Abstract: Trivandrum being the capital city is one of the most
developed cities in Kerala. Many major projects took birth here in
the capital city during the last few years. One of the major cities in
Trivandrum is Kazhakuttam which is now called as “New
Trivandrum”. Such a growing city does not have a proper
Geodatabase which could make the civil engineering works easier.
The main objective of this study is to create a database of
properties of soil at 0.5m depth from Kazhakuttam area.
Evaluation of soil properties is a very time consuming process that
also relies on the memory of the personnel that are responsible for
maintaining the database. If such a geodatabase is available and
easily accessible, it will be of great advantage for civil engineering
works. Hence this study aims to investigate the development of a
Geographic Information System (GIS) to better manage and
disseminate soils information, as developed from soil test results
(soil at 0.5m depth was taken).

Keywords: Soil mapping, Geographic information System,
Digital Elevation modeling.

1. Introduction

As technology develops the representation of geotechnical
properties of soils also become easier. This makes the common
man aware about the soil properties of each area in just a single
click. The area mainly focused in my study includes evaluation
of soil properties, creation of a database and its representation
in the form of map using GIS software.

A. Geographic information system

In the strictest sense, a GIS is a computer system capable of
assembling, storing, manipulating and displaying
geographically referenced information, i.e. data identified
according to their locations. USGS defines a geographic
information system (GIS) as a computer based tool for mapping
and analysing things that exist and events that happen on earth.
Geographic Information System provides efficient tools for
inputting data into database, retrieval of selected data items for
further processing and software modules which can analyze or
manipulate the retrieved data in order to generate desired
information on specific form. GIS stores spatial and non-spatial
data in two different databases. The geocoded spatial data
defines an object that has an orientation and relationship with
other objects in two (2D) or three dimensional (3D) space. GIS
uses three types of data to represent a map or any geo-
referenced data, namely, point type, line type, and area or

Compaction Characteristics Mapping of
Kazhakuttam Soil using GIS

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The properties of soil can be divided as Index properties and
Engineering properties. The main Engineering properties are
shear strength, permeability, and compressibility. Permeability
indicates the ease with which the water can flow through soils.
Compressibility is related with the deformations which soil
undergoes when subjected to compressive loads. The shear
strength helps in determining stability of slopes, bearing
capacity of soils and the earth pressures on retaining structures.
The specific gravity of soil solids is the ratio of the density of a
given volume of solid solids to the greatest density (at +4°C) of
an equal volume of pure water. The principal soil grain
properties are the size and shape of grains and the mineralogical
character of the finer fractions. The most significant aggregate
property of cohesion less soils is the relative density, whereas
that of cohesive soils is the consistency. Moisture content is that
amount of water which is contained in the voids of the soil. It is
one of the important factor depending upon which the shear
strength of soil will change. Consistency is the property of
materials which shows its resistance to flow. When referred to
soil, it means, the degree of resistance offered by fine grained
soil to deformation. The water content at which the soil changes
from one state to another state termed as consistency limits. Dry
density of soil mass is the ratio of mass of soil solids to the
volume of soil mass. Therefore the properties of soil such as
specific gravity, moisture content, dry density, wet density and
consistency limits such as liquid limit, plastic limits and
shrinkage limits are the essential for determination of
engineering properties of soil, which will help to geotechnical
engineer for decision making process of suitability of soil as foundation materials or construction materials. If the properties of soil are properly studied and the results of soil exploration correctly understood and intelligently applied to the design and construction of earthworks and structural foundations, failures usually can be avoided. The soil properties can be found out using the test apparatus and the test procedure specified in the Indian Standard codes.

C. Study area

Kazhakuttam is a major city in Trivandrum district which is now called “The New Trivandrum”. The area is covered between 8°33’30”N and 8°35’30”N latitude and 76°51’0”E and 76°53’30”E longitude and it covers an area of about . The place gained significance because of its proximity to the Vikram Sarabhai Space Centre, Techno park and the Trivandrum International Stadium. But such a prominent city does have a geodatabase of soil properties. The study focuses on mapping compaction characteristics and natural water content of soil of Kazhakuttam ward.

2. Methodology

The project work was done with the help of ARCGIS. Non georeferenced Kazhakuttam ward (study area) map was obtained from Kazhakuttam Corporation Office which was then georeferenced in ArcMap 10.2 version. The ward boundary was then drawn using line feature and the thus obtained shape file is used for further work. During sample collection the geographic coordinates of the area were recorded using a GPS. Point layers were created to represent the location of sample collected. Total 10 samples were collected from different regions of Kazhakuttam ward and these were plotted on ArcMap. Microsoft word 2007 is used for the creation of database of soil properties such as dry density, optimum moisture content and natural water content. The soil properties created on excel file was converted to geodatabase using conversion tools in Arc tool box. Finally the thematic maps of soil properties such as liquid limit, dry density and moisture content were prepared using Interpolation technique in spatial analyst tools. Interpolation techniques used is Inverse Distance Weighted (IDW).

3. Results and discussion

The samples were collected from 10 different sites in Kazhakuttam ward. The Google Earth scene of the ward along with GPS locations of 10 sampling sites are represented on Fig. This was developed after geo referencing the ward map.

Fig. 2 shows the thematic map created using ArcMap 10.2 version. The map is used to represent the locations from where the sample was collected. Each location is marked S1, S2, S3, and so on inside the ward boundary.

Fig. 3. Shows the Digital elevation model of the study area. DEM is the map extracted from the Cartosat DEM data obtained from BHUVAN which is the Indian website handled by the National Remote Sensing Department of Indian Space and Research Organisation (ISRO).

A. Variation in natural water content

The fig. 4 shows the variation in natural water content of soil at different sites in Kazhakuttam ward. Table 2 shows the liquid limit values at different sites. The maximum value of natural moisture content obtained from test is 35.26% for S8.
the liquid limit values at different sites. The maximum value of optimum moisture content obtained from test is 32.61% for S_8.

Table 4  
Dry density at different locations

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Dry density (gm/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_1</td>
<td>8.576419444</td>
<td>76.859825</td>
<td>1.623</td>
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<tr>
<td>S_2</td>
<td>8.563780556</td>
<td>76.8690972</td>
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<td>S_3</td>
<td>8.571094444</td>
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</tr>
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<td>S_4</td>
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<td>76.8687361</td>
<td>1.864</td>
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<td>S_5</td>
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<td>76.8701222</td>
<td>1.702</td>
</tr>
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<td>S_10</td>
<td>8.574688888</td>
<td>76.87515</td>
<td>1.438</td>
</tr>
</tbody>
</table>

C. Variation in dry density

The fig. 6 shows the variation in dry density of soil at different sites in Kazhakuttam ward. Table 4 shows the liquid limit values at different sites. The maximum value of natural moisture content obtained from test is 1.962 gm/cc for S_8.

4. Conclusion

The properties of soil are very important to a geotechnical engineer to take the decision regarding the suitability of soil as good foundation material or construction material. The thematic maps of soil properties were prepared using ArcMap 10.2. These maps can help in reducing the time for soil exploration and cost of construction procedures. However, it is true that the generated GIS maps cannot be the total
replacement for soil exploration but definitely will help in proper planning with minimum loss with a validation of soil properties of Kazhakuttam ward.

References


