IMPROVEMENT OF LIQUEFACTION RESISTANCE OF SAND BY CEMENTATION

Maral GOHARZAY
M.Sc. Student, Shahid Beheshti University, Tehran, Iran
goharzay.maral@gmail.com

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Soil liquefaction caused extensive damage to the structures and foundations for centuries.Many different practical methods have been carried out to predict potential soil liquefaction. Chemical grouting is a well-established geotechnical process for strengthening the ground. Cementation of sand to improve their engineering properties has been in practice for a long time. The cementation integrity tests reveal a change in behaviour from "soil-like" to" rock-like" with an increase in treatment level. Cementation causes formation of weak to strong bonds between soil particles. Carbonates, silicates, iron oxides and gypsum are usual natural cementing agents. The bonds strongly affect the mechanical behaviour of cemented soil.

Study of the effect of cementation on the mechanical behaviour of cemented gravely sands started in late 20th century (1998). Cementation increases the soil stiffness and brittleness. The effect of cementation on the mechanical behaviour of fine sandy soils has been considered by several researchers (Saxena and Lastrico, 1978; Dupas and Pecker, 1979; Clough et al., 1981; O'Rourke and Crespo 1988). According to the research results, the uncemented samples and lightly cemented samples at high confining pressure showed contractive behaviour accompanied with positive excess pore water pressure. However, cemented samples and uncemented samples at low confining pressure showed dilative behaviour accompanied with negative pore water pressure.

The treatment of soils with cement is a good solution when a project requires improvement of the local soil for the construction of subgrades for road way and railway lines, especially under the platforms and mostly in transition zones between embankments and rigid structures, where the mechanical properties of supporting soils are very influential. These solutions are especially attractive in line works where other ground improvement techniques are very expensive. On the other hand, the economic and environmental costs of such works should be optimized with good balances between excavation and embankment volumes.

This paper presents findings from comprehensive research studies on the beneficial effects of cementation of sands on their mechanical behaviour, also describes the results of an experimental investigation on the behaviour of a grouted sand under both monotonic and cyclic loading to identify Static and dynamic properties of a cemented sand. Cement content had a great effect on the strength of the soils, and the unconfined compressive strength increased approximately linearly with increasing in cement content. The results shows that treated soils reduced excess pore pressure generation and reduced settlements compared to the untreated soils.

A convenient method for viewing the pore pressure development in the tests is using the nondimensionalized form suggested by Martin and Seed (1976). The pore pressure is plotted versus the number of the load cycle. The range of variables considered is given in Table 1 and Figure 1 gives a summary of the nondimensionalized pore pressure curves for all of the tests on cemented sands.

Table 1. Variables and their range of values for cyclic testing (Martin and Seed, 1976)

Variable	Range of values	Symbol	Unit
Cement content	1, 2, 5, 8	CC	%
Curing period	15, 30, 60	CP	days
Effective confining pressure	98	σ_0'	kPa

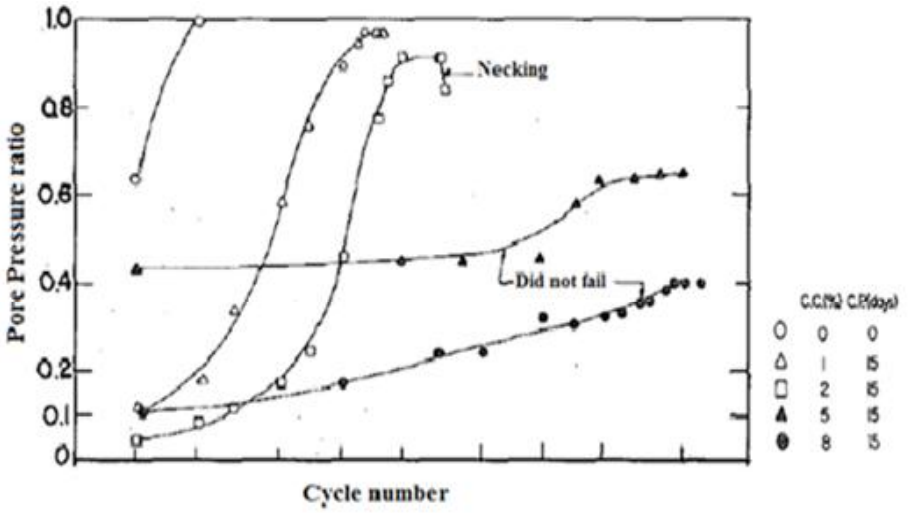

Figure 1. Effect of cement content on pore pressure ratio (Martin and Seed, 1976)

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