PROPERTIES OF FINE GRAINED SOIL BLENDED WITH ORGANIC MATTER

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ABSTRACT: The organic matter has a significant influence on the engineering and index properties of soil. In the present paper, the influence of organic constituents on engineering and index properties of the soil has been studied by blending organic matter in various proportions (2%, to 20%).The investigation comprised Atterberg Limits, Grain size distribution, Specific Gravity, Proctor Compaction, Unconfined Compression test, loss on ignition at 550^0C, ratio of Liquid Limit of oven dried soil and air dried soil. The work was planned in three stages viz. Geotechnical Investigation of soil, Geotechnical Investigation of blending material and Geotechnical Investigation of blended soil samples. Significant alteration in engineering and index properties such as liquid limit, plastic limit, plasticity index, and maximum dry density, optimum moisture content and unconfined compressive strength was observed. The liquid limits, plastic limits were found to increase with increase in organic content beyond a threshold limit of 6 % whereas increase in plasticity index was beyond 2 % of organic content. The reduction in MDD values and increase in OMC values were significant beyond 10 % of organic matter. UCC strength decreases with increase of organic matter.

Key words: Atterberg limits, Maximum dry density (MDD), Optimum moisture content (OMC), Unconfined Compressive Strength (UCS), and Loss on ignition (LOI)

1 INTRODUCTION

Organic soils are generally referred to as problematic soil on account of its poor strength, stiffness characteristics, high void ratio, high water content and more compressibility when compared to mineral or inorganic soil. Construction on soft organic soil is often problematic due to occurrence of large deformations during and after construction both vertically and horizontally[7]. Past studies on the effect of soil containing organic matter on geotechnical properties indicate that the organic matter has a significant effect on the engineering and index properties of soil[5]. The behaviour of soil samples from borrow area of East and West Sikkim projects having higher organic content were studied[2,3,8]. These samples were showing, low dry density, high optimum moisture content, high liquid limit and plastic limit, low plasticity index, low strength and high compressibility. In addition to above, these soil samples were blended with lime, sand and cement to modify the soil properties[4,7 8].

In the present paper, effect of organic matter on index and engineering properties of soil has been studied by blending organic matter in various proportions with fine grained clayey soil.

2 METHODOLOGY

Dairy manure compost was blended in various proportions viz 2%, 4%, 6%, 10%, 15% and 20% with clay soil sample. The influence of blending material on index properties and engineering properties has been studied. Methodology adopted is described in following steps.

2.1 Collection of Materials

- About 50 kg of fine grained soil samples were collected from project site.
- Dairy manure compost rich in organic content was collected for blending.

2.2 Geotechnical investigation

Geotechnical investigation of original soil, blending material and blended soil samples were done in laboratory. The following tests were done.

- Atterberg Limits
- Grain size distribution
- Specific gravity
- Proctor Compaction
- Unconfined Compression test (av. of 2 specimen)

- Ratio of liquid limits of air dried and oven dried soil sample
- Loss on ignition at 550^0C

3 GEOTECHNICAL INVESTIGATION OF ORIGINAL SOIL

3.1 Grain Size Distribution and Atterberg Limits

The Grain Size Distribution curve for the soil sample is presented in Fig 1. The sample possesses 33.5% silt size, 28.0% clay size, 25.9% fine sand size, 12.2% medium sand size and 0.4% coarse sand size indicating predominance of silt, clay and fine sand sizes. The gravel size was absent in the soil sample. From the Atterberg Limit test, it has been observed that the Liquid Limit, Plastic Limit and Plasticity Index are 38.0, 18.4 and 19.6 respectively and the sample possesses medium compressibility and plasticity characteristics.

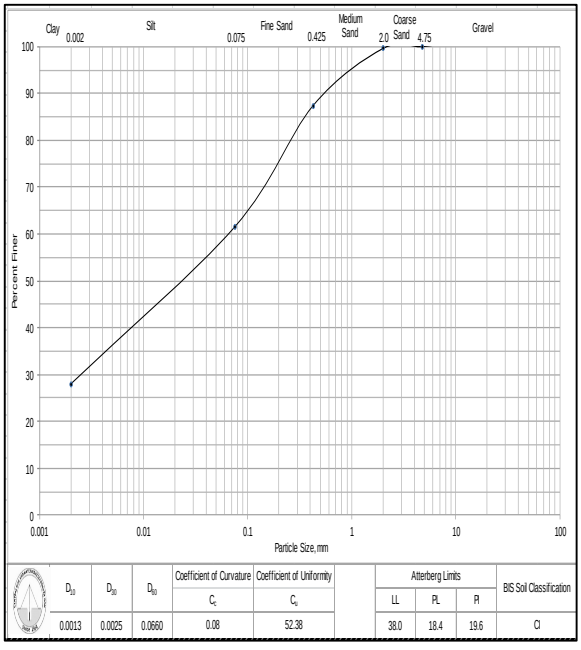

Fig 1 Grain size distribution and Atterberg Limits for original soil sample

3.2 Standard Proctor Compaction

The soil sample was subjected to Standard Proctor Compaction test. The Maximum Dry Density and Optimum Moisture Content of the soil sample were 1.79 g/cc and 15.3% respectively. The test results comprising values of Maximum Dry Density and Optimum Moisture Content are presented in Fig 2.

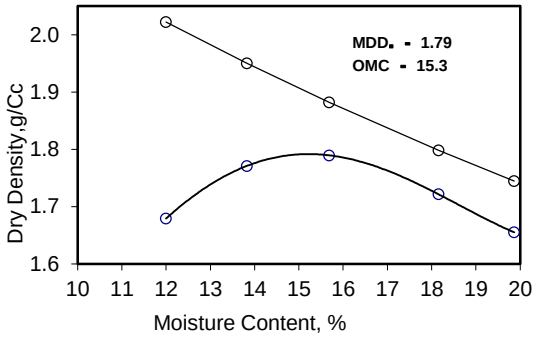

Fig 2 Proctor compaction test results for original soil sample

3.3 Unconfined Compression Test

The soil sample was subjected to Unconfined Compression test. The unconfined compressive strength of soil specimen was found as 2.064 Kg/cm^2

3.4 Ratio of liquid limits of oven dried and air dried soil [6]

Liquid limit for both air dried and oven dried soil sample were determined for the soil sample. According to BIS 1498, 1970, a soil is to be classified as 'Organic' subject to the condition

$$\frac{LL(oven\ dried\ at\ 100{-}110°C)}{LL\ (Air\ Dried)} < 0.75$$

The above ratio was found as 0.94 for the soil sample, indicating the soil under study was not an organic soil.

4 GEOTECHNICAL INVESTIGATION OF BLENDING MATERIAL

4.1 Atterberg Limits

Liquid limit, plastic limit and plasticity index for blending material were 76.0, 52.5 and 23.5 respectively indicating high compressibility with medium plasticity.

4.2 Loss on Ignition at 550^0C

Loss on ignition[1] test was performed at 550^0C for approximate, instant and cost effective estimation of quantity of organic content. Loss on ignition value was found as 24.9%.

4.3 The ratio of liquid limits of oven dried and air dried soil

The ratio of liquid limits of oven dried and air dried soil for blending material was 0.71 indicating the blending material was an organic material.

5 GEOTECHNICAL INVESTIGATION OF BLENDED SOIL SAMPLES

5.1 Atterberg Limits

A total of 5 blended samples at, 2%, 6%, 10%, 15% and 20% blending organic soil were subjected to Atterberg Limits tests. The graphical representation of Atterberg Limits (liquid limit, plastic limit and plasticity index) of blended soil samples and the non- blended soil are presented as in Fig 3, 4 and 5 respectively.

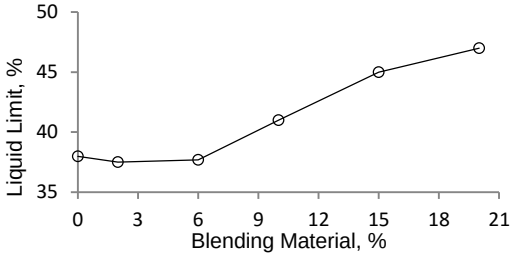

Fig 3 Liquid Limits of Blended Soils

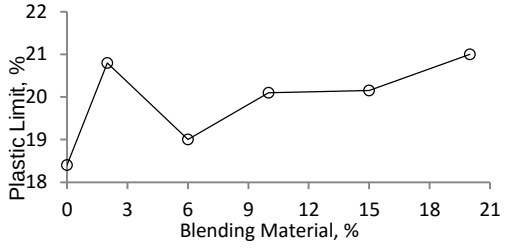

Fig 4 Plastic Limits of Blended Soils

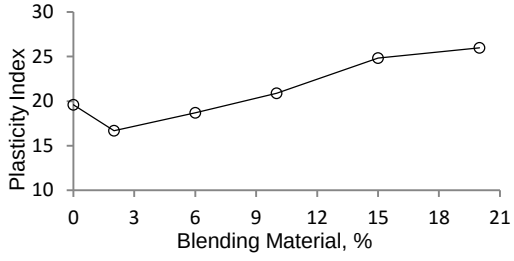

Fig 5 Plasticity Index of Blended Soils

Inconsistent behaviour was observed for liquid limit and plastic limit till 6% of blending material. Beyond 6% blending, liquid limits and plastic limits were found to increase. The Plasticity Index was found to decrease up to 3% blending. Beyond 3% blending PI values increase with increase of blending material.

5.2 Standard Proctor Compaction

A total original soil sample) were subjected to Standard Proctor Compaction tests. Significant reduction in MDD values and increase in OMC values was observed with increase in blending soil beyond 10 % as seen in Fig 6 and Fig 7 respectively.

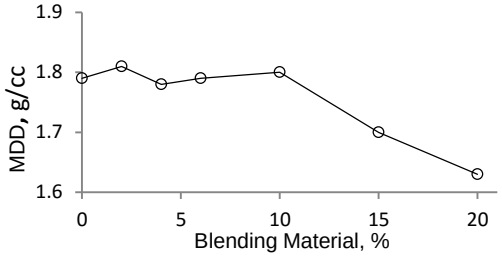

Fig 6 Maximum Dry Density of Blended Soils

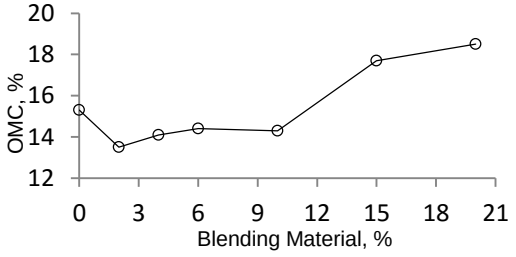

Fig 7 Optimum Moisture Content of Blended Soils

5.3 Unconfined Compression Test

The unconfined compression tests were conducted on original soil sample and blended soil samples with, 15% and 20% blending material (specimen sizes 38mm dia and 76mm height). The UCS was found to decrease with the increase of blending material. UCS was also determined at 7 days after mixing the samples and keeping under humid chamber for 7 days before testing. The initial moisture content for 15% and 20% blending for immediate strength determination were 22% and 24% respectively and those for 7 days strength determination were 18% and 20% respectively. Increase in UCS values at seven days was observed in both samples for 15% and 20 % blended soil. The UCS values determined immediately after mixing of blending soil and after 7 days of mixing are presented in Fig 8. The photographs taken before, during and after UCC tests are presented from Fig 9 to Fig11 respectively.

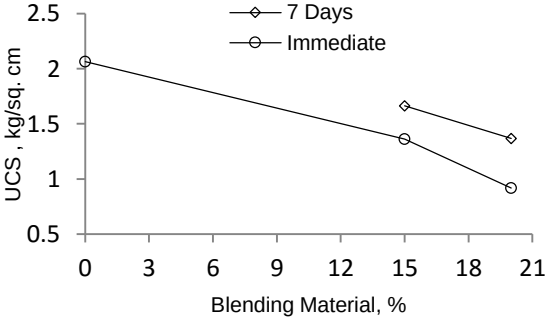

Fig 8 Unconfined Compressive Strength of Blended Soil

Fig 9 Sample before testing

Fig10 Sample during testing on load testing machine

Fig 11 Sample after testing

5.4 Liquid Limits for oven dried and air dried samples

Blended soils samples (15% and 20%) were subjected to liquid limits tests for both air dried and oven dried samples. The ratios of oven dried and air dried samples were 0.8 and 0.78 for 15% and 20% blending respectively. It is seen, therefore, that even after 20% blending the composite soil is still inorganic in nature (ratio of liquid limit of oven dried and air dried samples is greater than 0.75), however, addition of blending material always imposes deleterious effect in soil properties.

6 CONCLUSIONS

- The liquid limit increases and plastic limit decreases with increase in blending material beyond 6 %. The PI (plasticity index) increases with increase of blending material beyond 2 %.
- Significant reduction in MDD values and increase in OMC values was observed with increase in blending material beyond 10 %
- UCS strengths was found to decrease with the increase of organic content
- 7 days UCS strength was found more than immediate strength.

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