Experimental Research on geogrids Creep property of at different low temperatures

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Abstract: Creep property is the key factor for effecting geogrid-reinforced earth retaining structures under a long-term behavior. Contrast test is adopted for creep property of geogrids under different temperature in the indoor test. The result indicates as follows: creep property of plastic geogrids is totally different with different temperature. So temperature has a great influence on creep property of geogrids. The lower the temperature is, the smaller the creep is.

Introduction

As the development of geotechnical composite material, geotechnical reinforced fabrics is extensive used in the permanent project. Under different temperature and load, geotextile produces different properties which can weaken the function of reinforcement and damage the buildings[1]. So it is very important to study on creep property of reinforced earth retaining structure. With economic development, many project will be founded in the lower temperature area.In order to display the function of geotextile under the lower temperature, the creep property should be studied.

Now many domestic and overseas scholars[2−10] have been studied on creep test of geogrids. TGDG25 one-way tensile geogrids is used is indoor test. The temperature is among -20℃，-10℃ and 0℃.In need of contrast, the test is also done at 10℃ and 20℃. In order to guide engineering practice, this text makes an analysis of the result of creep property at a low temperature.

Creep test mechanics and physical quantity

Creep deformation is that material is deforming as time is increasing, but the load dose not change. Geotechnical composite material is made of polymeric material. Creep property of geogrids has influenced on geogrid-reinforced earth retaining structures in a long-term behavior. Creep deformation of reinforced earth retaining structure and stress relaxation can lead to the change of internal stress; This will cause an accident such as losing the whole stability, excessive deformation and so on. It is the key for tensile strength whether it acts long-term or not. When geotechnical composite material is used to strengthen, creep property is very important.

Relating to plastic geogrids' physical quantity of creep test :

(1) creep strain Test sample of creep strain is the ratio of extension to initial length under the long-term static loads.

$$\varepsilon = \frac{L - L_0}{L_0} \qquad (1)$$

In equation:ε—creep strain； l— ength of sample at any time, mm； L_0— initial length of sample, mm.

(2) Creep stress: Creep stress is the ratio of external force to sectional area.

$$\sigma = \frac{F}{S} \qquad (2)$$

In equation:δ—creep stress, Pa；F— external force of sample, N；S— sectional area of sample, m.

(3) Intensity In common, dimension of intensity is the same as stress, but intensity of geogrids is force at the unit-width. In national standards, intensity is defined as stretcher yield force each meter; we consider this method .Load intensity is expressed by equation (3) under feeding and data processing.

$$L = \frac{F}{W} \qquad (3)$$

In equation:

L —Load intensity, N / m;F—Load of sample, N;W—Length of sample, m;

Test apparatus, material and processing

Test apparatus Temperature control lab: internal dimensions: 6.40m ×5.10m ×2.95m， it is composted of cold compress machine with large power and computer temperature control machines. The range of temperature is +20℃～-35℃,control accuracy is ±0.5℃.Tensile-testing machine must be put in the indoor.

Creep deformation tester: it is made by us. Creep test is running in adjustable temperature and humidity. Creep test machine of geogrids sample is shown in the graph1. According to graph 1, top and bottom side clamps of measurement system are individually fixed on top and bottom boundary at initial length L_0. These are tow micrometer gauges fixed on the top clamp, which read the change of measurement range. Freezing loop temperature is controlled in -20 ℃～+20 ℃.

Test material In this test, material adopt TGDG25 one-way tensile geogrids; Qualification of TGDG25 geogrids is showed in the table 1.considering about special mesh structure of geogrids and avoiding size effect, samples use five longitudinal ribs. The length of sample is 100cm. Effective length of geogrids is the distance between top and bottom clamping fixture. Extension of creep deformation is displacement value between two parallel cross-bars which belongs to measuring displacement table.

Table 1 qualification of TGDG25 geogrids

Project	A unit of mass （g/m2）	Tensile yield force at each meter ≥(kN/m)	Yield extensibility≤ (%)	Tensileforce of 2% extensibility≥(kN /m)	Tensileorce of 5% extensibility≥(kN/m)
TGDG25	370±50	25	10	7 7	14

Test process 20%、40% and 60% of bearing capacity is taken for creep test under horizontal effect. Fetching 0 min、1min、5min、8min、12 min、30 min、1h、2 h、4 h、8 h、12 h、24 h、3d、7 d、14 d、21 d、42 d……These times are deformation of authorized points of geogrids.

Experimental error: deformation measurement adopts micrometer. Its accuracy is mm and error is 0.1%. Outside the two gauge length, distance is 25mm between lines of gauge length and clamping fixture, this can avoid the influence on deformation which is caused by retaining.

Method of retained sample: the top clamping fixture has two armor plates as well as the bottom one. It has nonskid canal inside. Use bolts to screw up and fix sample. It is required that the retaining is equalization. It can not appear destruction, which is caused by non-uniform loads after feeding.

Test environment: Test temperature is at -20℃, -10℃, 0℃, 10℃,and 20℃.Put three samples on the creep tester, control temperature in the indoor, protect from direct sunlight and ultraviolet ray.

Loads: Use weights as loads. Hang the loads on lever system as tensile load. Horizontal load is 5%、10%、20% of rupture strength.

Strain measurement: Time spacing increases gradually. Sensing time is 0 min, 1min, 8min, 12min, 30min, 1h,2h, 4h, 8h, 12h,and 24h. After that, the sensing time is 24h at intervals until 1000h.Strain is extension of sample gauge length divided by initial length.

Test result and analysis

When recording of test data and drawing of curve are beginning, it measures a time interval at 1 min,6 min,12 min,30 min, 1h,2h,3h,5h,7h and 10 h. After that it measures every 24 hours. The record is originating from the time of left and right instrument. Average deformation of left and right rib is used as the whole deformation at every time. Total time of this record is 1600h. According to base data, graph of time-strain is shown as follows:

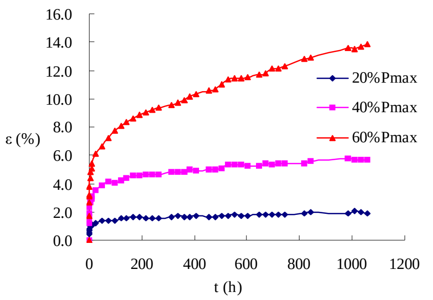

Fig.1-1 Curve of stress and strain at 20℃

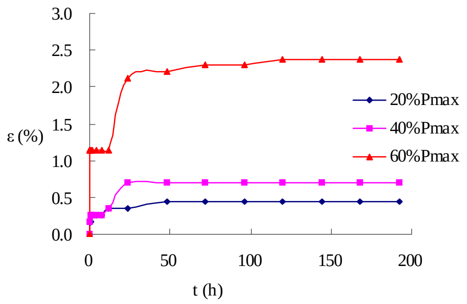

Fig.1-4 Curve of stress and strain at -10℃

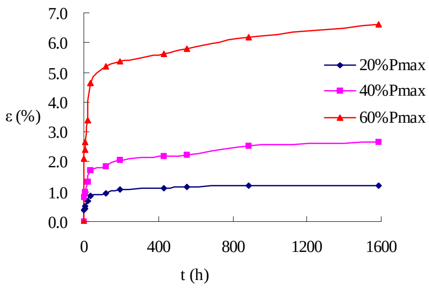

Fig.1-2 Curve of stress and strain at 10℃

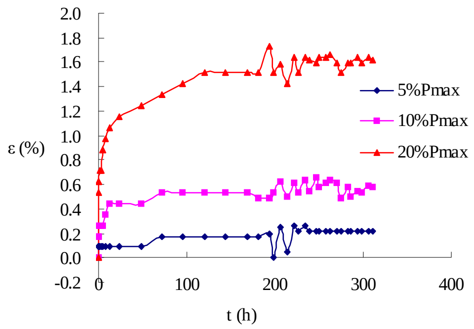

Fig.1-5 Curve of stress and strain at -20℃

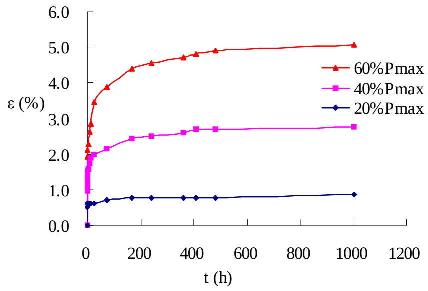

Fig.1-3 Curve of stress and strain at 0℃

The main feature of creep behavior is gained through that analyzing creep data. According to graph 2, the more the loads are, the lager the strain in the same time. When the load is than less or equal to 40%, the curve of strain is becoming flat after 400h at 20℃. This is shown that change of creep becomes less and less. When the load is more than 40％, the curve becomes comparatively cliffy. The strain has exceeded 5% within short time. According to the conclusion, geogrids should not be used when the loads are higher than 40％.

At the beginning, the curve of strain rises steeply under -20℃. However, the curve tends to be constant after only 100 hours and extensibility dose not reach 2.5%. It shows that environment temperature has a notable impact on creep property.

Conclusions

The main results and conclusion are as follows:

(1)Creep deformation of plastic geogrids at a low temperature is totally different from the condition at a normal temperature. Under -20℃, the curve of strain rises steeply tends to be constant after only 100 hours and extensibility dose not reach 2.5%.When extensibility is approaching 14% after 1000 hours at 20 ℃, the deformation is still not becoming stability under 60 percent of max-pressure. So the temperature has a great influence on creep property of geogrids. The lower the temperature is, the smaller the creep is. The design value of plastic geogrids should be properly decreased at a low temperature.

(2) The extensibility of One-way strengthened plastic geogrids with time is recorded through the test. According to the curve of strain-time, when load is small, the creep is flat. If the load is large, the creep of strain is large and develops quickly.

(3) From the test result, the deformation of geogrid is large under various stresses at the beginning. But it becomes flat and even nearly stops after a time. So we can draw the conclusion that Once reinforced earth retaining structure is built after a period, it is safe if the deformation within the permission.

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