

Sensitivity and physico-chemical properties of Mexico City clay

メキシコシティ粘土の鋭敏性と物理・化学的性質

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Introduction

The Sensitivity of clay defined as the ratio of undisturbed to remolded strength represents the degree of structure based on the characteristics of the clay before and after disturbance. Mexico City (MC) clay has been studied by several researchers (Diaz-Rodriguez et al., 1998), but the sensitivity of MC clay has not been discussed in detail yet. This paper describes the sensitivity and physico-chemical properties of MC clay.

Materials and Methods

Borehole samples collected from Texcoco, Mexico City were used for the experiments. Organic matter was measured by Tyurine method. Carbonate content was measured by the method proposed by Wada (1997). In grain size analysis, carbonate was dissolved by sodium acetate of pH 5 for dispersion. The undisturbed shear strength was determined by the constant volume direct shear test, and the remolded shear strength was by the vane shear test. The sensitivity was calculated from the undisturbed and remolded strength.

Results and Discussion

Geotechnical properties

Figure 1 shows the physical properties at different depths. For the grain size, clay and silt was predominant except 8 and 9 m. Clay (<5 μ m) was in the range of 24 to 56 % and silt 2~75 μ m was between 21 and 62.3 %. The particle density was 2.5 to 2.9 g/cm³. The liquid limit and plastic limit were in the range of 160.4 to 414.7 % and 29.7 to 64.2 %, respectively. The natural water content was greater or smaller than the liquid limit depending on the depth, which is reflected in the liquidity index greater or smaller than 1.0. The liquidity index ranges from 0.64 to 1.35.

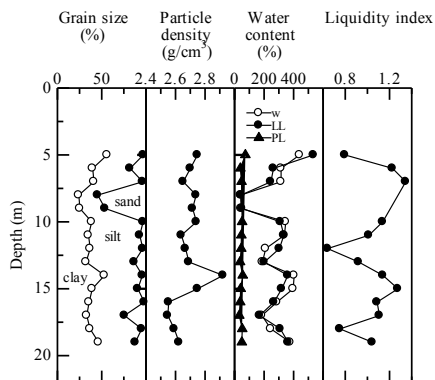


Fig 1. Geotechnical properties

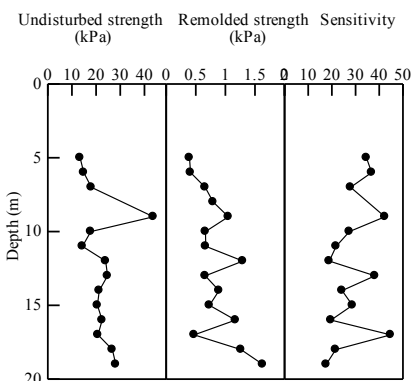


Fig 2. Shear strength and sensitivity

Figure 2 shows the undisturbed and remolded shear strength, and sensitivity. The undisturbed strengths were in the range of 13.64 to 44.61 kPa, which were reduced to a great extent by remolding and the remolded strength exhibits extremely low values of 0.39 to 1.63 kPa. The sensitivity obtained as the ratio of the undisturbed strength to the remolded strength was in the range of 18 to 45, which is grouped into high sensitivity according to the sensitivity scale of Norsk Geoteknisk Forening (Torrance, 1983). The clay at the depth of 5,6 and 17 m can be called

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Keywords: Sensitivity, , physico-chemical, quick clay, Mexico City.

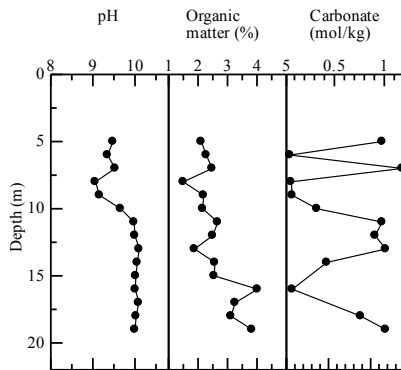


Fig 3. Chemical properties

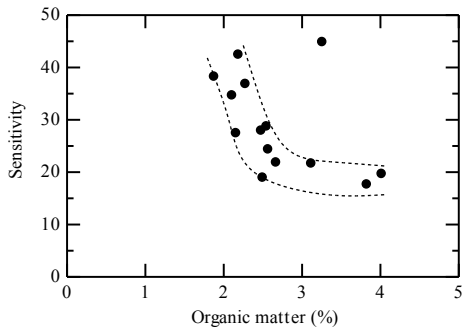


Fig 4. Sensitivity versus organic matter

quick clay because the remolded strength is less than 0.5 kPa. Quick clay has been found in marine clay sediment in Scandinavia, Eastern Canada and Ariake Bay of Saga prefecture, but has never been found in the volcanic ash derived sediments like Mexico City clay.

Chemical properties

Figure 3 shows the change in the chemical properties of Mexico City clay with depth. The pH values were extremely high with the range of 9.06 and 10.1. The high pH is due to the presence of carbonate in high amount. The organic matter changed from 1.5 to 4.0%. The carbonate content was in the range of 0.042 to 1.377 mol/kg, which is 0.42 to 13.77% assuming that the carbonate consists entirely of calcium carbonate (CaCO_3). Salt concentration in pore water was higher than sea water and cations in pore water were mainly sodium.

Factors affecting the sensitivity

The sensitivity of clay is defined as the ratio of undisturbed to remolded strength of clay. Increase in the sensitivity occurs either by an increase in the undisturbed strength or by a decrease in the remolded strength. In case

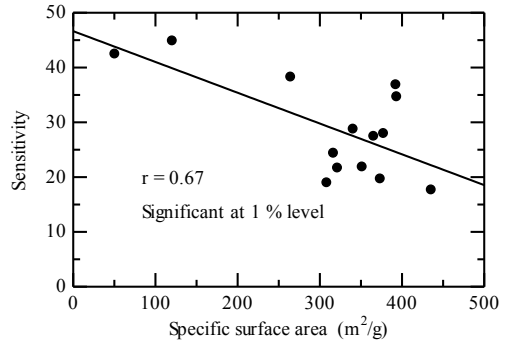


Fig 5. Sensitivity versus specific surface area

of Mexico City clay, increase in the sensitivity occurs through a decrease in the remolded strength since the correlation exists between the sensitivity and remolded strength of the clay (not shown).

The sensitivity of clay is controlled by the physical and chemical properties of the clay. For Mexico City clay, multiple regression analysis indicated the sensitivity of the clay is controlled by the organic matter and specific surface area. Figure 4 and 5 show the correlations between the sensitivity and the organic matter, and the specific surface area, respectively. It can be concluded that the sensitivity of Mexico City clay is changed by the organic matter and specific surface area through their effects on the remolded strength since there is a correlation between the sensitivity and remolded strength of the clay (not shown).

Conclusion

Sensitivity of Mexico City clay was rather high. There were correlation between sensitivity and organic matter and specific surface area. At some depths quick clays were found. This is a new finding that occurred in a volcanic derived clays.

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