ANALYSIS ON IMPROVISATION CBR OF MARINE CLAY SUB GRADE STABILIZED WITH LIME AND ROCK DUST

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Abstract
When a project calls for the local soil to be improved, adding lime is an appealing option. The purpose of the current study is to develop fundamental guidelines for the use of lime and rock dust in stabilizing soft soils. Lime and combinations of lime and rock dust were used to stabilize the soils (RD). According to the test results, the sub-base layer may be designed with an admixture with an optimal admixture concentration of around 6% lime combined with 25% Rock dust by mass of the soil.
Keywords: Marine clay, Lime, Rock dust, Atterberg limits, Compaction, CBR.

INTRODUCTION
A form of clay called marine clay is present in coastal areas all over the world. It is made up of salty and clayey soils with weak bearing capacity and poor drainage. Due to their unique physico-chemical composition, marine clays are susceptible to volume changes as a result of changes in their surrounding environment. Due to the high population density, these soils are heavily populated in coastal corridors and difficult to avoid marine clay zones for the building of pavements and foundations. A method of reaching the suggested objectives that is both affordable and simple to implement in nearly any type of soil is soil stabilization. Use of solid wastes such as fly ash, rice husk ash, marble dust, phosphogypsum, and granulated blast furnace slag,red mud, waste tyre,etc to change the physical and chemical properties of soil(Muntohar and Hantoro 2000, Pandian et al.2001, Swami 2002,Phanikumar and Sharma 2004, Kalkan 2006, Degirmenci et al. 2007, Cokca et al. 2009,Sabat and Nanda 2011,Patil et al. 2011) is one of them.Utilisation of solid wastes in this manner not only protects the environment from degradation but also improves the engineering properties of the soft soils. Marc Choquette et.al (1987), reported that the Atterberg limits and the strength of the marine clay has been increased with quick and hydrated lime stabilization. The engineering characteristics of the marine clay have been improved with the addition of lime with curing times. The laboratory investigations carried out by Locat et al. (1990) indicated that the lime stabilization of sensitive clays resulted in a significant increase in the strength.

Sabat and Das(2009) had stabilized expansive soil using quarry dust and lime and found the stabilization effects with improvement in Unconfined compressive strength (UCS), soaked California bearing ratio (CBR) and reduction in swelling pressure etc. Rajasekaran, G et.al (1998), reported that there is an increase in the size of clay particles towards silt or fine sand fraction due to lime treatment. The formation of aggregates due to lime –soil reactions can be seen in the micrographs of different lime treated soil systems.

2. EXPERIMENTAL INVESTIGATION
2.1 Materials
2.1.1 Soil
The geotechnical properties of the Marine clay are: Sand size -10%,Silt size -29%, Clay size- 61%, Liquid Limit(w_L)-79% Plastic Limit(w_P)-27%,Plasticity Index(I_P)- 52%,Shrinkage Limit(w_S)-9.5%,Specific Gravity -2.63,Optimum moisture content (OMC)- 34%, Maximum dry density (MDD) -1.365gm/cc,Soaked CBR -1.00%, Cohesion – 11.25 T/m² , Angle of internal friction- 2^0.

2.1.2 Lime
Hydrated lime was used in this investigation. It has 75–80% of calcium hydroxide and 7% silica.

2.1.3 Rock Dust (RD)

The properties of the Rock dust are: Gravel size -14%,Sand size -85%, Fines size- 1%,Specific Gravity -2.90,Optimum moisture content (OMC)- 12%, Maximum dry density (MDD) - 2.04gm/cc,Soaked CBR -9.25%, Cohesion – 0.50 T/m^2 , Angle of internal friction- 22^0.

2.2 Tests Conducted

Compaction tests and CBR tests were conducted in three different series. In the first series, compaction tests and CBR tests were conducted on the untreated marine clay. In the second series, compaction tests and CBR tests were conducted on both clay-lime mixes to study the effect of lime on the values of optimum moisture content (OMC) and Maximum dry density (MDD) and CBR of the Marine clay used. In the third series, compaction tests and CBR tests were conducted on RD-clay-lime mixes to study the effect of RD on the values of OMC and MDD and CBR of clay-lime mixes.

2.3 Variables Studied

All the tests performed for the determination of CBR were conducted on samples prepared at the MDD 1.365gm/cc and OMC 34% of the untreated natural soil. The diameter and the length of the sample prepared for the CBR test were 152 and 126 mm, respectively. The % contents of various additives by dry weight of the soil were varied as below:

- Lime: 0, 2,3, 4,5, 6,7 and 8%;
- RD: 0,15,20,25 and 30%.

The tests were conducted on samples prepared at various combinations of the above variables.

2.4 Sample Preparation and Test Procedure

2.4.1CBR Test

The required amount of the air-dried soil passing a 4.75 mm sieve was measured and thoroughly mixed with the placement water content and predetermined amount of the additives. The blend was statically compacted by pressing in the spacer disk of 50 mm thickness with the help of the testing machine. The penetration test was done on the specimen in soaked condition. The load penetration curve was plotted and the CBR value obtained.

TEST RESULTS AND DISCUSSION

The results as obtained from the above laboratory tests are presented as follows

3.1 Compaction test

Fig. 1 shows the variation of OMC and fig.2 shows the variation of MDD of the Marine soil mixes with % variation of lime content.

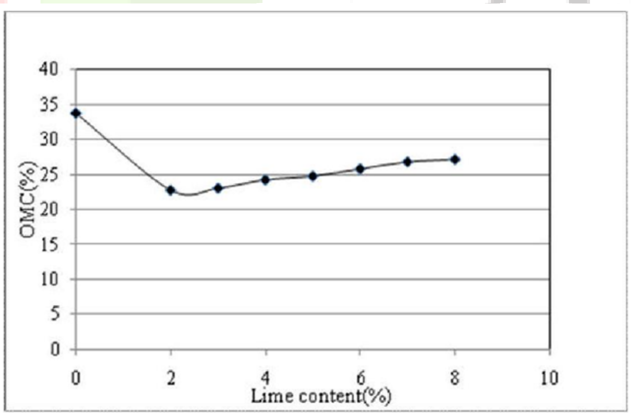

Fig. 1 Variation of OMC with lime content

It was observed that out of the different combinations tried in this investigation, 6% lime is found to be optimum. The OMC goes on increasing with the addition of lime and MDD goes on increasing up to 6% of lime content beyond the addition of 6%, there is reduction in M.D.D values of treated Marine clay.

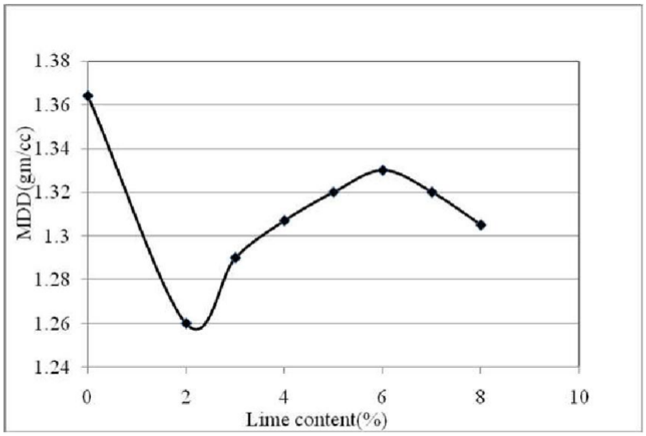

Fig. 2 Variation of MDD with lime content

3.2 CBR Test

The soaked CBR values of various mixes of marine clay and Lime using OMC obtained from compaction tests are determined. The soaked CBR after immersing in water for four days , that is when full saturation is likely to occur, is also determined. Fig. 3 shows Variation of CBR with % variation in Lime content is presented.

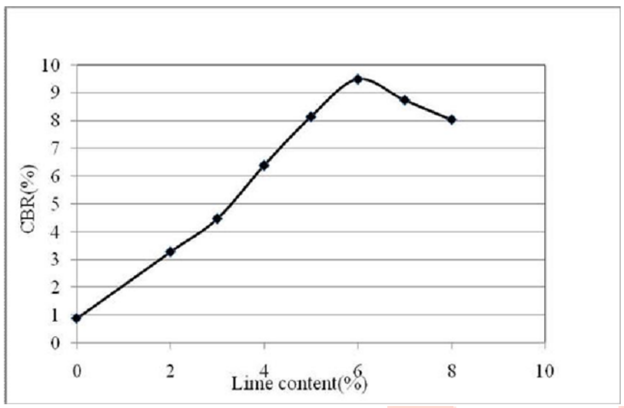

Fig. 3 Variation of CBR with lime content

Under soaked conditions the CBR value is highest for 6%Lime content, the CBR value increases from 0.9% at 0% lime to 9.5% at 6% lime. Beyond the addition of 6%, there is reduction in CBR values of treated Marine clay.

3.3 Compaction test

Fig. 4 shows the variation of OMC and fig.5 shows the variation of MDD of the Marine soil mixes with % variation of RD content.

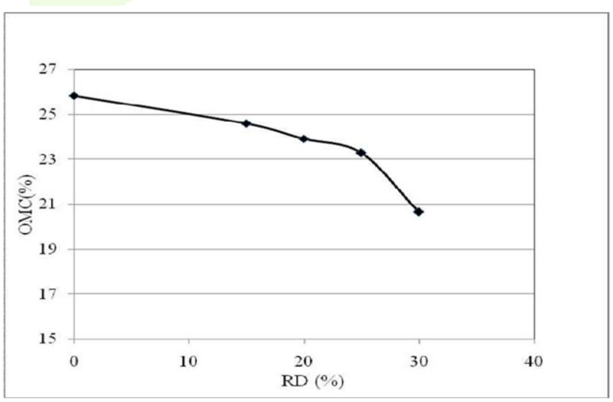

Fig. 4 Variation of OMC with RD content

It was observed that out of the different combinations tried in this investigation, 25% RD is found to be optimum. The OMC goes on decreasing with the addition of RD and MDD goes on increasing with the addition of RD. For convenience and economical point of view we select 25% RD as optimum.

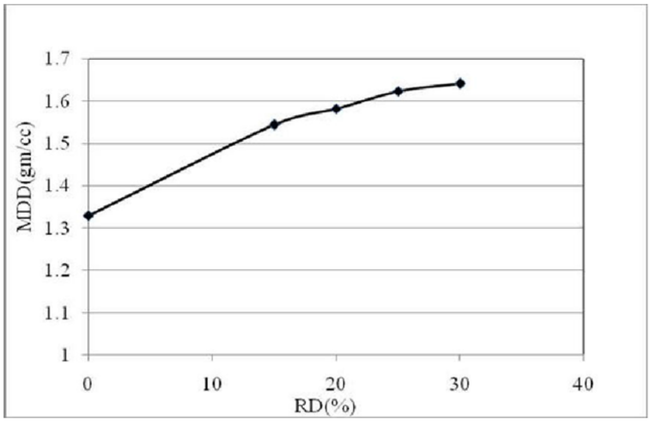

Fig. 5 Variation of MDD with RD content

3.4 CBR Test

The soaked CBR values of various mixes of lime treated marine clay and RD using OMC obtained from compaction tests are determined. The soaked CBR after immersing in water for four days , that is when full saturation is likely to occur, is also determined. Fig. 6 shows Variation of CBR with % variation in RD content is presented.

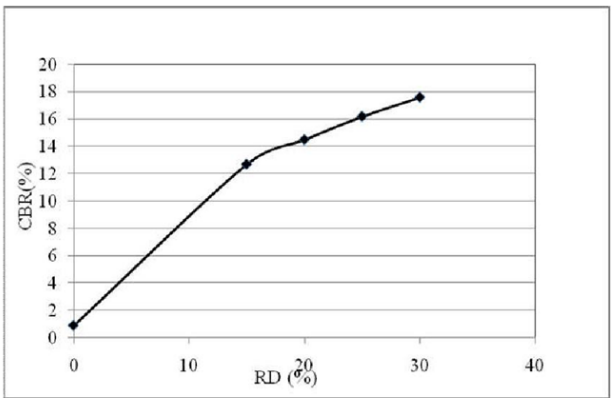

Fig. 6 Variation of CBR with RD content

Under soaked conditions the CBR value of lime treated marine clay is goes on increasing with the addition of RD content. At 25%RD content, the CBR value increases from **0.9%** at 100% marine clay to **16.2%** at 75% of lime treated marine clay+25% RD. This is due the clay particles were replaced by means of coarser particles of rock dust and thus the strength characteristics of marine clay have been improved. A minimum CBR value of 6% and 20% are recommended for the use in the sub grade and sub-base layer of strong and durable road pavements.

3.5 Atterberg's Limits

The Consistency limits of various mixes of marine clay, marine clay with lime and lime treated marine clay with RD are determined at their corresponding obtained OMC from Compaction tests. Fig. 7 shows the variation of w_L ,w_P and I_P of the marine soil-Lime mixes with RD content. From the Fig. 7 it was observed that Addition of 6% of Lime decreases the w_L to 65 % from 79%, I_P to 34% from 52%, and increases the w_P to 31 % from 27% .Increase in percentage of addition of RD further decreases the w_L ,I_P and increases the w_P . The w_L decreases to 50 % , w_P increases to 33 % and I_P decreases to 17% when 25% RD was added to marine soil-lime mixes. It is observed that the addition of lime decreases the Liquid limit, Plasticity index and increases the Plastic limit of the marine soil. Liquid limit, Plasticity index goes on decreasing and plastic limit goes on increasing with increase in percentage of RD in marine soil-lime mixes.

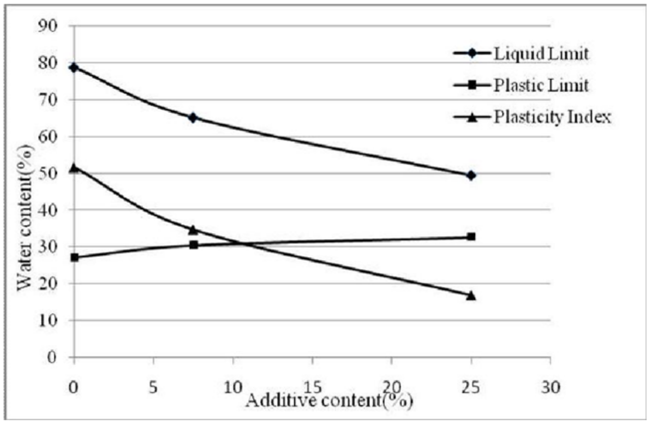

Fig.7 Variation of Liquid limit, Plastic limit and Plasticity index with additive content

From the figures, it is clear that the problematic marine clay was improved by stabilizing it with lime and quarry dust. The quarry dust replacement in the marine clay has reduced the plastic nature of the marine clay this resulted in the improvement of CBR parameters of marine clay and probed its applicability as a potential fill material and an effective sub grade material. From the above discussions, it can be summarized that the materials lime and quarry dust had shown promising influence on the properties of soft marine clay, thereby giving a two-fold advantage in improving problematic marine clay and also solving a problem of waste disposal.

CONCLUSIONS

It has been investigated how Marine clay-lime mixtures respond to Rock dust (RD). Untreated marine clay and marine clay combined with lime and rock dust (RD) were both examined for their California Bearing Ratios (CBR). The key findings are as follows:

Lime is added, and this changes the marine soil's plastic limit, plasticity index, and liquid limit. With a rise in the percentage of RD in lime-treated marine soil, the plastic limit, the liquid limit, and the plasticity index all continue to decrease.

The OMC goes on increasing with the addition of lime and MDD goes on increasing up to 6% of lime content beyond the addition of 6%, there is reduction in M.D.D values of treated Marine clay.

The soaked CBR value is highest for 6%Lime content, the CBR value increases from 0.9% at 0% lime to 9.5% at 6% lime. Beyond the addition of 6%, there is reduction in CBR values of treated Marine clay.

The OMC goes on decreasing with the addition of RD and MDD goes on increasing with the addition of RD.

The soaked CBR value of lime treated marine clay is goes on increasing with the addition of RD content. At 25%RD content, the CBR value increases from **0.9%** at 100% marine clay to **16.2%** at 75% of lime treated marine clay+25% RD.

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