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The Behavior Study of Geogrid Concrete Mats under Loading Using Laboratory Model

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***Abstract*—Rivers, coastal zones and everglades are always in transit equipment at the crisis. Geogrid concrete mats can be used in applications of appropriate. Concrete mats consist of light weight reinforced concrete beams with high strength which are connected using the geogrid network. Quickly and easily removable, high flexibility and resistance can held together the concrete beams with lower thickness and be able to spread on watery land using crane are the main characteristics of these mats. In this case, condition is prepared to cross military equipment and vehicles on the shallow and marshy rivers. Panel structural design, measurement strain on mats and discussion about time series obtained from panel has been carried out in this research. The results show that the amount of created strain in geogrid was 11%, which was much less than the allowed amount and coherence between the concrete and geogrid was very good because of proper function of the metal wire.**

***Keywords*— geogrid , concrete mat,, strain gauges**

I. Introduction

One of the major goals in the transportation engineering is crossing heavy machines on the watery and marshy lands. This is possible by routing, barriers identification, investigate behavior and interaction analysis. One of the basic problems in this case is reach to shallow and inflate rivers that by come the machines to the barriers may lead to traffic or change of direction. Changes of direction are paid with the financial heavy costs in terms of loss time and energy of human. The issue is show in times of war and as assist people during flood and after these conditions.

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For first time in World War II, when Germany invaded the Soviet Union, the German army used from wooden planks but because of low resistance and unsuitable connect of the woods arose many problems. In war between Iraq and United States of America were used carry-on netted concrete blocks, perhaps it is the first idea in the field of engineering. With the advent nano science and mass production of geo sanastaky networks use of this material as the flexible connection materials have been introduced in many cases. One of the geo sanastaky materials productions is geo grid networks with high strength that many applications began with these materials, such as soil trenches stabilization, land consolidated, road bed layer, asphalt complement layer, bedding runway of airport and many other applications. Concrete in composition geogrid, because of high strength gave a good quality, but the fundamental problem is the lack of adhesion between the concrete and geogrid network. Unlike bar with excellent adhesion to concrete , in these networks because of variety Poisson's ratio and also lack 45 degrees interactions arms between concrete and geogrid used accessories instrument such as complementary metal wire to connection concrete and geogrid but to connect the network and concrete were used steel pieces .Due to these cases, must be have good understanding about how to build and investigate strength of the mat in construction and operation stages and resistance of the mats during movement .Therefore use of physical models and laboratory will help in this field.

II. Research Background

For the first time in World War II, when Germany invaded the Soviet Union, the German army used wooden planks that because of improper connection between them and low resistance wood arose many problems [1]. In war between the United States of America and Iraq were used net concrete blocks which probably first engineering idea in the field. With the advent nano science and mass production of geo sanastaky networks use of this material as the flexible connection materials have been introduced in many cases [2]. Chow in 1959 is referred to problems of traffic and Construction Bridge on the river [3]. Clopper for the first time proposes using netted concrete blocks with the laboratory work in 1989 [4]. He investigated optimization the concrete blocks using motion threshold theory [5]. Koerner in 1998 was studied the idea of using geogrid in improving the soil at the bottom of rivers and its resistance during flood [6].

III. Experiments

In order to test the concrete mat about 5 concrete panel with thickness of 30 cm, length of 3 meters and a width of 10 cm put together a distance of 25 cm which they were designed and were constructed as concrete beams then the panels using network geogrid were connected together to have a unified manner. Note that the adhesion between the concrete and geogrid is very low therefore, between the concrete and geo grid springs are used the metal wire. The wires are passing through geo grid springs as well as are placed between panel rein for cement bars. On the other hand their performance between the concrete and geogrid and boxer wire (to movement) were good. Figure 1 shows an overall picture of experimental model and figure 2 shows a plan of concrete mat.

A. *Concrete Mix Design*

Given the strategic situation and frequent movement concrete mats should be provided concrete with light weight and high strength. Concrete details are outlined briefly in Table 1.

Figure 1. Concrete mats are made in the laboratory

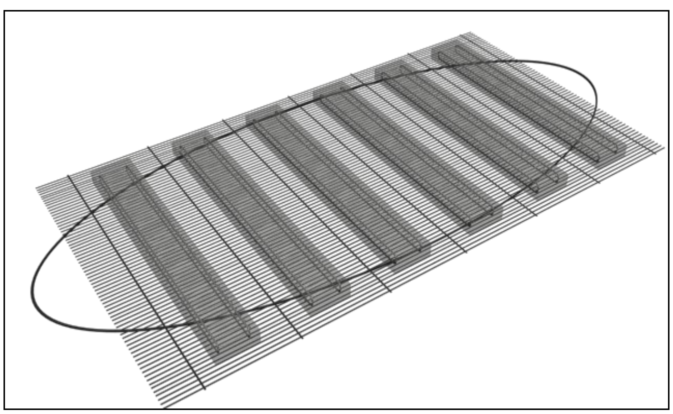

Figure 2. Concrete mat plan

By counting bar and geogrid and measuring on the bascule, total weight of the tested mat was 569 kg.

TABLE I. THE STANDARD TO PRESENT MIX DESIGN OF LIGHT WEIGHT CONCRETE ACI211.2R

Cement (II)	450 kg
Micro Silica	100 kg
Extra Lubricant	10 kg
Water	160 kg
Lice	300 kg
Aggregate	450 kg
Stone Powder	200 kg
Density (Wet Concrete)	1690 kg per m^3
Resistance in 11 Days	35 Mega Pascal
Resistance in 32 Days	40 Mega Pascal

B. *Panel`s Structural Design*

In order to design panels and due to loading condition was used LUSAS8 Elman finite software, which is powerful software in modeling. In primary design, loading on the beams is from 2500 kg (The reason for this choice use car model and considering the resulting force during brake). Support condition to use in the mat is not clear therefore critical modes were considered. All of these modes are considered when the very low bearing capacity of sand (0/5 kg/ cm square) will be the most critical. Due to the high volume of analysis, using obtained deformations contour curves on soft substrate (Figure 3) and two supporting (Figure 4) is satisfied.

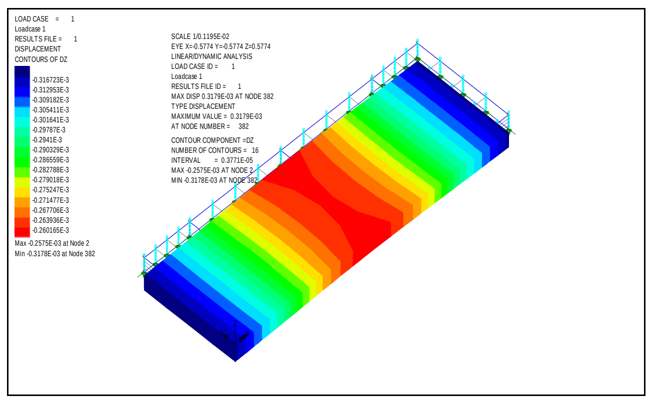

Figure 3. deformation contour in a sand soft bed

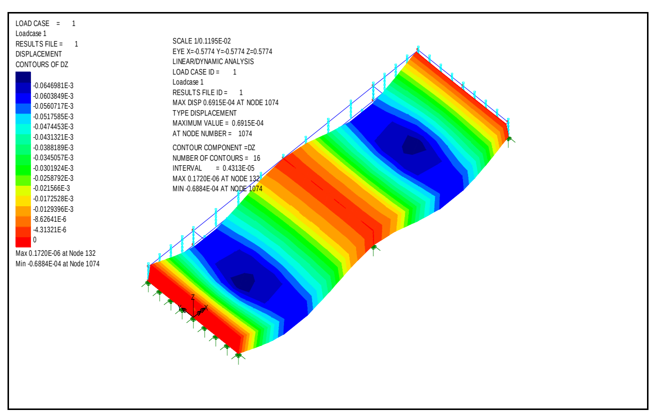

Figure 4. deformation contour in two supporting mode

C. *Geogrid*

Specifications of geogrid used in this study are accordance to table 2. As can be seen from this table, a very high failure strain (800%) and high fracture resistance cause proper connection between the panels of the concrete mat.

TABLE II. SPECIFICATIONS OF GEOGRID

Specifications	IS-10	CE-30	CE-35	GS-45
Size Spring (mm)	1.0	3.0	3.5	4.5
Thicknesses (mm)	0.9	1.1	1.87	2.2
Weight	245	216	208	187
Melt Index	0.5			
Relative Density	0.956			
Resistance Welding	28			
U.T.S (N/mm^2)	40			
Failure Strain	800			

D. *Strain Gauge*

The strain gauges are kind of TML Metal Pam E-101R [7], which are used to measure the bending moment as half-bridge strain, gauges. Sampling range of theses train gauge is from zero to 100 Hz. Due to the fast vibration of panels therefore should be careful in selecting the sampling frequency of mat reaction to prevent create undesirable problem. In this study the sampling frequency is 30 Hz. Due to the system error, reach this frequency is not possible exactly. However, in data obtained frequencies near 50 Hz such as 49 Hz have been observed [8]. During mounts train gauges on both sides of the panel should be careful in attaching two strain gauges on along a side and both sides of the panel because minor deviation will cause error. Method closes the strain gauges to take off strain in order to determine the flexural moment is as half-bridge. Equations 1 to 3 express the relations are used to determine strain gauges [8].

$$R_1 = R_0 + \Delta R, R_2 = R_0 - \Delta R, R = R_0 \tag{1}$$

$$\Delta e = \frac{\Delta R}{4R + \Delta R} E \tag{2}$$

$$\varepsilon = \frac{4\Delta e}{E.K} \tag{3}$$

In the above equation, R1 is the first gauge strain electrical resistance; R2is the second strain gauge electrical resistance;R0 is capacitance electrical resistance into system board; E is drive voltage; is resistance change because of change in strain; Δe is voltage change due to a change in strain; K is strain gauge constantan is the strain which is measured. Variety loading was gradually added on the car which crossing on the mat. The car empty weigh was 1,100 kg and load 50 kg is added in each loading.

IV. Tests

Tests have done on a soft bed of sand. On this basis, the maximum strain gauge is applied on the panel. Figure 5 shows strain time series on the panel (1).In practical, proper behavior as observed during crossing the car on the mat under different loads.

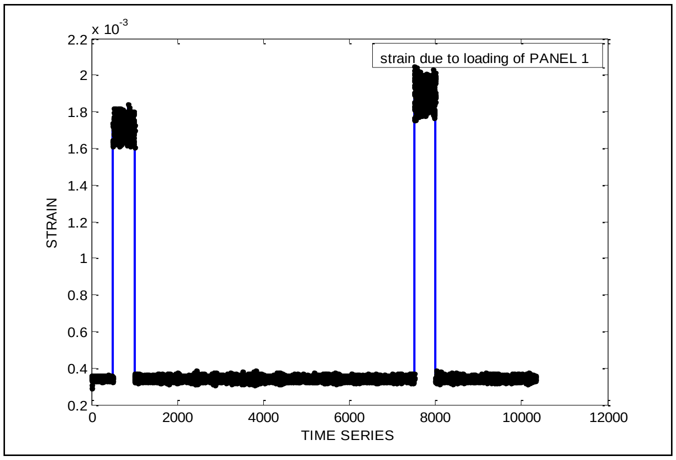

Figure 5. time series obtained from panel 1

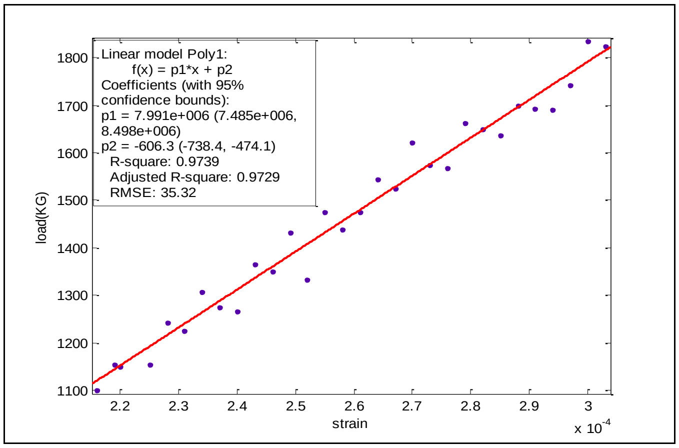

Figure 6. load-strain diagram

Panels 2 and 6 have similar strain time series. As can be seen in figure 5 at two areas the diagram have maximum amount which are related to crossing load. Maximum obtained strain is 0.000216 which is much less than the maximum allowable strain. This behavior indicates proper behavior of the mat. The strain results were obtained using repeated take off under different loads. Figure 6 diagram shows nearly linearly behavior between load and strain with determinate factor 97%.Based on this chart can be assessed the concrete mat behavior under different loads.

V. Conclusion

Application concrete mats should be considered in emergency situations. With removing mats by boxers wires the following cases were observed:

- The amount of created strain in geogrid was 11%, which was much less than the allowed amount.
- Coherence between the concrete and geogrid was very good because of proper function of the metal wire.

After movement did not break or crack when put a mat on the floor.

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