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The finite element analysis of reinforcement mechanism in reinforced earth and reinforced foundation

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ABSTRACT The deformation and stability behaviors of a reinforced foundation are studied by FEM in this paper. The friction-contact interface element is introduced to simulate the interaction of soil-geotextile. The flexible beam element is used to simulate the geotextile. Experiment and computational result of a fly ash dam verify the simulation method.

A reinforced foundation is that the geotextile or some broken stone enclosed in the geotextile put on the soft foundation and the soil body above. The co-work between soil and the geotextile is the basic character. Through the anti- friction between the geotextile and foundation earth the displacement of the foundation is confined relatively. Through this style decrease the settlement of the foundation and dam, decrease the stress in the foundation, enhance the stability of dam foundation.

1 INTRODUCTION

Geotextile is one new kind of chemical fiber material using in geotechnics during1960s. When the foundation is strengthened, the foundation carrying capacity of the reinforced foundation is devised according to experience or limit equilibrium condition. Because the tensile stress of the pull pole has some relation with the deformation of the soil mass, if the size of the deformation of the soil body can not be evaluated, the tensile force of pole can not be planned. The effect of the pole to earth dam shows that the settlement, horizontal displacement and porosity pressure of the earth dam have much relation with the reinforcement. These effects can not be calculated by slice method.

In this paper the reinforcement mechanism of the geotextile by using finite element method and model test is analyzed. Some examples are analysed and presented.

2 ANALYZING MODEL

A reinforced foundation is a system that composes of earth embankment, geotextile and foundation. Soil mass and the geotextile affect the deformation and Failure State. According to the stress and deformation of soil mass and the geotextile respectively the analysis model about the

reinforced foundation.(1)To soil mass's loading and unloading the Ducker-Zhang model is used as the calculating model.(2)The six nodal element is introduced to simulate soil mass. The beam element is introduced to simulate the geotextile. The friction-contact interface element is introduced to simulate the interaction of soil-reinforcement.(3)The Grifith-Mohr strength failure criterion is introduced to simulate tensile and shear coupled failure problem. For failure problem of a reinforced foundation, Mohr-Clumonb strength failure

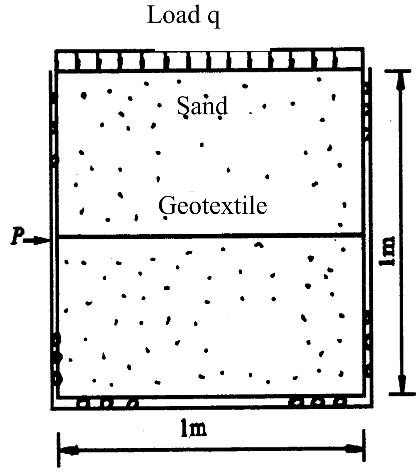

Fig. 1 Pulling test model

criterion has some unreasonable.

3 ANALYZING MODEL OF PULL-OUT TEST

3.1 numeric model of pull-out text

(1) pullout test is figure 1 and the parameters of every material lists as table 1.

(2) Calculating scheme In this calculating scheme the pull force P=40,60,80,100,120,160Kn and q =100kN/m.

Table 1

classifying	E /(kN/m^2)	μ	C /kPa	φ (°)	γ /(kN/m^3)	σ_z /KPa
Fine sand	8.0×10^3	0.3	6.0	35.0	21.0	0.1
interface	\	0.3	30.0	25	\	\
geotextile	8.0×10^5	0.3	5.0	25	26.0	1000

3.2 The calculating results and results analysis

The calculating result of each scheme and the inclusion are as follows.(1)Because the stress distribution in geotextile is nonuniform, the stress in soil mass is nonuniform (Fig.2).(2)The displacement in geotextile is nonuniform(Fig.3).(3)The sheer stress on interface of geotextile is nonuniform and is influenced by boundary of soil mass, tensile force, etc(Fig.3).(4)The geotextile can adjust the stress distribution in the reinforcement and make it nonuniform and enhance the foundation carrying capacity. The geotextile can confine the lateral and vertical deformation of soil mass.(5)The method that the friction-contact interface element is introduced to simulate the interaction of soil-reinforcement and the flexible beam element is used to simulate the geotextile can analyze reinforcement mechanism of the reinforcement foundation and interaction between soil material and the geotextile.

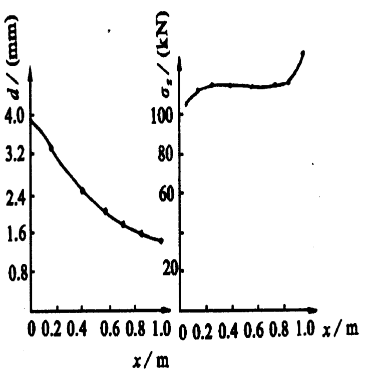

Fig. 2 (a) The displacement distribution of geotextile
(b) The normal stress distribution under geotextile

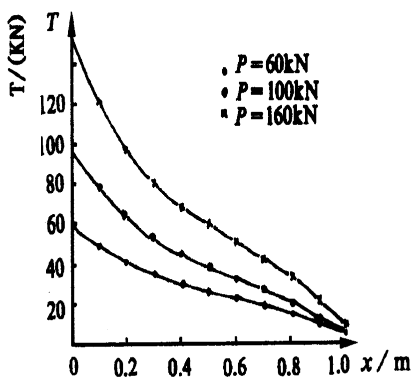

Fig. 3 The tensile force distribution of geotextile

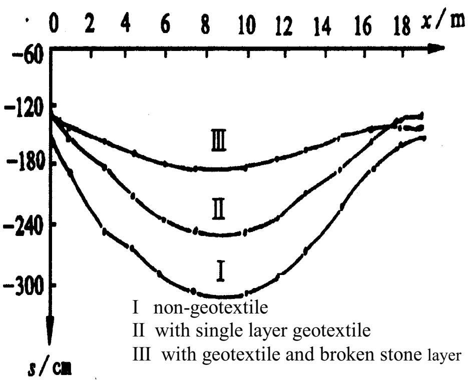

Fig. 4 The displacement of sample points
under geotextile of fly-ash dam(measure settlement)

4.THE ENGINEERING EXAMPLE

There is a enhancing height dam engineering on the natural sedimentary fly ash at electric plant in Shaanxi province. The dam is schemed 5 meters in height, 3 meters in width of top of dam and 1:2 in grade of slope (figure 7). Because the sedimentary fly ash has a higher porosity, higher water content, a higher compressibility and lower strength. The handling steps are (1): Plane the surface; (2) lay a layer earth net on it; (3) lay a layer geotextile on the net. (4) Fill broken stone layer on the geotextile; (5)A layer geotechnics cloth and a layer geotechnics net on the broken stone layer respectively. So the confining movement integer foundation is formed. The beam element is used to simulate the stress and displacement in the foundation. Three kinds of foundation that include no geotextile, or existing a layer geotextile but no broken stone layer or the confining movement integer foundation are analyzed respectively.

4.1 Three simulating schemes

(1) No reinforcement in the foundation.
(2) Existing a layer geotextile but no broken stone layer
(3) The confining movement integer foundation

4.2 Calculating parameters (Table 2)

4.3 Calculating result and analysis to the result

Every result for the special scheme and analysis to the result list as follows.

Table 2

Classes	γ /kN/m^3	C/kPa	φ (°)	R_f	K	n	G	F	D	E/(kN/m^2)	K_{ur}/(kN/m^2)	μ	σ_z/kPa
Dam body	13.72	0.0	13	0.85	2400	0.7	0.37	0.15	0.15	4.5×10^3	2400	0.3	0.1
Foundation	10.29	0.0	11	0.8	1200	0.6	0.35	0.15	0.15	4.0×10^3	1200	0.3	0.1
Geotextile and broken stone layer	21.56	200	25	\	\	\	\	\	\	8.0×10^5	\	0.3	10.0
Geotextile	\	8.0	39	\	\	\	\	\	\	8.0×10^5	\	0.3	10.0
contact interface element	\	20	35	\	\	\	\	\	\	\	\	0.3	\

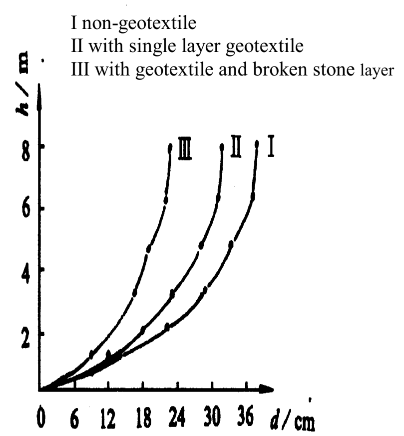

Fig. 5 The displacement of sample points at
The center of cross-section fly-ash dam

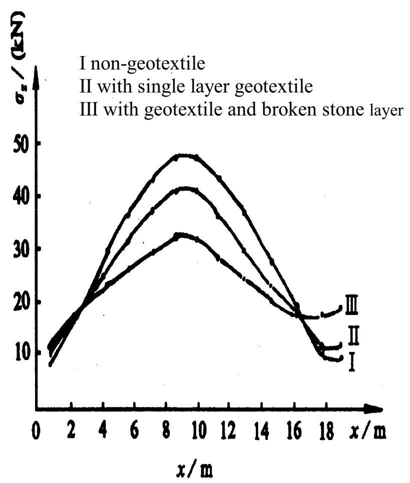

Fig. 6 Normal stress distribution
Foundation under geotextile

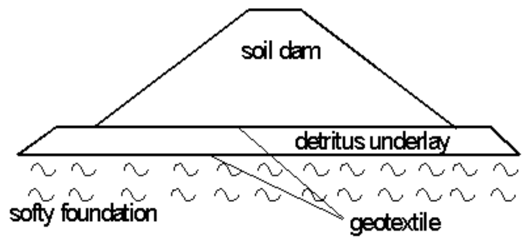

Fig 7 Construction of the reinforced foundation dam

(1) From Fig.5, the geotextile can remarkably decrease the normal pressure strain. The confining movement integer foundation can adjust strain in the foundation better than the other two conditions.

(2) From Fig.6, the geotextile can confine the vertical deformation and settlement effectively and broken stone reinforcement layer has a better effect.

(3) If there is no the geotextile in the foundation, the horizontal displacement of the foundation is high. When a layer of geotextile is filled in the foundation, it becomes little. When the confining movement integer foundation forms, it becomes little most. So the geotextile can decrease the lateral displacement of foundation. In particular the confining movement integer foundation has a better effect for it.

5 CONCLUSION

This paper proposes a method that the beam element is used to simulate the reinforcement material and the confining movement layer foundation and the friction-contact interface element is introduced to simulate the interaction of soil-reinforcement. The pullout test result is introduced to analyze reinforcement mechanism in reinforced earth and reinforced foundation. For analyzing the deformation and stability of reinforcement foundation, this method is successful. This method has a wide use in studying the application of reinforcement foundation, design of engineering and optimization of design. Meanwhile this method provides a new idea for analyzing the reinforcement foundation with using the finite element method.

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