ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/325202893

Preparation of SPT Contour Map of Rajshahi City Area and its Application to Foundation Design

Article · May 2012

CITATIONS
6

READS
1,278

1 author:



Md. Robiul Awall
Rajshahi University of Engineering and Technology
47 PUBLICATIONS **117** CITATIONS

SEE PROFILE

All content following this page was uploaded by Md. Robiul Awall on 17 May 2018.

The user has requested enhancement of the downloaded file.

Preparation of SPT Contour Map of Rajshahi City Area and its Application to Foundation Design

Tasnuva Humyra[1], Md. Robiul Awall[2], Dr. Syed Abdul Mofiz[3], and Mohd. Abdus Sobhan[4]

***Abstract*— Standard Penetration Test (SPT) value contour map will be great helpful to the foundation designer. Every engineer wants to ensure the structural safety and serviceability. For this reason it is very important to know the soil condition before any construction. This study is carried out to prepare SPT contour map at Rajshahi city which will be helpful to construct small and low cost structures. To this end, firstly SPT value data of different locations and different depths at Rajshahi city have been collected from field test results. X- axis and Y- axis has considered in such a manner that the available boreholes data are in between these two axis. By using the commercially available Origin Software two types of SPT value contour map have been plotted at each depth (3ft, 6ft, 10ft, 15ft, 20ft, 30ft, 40ft, 50ft and 60ft). Line type contour maps shows the same SPT value line, from these people can understand the SPT value and direction of the SPT value line at Rajshahi City. Fill color maps shows different types of color area, each color contains same SPT value and people can understand from which area what the SPT value is. SPT values correlate empirically with the foundation design parameters such as soil density, friction angles, settlement of shallow and deep foundations, bearing capacity values, etc. By using SPT value a typical example have been done. At a glance to observe the prepared SPT value contour map any engineer can understand the soil condition at different depth of Rajshahi City.**

***Index Terms*—Contour map, Foundation design, Soil condition, Standard Penetration Test.**

I. Introduction

SOUND geotechnical design requires a thorough quantification of soil properties. Engineers must determine the average values and variability of those properties. They must use tests that assess the site variability but minimize the parasitic test variability. The more variable the site is, the higher the risk is and therefore the more conservative the design should be. The contrary is also true. After determining the average and standard deviation values of the soil properties, the engineer can provide a design at a level of computed risk that is acceptable to the owner. Most of the people of developing country like Bangladesh do not know the importance of soil test before construct any structure. Mainly they want to complete their construction as cheap as possible. On the other hand if the structure fails due to soil failure then the owner gives the discredit to the engineer. For this reason it is very important to prepare a soil condition map at every city of developing country like Bangladesh.

The Standard Penetration Test (SPT) is one of the most popular tools for geotechnical characterization of a site primarily due to its simplicity and economy. A geotechnical problem in which the SPT is particularly popular is the design of foundations. The SPT was first standardized by the American Society for Testing Materials (ASTM) in 1958 (designation D1586-58). It was soon recognized by Tavenas [1] and Fletcher [2]; they said that the test was not a reliable source of information. To increase the reliability of the in-situ test, the method was further standardized with the most recent update in 1999 (ASTM D1586-99). This update addresses many of the uncertainties involved and provides guidelines for the performance of the SPT.

An extensive literature review was made to evaluate sources of uncertainty in the performance of the SPT, based on the previous work of many researchers [3]-[6]. Zekkos *et al.* [7] examined the uncertainty, variability and bias in the performance of the SPT were identified using an extensive literature review and were classified in a manner that should assist the practice in recognizing and reducing them. Failmezger *et al.* [8] examined and suggested that SPT is a better approach to site characterization of residual soils using other in-situ tests. They compare SPT test with other Pressuremeter Test (PMT), Cone Penetrometer Test (CPT), Dilatometer Test (DMT), and Iowa Borehole Shear Test (BST). Babbitt et al. [9] explain division of safety of dams following the San Fernando earthquake. They identify many tools (including SPT, CPT, Drilling, Surface Trenching etc.) available to the practicing engineer; discuss how the tools are used within division of safety of dams and outline the general steps for analyzing an earth embankment dam.

Manuscript received March 7, 2012.

[1]Tasnuva Humyra is Graduate Student at Graduate School of Engineering, Hokkaido University, Sapporo, Japan (Corresponding author, phone: +81-8040429511; e-mail: anny030114@yahoo.com).

[2]Md. Robiul Awall is Assistant Professor at Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi, Bangladesh (e-mail: robi95@gmail.com).

[3]Dr. Syed Abdul Mofiz is Professor at Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi, Bangladesh (e-mail: samofiz@yahoo.com).

[4]Mohd. Abdus Sobhan is Associate Professor at Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi, Bangladesh (e-mail: msobhan@yahoo.com).

Suwanwiwattana *et al.* [10] utilized the number of soil boring reports of Bangkok and created information technology including geotechnical database system and GRASS-GIS which can be served the geotechnical engineer as the very effective tools. Shirato *et al.* [11] investigated the present situation regarding the determination of soil parameter values in a progress from ground investigation through to design. Their survey was designed to assemble fundamental information for the revision of the Japanese Specifications for Highway Bridges with the introduction of an LRFD (Load and Resistance Factor Design) format and a reliability design concept.

This study involves preparing a generalized SPT contour map of Rajshahi City to know the soil condition which is vastly used to design geotechnical structures. There are many places at Rajshahi City soil was tested before to construct any important structures. But in low cost structure generally soil are not tested. So by prepare a soil condition map peoples can get idea about the soil condition of any place under the area of the map. It will be helpful for constructing small and low cost structures.

II. Scope and Objectives

As a civil engineer our first aid is to ensure the structural safety. Therefore, it is very important to do the subsoil exploration before any construction work. In many places at Rajshahi city subsoil exploration was done before to construct any important structures. However, to construct low cost structure generally owner could not do subsoil exploration. So by preparing a SPT contour map, civil engineers can get idea about the soil conditions of any places. Generally to construct a low cost structure, the owner does not want to increase his construction cost by doing subsoil exploration. For this reason it may be collapse due to poor soil condition. Therefore, the SPT contour map will be helpful for civil engineer as well as owner to construct low cost structure and that is the main objective of this study. Also by using SPT values from prepared SPT contour maps, a typical example to foundation design has been done. To fulfill the objectives 21 subsoil investigation reports of different places of Rajshahi City area was considered, from those 73 boreholes SPT values of different depth like 3ft, 6ft, 10ft, 15ft, 20ft, 30ft, 40ft, and 60ft were considered to prepare the SPT contour maps.

III. Methodology

A. Data collection from sub-soil investigation report

The homebuilder especially wants to know what type of foundations and other construction details are likely to be required so that he can figure his cost to build. The land developer needs to know the additional cost due to any soils

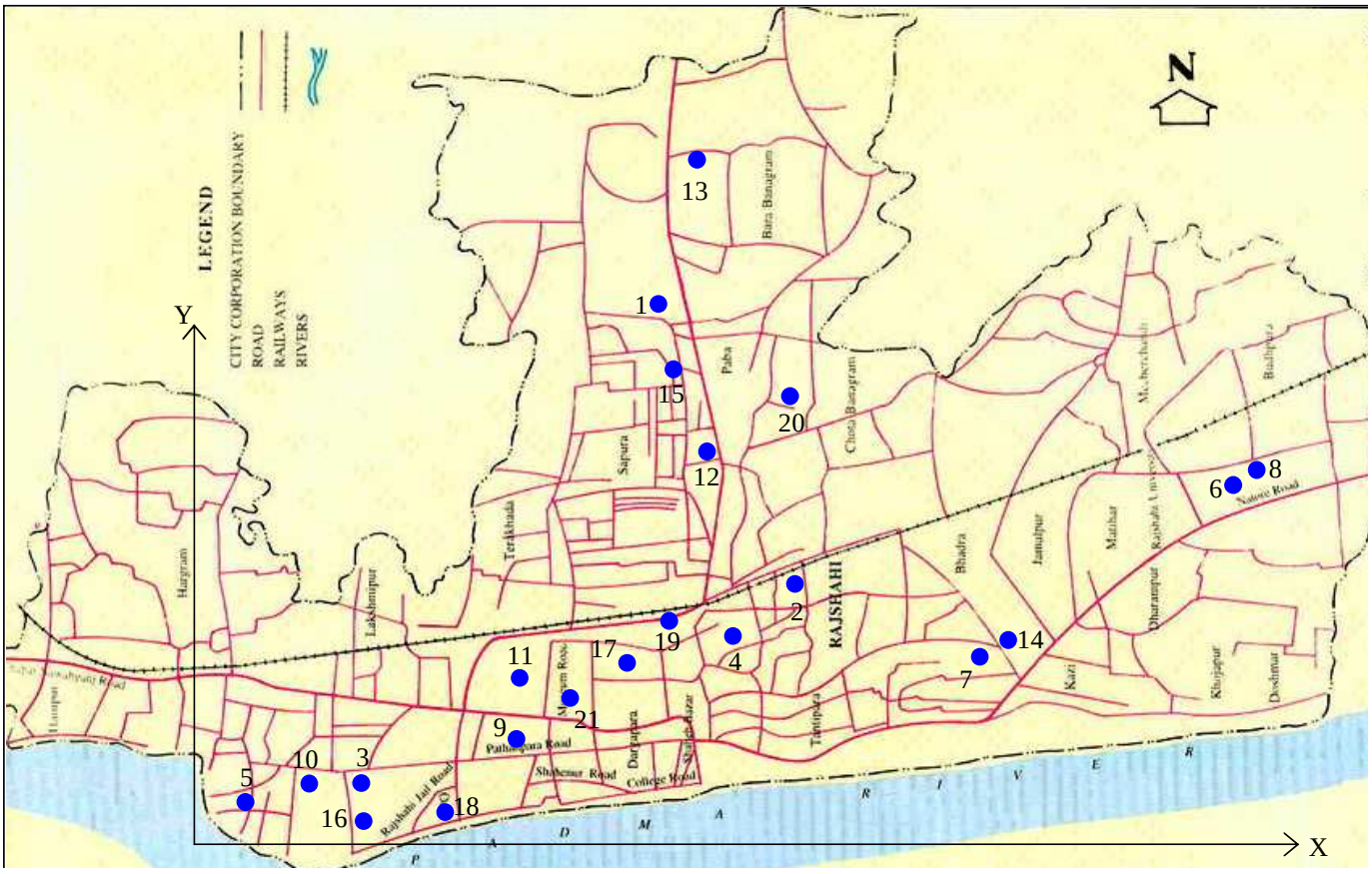


Fig. 1. Location of available soil report on different places of Rajshahi city area.

problems or conditions. For that reason homebuilder did the subsoil investigation before construct their structures. In this study 21 soil report of Rajshahi city are used, which was prepared by Civil Engineering Department of Rajshahi University of Engineering & Technology enter the Rajshahi city area. For preparing the SPT contour map, 21 soil test reports at different places of Rajshahi city was considered. Black circle shows the places of soil test at Rajshahi city area shown in Fig. 1. From those each project has many boreholes. X- axis and Y- axis is considered in such a manner that the available boreholes data are in between these two axis. For the above consideration in this study origin is taken near Rajshahi coat and X-axis and Y-axis was drawn respectively. Then measures the distance of each bore hole of every project from X-axis and Y-axis. The availability soil test reports are limited and the study area is from Rajshahi Coat to Rajshahi University. The SPT test was done at different depth like 3ft, 6ft, 10ft, 15ft, 20ft, 30ft, 40ft, 50ft and 60ft. For this reason map of different depth are prepared in this study.

B. Contour map preparation

A contour is an imaginary line on the ground joining the points of equal elevation. It is a line in which the surface of ground is intersected by a level surface. A contour map is a map illustrated with contour lines. To prepare the SPT value contour map of Rajshahi city area distances of borehole from reference lines are calculated. X-axis is gone through from bulunpara river side to shishu academy, kumarpara, alupatti, ahmedpur, talaimari and so on to the straight line. Y-axis is gone through from bulunpara river side to police line, haragram, bathanbari and so on to the straight line. Every borehole distances are measured from these two reference lines according to the scale of the map. X-axis distance, Y-axis distance and SPT value of each depth are given to the Origin Software data sheet and finally plot two types of contour map. One is line type contour maps and another is fill type color contour maps.

C. Foundation design using SPT value

To construct a structure, N value (SPT value) is an important parameter to understand the soil condition at different depths. After investigating N value of different depths, foundation depth can be selected according to load of the structure. Then determine the corrected N value at the required depth. Angle of internal friction is determined from corrected N value. After that calculate bearing capacity factor follow the bearing capacity of the soil. From this bearing capacity of soil foundation can be designed. Flow chart of foundation design is shown in Fig. 2.

IV. RESULTS AND DISCUSSION

By considering the boreholes distance from the selected reference lines and measured SPT values at 3 ft, 6 ft, 10 ft, 15 ft, 20 ft, 30 ft and 40 ft depths are used to prepared the SPT contour maps. Two types of contour maps are prepared. First

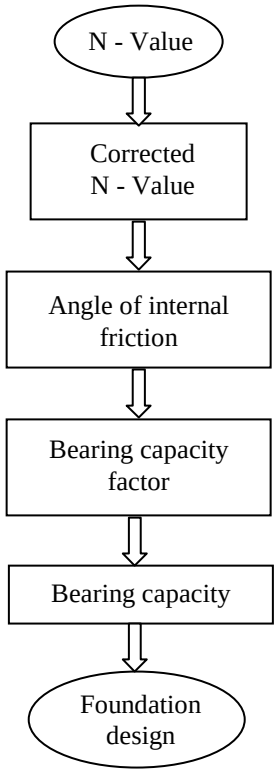
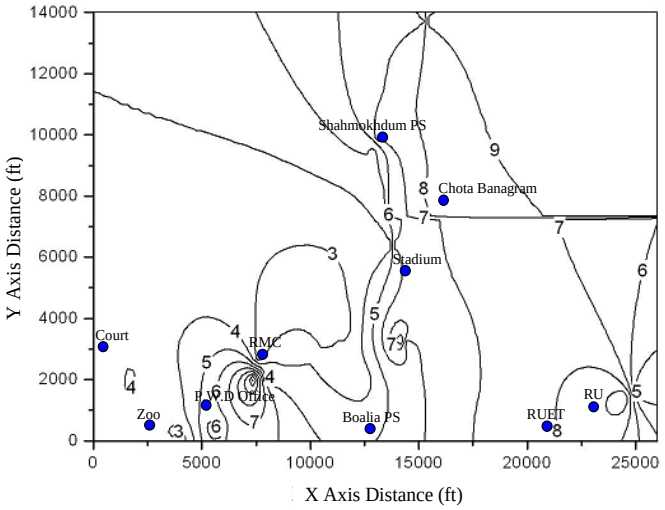


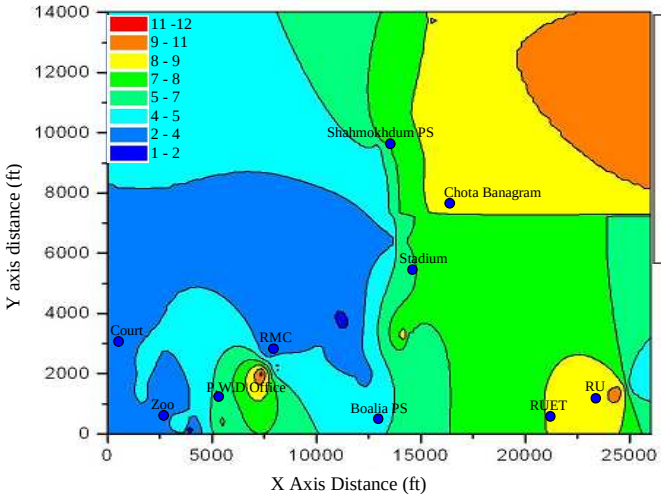
Fig. 2. Flow chart of foundation design using SPT value.

type is line contours maps and second type is fill color contour maps. Line type contour maps show the line which contains same SPT value with respect to depth at the different location of the Rajshahi city. From these line type contour maps engineers can get idea about the SPT value of different depth in the Rajshahi city area. Fill color maps shows different types of color area in the Rajshahi city which contains same SPT value. From this type of fill color contour maps engineers can understand the SPT value in that area. At 3 ft depth two types of SPT contour maps are shown in Fig. 3 and line contour maps of 6 ft, 10 ft, 15 ft and 20 ft depths are shown in Fig. 4. Because of shallow foundations are normally constructed between these ranges. Also, the fill color contour maps of different borehole depths are shown in Fig. 5, from which engineer can understand what the SPT value under the areas to observe at a glance.

From Fig. 3 to Fig. 5 it can be observed that at 3 ft depth SPT value are ranges from 2–12. The area gone through the location RUET, north side of RU, vodra, stadium, Shahmokhdum thana are the same SPT value is between 7-8. But the area RMC to Court, SPT value is very low is 2-4. Chota Banagram, Boro Banagram and south side of RU side SPT value is 8-9. At 6 ft depth SPT values are ranges 2–8, which is lower than the 3 ft depth. The area gone through the location RUET, RU, Boalia thana are the same SPT value is between 5-6. The area Talaimari, Shahmokdum thana and south side of Chota Banagram SPT value is between 7-8. But the area Court, Horogram side SPT value is very low is 2-3.

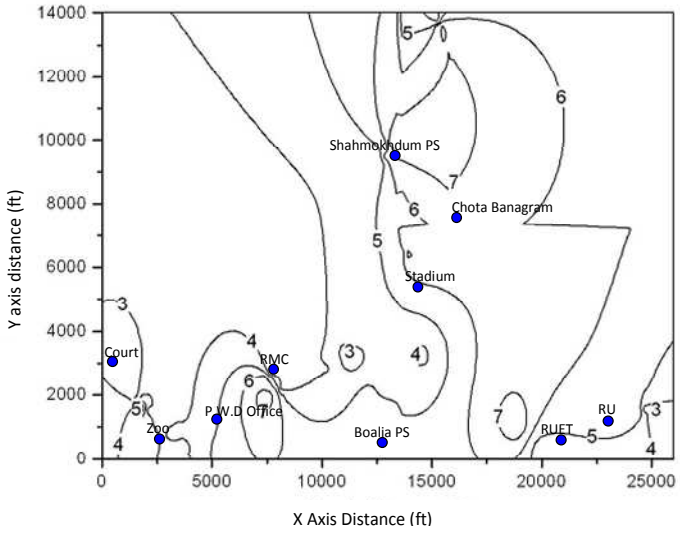


(a) Line contour map.

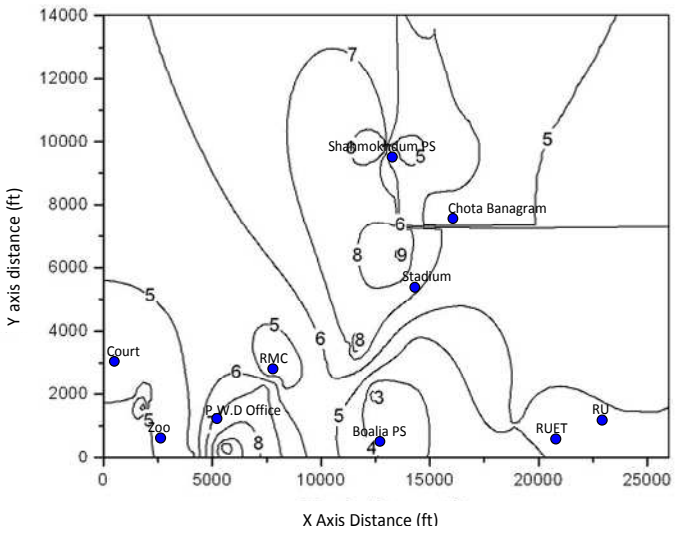


(b) Fill color contour map.

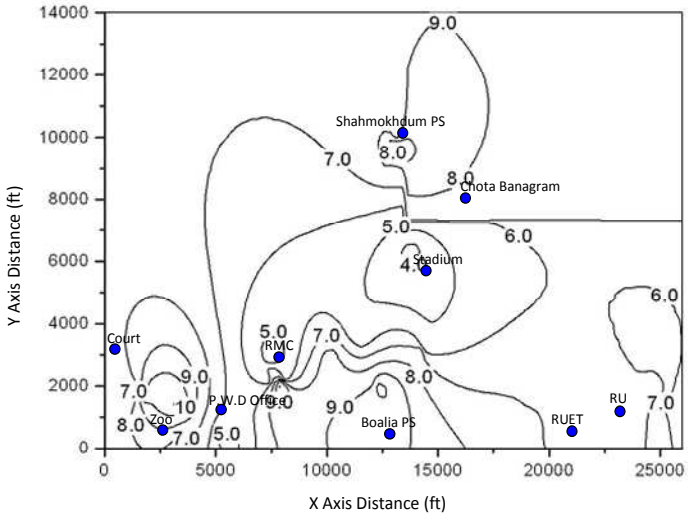
Fig. 3. SPT value contour maps at 3 ft depth.



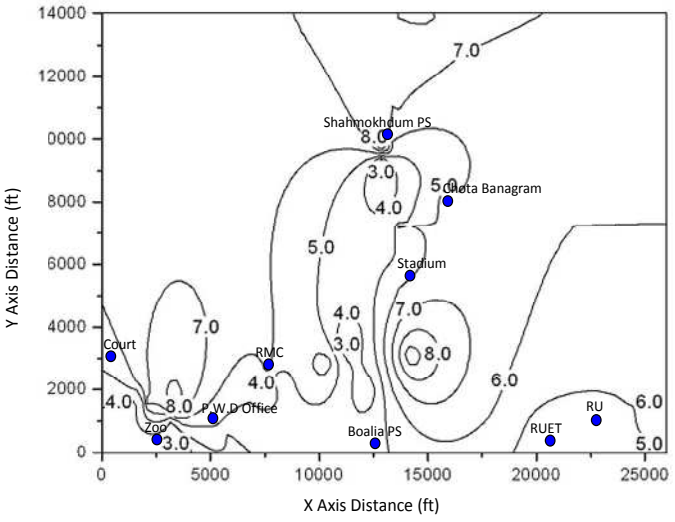
(a) At 6 ft depth



(b) At 10 ft depth

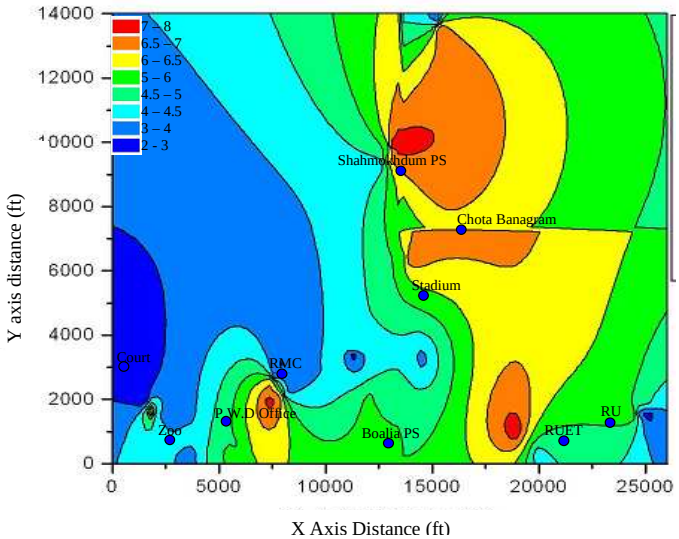


(c) At 15 ft depth

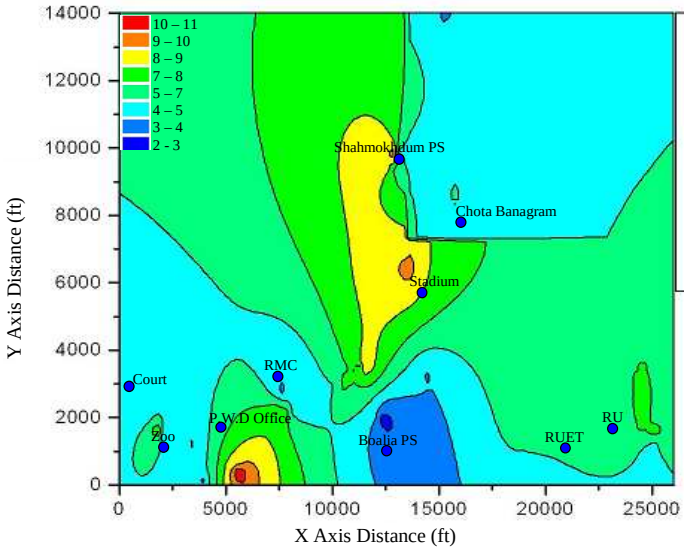


(d) At 20 ft depth

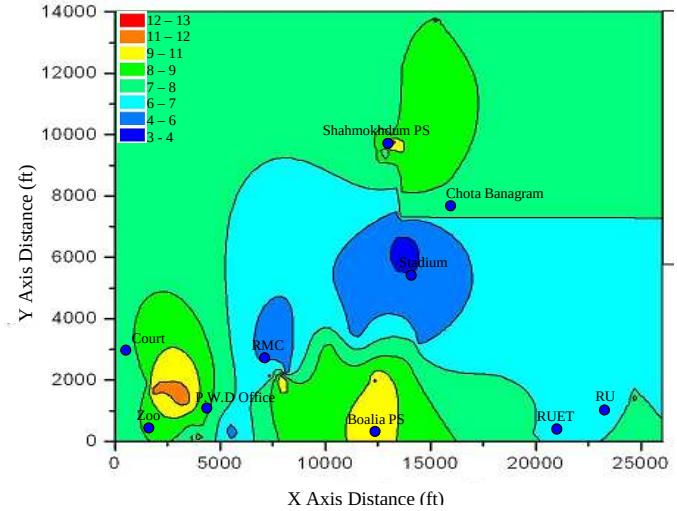
Fig. 4. SPT values line contour maps at different depths.



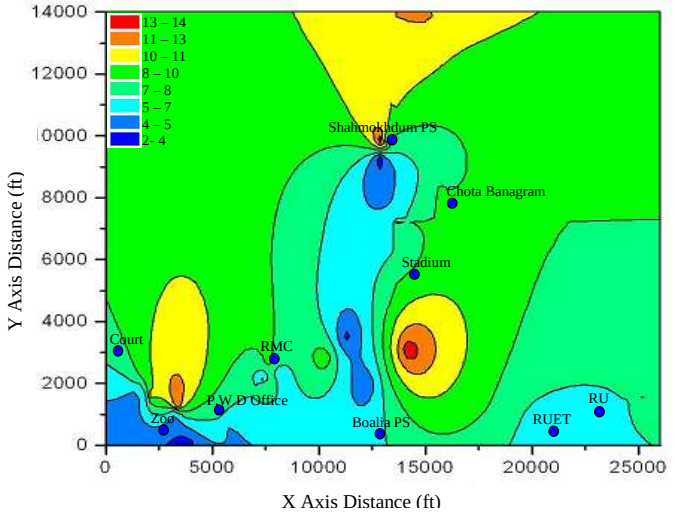
(a) At 6 ft depth



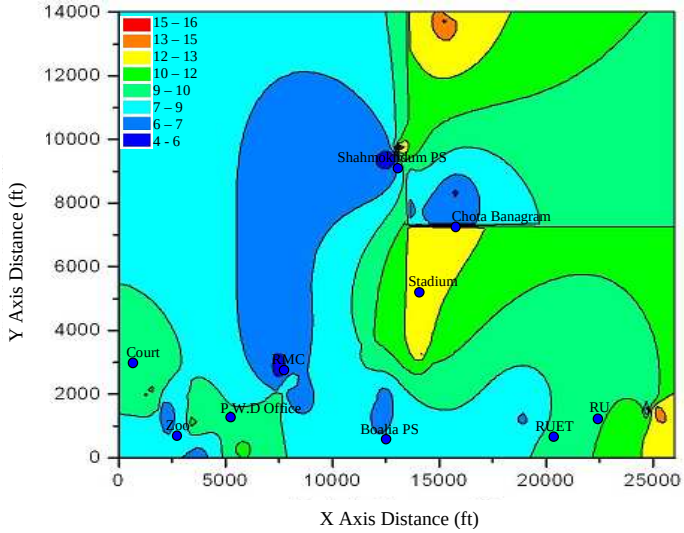
(b) At 10 ft depth



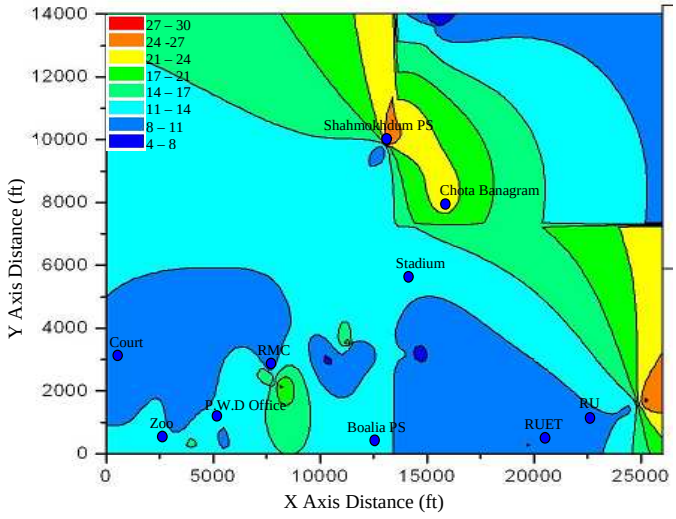
(c) At 15 ft depth



(d) At 20 ft depth



(e) At 30 ft depth



(f) At 40 ft depth

Fig. 5. SPT values fill color contour maps at different depths.

At 10 ft depth SPT values are ranges from 2–11. Most of the area of the Rajshahi city including RUET, RU, Stadium and so on, the SPT value is 7-8. Also the area gone through Court, Zoo, RMC, Choto Banagram, are the same SPT value is 4-5. Of course some area surrounding the Boalia thana, SPT value is very low is 2-3. At 15 ft depth SPT values are ranges from 3–13. Most of the area of the Rajshahi city including Court, Zoo, Circuit house, Chota Banagram, Shamokdum thana and so on, the SPT value is 7-9. Also the area gone through Bandogate, Bilshimla, Baliapukur, RUET, and RU are the same SPT value is 6-7. Also some are like west side of Boalia thana and in front of zoo has higher SPT value ranges from 9-11. There are some areas surrounding the Stadium, RMC has lower SPT value ranges from 4-6. At 20 ft depth SPT values are ranges from 2-14. Area near Court, RMC, Stadium, Chota Banagram, PWD Office and so on, the SPT value is 7-10. Also the area of RUET, RU Boalia PS, and Zoo are the same SPT value is 5-7. Some are like west side of Boalia thana and in front of zoo also has higher SPT value is 9-11. At 30 ft depth SPT values are ranges 4-16. Area near Court, PWD Office, RU, RUET, Boro Banagram, and so on the SPT value is 9-12. Some are like Stadium, Boro Bongram has higher SPT value is 12-13. At 40 ft depth SPT values are ranges 4-30. Most of the area of the Rajshahi city including Zoo, PWD Office, Boalia thana, Stadium, and so on the SPT value is 11-14. Also the area RUET, RU, Baliapukur, seroil, Surrounding Court, the SPT value is 8-11. At Chota Banagram area SPT value ranges from 17-21, and surrounding the Boro Banagram area SPT value is 21-24.

V. CONCLUSIONS

The Standard Penetration Test (SPT) is currently the most popular and economical means of obtaining subsurface information. In this study generalized SPT contour map is prepared by using measured SPT values of different depths of Rajshahi city. Two types of contour maps are found in this study. One is line type contour map, which shows the same SPT value line gone through the different location at Rajshahi city. Another is fill type color contour map, which shows the same SPT value area gone through the different location of Rajshahi city.

In different depth different types of SPT values are obtained in different location of Rajshahi city area. At 3 ft depth SPT value are ranges between 2–12 and most of the location SPT value are 5-8. Between 6 ft to 30 ft depths, SPT values are ranges from 2-16. Highest SPT values obtained at 40 ft depth ranges from 4-30 and most of the location SPT value are 11-14 at this depth. In shallow depth between 3 ft to 10 ft, larger SPT values are obtained in Choto Banagram, Stadium and RUET areas.

SPT values correlate empirically with the foundation design parameters such as soil density, friction angles, settlement of shallow and deep foundations, bearing capacity values, etc. At a glance to observe the prepared SPT value contour map any engineer can understand the soil condition at different depth of Rajshahi city area.

There are plentiful scopes for further studies in this type of project. In this study 21 numbers of project reports which include 73 boreholes of soil test in Rajshahi City are available. But this number is few to represent most accurate contour map, because these numbers can not cover the whole city area. That's why more and more project reports of soil test in Rajshahi city will give more accurate contour map. In this study those soil test reports of Rajshahi city area are used which is prepared by the Department of Civil Engineering, RUET. There are many company in Rajshahi city who are doing soil test in Rajshahi city area. After managing all companies soil test report in Rajshahi city area, this study can be improve further, which will give more accurate result that can be more reliable to the engineer.

REFERENCES

[1] F.A. Tavenas, "Discussion to deMello (1971)," *4th Panamerican Conference on Soil Mechanics and Foundation Engineering*, Puerto Rico, 1971, Vol. III, pp. 64-69.

[2] G. Fletcher, "Standard penetration test: Its uses and abuses," *ASCE Journal of Soil Mechanics and Foundation Engineering*, Vol. 91, SM-4, July, p.67, 1965.

[3] J.H. Schmertmann, "Measurement of insitu shear strength," *keynote lecture, Proceedings of the conference on in-situ measurement of soil properties*, June 1-4, 1975, vol. II, American Society of Civil Engineers.

[4] M.E. Barton, "Field testing in engineering geology," *Geological society special publication* No. 6, pp. 121-127, 1990.

[5] F.H. Kulhawy and P.W. Mayne, "Manual on estimating soil properties for foundation design, final report, August 1990," *Electric Power Research Institute*, EPRI EL-6800.

[6] F.H. Kulhawy and C.H. Trautmann, "Estimation of in-situ test uncertainty," *Proceedings of uncertainty 96: Uncertainty in the geologic environment: From theory to practice*, pp.269-286, 1996.

[7] D.P. Zekkos, J.D. Bray and A.D. Kiureghian, "Reliability of shallow foundation design using the standard penetration test," *Proceedings ISC-2 on Geotechnical and Geophysical Site Characterization*, Viana da Fonseca & Mayne (eds.), pp. 1575-1582, 2004.

[8] R.A. Failmezger, D. Rom and S.B. Ziegler, "SPT?– A better approach to site characterization of residual soils using other In-Situ tests," *Behavioral Characteristics of Residual Soils Geotechnical Special Publication No. 92*, Bill Edelen, editor, ASCE,1999, Reston, VA, pp. 1-14.

[9] D.H. Babbitt, and S.W. Verigin, "General Approach to Seismic Stability Analysis of Earth Embankment Dams," . Available: http://www.water.ca.gov/damsafety/docs/dhb_1996_paper.pdf

[10] P. Suwanwiwattana, K. Chantawarangul, W. Mairaing and P. Apaphant, "The Development of Geotechnical Database of Bangkok Subsoil Using GRASS-GIS," *22nd Asian Conference on Remote Sensing*, 2001.

[11] M. Shirato, K. Matsui, S. Nakatani and J. Fukui, "Soil Investigations and the Determination of Geotechnical Parameters for Highway Bridge Foundation Design in Japan," *Public Works Research Institute*, Tsukuba, Japan, Structural Design, 2000.

View publication stats