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The Zoning of Soil Strength Parameters in Rasht using Geographical Information System (GIS)

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ABSTRACT: Geotechnical studies constitute a key part of civil engineering projects that have economic and qualitative implications for the structure and its safety during both construction and operational phases. In addition to requiring time and expenses, borehole drilling, soil sampling, and geotechnical testing can at times lead to irreparable losses and damage, such as the explosion of gas pipes or the collapse of adjacent buildings. For typical buildings, such tests can be skipped with the help of geographical information system (GIS) analysis functions. In this study, the geographical coordinates about the location of previous geotechnical studies conducted during the construction of residential structures have been determined, to create an appropriate database and with the use of GIS interpolation functions, zoning maps are prepared and presented to offer a general visualization of the geotechnical status of the area. Therefore, in this study, the geotechnical data of 170 boreholes drilled in Rasht, including soil strength parameters for individual soil layers to a depth of 12 m from ground level were collected and implemented in GIS interpolation functions. Thus, raster layers were created and after selecting the best interpolation method, zoning maps for geotechnical parameters were plotted. Results showed that overall, more than 99% of the study area has an SPT number higher than 10 and an internal friction angle lower than 28 degrees. Qualitatively, aggregate soils in the study area were generally composed of medium sandy soils while most cohesive soils in the area fall in the category of stiff.

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1. INTRODUCTION

Geotechnical zoning maps are important tools in sustainable urban development. To reduce the costs associated with geotechnical studies and provide an appropriate estimate of soil strength, Al-Ani (2014) used GIS[1] interpolation functions to zone Australia's Surfers Paradise soil based on its SPT[2] [1]. Kadkhodazadeh and Rahnamarad (2015) prepared zoning maps for the shear strength of the Nehbandan city soil. Results showed that the internal friction angle of the city soil increases from south to north and the soils have low shear strength parameters [2]. Sharma and Shaffi (2016) used GIS to evaluate Guwahati city's soil. A database was prepared using the geotechnical data of the city's subsurface soil and the SPT number, shear wave velocity, and groundwater level of the city were zoned in the form of GIS-based maps for preliminary soil evaluation [3]. Razmyar and Ismaili (2017) carried out geotechnical zoning of the east and west of Tehran. In this study. Results showed that the soil type in these areas is coarse and the internal friction angle of the soil ranges between 30 and 37°. The coarse-grained soil of this region falls in the category of medium and dense soil [4]. In this research, zoning is carried out for the following soil parameters for the soil in the city of Rasht: SPT number, internal friction angle, shear wave velocity, liquid limit, and plastic limit. Maps are prepared for depths of 2, 4, 8, 10, and 12 m.

2. STUDY AREA

The city of Rasht is located at 49° 35′ 45″ L and 37° 16′ 30″ N of the Greenwich meridian and its area is about 10240 hectares.

3. METHOD

In this study, data has been collected from public and private companies, the Guilan Construction Engineering Organization, the country's geotechnical studies databank, the city's pipeline reports, available information from Rasht pumping station and municipal sewage construction as well as building construction projects.

In this study, the IDW method has been used. In the IDW[3] method, the values of unknown points are estimated by averaging the values of nearby known points. Each of the points in the calculation has a weight. The smaller the distance from the known point to the unknown point, the

1 Geographical Information System
2 Standard Penetration Test

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3 Inverse Distance Weighted

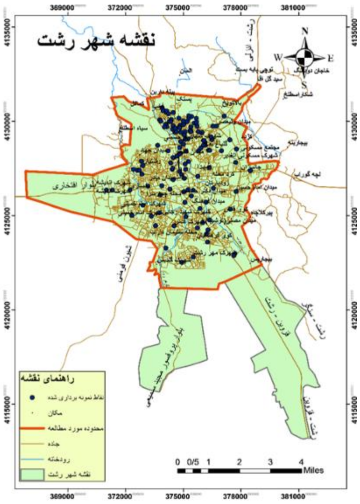

Fig. 1. Study area and location of samples

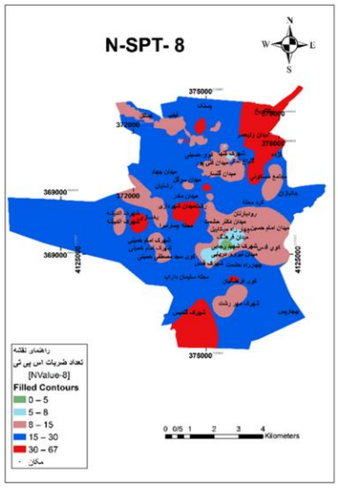

Fig. 2. Rasht SPT zoning map at a depth of 8 m

higher its weight value is, while on the other hand, the greater the distance, the smaller is the effect of this known point on the estimation and averaging of the unknown point. [5]. Fig. 1 shows the study area and the location of the sampling.

4. RESULTS AND DISCUSSION

The cross-validation method has been used to determine the best interpolation method. Figs. 2 and 3 present the SPT and the internal friction angle zoning maps of the soil at a depth of 8 m, respectively.

Table 1 shows the consistency of cohesive soils based on SPT number. According to Table 1, the cohesive soils of Rasht fall in the category of stiff and very stiff soils.

Table 2 presents the correlation between the relative density of coarse-grained soils and their friction angle with the SPT number. According to this Table, it can be concluded that the coarse-grained soil of Rasht is generally of medium sandy soil type. Also, fine-grained soils located in the northern, northwestern, and southern regions have a friction angle of less than 28° for clayey soils and an internal friction angle of 28 to 30° for silty soils.

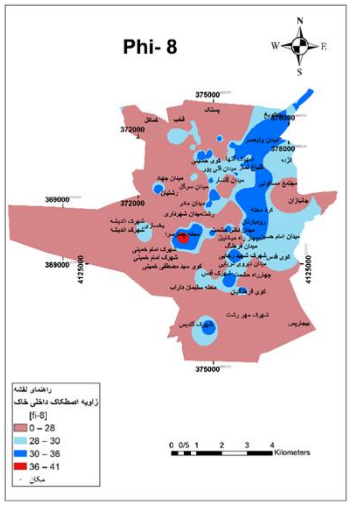

Fig. 3. Rasht internal friction angle zoning map at a depth of 8 m

5. CONCLUSION

According to the prepared zoning maps, the following conclusions are made.

1- More than 99% of the studied area had an SPT number higher than 8 and an internal friction angle lower than 28°.

2- Considering the range of numerical values for SPT and f soil parameters of Rasht, it can be said that the general grain-soil soils in terms of relative density in the category of medium sandy soils and generally sticky soils in terms of Stability is in the category of hard and very hard soils. Considering the range of SPT and friction angle values for Rasht soil, the coarse-grained soils fall in the category of

Table 1. Consistency of cohesive soils [6]

N	Consistency
0-2	Very soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very stiff
>30	Hard

Table 2. Relative density of coarse-grained soils [7]

Density	φ (°)	*Dr* (%)	*N*
Very loose	<28	0-15	0-5
Loose	28-30	15-35	5-10
Medium	30-36	35-65	10-30
Dense	36-41	65-85	30-50
Very dense	>41	>85	>50

medium sandy soils and cohesive soils fall in the category of stiff and very stiff soils.

3- The lowest SPT was observed in the north towards the center and part of the south of Rasht. The highest SPT was in the west and south of Rasht.

4- Gradually, with increasing depth, Rasht soil layers tend to be more fine-grained, so that at a depth of 10 m and beyond, most of the Rasht soil was clay and silt.

5- The surface soils of the samples can be categorized as CL-ML for fine-grained and SC-GC for coarse soils.

6- Since the shear wave velocity for more than 99% of the soil in the region falls between 175 to 375 m/s, it is classified in soil group type 3 [8].

REFERENCES

[1] H. Al-Ani, E. Oh, G. Chai, B.N. Al-Uzairy, GIS-interpolated geotechnical zonation maps in surfers paradise, Australia, in: 6th International Conference on Advanced Geographic Information Systems, Applications, and Services (GEO-Processing 2014), Spain, Barcelona, Citeseer, 2014, pp. 148.

[2] M.H. Kadkhodazade, J. Rahnamarad, The Zoning of Nehbandan soil shear strength parameters using GIS, Indian Journal of Fundamental and Applied Life Sciences, 5(S1), 2015, 2911-2915.

[3] B. Sharma, S.K Rahman, Use of GIS Based Maps for Preliminary Assessment of Subsoil of Guwahati City, Journal of Geoscience and Environment Protection, 4(05), 2016, 106-116.

[4] Razmyar, A. Eslami, Geotechnical characterization of soils in the eastern and western areas of Tehran, Engineering, Technology & Applied Science Research, 7(4), 2017, 1802-1810.

[5] S. Sanjari, ARC GIS Application Guide, Abed, Tehran, 2012.

[6] V. Murthy, Advanced Foundation Engineering, CBS Publishers & Distributors, 2007.

[7] B.M. Das, Principles of geotechnical engineering, PWS Publishing Company, 1990.

[8] Road, Housing and Urban Research Center, Building Design Regulations against Standard Earthquake 2800, Fourth edition.

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