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Geotechnical analysis and zoning in order to evaluate the allowed load capacity of Iranshahr city - East of Iran

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ABSTRACT

In this paper, the geotechnical analysis was used to zoning of Iranshahr city with an emphasis on the allowed load capacity of the foundation, based on information of 26 boreholes related to projects in the city, has been prepared. Accordingly, the mechanical properties of the soil, according to the results of direct shear tests, shear wave and SPT number are determined and then the bearing capacity for strip foundation with a width of 2 and 1 m and a depth of 5 / A and A is calculated and the bearing capacity map, Authorized. The map shows that in general, the allowable load capacity of the foundation in Iranshahr city, with the exception of the northern and southern parts of the city, is high.

1. Introduction

Geotechnical zoning maps are important and necessary factors for achieving sustainable urban development. Damage reduction in construction projects and events such as land subsidence, slope movements, etc. requires the preparation of accurate geotechnical zoning maps. By providing detailed information on the physical and mechanical characteristics of the bed, these maps, in addition to providing a kind of forecast for the conditions of different areas of the region, can also provide a perspective of potential points for the implementation of specific development projects. In fact, with the help of these maps, the conditions of various urban constructions in different places can be examined and the best form of urban development can be taken according to the conditions of soil layers. In the initial studies phase of designing a construction project, detailed information on soil type and strength, slope, topography, groundwater level, construction site, etc. is required, and the use of spatial information system in collecting this information and Finally, the preparation of zoning maps of resistance parameters for the simultaneous use of different data reduces the cost of studies. Various studies have been done so far on zoning methods, type of zoning maps, interpolation methods in geotechnical engineering and geology and the best method for interpolation in various subjects. For example, we can refer to the studies conducted in the country by Hafti Moqaddas and Ghazi (2013) in relation to geotechnical zoning and evaluation of authorized bearing capacity of Mashhad, Javan Doloui et

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al. (2009) Geological, geotechnical and geophysical features Toos fault in the north of Mashhad, Mohammadi et al. (2013) in connection with the preparation of engineering geotechnical and geotechnical map of Shahroud. Globally, studies have been conducted by Elmay et al. (2009) on the analysis of geotechnical and geological engineering data for urban development and planning.

2. Studied Case

Iranshahr city is geographically located at 60 degrees and 41 minutes east longitude and 27 degrees and 12 minutes north latitude and in the central part of Sistan and Baluchestan province in Iranshahr city. Iranshahr is bounded on the north by Zahedan, on the west by Bampur, on the east by Mags and on the south by Chabahar, and is bordered by Pakistan at the eastern end. Iranshahr city is located 333 km southwest of Zahedan and on the Zahedan-Chabahar port road, 571 meters above sea level. The Bampour River passes 4 km south of the city and flows into Hamoon Jazmourian after 130 km. According to the latest census (2016), the population of the city is 113750 people and with the growing population, attention to infrastructure and implementation of engineering projects is of great importance. Fig. 1 is provided information about the location of the study.

According to Stocklin and Nabavi (1973), the geology of Iran is divided into four zones: Zagros, Central Iran, Kopeh Dagh and Makran. The study area is located at the end of the sedimentary zone of eastern Iran and at the intersection with the Natanz-Bazman zone. This zone is bounded on the east by Afghanistan, on the west by the Nehbandan fault, and on the south by the Makran zone, which is bounded by the Bashagard fault. Upper Cretaceous facies of flysch type mixed with volcanic rocks and with weak metamorphism is observed. The stone units have been severely crushed under the stress of the Lut and Afghan Bloc. Old alluvial sediments include conglomerates that are otherwise located on green marls. Young sediments include river sediments and eruptions. The engineering geology of the region has been studied from 4 perspectives: lithology, geological morphology, geological water and morphology: - Petrology: Sediments including sand that are located on the sediments of the old conglomerate. The sediments are coarse-grained conglomerates and have calcareous interference and in some places are accompanied by gypsum and salt. In the western parts of Iranshahr, below the conglomerates, green Chile units are observed. Geological morphology: Drift faults and folds (inverted synclines) are observed in conglomerate sediments north of Iranshahr. The study area is covered with young river sediments. In the map of faults in Iran (Hesami et al., 2003), active faults of Nehbandan and Bashagard can be seen in the region. Saravan earthquakes with a magnitude of 8, Sarbaz 5.5 and Sarjangal 3 to 4.5 Richter have been reported in recent years in the study area. Geological water: Sedimentary units in the study area have high permeability. Groundwater level depends on the amount of annual rainfall and municipal sewage and has not been observed up to a depth of 10 meters. Morphology: This area is part of the alluvial fan area and plain margin. Basically, waterways are dendritic in shape and depend on the type and size of the grain. Fig. 2 is provided the geological map of the studied area.

3. Material and Methods

The main parameters for determining soil bearing capacity are adhesion (C) and internal friction angle (ϕ) of soil, which are performed by laboratory tests on intact specimens. Terzaghi (1967) proposed the ultimate bearing capacity q_f of surface foundations with depth D, width B and length L as follows:

$$q_u = CN_c + qN_q + 0.5BN_\gamma S_\gamma \quad (1)$$

$$\frac{D_f}{B} < 1 \quad (2)$$

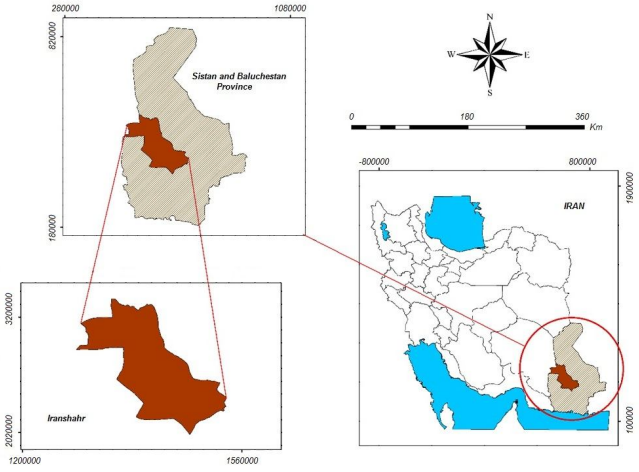

Figure 1. Location of the studied area

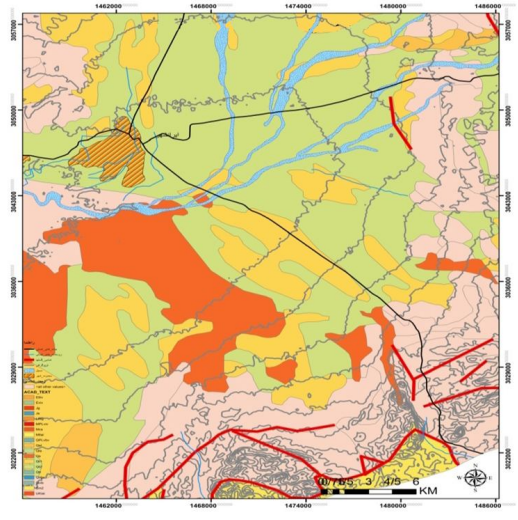

Figure 2. Geological map of the studied area

In order to prepare the zoning map of Iranshahr bearing capacity, the information of more than 65 exploratory boreholes dug in the city was examined and 26 boreholes with more accurate information were selected which is illustrated in Fig. 3. The values of adhesion and internal friction angle of the soil at a depth of 2 m, the results of direct shear tests, standard penetration results and shear wave were used to estimate the above parameters. Then, the bearing capacity in 26 points under the assumption of strip foundations with a width of 2 and a depth of 1.5 meters and a width of 1 and a depth of 1 meter has been determined. By obtaining the carrying capacity in 26 points of the city and with the help of the map, surface soil texture and Ladira classification, Table 1 of carrying capacity in the city of Iranshahr has been obtained. Tables 2 and 3 are showing the mechanical properties for different soils at the desired depth.

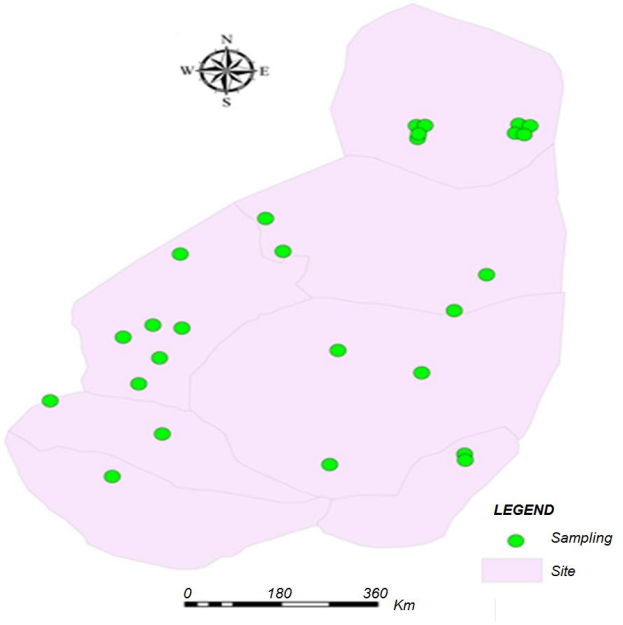

Figure 3. Location map of sampling in the study area

Table 1. Soil classification by bearing capacity (Ladira, 1994)

q_a (Kpa)	Class	Description
0 - 50	Infinitely low	Soft silty or silty clay organic soils
50 - 100	Very low	Silty or silty soft clay soils - clayey or loose sandy soils
100 - 200	Low	Clay-silty or silty clay soils with medium strength or sandy soils with medium density
200 - 300	Moderate	Hard soils and well-compacted sandy soils, well-compacted sands and gravels
300 - 500	High	Very hard soils and very dense sandy soils, very good dense sands and gravels
500 - 800	Very high	Extremely hardened soils and extremely dense sandy soils and gravels
800 <	Infinitely high	Extremely dense soft rocks and non-stick soils

Table 2. Physical and mechanical properties of soil types in Iranshahr with dimensions of 1 m at 1 m depth

USCS	C (kg/cm^2)	ϕ (°)	γ (g/cm^3)	SPT	q_{all} (kPa)
GW-GM	0.11	39	1.90	30 - 50	237
GP	0.09	48	1.90	30 - 50	306
GP-GM	0.12	49	1.95	30 - 50	365
GW	0.17	46	1.95	30 - 50	281
SM	0.08	48	2.00	30 - 50	274
SP	0.11	47	2.00	30 - 50	221
SP-SM	0.06	48	2.10	30 - 50	378

Table 3. Physical and mechanical properties of soil types in Iranshahr with dimensions of 2 m at 1.5 m depth

USCS	C (kg/cm^2)	ϕ (°)	γ (g/cm^3)	SPT	q_{all} (kPa)
GW-GM	0.11	39	1.90	30 - 50	403
GP	0.09	48	1.90	30 - 50	514
GP-GM	0.12	49	1.95	30 - 50	606
GW	0.17	46	1.95	30 - 50	471
SM	0.08	48	2.00	30 - 50	422
SP	0.11	47	2.00	30 - 50	377
SP-SM	0.06	48	2.10	30 - 50	554

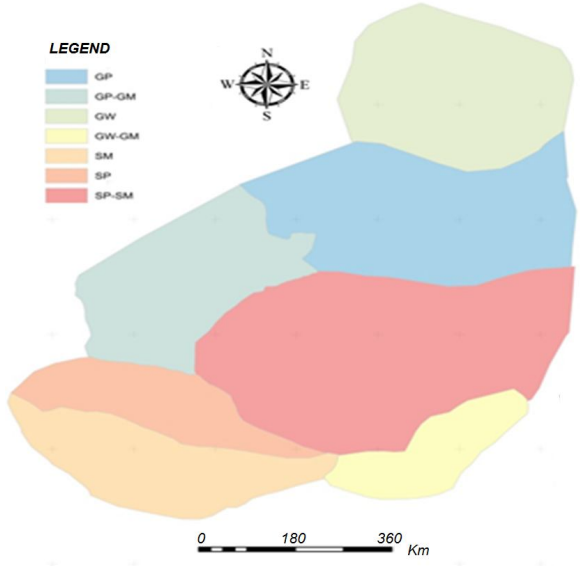

Figure 4. Soil type of the studied area

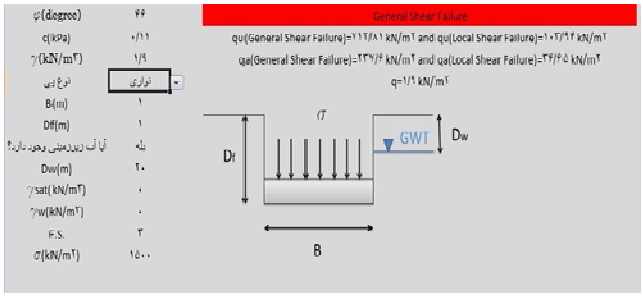

Figure 5. The example of q_u estimation for the foundations

4. Results and Discussions

Figs. 6 and 7 are providing the maps of the bearing capacity variation and geotechnical zonation for studied area. The maps indicated the map shows that in general, the allowable load capacity of the foundation in Iranshahr city, with the exception of the northern and southern parts of the city, is high. The accuracy of the present study is a function of the two parameters of degree of soil homogeneity and dispersion of boreholes used. Texture changes and soil resistance are relatively high in the north of the city, while the western, eastern and northern parts have more homogeneous conditions. It is observed that the data concentration is less around the north, northwest and west in the southern, southeast and east parts of the city. Due to the degree of soil homogeneity, the results of the study are less for the south, downtown, east, etc. The results and interpretation of bearing capacity were performed in Tables 4 and 5.

5. Conclusion

The results obtained from the analysis and geotechnical zoning in the study area, will have an overview of the implementation and forecasts required for ongoing and future projects. These studies were evaluated for Iranshahr region. Evaluation and classification of soil bearing capacity for two foundations with a width and depth of 1 meter and a width of 2 and a depth of 1.5 meters in Iranshahr city on average shows that the dimensions of the foundation with a width and depth of 1 meter in the north and south.

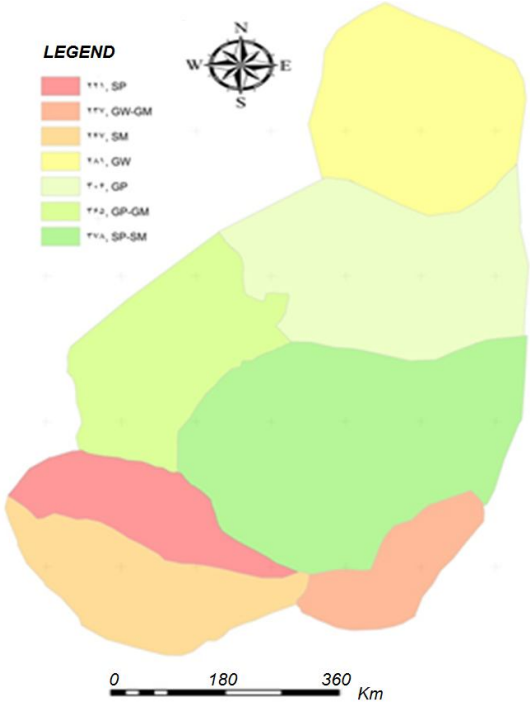

Figure 6. Map of allowed bearing capacity with 1 m dimensions at a 1 m depth

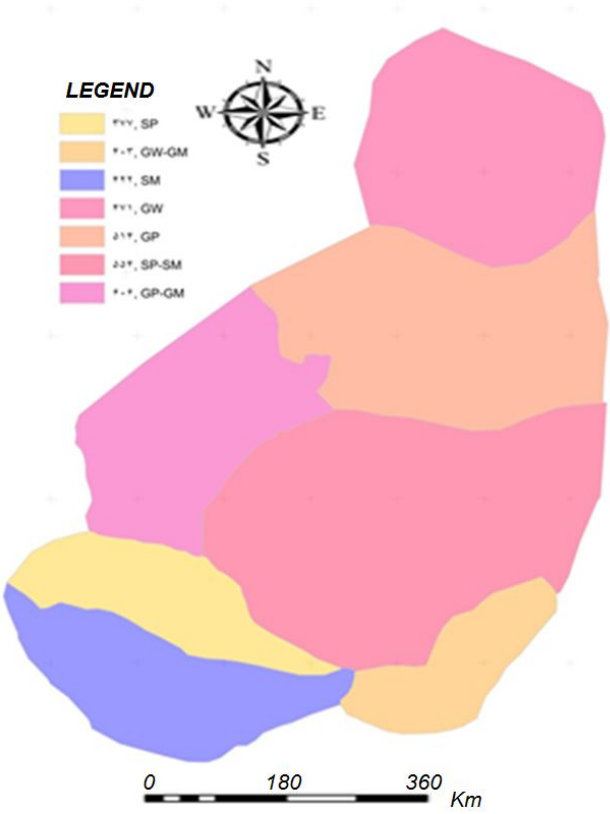

Figure 7. Map of allowed bearing capacity with 2 m dimensions at a 1.5 m depth

They are in the group of medium load capacity and in the eastern, central and northwestern regions are in the large group. In the next case, with a width of 2 and a depth of 1.5 meters, they are in a large and very large group in almost all areas. Due to more changes in soil texture in different parts, deeper and wider geotechnical operations should be performed in important projects.

Table 4. Description of soil by bearing capacity for foundations with 1 m dimensions at 1 m depth

No.	Soil type	q_{all} (allowed bearing)	Description
1	GW-GM	237	Moderate
2	GP	306	High
3	GW	365	High
4	GP-GM	365	Medium
5	GW	281	Medium
6	SM	274	Medium
7	SP	221	Medium
8	SP-SM	378	High

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Table 5. Description of soil by bearing capacity for foundations with 2 m dimensions at 1.5 m depth

No.	Soil type	q_{all} (allowed bearing)	Description
1	GW-GM	403	High
2	GP	514	Very High
3	GP-GM	606	Very High
4	GW	471	High
5	SM	422	High
6	SP	377	High
7	SP-SM	554	Very High

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