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Evaluation of Problematic Soil Behavior In Poldokhtar City

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ABSTRACT

Due to spreading the range of problematic soils and the necessity of implementing the development and civil projects in these location, the geotechnical investigation of these Kinds of Soils is quite necessary, because the lack of paying attention to these Soils cause extensive damages in the developmental and structures. Problematic Soil is a type of soils that in large construction projects cause a lot of engineering and technical problems such as cracking building, asymmetric settling of building, and vising the levels of underground waters which in low points and because of swelling the site can create main problems for the building foundations..One of the most important factors for having a stable and resistance building is the recognition and identification of the subsoilwhich the building is performe upon it. In this regard, recognizing and identifying the problematic soils seems important. In this paper, it has been tried to recognize and identify the problematic soils and then evaluation of problematic soil of the site of constructing Welfare Office of Poldokhtar City which is a represcntation of the lack of paying attention to the geotechnical considerations during construction.
KEYWORDS: problematic soils, Poldokhtar City, Asymmetric settling, Geotechnical investigation

1. INTRODUCTION

Soils make the surface cover of the earth and in fact are the first and most important port which are dealt with in an engineering project. Some of these kinds of soils are problematic in engineering project and in practice we may deal with some soils which making the foundations on them is associated with problems. Since the physical and mechanical properties of the soils are different from each other, it is necessary to do geotechnical investigation for identifying the soils. Identification of soils is considered as one of the early stages of constructions and also it is one of the most important and main stages of constructing buildings. In fact, sustainability and conservation a structure against natural and environmental factors is much dependent on the bed which the building is made on it. In this regard, the problematic soils are considered as the most important soils. Then, in this paper we will deal with the problematic soil of Poldokhtar City.

2. Problematic soils

Regarding the engineering field, the soil which is performed the structures upon it is associated with many problems, and also the effect of weather conditions on these soil makes changing their properties, are called the problematic soils. The problematic soils are in different species such as Dispersive soils, collapsing, Swelling, soluble, and Liquefiable soils.

3. Collapsible soils and the identification methods

Some kinds of soils are found in the nature which under the some strain and by increasing the content of moisture, their volumes decrease to a significant amount. Such soils are called Collapsible soils. Generally, it is possible to define collapsibility as the sudden fall of soil due to the loss of resistance the connecting factor of soil particles, some of the silty sediments formed under dry weather conditions, are located to a considerable reducing volume during saturating stage (wetting). These kinds of soils are sensitive to moisture and due to increasing the amount of moisture, their volume will reduce to a considerable level and then the collapsing mechanism begins. Therefore, penetrating the surface waters in the forms of irrigation, leaking form pipes, and rising the level of underground waters may cause a lot of settlings.
The main characteristics of collapsible soils are:
High porosity (more than 40%)
Low saturation (saturating percent is below 60%)

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The silt amount (ranging between30% to 90%)
The rapid softening water
The existence of collapsible soils has been reported in **5** continents of the world [1]. The necessity of studying the collapsible soils regarding the wide spreading of these soils and the need to design dams, and irrigation canals and other technical buildings in these areas and also due to developing urbanization and the necessity of extending large cities and constructing the residential areas and water and sewer pipes on these kind of soils is very important.

Shape 1. Collapsible soils

Damages caused by collapsibility of the structures which normally occur due to the flow of water and the saturation of subsoil, are generally detected as the settlement of subsoil and the chaotic cracking of concrete and hard coverings of the floor walls. The sudden and significant settlement on the floors of structures is considered as the aspects of possibility of the existence of collapsible soil in the bed.
The phenomenon of collapsibility occurs in soils with a specific particle size and in the certain density conditions. Therefore, its detection method is based on the evaluation of these two factors or doing the following tests:
A) Assessment of soil grading
B) Evaluation of soil compaction on the spot
And in order to determine the potential of soil collapsibility, the test of determining the capability of soil collapsibility (ASTM-D5333) is also used (Table 1) [2]. The foundation of this test is based on the consolidation test.
Jennings and Knight(1975) completed and applied the Multiple Cosolidation Test for the quantative assessment of collapsibility potential (Table 2) [2].
The models defined by Holtz and Hylf which are based on the psychological limit, porosity,and dry specific gravity of soil are also used for this purpose in this study.

Table 1. The classification of collapsibility indicator

Collapsibility Indicator	Collapsibility Intensity
0	No problem
0.1-2	Rather problematic
2.1-6	Average difficulty
6.1-10	Rather high
>10	High

Table 2. The Indicator of Collapsibility Definition

Collapsibility Indicator	Problem Intensity
0-1	No problem
1-5	Rather problematic
5-10	Average difficulty
10-20	Rather high
>20	High

The extreme sensitivity of these soils to the increasement of moisture and pressure causes detecting them in the tests such as Consolidation Test will be done easity and rapidly. Also, in the wilderness weather conditions, if the flooding of the earths surface causes significant soil settlement then it will be considered as an indication of the possibility of the existence of collapsible soils overthere.

4- Swelling soils and identification methods

The soil swelling means the swelling due to the water absorption.Swelling caused by the reduction of effective strain such as unloading or rising the levels of underground waters or swelling caused by the crystallization of salt crystals and etc.

Are considered as the other independent phenomena.Swelling soils are kind of soils which due to increasing moisture content, their volumes also change significantly.

Pressure Caused by the swelling of soils can cause complete destruction of light buildings and irrigation canals and floorings and etc.

In fact, these kind of soils act in the strongly opposite direction with the consolidation act.

It means, instead of water loss and volume reduction, they absorb water and their volumes also will be increased.

The best definition swelling is mentioned as the physical and chemical reaction between soil and environment which its content depends on the severity of physical and chemical repulsion and attraction forces.

The phenomenon of swelling is a reversible phenomenon, which means after the loss of moisture, the soil will be condensed.

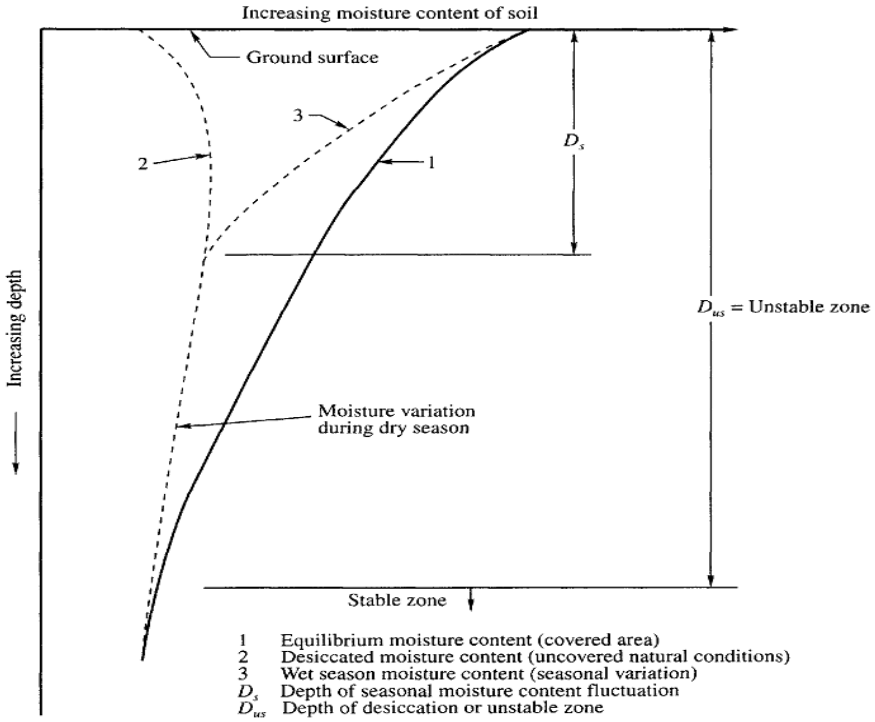

Figure 2. The changes of the moisture content in depth of a swelling soil

Swelling soils are sitty sedimentaries resulting from weathering of rocks.The content of swelling is also subordinate to the kind of clay minerals and the molecular bond between them. Currently Montmorillonite clay minerals have been known as the most swelling kind of clay minerals compared to Illite and Kaolinite clay minerals and etc.

In some areas the depth of these soils may be greater than b meter. Figure2[3]. The levels of underground waters in these areas is usually very low and for this reason, these soils are only wet in rainy seasons and are semi-saturated in dry seasons. In this way, these kind of soils experience will contract swell through the weather.

The accurate and efficient identification method of swelling soils is based on the laboratory tests. However, some wilderness observations may be efficient in the early and rapid detection of these soils.

Generally, cach kind of soil which shows the signs of compression and cracking from itself in dry conditions, has the capability of swelling due to absorbing water. The identification of swelling soils is mainly done in two direct and indirect methods. In the direct methods, measuring the swelling content in the laboratory is performed by using consolidation device and in the indirect method, soil swelling will be studied through empirical relationships and the other soil properties.

Also if the clay minerals have been swelled or have the capability of swelling, they may be identifiable by a series of wilderness observations.

-Topography: In terms of topography, the areas with swelling soils sometimes have "Gylgay" buildings and structures. Gylgay building is defined as the specific from of rising and dipping on the surface of swelling clays which are exposed to weathering in relatively dry weather conditions.

-Specific density and harness of soil**:** Hardness of these soils in dry conditions is very high and therefore, specific dry density of soil isn't considered as an important factor in identifying swelling soils. If the soil is porous and hollow and on the other hand, if we grind the soil and measure its swelling content in the laboratory, it may be amortized due to high porosity on the spot.

-Soil color**:** swelling soils have been observed in a variety of colors. Soil color is partly influenced by the degree of weathering. The most important and visible characteristics of these soils is that regardless of their color, when they are cut with a mechanical shovel, they will be seemed shiny.

Underground water depth**:** In areas where the swelling soil is problematic, the levels of underground waters may be low. The soil which shows high swelling capability from itself, should be above the underground levels in normal state and its natural moisture should be also low to provide the possibility of high moisture absorption and swelling due to raining.

-Cracking earth**:** The soils which crack on the spot due to drying, contain a large percentage of swelling clay.

-Type of failure of the existing buildings**:** The failures and damages due to the swelling were caused under light loads such as foundations and the walls of one or two –story buildings, highways, canals and linings of the reservoirs and retaning walls.

5- Dispersive soils and identification methods

Dispersive soils are clay soils which easily can be washed in waters with low concentration of salt and lose their adhesion.

These clays usually contain large amounts of sodium in their absorbing cations.

Dispersive is a phenomenon which starts from a point of focusing on the water flow and gradually spreads.

The starting point of divergence phenomenon can be the cracks of contract and settlement or the cracks resulting from the roots. This phenomenon is very important in some projects such as dams and water channels which focus on water pressure in the soil and create some problems in the levels, in the walls of earthen channels, and in dams which are irreversible.

Divergence phenomenon is a physical and chemical phenomenon and it should not be confused with Regab process which is a completely physical phenomenon and occurs due to the drenching of silty soil particles [4].

Figure 3. developing of dispersively in soil

Dispersive soils are clay soils and the least clay content of them is 10 percent.

These soils in the engineering classification and according to the unified method are classified in to CL and groups.

In the areas where the ground has a relatively violent steep, the identification of Dispersive soils is very easy. Due to rainfall and rapid erosion in these areas, very deep and significant cuts are created which will be considered as the main characteristics of these kind of soils.but Dispersive soils Cannot be easily identified in flat areas,because when the rains wash the particles of Dispersive clay,a layer of sitty sand or sandy silt remains on the ground as a protective coating and covers the deep layers and in fact,the main feature which is erosion and water deep cuts cannot be seen in this case and therefore, here Dispersive soil is not detectable.

Dispersive soils have been observed in the colors of red, brown, yellow, gray, or a combination of these colors. Full identification of Dispersive soils in the deserts is subject to specific examinations and experiments.

Since divergence is a physiochemical phenomenon, therefore the diagnosis of Dispersive soils according to the results of classification, grading, and Atterberg limits is impossible and so here the specific checks and experiments should be used.

The specific experiments of identifying the Dispersive soils are:

- pinhole test
- Chemical test (determination the soluble salts in the soil)
- Double hydrometric test
- Krumb test
-Liquefiablesoils

6-Liquefiable soils and identification methods

If non-cohesive soils become saturated and loose or exposed to the trembling(vibration) of the earth as a result of earthquakes, the soils tend to be compacted , but within a particular grading along with draining, it is some what slow so that the rapid volume changes of soil do not occur due to the lack of drainage and will necessarily the pressure amount be rised.

Increasing the pressure of ditch water makes the reduction of effective strain which results in a reduction of shear strength.

Based on the relationship between geostatical strains in the soil, $\sigma'=\sigma-u$ increasing the perforated pressure amount may reduce the effective strains in soil which leads the shear strength amount being low or even zero and therefore, the fluid state of soil is so-called defined as smoothiness [5].

The Liquefaction phenomenon impacts on the buildings, bridges, and specially on buried structures and the other engineering projects and facilities in different ways.

The Liquefaction also effects the movement of the earth's surface and displacements.

The situations and conditions where the occurrence of smoothiness will be possible are**:**

Loose sandy and semi-compact soils

Mixed sand and gravel soils, loose or semi-compact sandy soils

Loose to half old silty sandy soils

The level of underground waters should be lower than 3 to 6 meter in the above circumstances.

If the soil and environmental conditions of considered area is in accordance with one of the above conditions, the geotechnical engineer must take the necessary regards and measures into consideration in the field of safety design.

7- Soluble soils and identification methods

Soluble materials such as salt and plaster cause these mentioned minerals dissolve in the water and some of the solid particles in the soil escapes through dissolving due to the contant of these soils with water.

If this phenomenon occurs frequently, it can increase soil porosity and makes the soil being hollow and finally by creating significant settlements can destroy the structures of soil and makes the soil to be collapsed.

Another problem is that the dissolution and removal of the solid plaster particles will replace it with water particles and consequently increases soil moisture which this condition will also reduce the shear strength of soil These kind of soils may have good mechanical properties and resistance under normal dry conditions so that using of these soils in the developmental projects will be considered suitable, but most of the saline soils often in dealing with moisture due being hydrophilic have less sever resistance t of the saline soils often in dealing with moisture due being hydrophilic have less sever resistance than regular clay soils and even in dealing with very small loads, they will be collapsed.

Therefore, the impedence of these soils in dry conditions is not ensured The effects of damages caused by drenching plaster or other soluble materials of soil can be summarized as the creating cavities or setting the soil bed and consequently as destroying the bed cover and as the creating cracks and collapsing the structures [3].

Generally, the plaster appears in the form of hydro calcium sulfate and in different crystal forms in the soils and as mentioned earlier, its content in gypsum soil may exceed than about less than 5% to more than 50% of soil weight.

The diagnosis method of soil gypsum in the desert is through identifying white crystalline granules or crystals in the soil and by their closer examination through using magnifier, Sometimes the white granules in the soil may be calcic and may be confused with gypsum particles which in this case, lime particles can easily be detected by using a diluted hydrochloric acid solution.

The exact diagnosis of gypsum and its content in the laboratory is done by using precise microscopes and chemical analysis methods of soil.

In general, the content of gypsum in different ways will be determined as follows:

-Determining the content of gypsum based on the measurement of Cattions.

- Determining the content of gypsum based on the measurement of SOions.

- Determining the content of gypsum based on the reduction of crystallized water which can be caused by heating or infrared radiation.

-Acetonic method or determining the content of gypsum based on the electrical conductivity.

-The methods which are based on complete washing gypsum in the soil.

As a whole, Acetonic method despite having a lot of problems and defects.

due to being prevalent in most of the country's laboratory is currently used for determining the content of gypsum.

8- The sample study of soil structure in Poldokhtar City

Poldokhtar City is one of the cilies in Lorestan Province which is located in the south of this province. This city has a mild climate in winter and hot in summer.

The center of this city is Poldokhtar. Poldokhtar is located about 100 km southwest of Khoramabad. Geographically, the center of Poldokhtar city is located in 47 degrees and 42 minutes from the eastern part and in 33 degrees and 9 minutes from the northern width and in the height of 660 meters above the sea level.

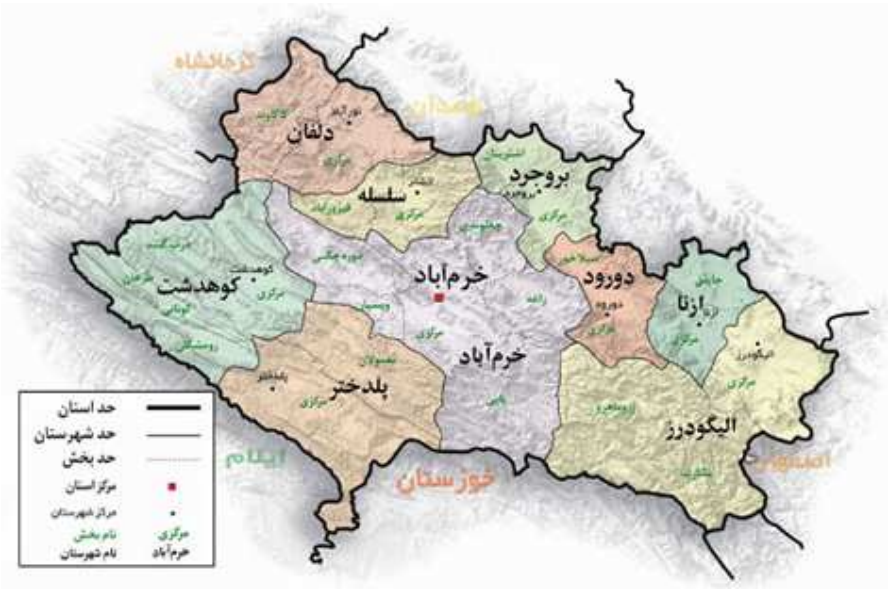

Figure 4. The geographical location of Poldokhtar City

Most of human structures are made on soil, in soil, or by using soil.

With decreasing the availability of suitable sites for construction and also in recent years due to the population growth and increasing demands for housing and developing the industry of construction and making buildings and regarding the constructions in large cities, the necessity of establishing the foundations on weak or

problematic soils and also constructing various technical buildings without regarding the geolocial and geotechnical matters has been considered very important

In addition, the need for rehabilitation, stabilization and improvement of the soil of the existing structures in order to provide the needed stability and strength against their adjacent drillings, constructing the inside or outside tunnels of the city, increasing the resistance against earthquakes and the other special loadings have been considered very important nowadays.

Although the use of shallow,medium depth and deep foundations is preferred for constructing the foundating system on unsuitsble lands in the relatively important and large projects, but it is consideredas a costly, time-consuming and with implementation problems project.

Constructing welfare Office of Poldokhtar city in Pasdaran Mountain region is considered as ono of the aspects of lacking attention to geotechnical studies in the region .since the beginning of implementing the project, no soil mechanical examination for measuring soil resistance of the region had been done.

After two years of operating this building and after creating deep fissures and settling the soil of the building, the soil Mechanics Laboratory of the province examined the experimental studies of the soil of region.

The results of drilling in different parts of the building and national researches show that the location of this project was foothills previously which in recent years and gradually due to achieving a smooth surface at various points and at different depths, they have been filled by soil and without the need to be compacted and also regarding the location of project on the slope of the hill, the risk of slipping and soil drifting downwords especially in the rainy seasons is probable.

Figure 5. The welfare Office of Poldokhtar City

Figure 6. settling the welfare Office of Poldokhtar City

According to the studies conducted and drilled boreholes in the region and also regarding the general characteristics, the natural and laboratory features of the project location soil showed that to the depth of 4 meters, the soil was in the form of clay and had low pasty properties and form the depth of 4 meters to the end of the depth of 10 meters, the silt was along with sand (sandstorm) and the studied soil would find the characteristics of collapsible soil.
Since the drillings did not deal with underground waters, the waters from the rainfalls, running waters and rainwater, could be effective in the collapsibility of soil location.
In order to determine the collapsibility potential, the multiple consolidating test was done on the three intact samples of soil which.
Table 3,4,5 shows the results of the tests done on three different boreholes in Pasdaran Mountain Region in the site of constructing the welfare Office of Poldokhtar City.

Table 3. The results of the carried out tests on the site of Poldokhtar city

V	Φu	Cu	S.P.T	PI	LL	ω(%)	Soil Quality	Borehole Depth	Borehole Number
0.3	2	0.4	27	G	30	22.2	CL	0-4	1
0.28	0	0.4	22	10	30	22.5	CL	0-4	2
0.3	1	0.4	22	15	30	23	CL	0-4	3

Table 4. The results of the carried out tests on the site of Poldokhtar City

Cp	e_{max}	e_{min}	e_0	γd(kg/cm³)	γ(kg/cm³)	Es(kg/cm²)	Soil Quality	Borehole Depth	Borehole Number
>10	0.72	0.42	0.93	1.5	1.85	100	CL	0-4	1
>10	0.78	0.44	0.98	1.55	1.89	100	CL	0-4	2
>10	0.76	0.51	0.84	1.51	1.86	100	CL	0-4	3

Table 5. The results of the carried out tests on the site of Poldokhtar City

γ(kg/cm³)	Es(kg/cm²)	V	Φ	C	S.P.T	PI	LL	ω(%)	Soil Quality	Borehole Depth	Borehole Number
1.66	100	0.3	23	0.03	31	NP	Undefinable	-	ML	4.5-10	1
1.58	100	0.28	22.3	0.028	31	NP	Undifin Able	-	ML	4.5-10	2
1.63	100	0.3	23	0.032	37	NP	Undifinable	-	ML	4.5-10	3

The presented parameters in Table 1 are**:**
ω**:** The initial moisture content
e_0**:** The initial porosity content
$e_{max(1)}$: The ratio of porosity before saturating
$e_{min(2)}$**:** The ratio of porosity after saturating
γ **:** The natural special density of soil
γd**:** The net special density of soil
Φ**:** The angle of internal friction
E**:** Elasticity Models
ν**:** Poisson's ratio
Cp**:** Collapsibility potention

$$Cp = \Delta\varepsilon = \frac{e1 - e2}{1 + e0} \quad (1)$$

According to the data presented in the Tables 1,2,3,4 and **5** (Jenning and Knight Criterion and ASTM) and based on calculations using equation [6]which were done on the three intact samples of soil having natural moisture, it can be concluded that the studied soil will be placed in the group of soils with high collapsibility potential [7].

Thus, based on the conducted studies, it can be concluded that the collapsibility potential of soil in Poldokhtar City is high.

The collapsibility phenomenon has left a lot of damage and cracks and settlement in in the residential buildings adjacent to the structure. Considering the problems occurred in the region and also according to the soil collapsibility and due to the fact that there has been no improvement in this region, the need to improve the soil for constructing the buildings in the future will be considered very necessary.

The proposed rehabilitation can be done in the form of improving the soil by lime and in places where the depth of the problematic soil is very much, the economic conditions and the importance of the project, Micro pile method will be used for retrofitting the buildings and consequently for reducing the created cracks.

9- Conclusion

Nowadays, with increasing human and increasing the development of constructions, identifying the soil of construction becomes more important than ever [8], because when there is problematic soils and when the employers and design engineers don't pay much attention to these soils, they will deal with serious damages in the building.

Therefore, it is necessary to carry out geotechnical study required in the design areas and the soil of location should be studied in terms of geotechnical points and in order to deal with the possible hazards of these soils.

The appropriate arrangements should be considered.

The problematic soil of Poldokhtar City is a representation of neglect during implementing the project which through the early geotechnical studies and appropriate rehabilitating methods, the structure which is likely to cost a lot of money during construction could be operational.

Considering the abundant problems occurred in the region and due to the soil collapsibility and the fact that there has been no rehabilitation in the area, the necessity of improving the soil of location for constructing the buildings in the future has been considered very important.

The proposed improvement and rehabilitation can be done in the form of improving the soil by lime and in places where the depth of the problematic soil is very much, the deep improvements and rehabilitation will be done by lime or cement and considering the economic conditions and the importance of the project, Micropyle method will be used for retrofitting the buildings and consequently for reducing the cracks.

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