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Stabilization of Expansive Soil from Adam

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Abstract

Expansive soils cause considerable damages to the structures worldwide. Structural damages cost associated with expansive behavior estimated to run into several billion dollars annually. Oman is one of the countries that face the problem of expansive soil in different locations. This research investigates an expansive soil from Adam, Al-Dakhiliya, Oman, that caused many damages on existing buildings and asphalt pavements. The study describes the characterization of soil from the site and investigates the possibility of stabilizing the soil using chemical additives.

Adam soil was subjected to an extensive laboratory testing program including: wet sieve analysis, hydrometer, Atterberg limits, specific gravity, salinity, PH, compaction, swelling percent, swelling pressure, free swell index, soil suction, chemical analysis, X-ray fluorescence (XRF), X-ray diffraction (XRD) and scanning electron microscope (SEM). It was found that around 59% of the sample particles are fines (silt and clay) with the amount of clay of more than 25%. The specific gravity was determined to be 2.72. Moreover, Adam soil was classified as highly plasticity clay with 82% liquid limit, 36 % plastic limit and 46% plasticity index. Shrinkage percent was found to be 12%. Compacted Adam soil exhibits high swelling potential which exceeded 11% and swelling pressure of about 92 kPa. The suction of Adam soil at the optimum water content was found to be 1600 kPa and 3000 kPa using filter paper method and WP4 method, respectively. The studied soil was highly saline with salinity nearby 14 dS/m. Adam soil contains a high percentage of SiO_2, Al_2O_3, CaO and Fe_2O_3. These results were confirmed by XRF and SEM techniques.

Adam soil was stabilized using Cement-By-Pass-Dust (CBPD) with amounts of 6, 9, 15, 20 and 30% of dry weight of soil. Treated soil was subjected to comprehensive testing program. The Atterberg limits were determined for all stabilized samples. It was found that the plasticity index and shrinkage percent decreased as the amount of CBPD increased. Also, from compaction test, it was found that there is a decrease in the dry unit weight of the soil and an increase in optimum water content as the percentage of CBPD increased. The swelling potential (swelling percent and swelling pressure) decreased as the amount of CBPD increased compared with untreated soil. For 20%CBPD, the swelling percent was 3.43% and the swelling pressure was 28 kPa. Both total and matric suction decreased to less than 100 kPa when the CBPD content was 20%. The optimum content of CBPD is 20%. The methods used in measuring soil suction were filter paper and WP4 methods were compared and studied. The two methods showed similarity in measuring total suction.

In addition, a relationship between swelling, suction properties and soil properties were developed and studied. An attempt was made to correlate swelling properties of expansive soils with their suction properties. A multiple regression analysis was applied to correlate soil suction

to CBPD% and water content. Also, correlations were proposed between swelling percent, CBPD% and seating load.