Behaviour of compaction piles made from reinforced sand and quarry fines

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Decrease in availability of suitable land for building on, coupled with numerous environmental restrictions, has encouraged more widespread use of areas that are underlain by weak soil deposits that would be regarded as either marginal or unsuitable. Soil deposits in these areas are generally composed of soft or organic soils that have low bearing capacity and construction can result in excessive settlement. Among the various ground improvement techniques, reinforcing cohesive soils with compacted granular column is a well-established method which allows construction of low-rise or less settlement-sensitive structures, such as industrial warehouses and road and railway embankments, on soft ground. The compacted granular column methods, including sand compaction piles and stone columns, have been developed as a cost-effective and versatile ground treatment technique for a wide range of soil types. The construction process involves replacing 10% to 30% of soft in-situ soil, by means of introducing well-compacted sand columns into a weak stratum in a grid pattern. The purpose of this improvement is to enhance load carrying capacity, accelerate consolidation to permit the application of higher imposed loads, and reduce settlement by densification and reinforcement of the subsoil.

The performance of granular columns under loading is controlled by the lateral support offered by surrounding soil, since the load transfer mechanism in this system relies on lateral deformation of columns. Therefore, the application of conventional compacted granular columns in soils with undrained shear strength less than 15 kPa is limited, as the lateral confinement provided by soft soil might be inadequate to prevent, or reduce, excessive bulging of the column.

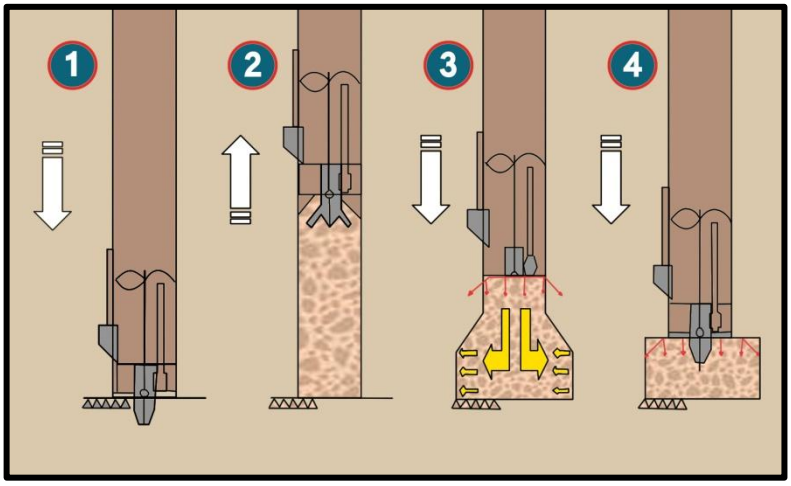

Figure 1- The construction process of compacted granular columns in the field

In order to enhance load capacity and control settlement of compacted piles, one or a combination of the following options can be adopted: (a) providing higher confinement pressure and (b) Utilising column infill materials with higher strength and stiffness or cementitious additives as a binder to strengthen the column. In order to achieve these goals, in this research study; (a) discrete reinforcing elements are used to increase the bearing capacity and reduce the excessive bulging and lateral movement of columns and (b) waste or recycled materials including quarry fines and granular blast furnace slag (GBFS) are suggested as an alternative infill material that can provide sufficient strength and permeability for the system. This approach also leads to a more sustainable design since the reuse of waste or recycled materials in the construction industry reduce the cost and minimise the adverse environmental impacts of waste disposal or aggregate quarrying.

This study evaluates the performance compacted granular columns in a weak soil under static and cyclic loading. The research project involves series of laboratory tests on soft clay model bed reinforced with granular columns in which the effects of key parameters in design of compacted columns including diameter and length of columns, area replacement ratio and strength of infill materials are studied to investigate load bearing capacity, settlement characteristics and failure modes of the model.

To reach these goals, in the first stage the proposed infill materials including sand and quarry fines are characterized in order to assess their suitability for compacted column methods. In the second stage, the ground improved with compacted granular columns is modeled in laboratory-scale and tested under both static and cyclic loading.

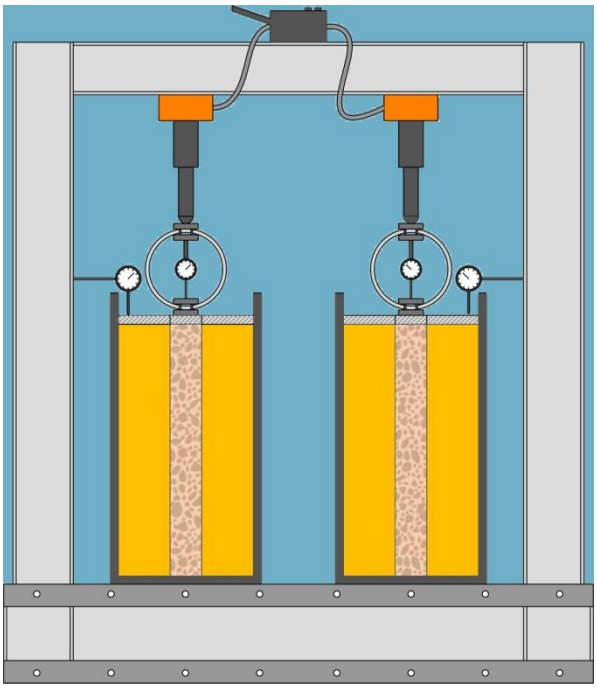

Figure 2- The test setup in the laboratory

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