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Behaviour of footings on reinforced sand subjected to repeated loading – Comparing use of 3D and planar geotextile

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A B S T R A C T

This paper describes a series of laboratory model tests performed on strip footings supported on 3D and planar geotextile-reinforced sand beds under a combination of static and repeated loads. Footing settlement due to initial static applied load and up to 20,000 subsequent load repetitions was recorded, until its value becomes stable or failure occurred due to excessive settlement. The response under the first few cycles was found to be a significant behavioral characteristic of footings under repeated loads. The influence of various amplitudes of repeated load on foundations containing different numbers of planar geotextile layers and different heights of the 3D geotextile reinforcement were investigated. Most of the observed responses show plastic shakedown developing – that is a stable, resilient response is observed once incremental plastic strains under each load repetition have ceased to accumulate. The results show that the maximum footing settlement due to repeated loading is comparable for either planar- or 3D-reinforced sand and much improved over the settlement of unreinforced sand. The efficiency of reinforcement in reducing the maximum footing settlement was decreased by increasing the mass of reinforcement in the sand. On the whole, the results indicate that, for the same mass of geotextile material used in the tests, the 3D geotextile reinforcement system behaves more effectively than planar reinforcement as a retardant for the effects of dynamic loading. Thus, a specific improvement in footing settlement can be achieved using a lesser quantity of 3D geotextile material compared to planar geotextile.

1. Introduction

Machine foundations require the special attention of a foundation engineer. In addition to static loads due to the weight of machine and the foundation, loads acting on such foundations are often dynamic in nature due to the action of the moving parts of the machine. While these dynamic loads are generally small, as compared to the static load, they are applied repetitively over a very large number of loading cycles. Therefore it is necessary that the soil behaviour is elastic, or else deformation will increase with each cycle of loading until the unstable soil behaviour develops.

Research into the behaviour of unreinforced soil and shallow foundations were subjected to dynamic loads was initiated during the 1960s. Both theoretical and experimental studies of the dynamic bearing capacity of shallow foundations have been reported by several researchers to understand the load–settlement relationship of footings and also the relationship between footing settlement and the number of load cycles (Cunny and Sloan, 1961; Raymond and Komos, 1978; Das and Shin, 1996).

In recent decades, due to its economy, ease of construction and ability to improve the visual appearance, reinforced soil has been widely exploited in geotechnical engineering applications such as the construction of roads, railway embankments, stabilization of slopes, and improvement of soft ground and so on.

In the case of monotonic loads, the beneficial effects of the planar geosynthetic (Shin and Das, 2000; Dash et al., 2004. Yoon et al., 2004; Deb et al., 2005; Ghosh et al., 2005; Patra et al., 2005, 2006; Hufenus et al., 2006; El Sawwaf, 2007; Alamshahi and Hataf, 2009; Bathurst et al., 2009; Sharma et al., 2009) and 3D geosynthetic geocells (Rea and Mitchell, 1978; Mitchell et al., 1979; Shimizu and Inui, 1990; Cowland and Wong, 1993; Krishnaswamy et al., 2000; Dash et al., 2001a,b; Dash et al., 2003; Sitharam et al., 2005; Dash et al., 2007; Madhavi Latha and Rajagopal, 2007; Sireesh et al., 2009) have most often been studied in geotechnical applications.

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