Strength Gain of Weak Slurries Using Admixtures
Xiaoyuan Xu (2014275)
Supervisor: Dr. Trevor Davies
MSc Civil Engineering & Management

Introduction
Additives will be used to increase the strength of very weak soils, defined here as soils with water contents more than their liquid limits (Schlue et al., 2011). In offshore engineering, rapid strength gain of weak (high water content) soils is often an important element in construction.

Objective
The major practical objective was to determine whether relatively low additive doses could yield significant strength gains within a short period of time for a range of remoulded soils at very high water contents. Tests on the soil concentrated on the effect of initial water content, additive concentration, time to testing (1 day, 3 days, 10 days, 30 days) and temperature.

Materials
The material used for testing in the current study was a fine-grained predispersed china clay called Devolite™ produced by the Imerys Group (Imerys Group, 2008).

Atterberg limit tests
Liquid Limit test and Plastic Limit test are laboratory tests for measuring the water contents of soils at certain characteristic strength levels.

The sample is classified as silt (ML) as is shown in the Fig. 1, with a Liquid Limit \( W_{LL} = 41\% \), Plastic Limit \( W_{PL} = 26\% \), and Plasticity Index \( I_p = 15\% \).

Sample Preparation
For the preparation of clay slurries, a weighed amount of soil powder (typically 900g) was mixed with de-ionized water into an electrical mixer for a period of fifteen minutes. The calcium hydroxide was mixed with 100 ml of water and decanted into the mixing container. This second stage of mixing was timed at thirty seconds. They were then stored under water at room temperature or under refrigeration until testing.

Experimental Method
The penetration depth was measured with the vernier scale when each load was applied. Each load and displacement were recorded and analyzed by Microsoft Excel. The discs used for testing in this study were 15mm in diameter.

Results
Results are shown for clay slurry with a water content of 2 \( W_{LL} \). Expected bearing pressure of this slurry (without additive) is about 0.1 kPa.

Test 1
Fig. 3 shows four bearing pressure profiles with 1 % additive in 1 day-old tests. The repeatability of the tests looked very good from the outset, with a coefficient of variation of \( \pm 3\% \).

Test 2
Fig. 4 illustrates that substantial strength gain develops slowly over a period of days and weeks, reaching nearly 1.7 kPa at 30 days.

Test 3
Fig. 5 shows increasing the dosage rate (to 2 %) dose not yield proportional increases in soil strengths, and at short times increasing the dosage rate above 1% has only a small effect at all.

Test 4
The average ratio of strengths(low/high temperature) is around 78% at 1 days and rises to 85% after 10 days (shown in Fig. 6).

Close
The experimental data shows that very weak clay slurries can gain substantial strength by the addition of modest doses of calcium hydroxide. Early strength gains are rapid but the soil strength continues to increase over time.

Reference