Abstract

Since the handover in 1999, Macau is experiencing the fastest development in her history. Construction of residential and commercial buildings, infrastructure development and casinos are throughout Macau. Having a total area of only 29.2 km^2 with a population of more than half a million, reclamation of land from the sea plays an important role in the sustainable development of the city. Characterization of marine deposits is one of the most important subjects among local geotechnical engineering. Yet, fundamental understanding of the material is not adequate despite having numerous construction projects in recent years. Therefore, a systematic study of the local material necessitated providing a comprehensive data set and improving the current understanding.

In this study, a site investigation was carried out at an onshore site located along the northern of Taipa. The investigation included boring of 100 mm diameter soft marine deposits samples in 3 boreholes (BH-1 to BH-3) and in situ vane shear tests at different depths. The samples were then taken to the university laboratory for further characterization study, including X-ray diffraction, SEM, organic content, pH-value and basic geotechnical indices, and a systematic series of oedometer and triaxial tests.

Two layers of different color are identified. Upper layer is characterized by yellow color while lower layer soil shows dark grey color.

The soil contains 1% gravel, 8% sand, 32% silt and 58% clay in average. Atterberg limits tests show the liquid limits range between 36.7 and 63.57 for upper layer Macau marine deposits (UMMD), but range between 41.67 and 45.78 for low layer Macau marine deposits (LMMD), except for sample from depth 11.16 m. Plastic limits range between 25 and 36 for UMMD, and range between 22 and 26 for LMMD. Organic content is 2.2%. pH value is range between 7.3 and 7.4. The X-ray diffraction test manifest that the major clay minerals are kaolinite, illite, mica and chlorite. It seems quartz is the major non-clay minerals. The SEM analysis shows there are primary face to face contact.

Based on oedometer test results, it is found that the values of coefficient of consolidation (c_v) in the OC stage are larger than that in the NC stage and a little increase with vertical loading stress after which is larger than the pre-consolidation pressure. They vary in the range 2.8 to 3.5 m^2/yr in the NC stage for UMMD. They vary in the range 2.8 to 3.2 m^2/yr in the NC stage for lower LMMD. The corresponding values of coefficient of permeability decrease with vertical effective stress vary between 0.001 m/yr and 0.16 m/yr in the NC stage for UMMD, 0.005 m/yr and 0.05 m/yr in the NC stage for LMMD. The C_c and C_r values are about 0.32 and 0.021 for UMMD, 0.33 and 0.067 for LMMD respectively.

The critical stress ratio for triaxial compression is about 1.2. The specimens show hardening behavior. Unique critical state line (CSL) can be defined for UMMD and LMMD apparently different respectively in an $e - \ln p'$ space.

The marine soil resembles typical soft soil behavior upon plastic loading except that a relatively high K_o value is attained. The coefficient of earth pressure at rest (K_o) of the soil was evaluated by performing K_o-compression tests in a feed-back controlled triaxial testing machine. The results are compared to other marine soils in the region as well as limited available data in Macau. Conventional empirical relations for K_o of clays are found to be inappropriate for the Macau soils.