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GIS-GPS Based Map of Soil Index Properties for Kavali Town (North Region)

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ABSTRACT

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. However, for a densely populated town like Kavali in Andhra Pradesh India, many times it is bit difficult to carry out such site investigation to obtain the exact soil profile at all locations. In this project, Geographic Information System (GIS) and Global Positioning System (GPS) are used to obtain the soil index property maps for Kavali Town. These maps will be extremely useful for obtaining a gross overall view of soil index properties of various locations of Kavali. About 5 numbers of soil samples were collected from several various locations and tested to create a soil database of Kavali Town. The integration of GIS, GPS and database of properties of soil such as liquid limit, Plastic limit, swelling index, compaction properties and particle size composition etc. will be very helpful to the soil investigators, geotechnical engineers and contractors working in Kavali region for understanding the soil strata to decide the location for a future structure based on geotechnical engineering design.

INRODUCTION

Soil map is a map i.e. a geographical representation showing diversity of soil properties (Liquid Limit, Plastic limit, Particle Size Composition, Compaction properties and swelling index etc.) in the area of interest. It is typically the end result of a soil survey inventory, i.e. soil survey. Soil maps are most commonly used for land evaluation for suitability for construction of structures. Traditional soil maps typically show only general distribution of soils, accompanied by the soil survey report. Many new soil maps are derived using digital soil mapping techniques. Such maps are typically richer in context and show higher spatial detail than traditional soil maps. Soil maps produced using (geo) statistical techniques also include an estimate of the model uncertainty.

In the digital era, soil maps come in various digital vector and raster formats and are used for various applications in Foundation Engineering, geosciences and environmental sciences. In this context, soil maps are only visualizations of the soil resource inventories commonly stored in a Soil Information System (SIS), of which the major part is a Soil Geographical Database. A Soil Information System is basically a systematic collection of complete (values of the target soil variables available for the whole area of interest) and consistent gridded or vector soil property and/or class maps with an attached report, user manual and/or metadata. A SIS is in the most cases, a combination of polygon and point maps linked with attribute tables for profile observations, soil mapping units and soil classes. Different elements of an SIS can be manipulated and then visualized against the spatial reference (grids or polygons). For example, soil profiles can be used to make spatial prediction of different index properties. In the case of pedometric mapping, both predictions and simulations (2D or 3D — geographic location plus soil depth) of values are visualized and used for GIS modeling.

LITERATURE REVIEW

Soil mapping or soil survey, is the process of classifying soil types based on particle size and other soil properties such as Atterberg limits in a given area and geo-encoding such information. It applies the principles of soil mechanics. Primary data for the soil mapping is acquired by field sampling and by remote sensing. Remote sensing principally uses aerial photography, but LiDAR and other digital techniques

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are steadily gaining in popularity. In the past, a Geotechnical engineers would take hard-copies of aerial photography, topo-sheets, and mapping keys into the field with them. Today, a growing number of soil Geotechnical engineers bring a ruggedized tablet computer and GPS into the field with them. The tablet may be loaded with digital aerial photos, LiDAR, topography, soil geodatabases, mapping keys, and more.

The term soil mapping may also be used as a noun to describe the published results. Today, soil surveys are no longer published in book form; they are published to the web and accessed where a person can create a custom soil survey. This allows for rapid flow of the latest soil information to the user. In the past it could take years to publish a paper soil survey. Today it takes only moments for changes to go live to the public. Also, the most current soil mapping data will be made available for high end GIS users such as professional consulting companies and universities.

The information in a soil survey can be used by an architect or engineer use the engineering properties of a soil to determine whether it is suitable for a certain type of construction.

EXPERIMENTAL WORKS AND PROCEDURES

ATTERBERG'S LIMITS:

LIQUID LIMIT TEST:

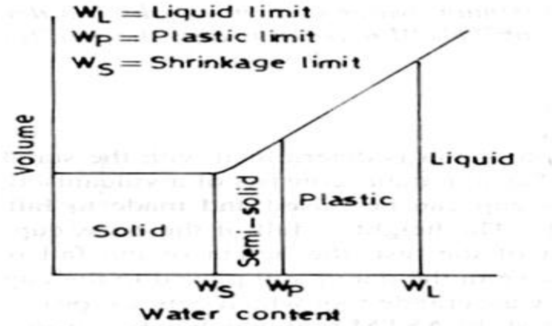
EQUIPMENT & ACCESSORIES

Casagrande Liquid Limit device
Grooving Tool
Glass plate
425µ sieve
Spatula
Balance
Water cans & Water

Fig 1

DEFINITION

Liquid limit is the minimum water content corresponding to arbitrary limit between liquid and plastic states of consistency of a soil. The limit of water content, at which soil water suspension passes from zero strength to an infinitesimal strength, is the true liquid limit.



PROCEDURE

1. Adjust the cup of Liquid Limit apparatus with the help of grooving tool gauge &adjustment plate to give a drop of exactly 1 cm on the point of contact on base.
2. Takeabout 120g of air dried sample passing through 425µ sieve.
3. Mix it thoroughly with known quantity of distilled water to form a uniform paste.
4.Place a portion of the paste in the cup, smooth the surface with spatula to a maximum depth of 1 cm. Draw grooving tool through the sample along the symmetrical axis at the cup; holding the total perpendicular to the cup.
5. Turn the handle at a rate of 2 revolutions per second & count blows until the two parts of the sample come in contact at the bottom of the groove.
6. Transfer the remaining soil in the cup to the main soil sample & mix thoroughly after adding a small amount of water.
7. Repeat the steps 4, 5 & 6obtain at least five sets of readings in the range of 10 to 50 blows.

(a) Mixing of soil

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(b)Placing of soil paste in cup

(c) Cutting the Grove

(d) Soil pat after test

PLASTICLIMIT TEST:
EQUIPMENT & ACCESSORIES

3 mm dia. rod
Balance
Glass Plate
Distilled Water
Oven
Water content cans
425µ sieve

Fig 2

PROCEDURE

1. Take about 30g of air dried sample passing through 425µ sieve.
2. Mix thoroughlywith distilled water on glass plate until it is plastic enough to be shaped in to small ball.
3. Take about 10g of plastic soil mass & roll it between the hard & the glass plate to form the soil mass into a thread. If the diameter of thread becomes less than 3mm without cracks, it shows that water added is more than its plastic limit, hence the soil is needed further & rolled into thread again.
4. Repeat the rolling & re-molding process until the thread starts just crumbling at a diameter of 3mm.
5.If crumbling starts before 3mm diameter thread, it shows that water added is less than the plastic limit of soil, hence same more water should be added & mixed to a uniform mass & rolled again, until the thread starts crumbling at a diameter of 3mm.
6. Collect the pieces of crumbled soil thread at 3mm diameter in an air light container & determine moisture content.
7. Repeat the procedure for 2 more steps or samples.

FORMULAS TO BE USED:

Plastic Limit = Mw/Ms
Where Mw= Mass of water added
Ms= Mass of dry soil

STANDARD PROCTOR TEST:
EQUIPMENT & ACCESSORIES

Cylindrical mould of 1000cc capacity
Metal rammer 2.6kg & having a drop of 31cm
Steel straight edge balance
Oven & water content container
Mixing equipment
Sample extruder

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Fig 3

PROCEDURE

1.Take about 2.0g for 1000cc mould (10cm dia.) or 4.5kg 2250cc mould (15cm dia.) of air dried & mixed soil.
2.Sieve this soil through 20mm & 4.75mm sieves.
3.Calculate the percentage retained on 20mm & 4.75mm sieved & passing from 4.75mm sieve.
4.Do not use the soil retained on 20mm sieve.
5.Use 10cm diameter mould it percentage retained on 4.75mm sieve is less than 20 or use a mould at 15cm diameter, if percentage retained on 4.75mm sieve is more than 20.
6.Mix the soil retained on & passing through 4,75mm sieve thoroughly.
7.Take about 3.0kg of soil for 1000cc (6kg for 2250cc mould).
8.Add water to it bring its moisture content to about 4% in coarse grained soils & 8% for fine grained soils.
9.Clean dry & grease lightly the mould& base plate; weigh the mould with base. Fit the collar.
10.Compact the wet soil in three equal for 10cm layer by rammer of mass 2.6kg & free fall 31cm with25 evenly distributed blows for 15cm diameter.
11.Remove the collar of the mould& base plate weigh the mould with soil & base plate.
12.Take a representative sample for which water content determination.
13.Repeat the above procedure till the weight of the soil decrease with increase in water content & tabulate as fallows.

FORMULAS TO BE USED

Bulk density ρ= M/V
Where M= Mass of soil
V= Volume of soil
Dry density ρd= ρ/(1+w)
Where w= Water content added

FREE SWELL INDEX TEST:
EQUIPMENT & ACCESSORIES

Measuring jars
Water
Kerosene
Balance
425μ sieve

Fig 4

PROCEDURE

1.Pour 20g of dry sample into 100ml graduated cylinder containing about 40 ml of distilled water.
2.The suspension was stirred repeatedly and then made up to the 100 ml mark with the addition of distilled water.
3.These cylinders were sealed and left undisturbed for the sample to settle.
4. After 24 hrs free swell index was calculated.

FORMULAS TO BE USED

Free swell index = [Vd - Vk] / Vk x 100%
Where, Vd = volume of soil specimen read from the graduated cylinder containing distilled water.
Vk= volume of soil specimen read from the graduated cylinder containing kerosene.

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DIRECT SHEAR TEST:
EQUIPMENT & ACCESSORIES

Direct shear box apparatus
Loading frame (motor attached)
Dial gauge
Straight edge
Balance to weigh upto 200 mg
Aluminum container
Spatula

Fig 5

PROCEDURE

1.Check the inner dimension of the soil container.
2.Put the parts of the soil container together.
3.Calculate the volume of the container. Weigh the container.
4.Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil.
5.Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of the soil.
6.Make the surface of the soil plane.
7.Put the upper grating on stone and loading block on top of soil.
8.Measure the thickness of soil specimen.
9.Apply the desired normal load.
10.Remove the shear pin.
11.Attach the dial gauge which measures the change of volume.
12.Record the initial reading of the dial gauge and calibration values.
13.Before proceeding to test check all adjustments to see that there is no connection between two parts except sand/soil.
14.Start the motor. Take the reading of the shear force and record the reading.
15.Take volume change readings till failure.
16.Add 5 kg normal stress 0.5 kg/cm2 and continue the experiment till failure.
17.Record carefully all the readings. Set the dial gauges zero, before starting the experiment.

GRAIN SIZE ANALYSIS
EQUIPMENT & ACCESSORIES

Balance
I.S sieves
Mechanical Sieve Shaker

Fig 6

PROCEDURE

1. For soil samples of soil retained on 75 micron I.S sieve
(a)The proportion of soil sample retained on 75 micron I.S sieve is weighed and recorded weight of soil sample is as per I.S 2720.
(b)I.S sieves are selected and arranged in the order as shown in the table.
(c)The soil sample is separated into various fractions by sieving through above sieves placed in the above mentioned order.
(d)The weight of soil retained on each sieve is recorded.
(e)The moisture content of soil if above 5% it is to be measured and recorded.

2. No particle of soil sample shall be pushed through the sieves.

RESULTS

TABLES

TEST RESULTS FOR DIFFERENT SAMPLES

		Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
Location	Latitude	14.9170◦N	14.9322◦N	14.9394◦N	14.9141◦N	14.9044◦N
	Longitude	79.9758◦E	79.9991◦E	79.9954◦E	79.9955◦E	80.0146◦E
Liquid Limit		23.52%	26.81%	29%	30.4%	0%
Plastic Limit		17.86%	22.22%	19.51%	20%	0%
Sieve Analysis	% GRAVEL	45.8%	39.6%	34.6%	36.6%	2.7%
	% SAND	53.4%	60.3%	64.4%	62.5%	93.9%
	% FINES	0.8%	0.1%	1%	0.9%	3.4%
Proctor Test	Optimum Moisture Content	9%	15.9%	11.8%	14.4%	11%
	Maximum Dry Density	2.325gm/cc	1.832gm/cc	2.03gm/cc	1.921gm/cc	1.96gm/cc
Swelling Index		9.09%	0%	20%	33.33%	11.11%

TEST RESULTS FOR DIFFERENT SAMPLES

		Sample-6	Sample-7	Sample-8	Sample-9	Sample-10
Location	Latitude	14.8968◦N	14.8957◦N	14.8996◦N	14.8830◦N	14.9147◦N
	Longitude	79.9931◦E	79.9994◦E	79.9768◦E	79.9842◦E	79.0146◦E
Liquid Limit		0%	0%	0%	0%	0%
Plastic Limit		0%	0%	0%	0%	0%
Sieve Analysis	% GRAVEL	35.5%	42.1%	21%	7.1%	55.5%
	% SAND	63.5%	56.8%	77.8%	92.4%	44%
	% FINES	1%	1.1%	1.2%	0.5%	0.5%
Proctor Test	Optimum Moisture Content	14.86%	14.29%	8.57%	10.2%	10.81%
	Maximum Dry Density	1.651gm/cc	1.831gm/cc	2.06gm/cc	1.974gm/cc	2.10gm/cc
Swelling Index		0%	0%	0%	0%	0%

CONCLUSION

1) By using GIS-GPS based map, we can obtain the Soil Index Properties at any Coordinate over the region.
2) The duration of determining the soil properties at other location, within the region can be reduced.
3) And we have to choose the better ways based on the economic considerations also.

REFERENCES

1)"GIS-GPS Based Map of Soil Index Properties for Mumbai" by SumedhYamajiMhaske, Ph.D.; and DeepankarChoudhury, M.ASCEEdited by Jie Han, Ph.D., P.E.; and Daniel A. Alzamora, P.E.

2) IS-1498-1970 "Classification and Identification of Soil for General Engineering Purposes", Indian Standard Institution, New Delhi.

3) K.R. Arora – "Soil Mechanics & Engineering Foundation.

4) B.M. Das – "Advanced Soil Mechanics" McGraw Hill.

5) B.C. Punmia- "Soil Mechanics and Engineering Foundation".

6) IS: 2720 (part V)-1972- Atterberg's limit analysis.