Earth Reinforcement, Ochiai, Yasufuku & Omine (eds) © 1996 Balkema, Rotterdam. ISBN 90 5410 833 9

Performance and creep characteristics of synthetic geogrids following hot dry climate

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ABSTRACT: This paper investigates the behavior of geogrids under a hot dry climate. Kuwait was chosen as it experiences a wide range of annual temperature throughout the year, with air temperature rising to 45°C in summer and dropping to 0°C in winter. It also has an extremely high UV radiation level. Two geogrids, one high density polyethylene (HDPE) uniaxial and the other polypropylene (PP) biaxial grid, are being used for reinforcement and soil retaining wall applications in Kuwait. They were fully exposed, stored out of sunlight and buried in soil at the depths of 0.5 m and 1.5. Samples of material provided by the manufacturers were tested on delivery, then after sustaining exposure, storage and burial in soil for 3, 6 and 12 months. The tests carried were constant rate tensile test and wide width sustained load (creep) test with a loading period up to 1,000 hours. These results revealed some different responses.

1 INTRODUCTION

Polymer grids are manufactured from polymer sheets. The action of stretching gives the grid a high tensile stiffness in stretching direction. Axial tensile tests performed under constant rate give an indication of the tensile strength and the axial strain at rupture. These values are greatly effected by strain rate and temperature. This urges the performing of long time creep tests under constant loading.

2 TEST SITE, MATERIALS, AND TESTING PROGRAM

2.1. Test Site is located in Kuwait with the following distinctions:

1. The soil is mostly yellow, fine to medium sand with a little silt.
2. No evidence of a water table was found down to 4 m depth.The water contents ranging from less than 2% at to just over 12%.
3. The soil was found to be poor, non plastic (NP). Liquid limit value ranged between 17.3% and 28%, with no plastic. CBR values ranged between 3.5 to 5%.
4. Chloride content 'Cl' ranges between 0.007 and 0.176%, while sulphate content as SO_4 content ranges between 1.0 and 4.1%.

2.2. Types of Geogrids

Two geogrids Tensar SS1 biaxial, manufactured from polypropylene(PP) and Tensar SR80 uniaxial geogrid, made from high density polyethylene

(HDPE), were selected. Both of them are protected from ultra-violet degradation.

2.3. Site Testing Program

Samples were 1.0 m in the machine direction and 4.0 m in the cross machine direction. They were:

a) One sample of each type was tested immediately to obtain the basic "Control" set of data.

b) Four samples of each type were "Exposed" to all weathering conditions at the site.

c) Four samples were subjected to all weather but "Stored" from sunlight.

d)Two sets of four samples were "Embedded" in soil at depths of 0.5 m and 1.5 m from ground level.

2.4. Laboratory Testing Program

a) Tensile test: The jaws were determined as 315 mm for the uniaxial grid and 200 mm for the biaxial grid. Rate of strain was 10 % per minute,. Test results were recorded as The maximum load and corresponding strain, The breaking load and the corresponding strain for each material.

b) Sustained Loading (Creep) Test

The clamps and the clamping technique were designed to ensure that no stress concentration occurs along the clamp edge. A data logger capable of plotting curves of strain versus time automatically was used.

3. TEST RESULTS AND DISCUSSION

3.1. Results of the Constant Rate of Strain Tensile Test: This test was conducted in accordance with BS 6906 part 1, using 3 ribs for uniaxial and 5 ribs for biaxial geogrids. The following results are obtained:

1. Effects on the average maximum load based on the control value are in Table 1.

2. Effects on strain at maximum load based on the control value. are in Table 2.

Table (1) Maximum loads from wide width strip test results compares to control value

Max Forc	Expo sed	Stora ge	1.5 m	0.5 m
SR80	+3%	+3%	+2%	0%
SS1	0%	0%	0%	0%

Table (2) Strain Maximum loads from wide strip test results compered to control value

Strain at Max Forc	Expo sed	Stora ge	1.5 m	0.5 m
SR80	+6%	+4%	0%	-3%
SS1	-8%	-5%	-2%	-4%

Table (3) Break Load from wide width strip test results compared to control

Average Break Load	Expo sed	Stora ge	1.5 m	0.5 m
SR 80	+5%	+5%	+4%	+8%
SS1	0%	0%	+2%	0%

Table (4) Strain at Break Load from wide width strip test results compared to control values

Strain at Break Load	Expo sed	Stora ge	1.5 m	0.5 m
SR 80	+3%	+4%	0%	0%
SS1	+4%	+4%	0%	+2%

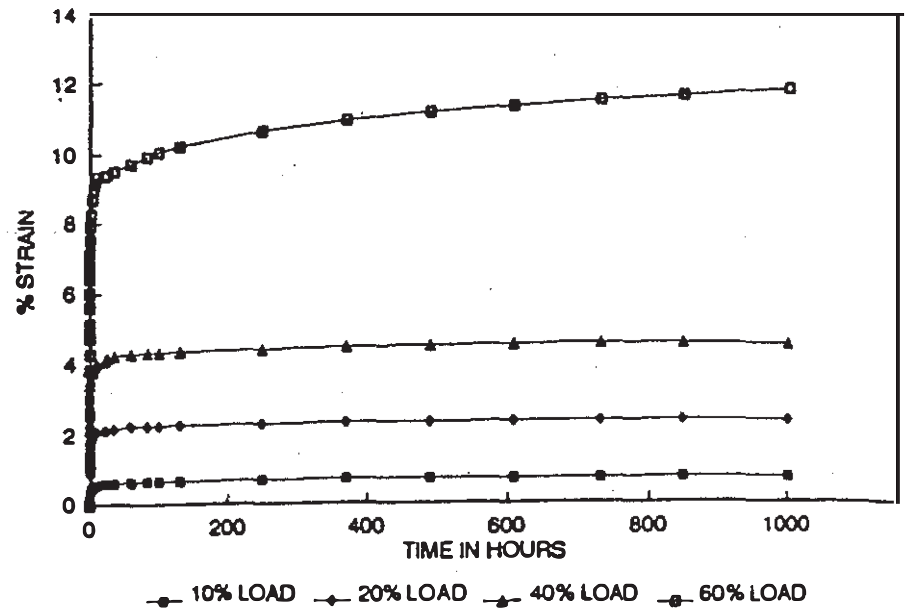

Figure 1 CREEP DATA FOR SR80, 0-12 MONTHS, 0.5m DEPTH, 0.0-1000 HOURS

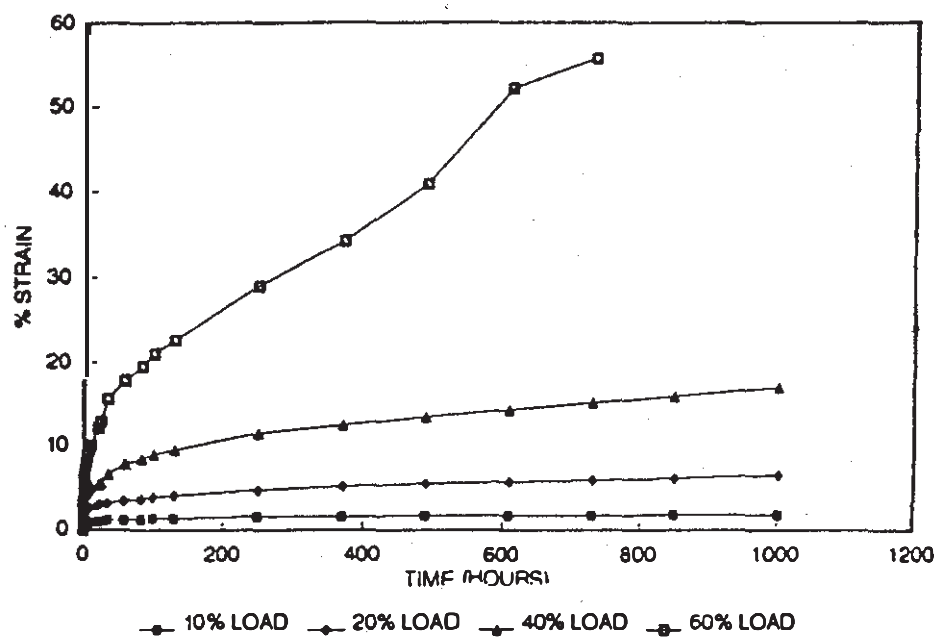

Figure 2 CREEP DATA FPR SS1, 0-12 MONTHS, 1.5m DEPTH, 0.0-1000 HOURS

3. Effects on the average break load based on the control value are in Table 3.
4. Effects on strain at break load based on the control value are in Table 4.

3.2. Creep Test Results

Samples of creep results for all types are shown in figs 1 and 2, with the following notes:
1. The biaxial geogrids has a large creep especially suspended by high loads for long terms. But, for short

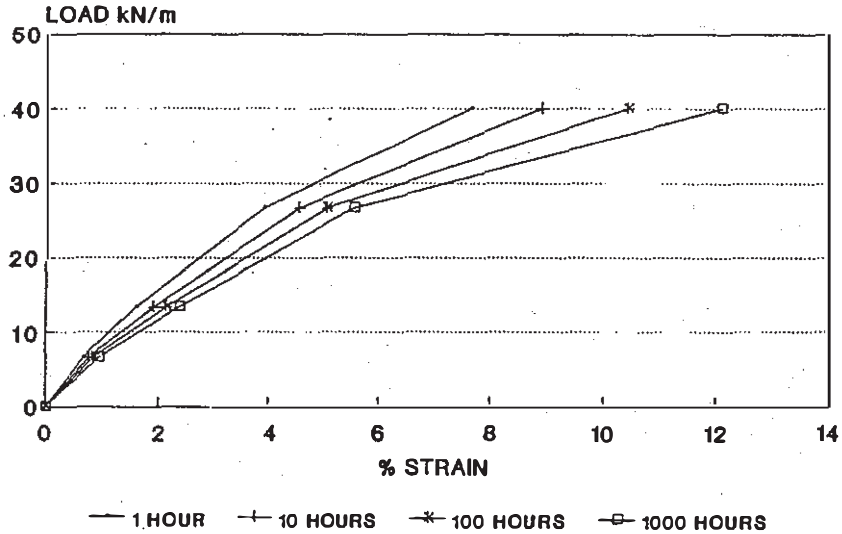

Figure 3 ISOCHRONOUS CHART FOR SR80, 0-12 MONTHS, EXPOSED

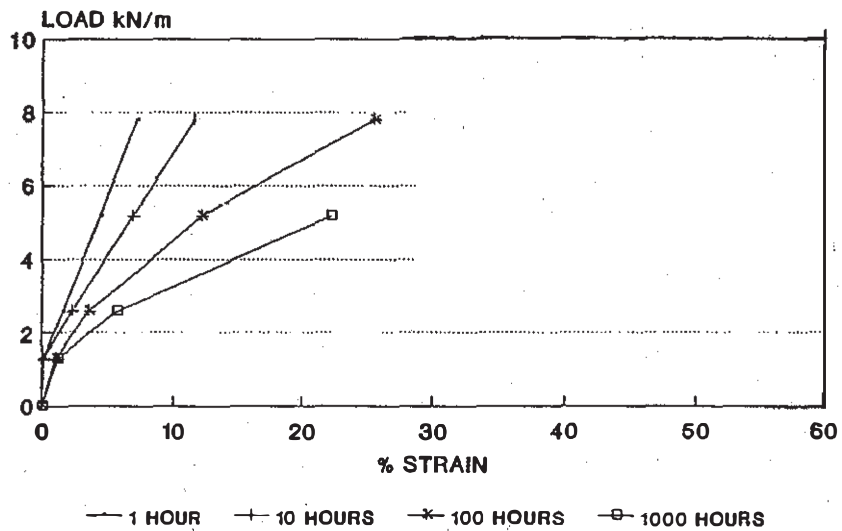

Figure 4 ISOCHRONOUS CHARS FOR SS1, 0-12 MONTHS, 1.5m DEPTH

terms it has a rapid and useful stress/strain response.

2. There was no significant change in the behavior of uniaxial grid.

3. Samples of "Isochronous" (Load-Strain) curves, used to determine the load limit and maximum possible load at any specific time interval are shown in figs 3 and 4.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Biaxial Grid: The results of testing Netlon SS1 biaxial grids showed that:

1. Long term loading resulted in great increase of strain values. For instance, for control samples strain after 100 hours loading time was 4% while after 1,000 hours loading time it reached to 61%. The same is

applicable to sample buried at 0.5 m in soil for 3 months.

2. Maximum load at the same strain has decreased under all duration and condition of storing than that of the control conditions.

3. Samples buried 1.5 m in soil had no change for duration of burying.

4. The three samples of the stored conditions for 3,6 and 12 months, loaded at 60% of maximum load (7.8 KN/m) which were broken down.

4.2. Uni-axial Grid

Load-strain curves for uniaxial SR80, showed that:

1. Neither the storing condition nor the storing duration has significant effect on load-strain curves.

2. Four cases of failure at strain ranges between 5% and 6% where maximum load reached 28 kN/m were observed

3. Load Strain curves of different loading times are very close to each other. Strain for 1, 10, 100 and 1000 hours are ranging from 4% to 5.5%.

4. Result showed excellent performance at all weather conditions.

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