

Contact Pressure Distribution on Weak Subgrades due to Repeated Traffic on Geocell Reinforced Base Layers

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1 Introduction

Design of pavements over weak subgrades is often a challenging task for design engineers. Stabilizing the weak subgrades with either cementitious compounds or geosynthetics is a common practice to improve the engineering behavior. Geocells is a recent introduction in geosynthetics as a reinforcement material, which offers all round confinement to the infill material against planar products. In addition, the geocell reinforced bases exhibit bending resistance, tensile strength, and shear strength, and intercept the failure planes reaching the subgrades. Understanding of these mechanisms originated mostly from the static plate load tests, however, the loading is repetitive in nature under moving traffic conditions. Hence, it is important to understand the behavior of weak subgrades under cyclic and repetitive traffic conditions when geocell reinforcement is adopted for overlying base layers.

2 Experimental Program and Results

This paper presents the results from a series of large scale repeated load tests performed on an unreinforced and geocell reinforced dense granular base layers overlying weak clayey soil subgrades. A dense sand base layer was prepared at 75% relative density over a weak clayey subgrade of undrained strength of 10 kPa. A tire pressure of 550 kPa equivalent to a single axle wheel load (ESAL) of 40 kN was applied through a circular steel plate using a dynamic hydraulic actuator of 100 kN capacity. Several earth pressure cells were placed at the interface of the dense base and weak subgrade layers to measure the contact pressure distribution on the latter layer. Both cyclic and repeated load tests were conducted to visualize the contact pressure distribution on the weak subgrades. The results have illustrated the variation of contact pressure distribution patterns over weak subgrades.

It is observed that the dense sand and granular base layers over weak subgrades improved the load carrying capacity of the subgrade. The surface layer on the unreinforced test bed has further improved the performance in terms of bearing pressure. Additional improvement is noticed with the geocell mattress in the dense base layers. A more uniform pressure distribution is depicted with the three dimensional mattress which offers all round confinement to the infill base material. It is further noticed that the granular base layer has performed superior to the dense sand layer in terms of pressure distribution and load carrying capacity due to high frictional resistance of the base material (Figure 1).

It is also observed that the contact pressure has reduced with the number of load repetitions against the incremental cyclic loading. It is interesting to note that the stiffer base layer acts like a rigid deep slab on the soft or weak subgrade and shows a reduction in the contact pressure distribution. With the inclusion of geocell mattress, the flexural rigidity of the granular base layer is expected to enhance further and hence, the base layer behaves as a rigid layer over weak subgrades. As high as 90% reduction in contact pressure distributed over on the weak subgrades with geocell reinforcement. Overall, there is no stress concentration and accumulation noticed with an increase in the repetitive load cycles due to resilient behavior of the geocell reinforcement (Figure 1).

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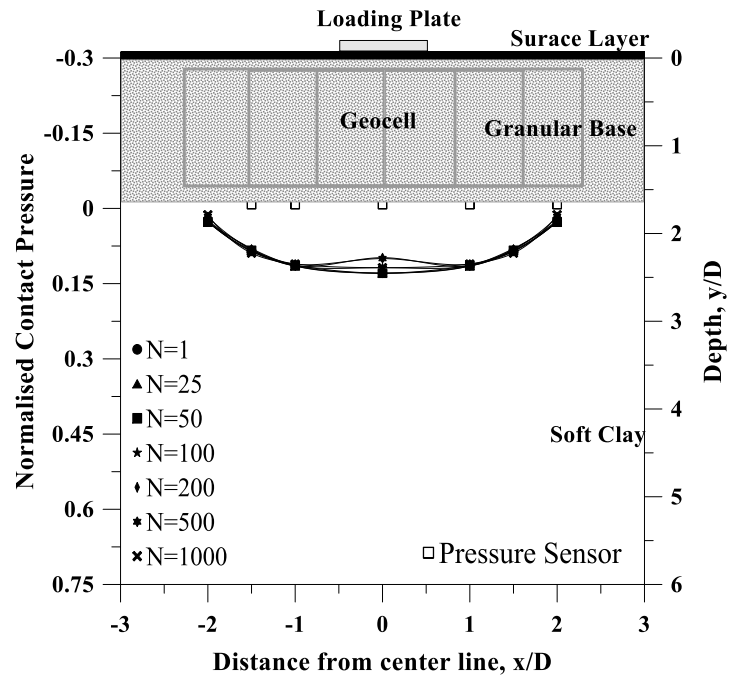


Figure 1: Contact pressure distribution on weak subgrade due to repeated traffic load (550 kPa) on geocell reinforced granular base – with surface layer