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SOIL INVESTIGATION IN DAVANGERE DISTRICT USING GIS

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ABSTRACT

This article presents the soil properties of Bulk Density, Dry Density, Dry Unit Weight, Coefficient of Curvature, Coefficient of Uniformity, Type of Soil pertain to few locations of in and around Davangere. The Davangere is located in mid part of Karnataka, India and found properties of soils is helpful for built up infrastructure and to connect substructure and superstructure with necessary structural arrangements. The soil samples are collected from different places and few soil investigation properties are found in laboratory and these are attributed in the map with Quantum Geographic Information System along GPS coordinates. By these facilities the users can understand without physical inspection prior to real execution of different construction activities.

INTRODUCTION

Soil is a natural material having varied properties which changes both along the depth and width of the stratum. To know the engineering behavior (e.g. bearing capacity) and nature of the soil, site investigation is recommended. To start any civil engineering project, investigation of soil profile and suitability of site selection are basic needy steps. The primary objective of soil investigation in civil engineering works is to determine the stratigraphy and pertinent soil index properties of the area under consideration. Index properties of soils are those properties which are mainly used in the identification and classification of soils. These index properties of soil finally help the geotechnical engineer in predicting the suitability o f soil as a foundation/construction material. The properties of soil, such as, specific gravity, moisture content, different size of soil particles, liquid limit, plastic limit etc. are the index properties of soil where as permeability, compressibility and shear strength are the engineering properties of soil.

Geographic Information System (GIS) is defined as an information system that is usedto capture, store, retrieve, manipulate, analyze, and display geographically referenced data, in order to support decision making for planning and management. In the GIS, theentire data set is stored in two different databases, such as spatial data and non-spatialdata. Point, line and area or polygons are three major types of layers which are used to represent the various ground features on a geo-referenced map. Vector data model is used to represent the discrete geographic feature. Raster data model is used to represent the continuous geographic feature on the map. The GIS is a platform where different data either available in aerial photographic data, remote sensing images data; tabular data can be merged in the master GIS map.GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth space-time may be recorded as dates/times ofoccurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively. All Earth-based spatial-temporal location and extent references should be relatable to one another and ultimately to a”real” physical location or extent. This key characteristic of GIS has begun to open new avenues of scientific inquiry.GIS is a combination of hardware and software that enables: a collection of spatial data from various sources (remote sensing is one of them). It deals with spatial/tabular data,performs spatial/tabular analysis, and designs the layout of a map.GIS software can handle both vector and raster data. The basic fundamental of GIS is geographic data and information. The focus is on understanding the basic structure of geographic data, and how issues of accuracy, error and quality are paramount to properly using GIS technology. The establishment of robust database is the cornerstoneof a successful GIS.

SPATIAL DATA REPRESENTATION

Spatial data is a fundamental component in any GIS environment.The data is based on the perception of the world

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as being occupied by features. Each feature is an entity which can be described by its attribute or property, and its location on earth can be mapped using a spatial reference. The most common representation of spatial data that measures the landscape is using discrete data (vector model) and continuous data (raster model). The data models are a set of rules used to describe and represent real world features in GIS software.

Vector Data Model: The vector data model is a representation of the world of distinct features that have definite boundaries, identities, and has a specific shape using point, lines, and polygons.Vector data is structured with two specific elements (node, vertex) and coordinates.This model is useful for storing data that has discrete boundaries, such as groundwater wells, streams, and lakes. Each entity has a dimension, boundary and location. For example, a well has a specific measurement and its location can be described using a coordinate system such as latitude-longitude. The following represents the three fundamental vector types that exist in GIS.

Point: A point entity is simply a location that can be described using the coordinate system (longitude, latitude or X, Y). The point has no actual spatial dimension and has no actual length and width but has a specific location in space (single coordinate pair). Point can be represented by different symbols. Points generally specify features that are too small to show properly at a given scale.It can be represented by different symbols. Points generally specify features that are too small to show properly at a given scale.

Line: A spatial feature that is given a precise location that can be described by a seriesof coordinate pairs. Each line is stored by the sequence of the first and last point together with the associated table attribute of this line. Line is one dimensional feature and has length but no width. Lines are a linear feature such as rivers, pipelines, and fences. The more points used to create the line, the greater the detail. The recent requirement that the line features include topology, which means that the system stores one end of the line as the starting point and the other as the end point, giving the line "direction".

Polygon: The polygon is an area fully encompassed by a series of connected lines. The first point in the polygon is equal to the last point. Polygon is a 2-D feature with at least three sides and because lines have direction, the area that falls within the lines compromise the polygon and the perimeter can be calculated. All of the data points that form the perimeter of the polygon must connect to form an unbroken line. Polygons are often an irregular shape such as parcels, lakes, and political boundaries. Advantages and Disadvantages of the Vector Model connect to form an unbroken line.

Raster Data Model: A representation of an area or region as a surface divided into a grid of cells. It is useful for storing data that varies continuously, as in an aerial photograph, a satellite image, a surface of humidity, or digital elevation model (DEM). The cell is the minimum mapping unit and the smallest size at which any landscape feature can be represented. These cells in the raster data set are used as building blocks for creating points, lines, and polygons. In the raster data model, points, lines, polygons are represented by grid cells.

SOIL SAMPLE

A soil sample is the representative of the whole lot from which it is taken. It completely represents all the characteristics from which it is recovered.

Types of soil samples:

Disturbed samples:Disturbed samples are those in which natural soil structure gets modified or destroyed during sampling operation. But with suitable precautions, we can preserve the natural moisture content and the proportion of mineral constituents which is called as Representative sample even though they are disturbed samples. Disturbed samples are generally used for determining index properties.

Undisturbed samples:Undisturbed samples are those in which natural structure of the soil and water content are retained intact. Undisturbed samples are generally used for determining engineeringproperties.

LITERATURE REVIEW

A.X. Zhu et al. (2001): Investigated GIS based on fuzzy soil inference scheme (soil land interference model ,SOLIM). It consist of three major components (1.a model employing a similarity representation of soils, 2. a set of interference techniques for driving the similarity representation, 3. use of the similarity representation). It was concluded that the model overcomes the limitation of the conventional discrete conceptual models models and allow the representation soils as continuous in both the spatial and parameters domains. It also makes the survey updates more efficient and less costly.

R.L.Parsons and J.D.Frost (2002): Investigated evaluating site investigation quality using GIS and Geostatistic. The development and implementation of a performance based investigation and monitoring approach for assessing the quality or thoroughness of site investigation and monitoring activities in a quantitative, spatially sensitive manner. It was concluded that continuous evaluation data set effected the segregation data into layers and resulted in subjects of data. The effect on local thoroughness of adding virtual data was examined and the results were showed that additional samples can have a significant impact on local thoroughness but oversampling in particular area can basis the results.

R.Ali and M.M.Kotb (2010): Investigated how to use the satellite data and Geographic information system (GIS) to produce the soil map and use the spatial analysis technique to assess the soil capacity. It was concluded the importance of shuttle radar topographic mission (SRTM) and satellite images in defining the main land forms and the soil phases of the area at a regional scale. The produced semi detailed map can be used to the relationship between land forms and soils qualities characteristics.

Sumedh Yamaji Mhaske and Deepankar Choudhury (2011): Investigated soil index properties such as (moisture content, wet density , porosity, void ration) using GIS and GPS in Mumbai. Over 450 number of soil testing reports were collected from several geotechincal laboratories and professional in Mumbai city. It was concluded that advanced information of soil index properties from GIS based thematic maps can reduce the time for selection of the site before the soil exploration activity and huge data base can be directly used for seismic hazard study of Mumbai city. The addition of underground utilities on thematic maps of index soil properties will help the soil exploration agencies to reduce the damage and reduce the economic loss of underground utilities.

Alaeddinne El Jamassi (2013): Investigated the development of a geographic information system (GIS) to collect , manage, analyze and visualize soils data of boreholes tests results collected from 92 boreholes covering about 70% of Gaza city. It was concluded that by using GIS can produce the maps of soil classification, engineering information regarding soil type, can create soil profile for any location.

T. Fikret Kurnaz et al. (2013): Investigated the soil conditions of Esenler district putting forward with GIS based maps and their contribution to land use planning for the reconstruction project of the district. It was concluded that GIS technique for the preparation of geotechincal zoning maps regarding the suitability of a safe construction.

Jafar Adam et al. (2018): Investigated the mapping and analysis of soil samples of ten trial pit distributed within the campus of Hassan Usman Katsina Polytechnic Nigeria. It was concluded that GIS based system can develop or produce the maps of different themes based on soil properties.

Margarit-Mirca NISTOR et al. (2019): Investigated shallow slopes failures due to rainfall commonly occur in residual soil, especially in tropical area like Singapore. The aim was to establish the necessary procedure and methods which are applicable to select the suitable location for soil sampling in Singapore using GIS. It was concluded spatial analysis for development of soil sampling locations using four methods in spatial analyst tools of Arc-GIS were been used to develop new suitable location for new soil sampling.

LITERATURE GAP

With reference to literature review previous researchers experimented and investigated about soil index properties such as moisture content, wet density , porosity, void ration, soil investigation quality, soil capacity, boreholes tests, soil land interference, shallow failures by using GIS and developed thematic map and different soil maps. Only few researchers covered the area of Davangere, so in the present study the aim is to develop soil gradation map and soil properties data to Davangere district using Geographic information system (GIS).

METHODOLOGY

- Collecting disturbed soil samples in various location in Davangere district.
- Various soil tests (soil texture, porosity, density etc.) are carried in geotechincal laboratory and soil analysis results are recorded.
- After the soil analysis results area analyzed and classifying the soil as per IndianStandards.
- With help of the collected data is inputted in QGIS software, with help of spacialinterpolation technique the soil map is formed.

SOIL SAMPLING LOCATIONS

The representative soil samples are collected from different random location's in Davangere district with help of core cutter method -IS 2720 (Part 29) :1975 (Reaffirmed 2005). Core cutter of size (diameter 10 cm, height 12.5 cm) with dolly ismeasured and noted as M1. Core cutter is placed on the surface where sample is to be collected. The assembly is driven into the soil with help of rammer until the top of the dolly protrudes about 15 mm above the surface. The core cutter along with dolly is dug out from surrounding soil such that some projects from the lower end of the core cutterdolly is removed and the soil mass is trimmed at both ends of the core cutter with soil is recorded as M2 and water content of the soil is determined by oven drying method. Sample 1 is collected from agricultural field near Davangere. Sample 2 is collected from barren field near Channgri. Sample 3 and 4 are collected from agricultural field near Channgri. Sample 5 and 6 are collected from agricultural fields near Honnali. Sample 7, 8 and 9 are collected from agricultural fields near Harihar. Sample 10, 11 and 12 are collected from barren field near Jagalur. Sample 13, 14 and 15 are collected near Davangere. All the sample location with GPS coordinates are marked.

ANALYSIS OF SOIL SAMPLE

The collected soil samples are tested in laboratory for various soil tests such as Sieve analysis, Core cutter method, Water content , Dry density , Dry unit weight. For finding the soil gradation sieve analysis - IS 2720 (Part 4) Reaffirmed 2006 test is carried out.1000 grams of soil has been taken for the test. The Sieves are cleaned using brush. Sieves are arranged in the decreasing aperture opening. Pan is kept at the bottom of sieve. The soil is placed on the top sieve and covered with lid. The set of sieves is placed in the sieve shaker. Sieving is carried out for about 10 minutes. The weight of soil retained on each sieve and pan is recorded. The sum of retained soil mass is then checked against the original mass of soil taken. The percentage retained on each sieve and percent finer are calculated. A graph of percent finer versus log of particle size is drawn. From the gradation curve obtained, the particle corresponding to 10% finer, 30% finer, 60% finer are obtained and Coefficient of Curvature Cc and Uniformity Coefficient Cu is calculated for each sample. For coefficient of Curvature the value should lie between 1 and 3 for well graded and above 3 are poorly graded. For Uniformity Coefficient value should be more than 4 for gravels and more than 6 for sand as per IS: 1498-1970. To determine the water content of soil is tested by oven drying method . In which sample is collected in oven dry container and weight is noted down and it is kept in oven for 24 hours. After 24 hours the reading are noted down. With help of Oven drying method we can find dry density and dry unit weight. With help of Cc and Cu results the gradation of soil can be obtained. By knowing soil gradation (i.e. Cc and Cu) can identify soil group by knowing the particular group different properties can be known for Road and Airfield constructions , Embankments, Canal sections and also Construction materials for different works. The detailed information as provided in text book of " Soil mechanics and Foundation Engineering, author by Santosh Kumar Garg" (Chapter 3 page no 51-54, table 3.15, 3.16 3.17.)ninth revised edition.For each soil sample the detailed analysis data is present in table 1.

EXPORTING DATAIN TO QGIS

All the test results are tabulated in excel sheet and transfer

Table 1 Soil Samples test data with GPS coordinates

Sample No	Latitude	Longitude	Soil Properties					
			Bulk Density (g/cc)	Dry Density (g/cc)	Dry unit weight (kN/m^3)	Sieve analysis		
						Cu	Cc	Type of soil
1	14.283579	75.968467	1.19	0.125	1.22	12.4	1.561	Well graded sand
2	14.205425	75.999779	1.43	0.483	4.73	8.74	0.714	Poorly graded sand
3	14.113658	75.984289	1.31	0.2	1.962	13.33	1.13	Well graded sand
4	14.03898	75.910214	1.596	0.094	0.922	13.46	2.153	Well graded sand
5	14.237837	75.692072	1.607	0.141	1.383	4.54	2.389	Poorly graded gravel
6	14.258002	75.678935	1.833	0.283	2.776	11.07	1.65	Well graded sand
7	14.416767	75.77909	1.54	0.141	1.383	15.88	0.92	Poorly graded sand
8	14.475369	75.80129	1.352	0.132	1.294	7.65	1.91	Well graded sand
9	14.481639	75.812359	1.415	0.09	0.882	6.73	1	Well graded sand
10	14.425419	76.27596	1.278	0.435	4.26	12.5	1.05	Well graded sand
11	14.432622	76.285987	1.343	0.248	2.432	8.52	1.46	Well graded sand
12	14.438665	76.298305	1.457	0.305	2.992	11.5	1.06	Well graded sand
13	14.43985	75.918994	1.332	0.157	1.54	12.5	0.98	Poorly graded sand
14	14.426267	75.902897	1.184	0.102	1	8.5	1.53	Well graded sand
15	14.443312	75.903374	1.809	0.125	1.226	8.52	1.46	Well graded sand

into QGIS software for developing Spacial variation of soil gradation map and dry density map.The sample locations are developed in the point form on the google map which are indicated by red colour as shown in Figure 1. These points are developed by using latitude and longitude of sample locations. Generally with help of QGIS we can access the information and data of any area. This data and information can be used in different fields according to their work. It can be used in agricultural sector, catchment area calculation, developing state and national boundaries etc. As our work is related to soil it can be used in the application of road construction, excavation, embankment, filling, canal section and construction material.

SPACIAL INTERPOLATION AND SOIL MAPPING

Figure 2 represents soil sampling locations within Davangere district Karnataka. The sample locations are marked on map with help of latitude and longitude and with help of Davangere district boundary shape file the sample location are developed on map by layers option in QGIS. Green colour indicates soil sampling locations. Purple colour indicates Davanagere district. Figure 3 represents Spacial variation of Soil gradation map of Davangere district.With help of spacial interpolation technique in QGIS the data of gradation soil is used to develop the map. Green dot indicates sample locations which are taken at random. Red colour indicates well graded sand. Yellow indicates poorly graded soil. Since one sample is well graded gravel the interpolation is failed to represent because it requires at least three samples to develop. Figure 4 represents Spacial variation of soil dry density of Davangere district. With help of Spacial interpolation technique in QGIS the data dry density of soil is used to develop the map. Green dots indicates soil sample locations. Dark green indicates dry density value ranges from 0.88- 1.57. Light green indicates dry density value ranges from 1.57-2.07. Yellow indicates dry density value ranges from 2.07-2.61. Orange indicates dry density value ranges from 2.61-3.4. Red colour indicates dry density valueranges from 3.40-4.72. Samples 1, 4, 5,7, 8, 9, 13, 14, 15 have low dry density value (i.e. 0.88-1.57). Samples 10, 11, 12 have moderate dry density value (i.e. 2.61-3.4).Sample 2 has high dry density value (i.e. 3.40-4.72). Sample 3 has lower density value (i.e. 1.57-2.01). Sample 6 has normal dry density (i.e.2.07-2.61).

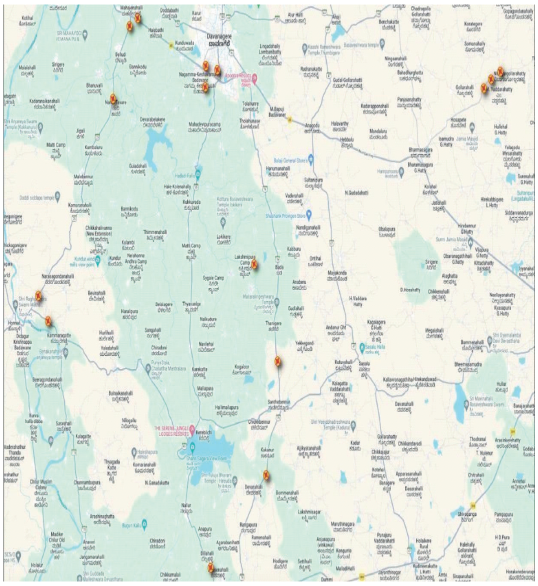

Figure 1. Sample Locations on Google Map

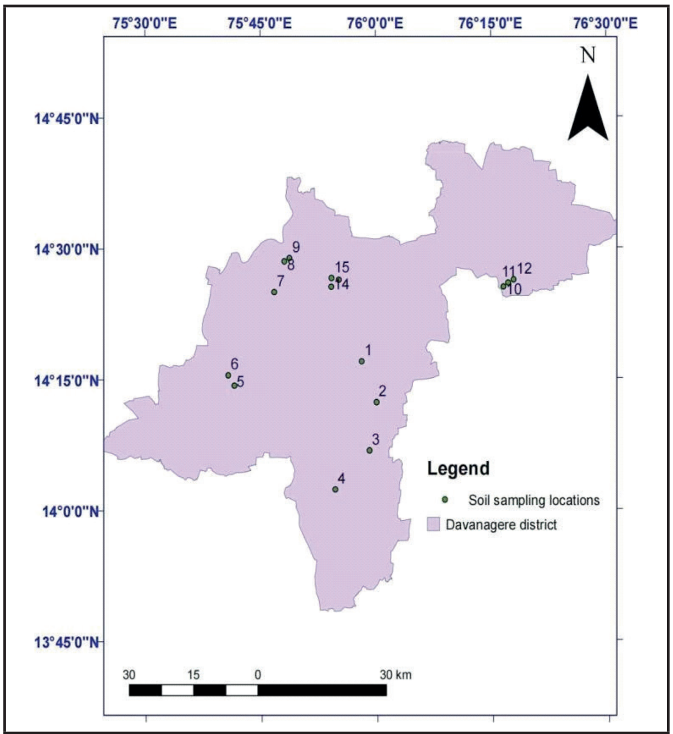

Figure 2. Soil sampling location within Davangere District Karnataka

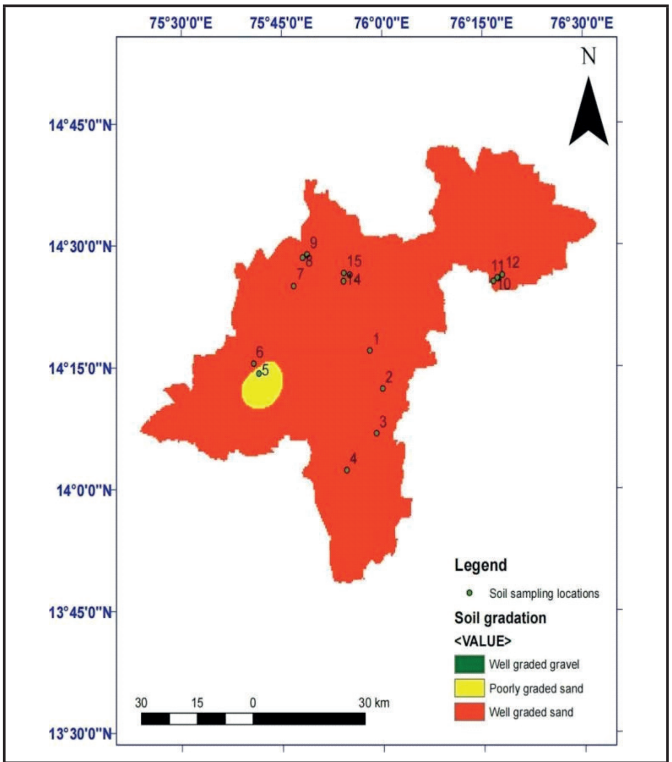

Figure 3. Spacial variation of soil gradation in Davangere District

CONCLUSION

In this study ,the representative soil sample of different location within Davangere district is collected and various tests were done (such as Bulk density, Water content, Dry density, Dry unit weight, Sieve analysis, Core cutter) and the data is used to prepare Spacial variation of Soil gradation and Soil dry density map of Davangere district using QGIS. The main conclusion of this study are:

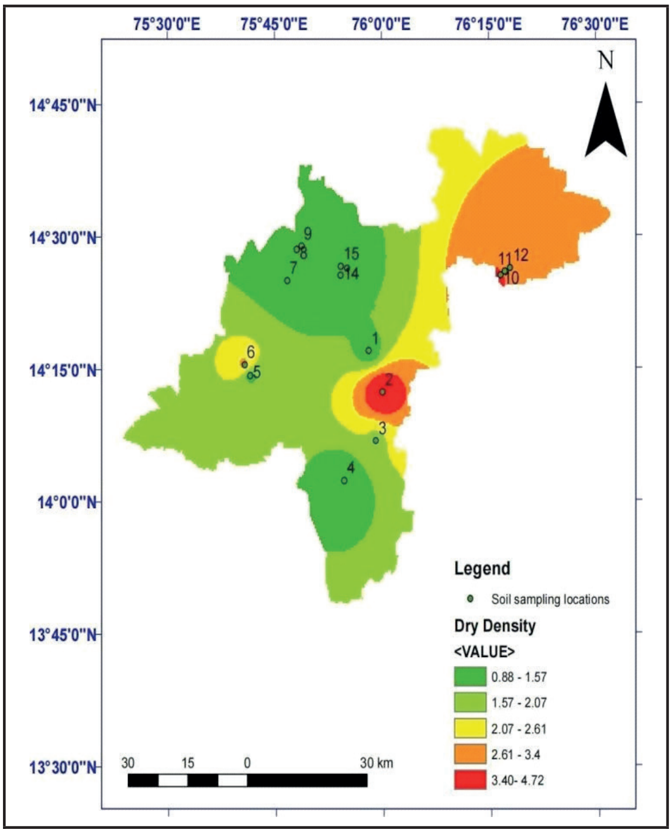

Figure 4. Spacial variation of Soil Dry Density in Davangere District

- The samples 1, 3 , 4 , 6 , 8 , 9 , 10 , 11 , 12 , 14 and 15 which are available in the area exhibited Cu and Cc values which resulted the soil gradation as Well graded Sand.
- The samples 2, 7 and 13 which are available in the area exhibited Cu and Cc valueswhich resulted the soil gradation as Poorly graded Sand.
- The sample 5 which is available in the area exhibited Cu and Cc values which resulted the soil gradation as Poorly graded Gravel.
- With help of test analysis data the Spacial variation map of Soil Gradation and Dry density of Davangere district are developed.
- With help of developed maps and data can be used in the application Road,Airfields, Embankments , Canal sections, Construction Materials.

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