The Use of GIS for Soil Mapping of Jabalpur City

Mrinal Singh, Rakesh Grover, Shailza Verma

Abstract— **Modern geotechnical engineering is generally believed to have started in 1925 with the publication of "Erdbaumechanik" by Karl Terzaghi (Goodman, 2002). In addition to establishing the theoretical principles of geotechnical engineering, Terzaghi also pioneered a large number of the investigation, instrumentation and testing methods used in soil investigations for the next few decades. Some of those methods are still in use today. Since then millions of borings have been made for different types of civil engineering projects. Traditionally, data was prepared and archived as boring logs in hard-copy. Hard copies are an unreliable archiving method, because they are bulky, hard to retrieve and susceptible to loss and deterioration. These shortcomings have resulted in massive amounts of lost, misplaced or inaccessible geotechnical data. The objective of this research is to investigate and apply current information-technology solutions in order to improve the accessibility and usage of geotechnical data. This research involves adopting current technologies, which are in use in various disciplines, and customizing them for geotechnical engineering applications. The main driving force behind this research is not only the demand from the geotechnical engineering community but demand from other research and engineering fields, which can use the geotechnical data in combination with other data types.**

Index Terms— **Geotechnical data1, Boring logs2, Latitude3 , Longitude4**

I. INTRODUCTION

Geotechnical data is used in a wide range of engineering and scientific applications. Civil engineers use the data in foundation engineering, geotechnical earthquake engineering and structural design applications. In these traditional applications, geotechnical data[1] are currently processed and used as hard copies, PDF files and, more recently, geotechnical database programs. For a typical small- to medium-size civil engineering project, these methods provide a practical and established way to exchange and use geotechnical data. While these methods might be inefficient for larger projects, the industry has continued to use the geotechnical data in the same basic way with gradual revisions and improvements. In recent years, however, there has been an emerging market for geotechnical data from large scale, multi-disciplinary projects, such as infrastructure planning, risk management, fragility study of transportation and water / wastewater networks, mining and scientific applications.

These analyses take advantage of the computational power of new computers in combination with spatial data served by powerful spatial databases and Spatial Data Infrastructures. Some of these analyses encompass areas as large as a state or country and require data from thousands of boreholes. Geotechnical data are valuable for these studies because they provide first-hand data for more realistic simulations of various phenomena impacted by soil conditions. Using more realistic models improves the accuracy of the predictions from these studies. Therefore, these applications will render the most benefit from the research conducted in this dissertation.

The current state of geotechnical data exchange is limiting for these large-scale studies because the majority of the existing geotechnical data is not readily accessible for these applications .Furthermore, there is no standard procedure to access and query this data. In this dissertation a framework for improved access and exchange of the geotechnical data is proposed. The proposed framework builds upon the standards recommended by the governing bodies in the field of spatial data management and SDIs. This framework provides a common interface with other SDIs and serves the needs of large-scale, multi-disciplinary applications that depend on this kind of spatial data.

Over the last four decades Geographical Information Systems (GIS) have emerged as the predominant medium for graphic representation of geospatial data, including geotechnical, geologic and hydrologic information routinely used by geotechnical and geo environmental engineers. GIS allow unlimited forms of spatial data to be co-mingled, weighted and sorted with any number of physical or environmental factors. GIS will continue to grow and evolve as the principal technical communication medium over the foreseeable future and engineers will be forced to prepare their work products in GIS formats which can be widely disseminated through the world wide web. This paper presents the use of GIS technologies in geotechnical engineering, with Jabalpur soil mapping by the use of this emerging technology.

1.1Overview

Gis is a technology to make more data more usable and put it to greater use for efficiencies, better performance, and profits. It is cheaper and faster technique than the traditional ones in mapping soil It has opened up new horizons in construction planning and engineering. It has developed an essential tool for the most effective use of spatial data. It is a powerful tool to handle different geotechnical issues. It is supportive tool for decision maker and planner to ensure economical construction work. Still, this technology is facing a lot of challenges to adjust itself with the complexity if geotechnical data analysis.

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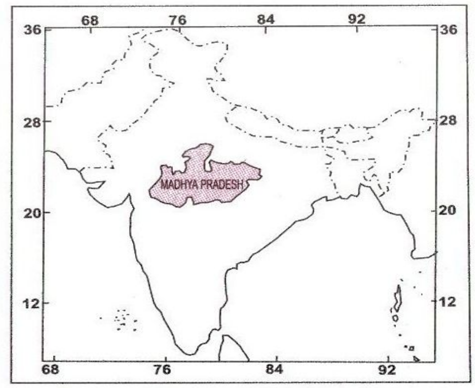
Traditionally, data was prepared and archived as boring logs[2] in hard-copy. Hard copies are an unreliable archiving method, because they are bulky, hard to retrieve and susceptible to loss and deterioration. These shortcomings have resulted in massive amounts of lost, misplaced or inaccessible geotechnical data.

The objective of this research is to investigate and apply current information-technology solutions i.e., Gis in order to improve the accessibility and usage of geotechnical data. This research involves adopting current technologies, which are in use in various disciplines, and customizing them for geotechnical engineering applications. The main driving force behind this research is not only the demand from the geotechnical engineering community but demand from other research and engineering fields, which can use the geotechnical data in combination with other data types.

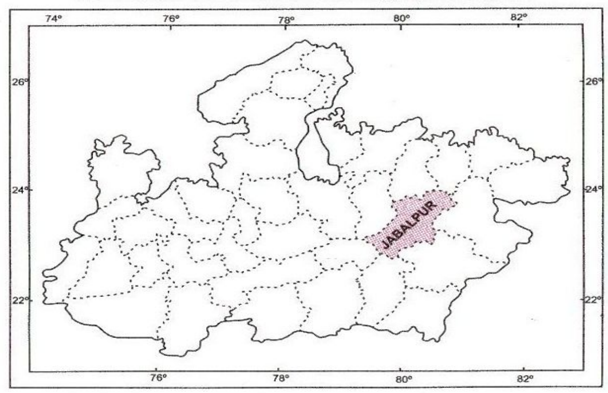
The construction activities in the city JABALPUR, which is located in the Mahakoshal region situated at the center of India in the state of Madhya-Pradesh, are in very good shape, with rapid progress on industrial developments. This city is also tipped to be an ideal place for IT industry, in central India as all other prominent cities are in a level of saturation. The cosmopolitan environment and pleasantness of the city has attracted peace loving citizens to settle down here by building their own hamlets. All these factors have contributed to rapid progress in the construction activity. The city having been brought under zone III of seismic classification, awareness has been created to do sub soil investigation for every construction. But, the professionals available in private in Jabalpur to take up such investigations are almost nil. Only a few established engineering colleges are extending the consultancy services for such works. Jabalpur is considered to be problematic for construction activities due to the presence of Black cotton soil. But this is not exactly correct because the black cotton soil extends only to shallow depths and it is followed by good stratum of soils. The black cotton soil is so deep only in certain locations warranting thorough analysis and provision of deep foundations. In the light of the above, it was considered necessary to create a data base for sub soil conditions and to make use of GIS for spatial analysis to obtain the required soil parameters for any location in the city once the longitude and latitude of that location is known.

II. Methodology

The Jabalpur city is the study area selected which is situated in the centre part of the Madhya Pradesh at a 23°10' North latitude[3] and 79°59' East longitude[4] . The total geographical area of the city is 367 sq. km. A total of 46 bore hole locations were identified for the purpose of this study. Soil samplings were taken at each layer to analyze the soil for its grain size distribution, plasticity characteristics and differential free swell in the laboratory. The bore-hole locations were selected such that it covers the entire area of Jabalpur City Corporation. The lesser number of bore-hole locations in some areas Is due to the presence of water bodies in these regions & defence area.



The territorial water of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.



When the base map with scanned using a scanner, it automatically captures map features, text and symbols in the map as pixels of vary grey scales (0-255) and produces an automated digital image in raster format. The map was registered and more than with five Ground Control Points (GCP). The longitude and latitude of the bore-hole locations were measured using Global Positioning System (GPS). The locations of boreholes were given as input to the vector map, as point feature. A database is then created for this point features with details of Lat – Long, sample identification number and the attributes. The attributes are percentage gravel, sand, silt and clay, depths, differential free swell, liquid limit, plastic limit, plasticity index, soil classification and N value. All the digitized data are imported and processed using Arch view. The digitized images with various layers are added to create thematic map. Thematic maps are the maps pertaining one particular theme. The thematic maps are overlaid and analyzed using relational tables. Grid maps are developed for thematic maps of each attribute, and were analyzed using spatial analysis tools. Grid maps display data of each attribute as continuous color gradations across the map. This color gradation is produced by an interpolation of point data from the source.

III. Results And Discussion

Records were acquired and entered for soil borings in the city map of the Jabalpur project area. The data were sorted based on standard penetration test N values .The values are from depths of 1 meter or more. These were existing boring and soils laboratory data that were originally acquired for construction projects. The amount of data in each record varies considerably between borings and project sites.

a)	LOCATION	N VALUE	SOIL CLASSIFICATION
1.	VEHICLE FACTORY	6	CI
2.	ORS, RIDGE ROAD	10	SC
3.	KOSAMGHAT BARELA	30	MI-OI
4.	IBM SITE, GARHA	10.5	CH
5.	ADM. BLOCK, COD	30	SM-SC
6.	AROGYA DHAM	20	ML
7.	DRP LINE	13	CL
8.	BEHIND MAHARAJPUR	15	CL
9.	GARHA SIDE	30	SM
10	SOI OFFICE, KRISHI UPAJ MANDI	16	CH
11	DRM OFFICE	11	CI
12	VIJAY NAGAR	5	CI-CH
13	OFK	30	SC
14	SPINAL INJURY CENTRE	10	SM
15	AGE, RIDGE ROAD		MOORUM
16	235,MARHATAL	20	CH
17	1158,VIJAY NAGAR	12	CH
18	SABJI MANDI , NIWAD GANJ	15	CH
19	CPWD	14	CH
20	POLYTECHNIC SITE	10	SC
21	GOVT.SCEINCE COLLEGE	8	CL
22	1416,MADAN MAHAL	16	CI
23	GLOBAL FOUNDN. VIJAY NAGAR	14	SC
24	SUKHA VILLAGE	24	SC
25	DAMOH ROAD	16	CH
26	MP, HIGH COURT	22	SC
27	GOKULPUR	18	CI
28	NSCB MEDICAL COLLEGE	37	SM
29	RICHHAL INDUSTRIAL AREA	2	SC
30	M.P. POLLUTION BOARD	14	SC
31	GAUR RIVER	22	SM
32	PWD NH SUB DN NO.1	16	ML-OL
33	VICTORIA HOSPITAL	7	CL
34	RLC SITE VIJAY NAGAR	13	SC
35	UPPER LINE AREA	30	SM
36	BALDEOBAGH	16	SM
37	AAI ,JABALPUR	15	CH
38	BYEPASS ON NH7	22	MI-OI
39	HOWBAGH	12	SM
40	SANJEEVANI NAGAR	10	SM
41	RAILWAY HEAD OFFICE	30	DM
42	ADHARTAL	22	SC
43	BAJRANG COLONY	5	CL
44	BURN COMPANY NEAR PARK	15	SM
45	GORAKHPUR	2	SM

CONCLUSION

In this paper we discuss about the overview of GIS and discussed how mapping of Jabalpur is made using arc gis software. Gis is cheaper and faster technique than the traditional ones in mapping soil, It has opened up new horizons in construction planning and engineering. The exercise above also offers considerable insight to the variability of surficial materials properties and thickness. Surficial material map units in the project area vary from silty sand and clayey sand deposits, to lean clay (clay of low plasticity) and fat clay (clay of high plasticity) deposits and thin stony residual bedrock Soils.

REFERENCES

[1] Gupta G.P., Tembhare B.R. And Mishra S.R. (1999), " Characterization And Classification Of Soils Of Granitic Terrain In Jabalpur District Of Madhya Pradesh", Agropedology, 1999,Vol. 9,No. 2, Pp. 77-81.

[2] Holzer Thomas L., Bennett Michael J., Noce Thomas E. , Padovani Amy C. And Tinsley John C. (2006) , "Liquefaction Hazard Mapping With LPI In The Greater Oakland", California Area Earthquake Spectra, Vol- 22, No. 3, Pp. 693–708, August 2006

[3] Igboekwe Magnus Uzoma, Akankpo Akaninyene Okon (2011), "Application Of Geographic Information System (GIS) In Mapping Groundwater Quality In Uyo, Nigeria", International Journal Of Geosciences, 2011,Vol- 2, Pp. 394-397, Doi:10.4236/Ijg.2011.24042 Published Online November 2011 (Http://Www.Scirp.Org/Journal/Ijg)

[4] Allbed Amal, Kumar Lalit (2013) , " Soil Salinity Mapping And Monitoring In Arid And Semi-Arid Regions Using Remote Sensing Technology: A Review", Advances In Remote Sensing, 2013, Vol-2, Pp.373-385 Published Online December 2013 (Http://Www.Scirp.Org/Journal/Ars) Http://Dx.Doi.Org/10.4236/Ars.2013.24040 .

[5] Sami Khemiri , Mohsen Ben Alaya, Afef Khnissi, Fouad Zargouni (2013), "Hydrological Modeling Using Gis For Mapping Flood Zones And Degree Flood Risk In Zeuss-Koutine Basin (South Of Tunisia)", Journal Of Environmental Protection, 2013,Vol-4, Pp.1409-1422,Published Online December 2013 (Http://Www.Scirp.Org/Journal/Jep) Http://Dx.Doi.Org/10.4236/Jep.2013.412161

[6] Sitharam T.G., Anbazhagan P. And Mahesh G.U. (2007), "3-D Subsurface Modelling And Preliminary Liquefaction Hazard Mapping Of Bangalore City Using Spt Data And Gis", Indian Geotechnical Journal ,Vol-3, No-37, 2007,Pp.210-226

[7] Hora Himanshu (2010), "Strengthening The Back Bone Of Indian Economy Through Application Of Gis In Agriculture", Journal Of Engineering Research And Studies, Jers/Vol. I/Issue I/July-Sept. 2010/5-14

[8] Okunade Emmanuel Akintunde (Corresponding author)(2010), "Design and Implementation of a Web-Based Geotechnical Database Management System for Nigerian Soils", Vol. 4, No. 11; November 2010