Road Construction on Sabkha Soils

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ABSTRACT. *Sabkha is an Arabic expression to describe recent coastal sediments with a high salt content and are characterized by very low bearing capacities and a relatively hard crusty surface which is strong when dry and looses its strength upon wetting. It forms heterogeneous and complex soil profiles with poor mechanical properties and appreciable organic. This type of problematic soil causes some engineering problems like differential settlement and failures under loads. The aim of the paper is study and evaluate the Sabkha soil problems, which exist in the East and South - East of Misurata city, where the infrastructure of Misurata Free Zone will be constructed. This paper propose one of the most economical solution for improvement and stabilization of Sabkha soil to increase the bearing capacity for construction roads to connect the projects on this area with the city centre and other villages.*

KEY WORDS: *Sabkha, problematic soil, bearing capacity, Road engineers, soil stabilization*

1. Introduction

Sabkha soils are not only found in the Middle East but are also widely distributed over the world, like in India, Australia, USA and Southern Africa, where Sabkha soils have different expressions. Sabkha is composed of sand deposits mixed with silt and clay. Two types of Sabkha are present in Libya, the first one is the coastal or muddy Sabkhas, which is found along the Mediterranean Sea, and the second type is inland or Sandy Sabkhas, which is located in the southern part of the country. Clearly, the muddy Sabkhas are the worst to construct roads on it. The main geotechnical hazards include settlement, corrosive action, heave due to salt crystallization / recrystallization and flooding due to the low infiltration rates. However, the Sabkha is a hydrological regime resulted from the upward movement of groundwater. The Sabkha soil varies with depth as deep, medium deep and shallow, therefore, it is important to search for proper technique to stabilize and improve the Sabkha properties. The Sabkha contains huge quantity of salt, which make it very weak and high disintegration, also the Sabkha is low ventilation and degree of reaction, for this soil will be alkalosis with pH ranges between 8 – 9.5. These salts concentrate in soil layers and sometimes exist on the surface of the ground as white salt shell. The defect of Sabkha soil is weakness in their bearing capacity, but their upper surface becomes cohesive in some seasons of year and this surface will change to weak surface when filled with water and it is impossible to walk on it. Several buildings constructed on Sabkha soils showed tilting and cracks. The causes of this problem was related to the special characteristics of Sabkha soils.

2. Problems of Sabkha

Several papers have been published about the Sabkha characteristics, which classified Sabkha soil as Muddy Sabkha areas along the sea and Sandy Sabkha areas Inland. The location of the roads is in the Tawarghah Sabkha reached 19 km south of Qasr Ahmed port, where the flat and generally coastline with sandy beaches. Table 1 shows the chemical composition of Sabkha soil in Libya, and the photos in figure 1 show the state of Sabkha soil ..

The Sabkha soil in Misurata city contains 28 % clay, 52 % silt and only about 20 % fine and medium sand as shown in table 2. The Sabkha soil contains an important quantity of dissolved salts as Na CL, (Na) SO4, Na CO4, Na HCO3, Ca (CL)2, Ca (CO4)2, Mg (CL)2, Mg SO4. Road engineers often face the challenge to design a solid road foundation on top of very soft soils, which are characterized by Sabkha soils, with the help of geosynthetics innovative solutions can be offered to several situations. The geotechnical problems caused by Sabkha are now well defined and although several standard soil improvement techniques are still extensively used, more economical and long-lasting soil improvement methods are playing an increasing role in foundation work of roads and highways.

Chemical Composition	Layer	
	Shallow Layer	Deep Layer
Loss on ignition	21.68 %	25.22 %
SiO_2	25.24 %	14.10 %
CaO	10.07 %	26.20 %
Mgo	8.15 %	7.26 %
Nacl	2.60 %	0.70 %
SO_4	28.05 %	28.29 %
Fe_2O_3	1.20 %	0.34 %

Table 1. *Chemical Composition of Sabkha Soil in Libya*

3. Treatment methods

Problems in the design of roads in the arid or semi-arid countries of North Africa are attributed to the detrimental effects of the environment on the bearing capacity of the soil, especially in Sabkha area. Therefore, before building infrastructure on Sabkha soils, an improvement or a stabilization method has to be done to improve the bearing capacity of the soils. In Libya the name of Sabkha is mentioned to describe the salt ground on the sea shore or far from it and it exist in the low lands, where, the ground of Sabkha is classified as desert, which used for construction of roads and building since few years, because of big increasing of population.

Figure 1. *State of Sabkha soil (South East of Misurata city)*

Description	Values %
Clay	28
Silt	52
Sand (fine and medium)	20
Liquid limit	35
Plastic limit	13
Plasticity index	22
Specific gravity	2.81
Visual description	Light brown
Soil classification USC system AASHTTO system	 A-6 CL

Table 2. *The physical properties of Sabkha soil in western region in Libya*

Despite the extensive distribution of Sabkha soil in Libya, Particularly along the coastal areas, there are a little attention from the geotechnical community to improve their properties. One of the most economical soil improvement method is the use of geosynthetics, which used as a reinforcement or as a separators, also may be used in combinations with other foundation technologies.

The soils of this area are generally found between +1.0 m and -2.0 m relatively to present sea level, which known as Muddy Sabkhas. In Arabic countries, there are some previous work carried out to improve the geotechnical properties of Sabkha soils, where, several methods for treatment and stabilization of Sabkha soil was used as:

- Cut and filling the Sabkha soils with different stone grading from large diameters down to smaller ones, till the required bearing capacity is reached.
- Pre-loading with an embankment to increase the consolidation of the natural soil.
- Installing chemical additives.
- Mechanical soil improvement techniques like vibroflotation, heavy tamping related methods, sand columns and piling.
- Geosynthetics.

4. Cut and Fill method

In this case the proposal of cut and filling method is preferred for Sabkha treatment to construct roads, where cut and filling used as reinforcement to increase the bearing capacity of soil. This method is used by excavation of weak layer of soil, which are known as salt layer, then filling the Sabkha soils with different stone grading, like igneous rocks ranging from large diameters of 20 cm approximately down to smaller ones of about 5 cm, to reduce water pressure until canceling the effect of settlement because rock fragments are incorporated in weak soil by compaction operations. Then layers of subbase compacted upon the stones, where the backfilling by layers of sand soil will be layered on the subbase, finally, the pavement layers of base coarse, binder and covering asphalt will construct as shown in figure 2.

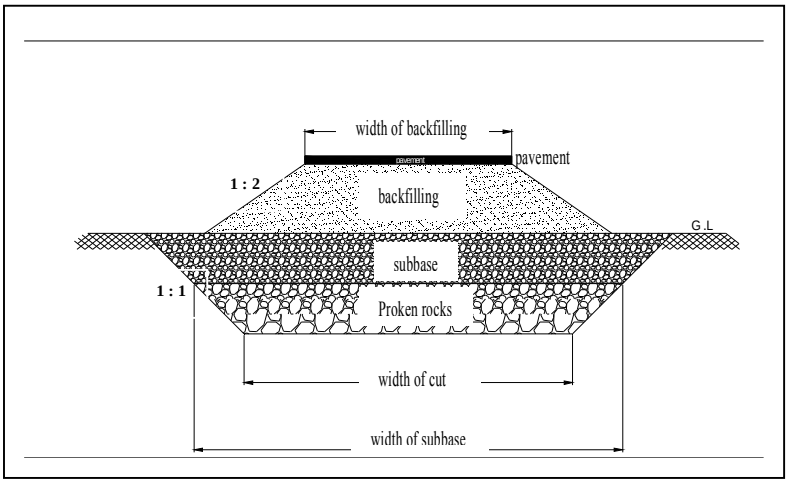

Figure 2. *Schematic diagram for cut and fill method*

Based on the axle loading and the traffic intensity, a rough indication can be made which treatment and stabilization system can be selected to build on Sabkha soil. The axle loading is based on the maximum axle load of a vehicle, either truck or a car. Till now, a final design code for treatment and stabilization methods in roads has not been established.

5. Conclusion

The application and use of cut and filling method for filtration of water and reinforcement to increase the bearing capacity of Sabkha soil in Misurata city is economical and more useful than other methods.

It is recommended more study for Sabkha soil stabilization to get more information and make comparison between different stabilization methods.

6. Bibliography

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