STUDIES ON CHEMICAL AND GEOTECHNICAL PROPERTIES OF MARINE SAND


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ABSTRACT

Present study deals with the Chemical and Geotechnical properties of Marine Sand collected from Mypadu Beach, Nellore District, AP, India. Samples selected from two trial-pits one at a depth of 0.5-1.0 m (Pit-1) and second at a depth of 1.2-2.0 m (Pit-2) and conducted laboratory tests on Chemical and Geotechnical Properties. Samples are said to be Alkaline soils and Non-Cohesive because it’s having greater than 8.5 pH and grain sizes more than 98% range in 0.075-1.18 mm respectively. The detailed test results and observations are discussed sequentially in the paper.

Key words: Marine Sand, Chemical Properties, Geotechnical Properties, Maximum, Dry Density (MDD), Optimum Moisture Content (OMC), Safe Bearing Capacity (SBC).

1.0 INTRODUCTION

A coastal plain corresponding to 0-150 meters covers almost entire coastal Andhra with some of the best agricultural land of the state. This area falls between two major river deltas, Krishna and Godavari and is largely composed of riverine and coastal alluvial soils and in some places red loams. Occupying 3% of the total area of the state the coastal soils are very deep (1.8-5mts) with coarse textured sandy subsoil. They are located all along the eastern coast, 3-12 km from the sea. Rapidly permeable soils due to very low day content and high amounts of sand. Neutral in reaction (pH 6.5-7.5) with subsoil salinity due to high water table. Saline and alkaline soils belong to one group of problem, soil the extent of which is not precisely known as no systematic surveys were carried out to asses and map them. These soils are estimated to occupy about 1.0 per cent of the total area. The area under salt-affected soils in the coastal region is estimated to be 0.176 m ha [1].
The marine sediments present in the Kerala coast between 20 and 80 m water depth carry an appreciable amount of silica sand. Systematic mapping of the seabed and exploration in selected areas have indicated the presence of huge reserves of construction-grade sand in different sectors. Sandy sediments in the deeper, western part of India are relatively finer and fall in the fine to medium sand category. The carbonate content is 10-25% but in certain areas the sand bodies carry 10-15% clay and silt. In certain other sectors clay contents exceed 25%. The sand also carries economic heavy minerals like ilmenite, sillimanite, garnet, rutile, Zircon and monazite in small proportions [2].

The five sites chosen were submitted from moderate to high energy level of deposition and showed depositional clean graded bedding which is diagnostic of the presence of storm surges, reflected through storm layers. Five areas and their sedimentary facies of the actual marine environment were chosen to apply the methodology used on the transitional coastal sediments[3].

The pH varied from slightly acidic (5.83) to moderately alkaline (8.47) in the soils of Sivagiri micro-watershed in Chittoor district of Andhra Pradesh. The variation in soil pH was related to parent material, rainfall and topography. Further, the KCl-pH values were lower than the water pH values, indicating the existence of net negative charge on colloidal particles [4].

The electrical conductivity of the soils of Garakahalli watershed ranged from 0.02 to 0.20 dSm-1 indicating non-saline nature of the soil. However, these soils did not show any relationship with depth. This may be due to the undulating nature of the terrain coupled with free drainage conditions, which favored the removal of releasing bases by the percolating and drainage water [5]. The Inceptisols and Entisols of Shahibi basin in Haryana and Delhi were non-saline with electrolyte concentration ranging from 0.18 to 0.95 dSm-1 [6].

2.0 MATERIALS USED IN THE STUDY

The soil samples were collected 2kms from the sea waterfront on the coast near Mypadu Beach, Nellore District, AP, India. Two trial-pits one at a depth of 0.5-1.0 m (Pit-1) and second at a depth of 1.2-2.0 m (Pit-2) and samples were collected in wet condition from both trial pits (Pit-1 and Pit-2). Tests on soil samples were determined by standard methods and conducted on Chemical Properties, Geotechnical Properties and Safe Bearing Capacity. It is mentioned here that three samples were taken at random and the average values of various properties are taken as the test values.

3.0 RESULTS AND DISCUSSIONS

3.1 Chemical Properties

Chemical tests were determined by the methodologies [7] suggested by Jackson (1973) for both Pit-1 and Pit-2 samples and observed the results of Chemical Properties of marine soil samples are tabulated in Table 1.
Table 1. Chemical Properties of Marine Soils Samples

<table>
<thead>
<tr>
<th>Chemical Properties</th>
<th>Alkalinity (mg/l as CaCO$_3$)</th>
<th>Hardness (mg/l as CaCO$_3$)</th>
<th>Chlorides (mg/l)</th>
<th>pH</th>
<th>Electrical Conductivity (µs/cm)</th>
<th>Total Dissolved Solids (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pit -1</td>
<td>670</td>
<td>1387</td>
<td>612</td>
<td>8.62</td>
<td>815</td>
<td>710</td>
</tr>
<tr>
<td>Pit -2</td>
<td>612</td>
<td>1220</td>
<td>574</td>
<td>8.58</td>
<td>702</td>
<td>650</td>
</tr>
</tbody>
</table>

Soils with a pH greater than 8.5 are considered alkaline [1]. Samples collected from the source were having pH > 8.5 and these soils considered as alkaline soils.

3.2 Geotechnical Properties

Tests on soil samples were determined by standard methods and observed results are tabulated in Table 2.

It is observed that the liquid limit, Plastic Limit, Plasticity Index and Free Swell Index were zero because of both Pit-1 and Pit-2 samples were cohesion less sand particles.

Table 2. Geotechnical Properties of Marine Soil Samples

<table>
<thead>
<tr>
<th>Geotechnical Properties</th>
<th>In-Situ Density (kN/m$^3$)</th>
<th>Natural Moisture Content (%)</th>
<th>Angle of Internal Friction (° in degrees)</th>
<th>Specific Gravity</th>
<th>Bulking of Sand (%)</th>
<th>Sand (%)</th>
<th>Silt + Clay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit-1</td>
<td>10.867</td>
<td>25.99</td>
<td>29°29’’</td>
<td>2.38</td>
<td>12</td>
<td>98.13</td>
<td>1.86</td>
</tr>
<tr>
<td>Pit-2</td>
<td>12.72</td>
<td>27.14</td>
<td>31°9’’</td>
<td>2.35</td>
<td>6</td>
<td>99.97</td>
<td>0.23</td>
</tr>
</tbody>
</table>
Grain size distribution

For determination of grain size distribution of marine samples, sieve analysis test was performed. From the test data, the particle size distribution curve was plotted from which it was found that the soil consists of more than 98% of particles range in 0.075mm-1.18mm for both Pit-1 and Pit-2 samples. Therefore the soil samples said to be sand particles. The grain size distribution curve is depicted in Figure 1.

![Figure 1. Grain Size Distribution Curve](image)

Compaction test

The standard proctor compaction test was carried out with remoulded soil sample with varying moisture content. In each test, the standard Proctor mould (size: 100 mm diameter x 127 mm height) was filled with soil-water water mixture in three equal layers, each layer being compacted by 25 blows of a 25 N rammer with a height free fall of 300 mm. From the test results observed Maximum Dry Density (MDD) versus Optimum Moisture Content (OMC) is depicted in Figure 2. The value of MDD and OMC (depicted in Figure 2) for Pit-1 and Pit-2 was observed 16.68 kN/m$^3$, 16.29 kN/m$^3$ and 15.48%, 15.62 % respectively.

Safe Bearing Capacity

It is observed from the results Ultimate Bearing Capacity (UBC) and Safe Allowable Bearing Capacity (SBC) for Pit-1 were found to be 190 kN/m$^2$ and 63 kN/m$^2$ respectively after considering factor of safety 3.0 and the settlement of 3.80 cm.

For Pit-2, UBC and SBC were found to be 200 kN/m$^2$ and 67 kN/m$^2$ respectively after considering factor of safety 3.0 and the settlement of 3.865 cm. However the SBC of cohesion less, loose, dry and fine sand may be limited to 100 kN/m$^2$ and allowable settlement of 5.0 cm in accordance with the IS: 6403-1981 [8].
4.0 CONCLUSIONS

1. The present studies explain the knowledge about the marine sand in connection with its Chemical Properties, Geotechnical Properties and soil Safe Bearing Capacity.
2. The Soil samples are alkaline because of both Pit-1 and Pit-2 having greater pH, than the allowable value of 8.5.
3. Grain size distribution of Marine Sand samples shows that the sediments consist of more than 98% of sand content when sieved through 0.075 - 4.75 mm size sieves.
4. It is observed that the liquid limit, plastic limit, plasticity index and Free Swell Index were zero because of both Pit-1 and Pit-2 were fine sandy particles of the Marine soil.
5. The value of Cohesion were found to be zero and hence only Direct Shear test was conducted for finding results of the MDD and OMC in present in soil samples. The test results of MDD and OMC for Pit-1 and Pit-2 is 16.68 kN/m$^3$ and 16.29 kN/m$^3$ and 15.48% and 15.62% respectively.
6. From the results the UBC and SBC of Pit-1 and Pit-2 were found to be 190 kN/m$^2$, 200 kN/m$^2$ and 63 kN/m$^2$, 67 kN/m$^2$ respectively, after considering factor of safety 3.0.
7. The settlement of foundation is observed for Pit-1 and Pit-2 were 3.80 cm and 3.865 respectively. These values are also well within the allowable settlement of 5.0 cm as per the code.

REFERENCES


