear test instead of consolidated direct shear test in measuring f value,f in column No.6 and column No.5 of Table 2 is bigger than that in column No.1 and No.2 respectively,because reinforcement exists among two soil layer, when we impose force on the pressuring plate,the reinforcement creats deformation and sinks into soil in downbox,then the soil in upbox also sinks into downbox, just as show in Figure 3.When we do direct shear,the shear is taken place between soil in upbox and downbox except the little at the two end of two boxes connecting, so shear strength parameter in light of method2 is near to that of pure soil and f value is bigger,so method2 does not reflect the shear property of reinforcement -soil,and is not reasonable,meanwhile,we are able to find that f is smaller than 0.4 from the Norm of China,f value from our experiment is 0.2～0.3.

3 THE CENTRIFUGAL MODELLING

Authors carried out centrifugal modelling test,at primilily,we made a model of highway reinforced soil retaining wall with frictional coefficient 0.4,it was collapsed after running 1 hour and second time,we give friction coefficient 0.2 in designing the model,and it is good-looking and stability under running 150g except appearing little cracks in the top of the model and then after we spent 20 minutes in running the model under 200g,When it was finished,the model did not change almostly.So we say that the friction coefficient value 0.2 which we suggest is reasonable.

4 CONCLUSION

(1) The shear stress-norm stress relationship is in accord with Colomb-Mohr theory.

(2) Method1 in mearsuring the friction coefficient between reinforcement and soil is reasonable.

(3) In designing the reinforced soil retaining wall which is filled with clayed soil, the friction coefficient between reinforcement and soil should be taken 0.15～0.3.

Because there is not much more the data about clayed soil which is used to fill in reinforced soil retaining wall, and cohesion is not thought in designing, we should do much work on developing reinforced soil engineering.

REFERENCES

Norm of highway reinforced engineering of China(in Chinese). People's Communication Press. Beijing. 13-14

Wu wenlan 1994. Study on the Reinforcement Engineering which is filled with clayed soil in Sichuan Provice(in Chinese). Proc. of 4th National Symposium on Reinforced Soil Engineering, Chongqing, 33-44

Yao dailu 1989. Study on friction character between soil and reinforcement in reinforced earth retaining wall. Chinese Journal of Geotechnical Engineering 4:49-54