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DEVELOPMENT OF ZONATION MAP BASED ON SOFT CLAY FOR BANGLADESH

Ripon Hore*, M. R. Arefin, and M. A. Ansary

Department of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

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ABSTRACT

Zonation based on soft soil is very much significant for the proper identification of soft soil improvement techniques on the specific/defined location of Bangladesh. In this paper, about one thousand boreholes have been used to find the Standard Penetration Test (SPT) values around different locations of Bangladesh. Out of these about one thousand boreholes, four hundred and seventy have been used to identify soft clay soil layer formation. Three Geographic Information system (GIS) maps have been proposed by ArcView-GIS-2010 software as follows: a) Soil parameters information map b) SPT (N) value-based map (SPT 1-5) and c) Soft clay layer thickness maps. Bangladesh is on the delta formed by the three main rivers the Meghna, the Ganges, and the Brahmaputra. These rivers originate outside the country's national boundary and make up the Meghna-Ganges -Brahmaputra river system. Therefore, availability of soft clay is higher in the southern part of the country and the riverside areas.

Keywords: *Standard Penetration Test (SPT), Boreholes, GIS*

1. INTRODUCTION

For the selecting the different soil improvement techniques, soft clay soil layer identification is very much significant. So, a major challenge is the presenting the subsoil characteristics in one platform. In fact, soft clay soil is a finely-grained natural material or rock soil that consists of one or more clay minerals with possible traces of quartz, metal oxides, and organic matter. Therefore, soft clay deposits are mostly composed of phyllosilicate minerals containing variable amounts of mineral trapped in the structure. Construction on soft clay soil causes possible failure of the structure for consolidation settlement. So, before construction; implementation the soil improvement techniques/procedures were needed. Different types of research/studies were regulated on the zonation map with different aspects.

Ansary and Rashid (2000) have presented to analysis the alleviation of the disaster due to future shocks which is an indispensable consideration for proper land use and effective town-planning. Silty-sands and loose sands induce flow slides, settlements, loss of life and damage/destroy to property due to liquefaction potential. The susceptibility of liquefaction within a zone of probability two hundred square kilometers in the Greater Dhaka City zone, Bangladesh has been assessed based on SPT data from one hundred ninety boreholes. Liquefaction of saturated loose sands and silty-sands induce flow slides, settlements, loss of life and damage to property. The susceptibility of liquefaction within an area of approximately 200 square km in the Greater Dhaka Metropolitan area, Bangladesh has been assessed based on Standard Penetration Test data from 190 bore holes. The analytical results have been classified into two groups according to the extent of liquefaction observed, namely, as to whether the site is liquefiable or non-liquefiable.

Hossain *et al.* (2003) has described liquefaction potential index and sub-soil characteristics of Mirpur area. To characterized/identified soil deposit 8 boreholes were drilled at the proposed site. In the laboratory, Specific gravity, Grain size distribution, Moisture content, Atterberg limits, unconfined compressive strength, density and Shear strength parameters of the samples have been analyzed. It was observed that geotechnical properties of the soil in the study area varied with depth and location. It was observed that loose soil exists from 4.7 m to 14.0 m depth below the existing ground level (EGL). From the study, the possibility of the liquefaction had been found to be zero. Rahman (2004) updated the seismic micro-zonation maps for liquefaction as well as site amplification due to an earthquake. Alam and Islam (2009) have evaluated the understanding of the geological setting of Bangladesh which is important for foundation design as well as to estimate the Earthquake Hazards. Soil formation below the foundation need to be identified for proper selection and design of foundation. A process of deltaic sedimentation into a slowly and continuously subsiding tectonic basin has developed the geology of Bangladesh.

Above the papers evaluated the sub-soil characteristic at the different location of Bangladesh. In fact, liquefaction micro-zonation or seismic map has been proposed. In this research, an attempt was conducted to create a proposed zonation map based on soft soil regarding clay using GIS interface which is useful for identifying proper soft soil improvement techniques.

* Corresponding Author: riponhore@gmail.com

2. GEOLOGICAL CONDITIONS OF BANGLADESH

Bangladesh is the largest delta in the world. Huge alluvium is opened on the surface. The oldest deposit is the Plio-Plesitocene Barend clay, Madhupur clay and Lamaic region clay. Sediment deposited is not evenly distributed through the country. At the northern part it is about 128 m thick where granite is extracting for construction purpose. But thickness was gradually increased towards the south. At center the capital city Dhaka of Bangladesh where sediment is covering more than 22+ km.

About 250 large and small rivers are flowing through the country. River born sediment was deposited from these rives system. From north to south Bangladesh was classified into 3 tectonic zone namely; a) Stable platform or Indian plat form (consisting of Himalayan for deep, Rangpur Saddle, Dinajpur Shield, Bangura platform and Hinge zone); b) Bengal Basin (consisting of Faridpur Trough, Hatiya Trough, Barisal Trough, Surma Basin); and c) the Chittagong Hill tract.

Sedimentary covers are not uniform throughout the country. Massive drilling, geophysical survey viz. electromagnetic survey, seismic survey, resistivity survey etc. are revealing the depositional and basin history of the country. Various deposit such as, Natural hydrocarbon deposit such as Coal deposit at the Northern part of Dinajpur district; gas at south and eastern part, Bijoypur clay of Netrokona district, Heavy minerals of Cox's Bazar Inane beach with radiometric element, glass sand, limestone etc. are major resources of the country. A geological map is shown in Figure 1. Three types of soil [a) Alluvial Clay and Silt b) Alluvial Silt and c) Madhupur Clay residuum] have been described in this map.

3. SUB-SOIL INVESTIGATIONS

The execution of one thousand borings has been performed for sub- surface investigation works. The stiffness and density characteristics of the soil layers were analyzed by conducting the SPT. The information of eight representatives bore logs has been shown in Figure 2. The sub-soil investigation has been performed by consulting firm named Soil and Foundation Consultants. The thickness of layers (soft clay) varies from 1 to 17 meters. The Reduced Level (RL) has been varied from 0 to 0.91 meters and Groundwater Level (GWL) has been varied from 0.15 m to 3.05 meters. The SPT consists of driving a sampler named thick-walled into the granular soil deposit. The deep of the split-barrel sampler (standard)is 460 millimetres into the soil below the bottom of the boring and counting the number of blows to drive the sampler into the last 305 mm. The driving mass is 63.5 kg. The falling height is 760 mm.

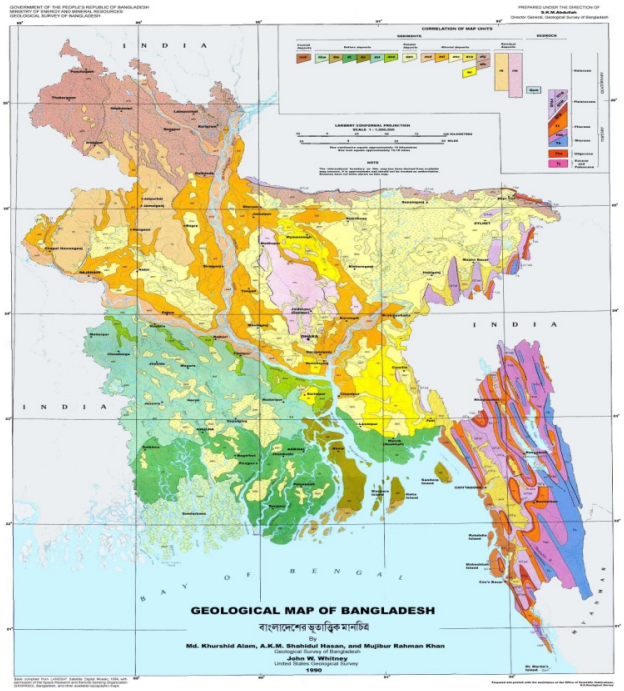
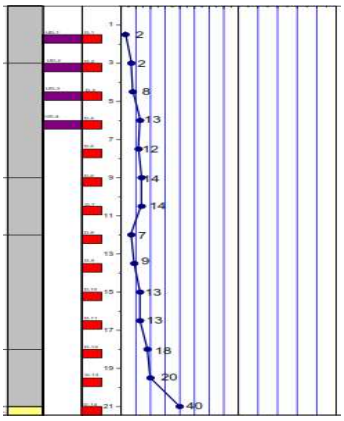
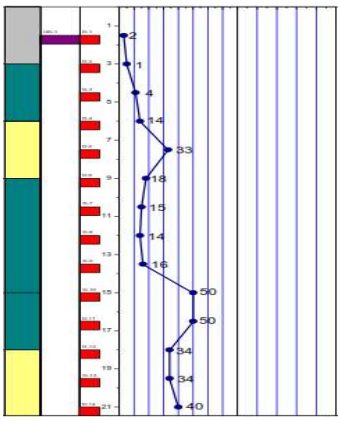


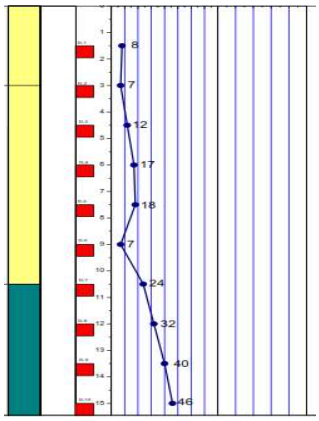
Figure 1: Geological map of Bangladesh (Source: www.gsb.gov.bd)



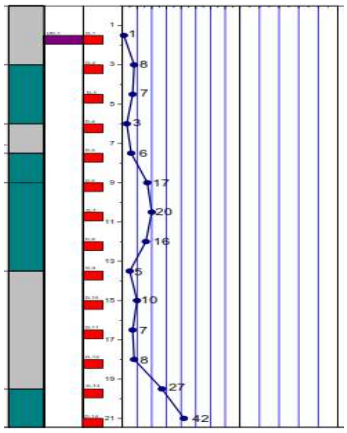
(a) Bore log of Soil (Dhaka)



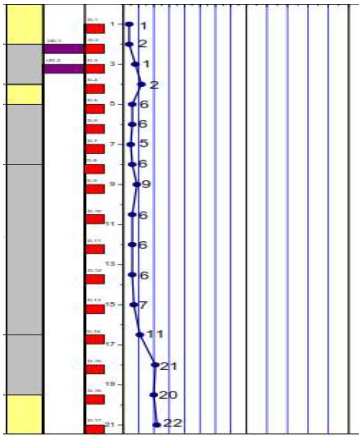
(b) Bore log of Soil (Barishal)



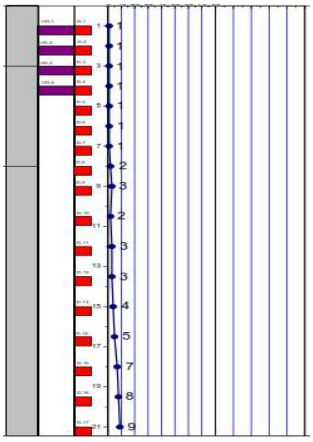
(c) Bore log of Soil (Cumilla)



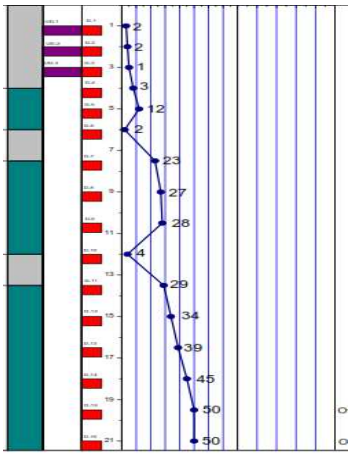
(d) Bore log of Soil (Mymen)



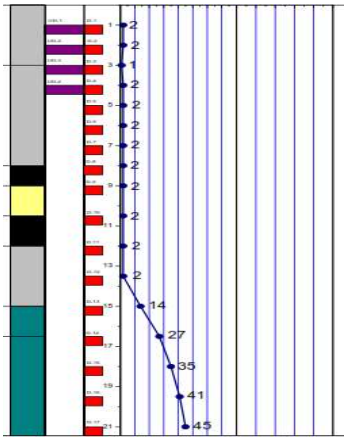
(e) Bore log of Soil (Rajshahi)



(f) Bore log of Soil (Khulna)



(g) Bore log of Soil (Rangpur)



(h) Bore log of Soil (Sylhet)

Figure 2: Sub-Soil information

4. DATA ANALYSIS WITH GIS

GIS application in the spatial distribution is a new dimension for data analysis and interpretation for proper structural suitability research. The first step for the GIS interpretation is data processing interface for GIS input. Data processing is belonging to the modification of the analysis of the database and location of the lithology. The soft layers have been identified at a significant interval depending on SPT (1 to 5). The SPT distribution and lithological thickness maps have been shown in Figures 5 and 6. After processing and arranging the locations wise data has been input into the ArcView GIS. The flow chart regarding processing has been shown in Figure 3. Table 1 shows subsoil information. Layer thickness (soft clay), N value ranges, and soil type was presented in Table 1. Location, Latitude, and Longitude was also presented in Table 1. This Table was placed to the GIS interface.

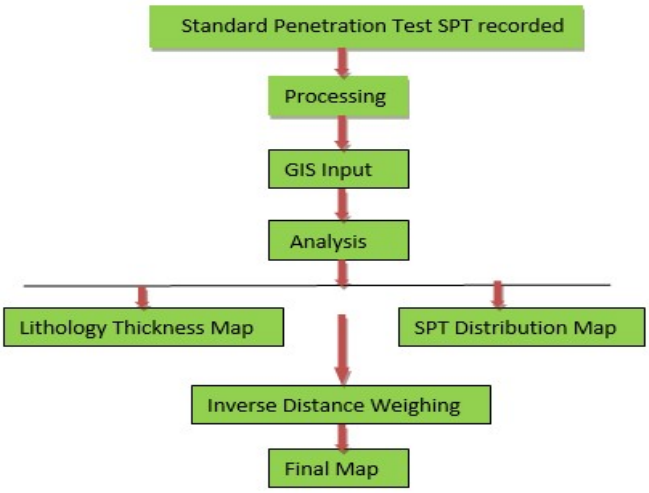


Figure 3: Process flow chart

Table 1: Information of soil parameters for GIS input

Lat.	Long.	Layer Thickness (m)	Thickness (m)	Range of N value	N value (Maximum)	N value (Minimum)	Type of Soil	District
91.20	24.70	0-17	17	1-4	4	1	Clayey Soil	Khulna
90.10	24.55	0-6	6	1-5	5	1	Clayey Soil	Khulna
90.88	25.33	1-5	4	2-4	4	2	Clayey Soil	Khulna
92.28	25.24	1-6	5	2-3	3	2	Clayey Soil	Khulna
91.12	26.16	3-7	4	2-4	4	2	Clayey Soil	Khulna
92.90	25.89	1-8	7	2-4	4	2	Clayey Soil	Khulna
92.83	25.58	1-6	5	2-4	4	2	Clayey Soil	Khulna
92.70	24.58	1-5	4	2	2	2	Clayey Soil	Khulna
93.83	25.80	1-3	2	2-3	3	2	Clayey Soil	Khulna
91.26	25.50	1-3	2	2-3	3	2	Clayey Soil	Khulna
90.76	25.81	1-6	5	1-3	3	1	Clayey Soil	Khulna

In this paper about one thousand boreholes have been used for SPT test in and around whole Bangladesh. Above the boreholes, four hundred and seventy boreholes were identified for formation of clay layer (soft soil). Three GIS maps were proposed by ArcView GIS 2010. These maps are: a) soil parameters information b) zonation for N value (1 to 5) and c) thickness map for the soft clay layer. In Figure 4, Soil parameters information has been shown. The different subsoil parameters have been showed from the map by clicking the defined location of Bangladesh. The four hundred and seventy boreholes regarding clay layer (soft soil) have been also reflected in the GIS map. Besides these, the zonation map of N value was presented in Figure 5. Thickness map for soft soil have been presented in Figure 6.

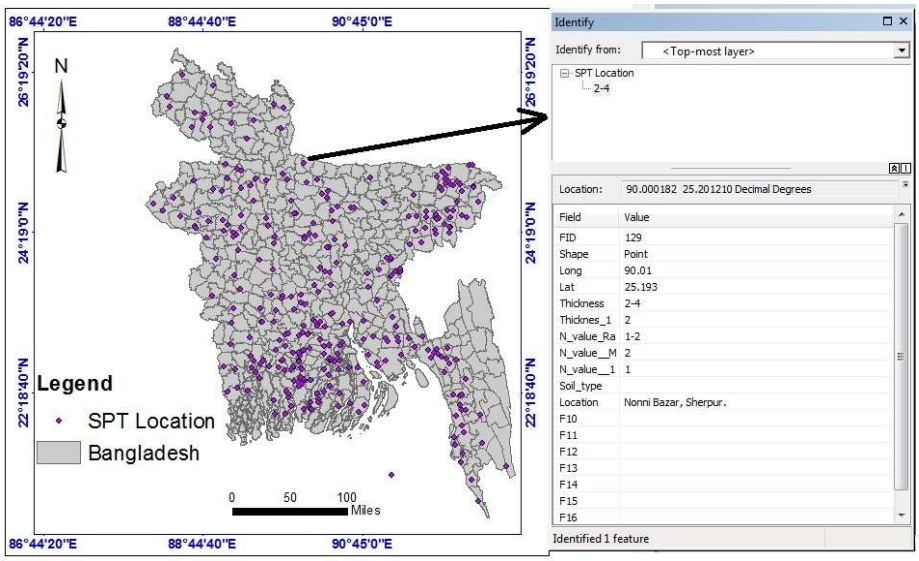


Figure 4: Soil parameters information

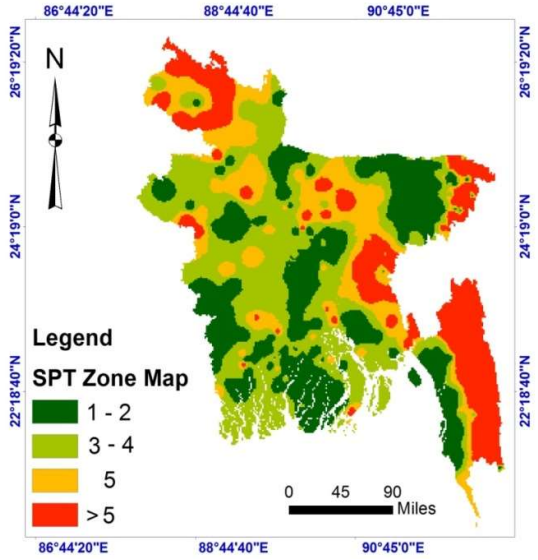


Figure 5: Zonation map using N value

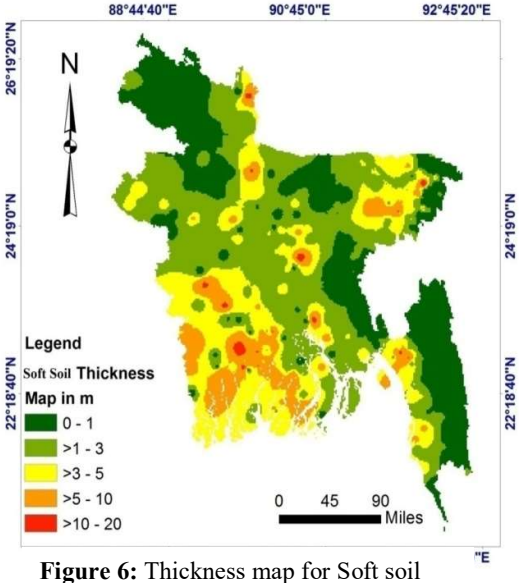


Figure 6: Thickness map for Soft soil

5. CONCLUSIONS

Three (3) GIS maps were proposed in this paper, using ArcView GIS. First is the soil parameters information map, second is the zonation map using N value and third is the thickness map for the soft clay layer. Accessibility of soft clay is higher in the southern part of the Bangladesh, mainly along the riverside. The clay layer (soft) thickness varies from 1 to 17 meters. This paper has been proposed three GIS-based maps which might be useful for identifying soil improvement techniques/procedures in the different locations of the Bangladesh.

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