

Structure due to cementation of Osaka bay clay and its mathematical modeling

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ABSTRACT

To understand the large compressibility of Osaka Bay Pleistocene clay, the concept of standard compression curve was introduced to evaluate the structure due to cementation effects during the sedimentation process. The standard compression curve consists of ultimate standard compression curve, *USC*, and the standard compression curves from an initial void ratio, *SCC* (e_0^*). Using the specific volume index, I_{sv} , *USC* was given as a unique $I_{sv} - \log p$ relationship not dependent on the plasticity of clays. By comparing in-situ specific volume index of Pleistocene clays in Osaka Bay with the value on of the *SCC*(e_0^*), the degree of structure of marine deposits were evaluated as volumetric strain. It was shown that Osaka Bay Pleistocene clays have well-developed structure due to cementation and it is the main reason of the large compressibility when the overburden pressure exceeds the yield stress. Based on the equation by Tan and Tsuchida on the shear strength gain by cementation effect, the strength increase during one-dimensional sedimentation and consolidation is discussed mathematically. It is shown that the model used in this study has a possibility to explain the in-situ apparent OCR – depth relation in Osaka Bay. However, as the in-situ large specific volume index of Pleistocene clay could not be reproduced by the calculation with the model, further improvements is necessary.

1. INTRODUCTION

The settlement prediction of the Pleistocene clay layer, on which Kansai International Airport (KIX) is constructed, has two difficulties that have never been experienced in that of Holocene clay layer. When a clay layer, whose consolidation yield stress and in-situ overburden stress are p_c and σ_{v0}' , respectively, is consolidated by the stress increment, Δp , and $(\sigma_{v0}' + \Delta p) > p_c$, the compressive strain of clay, ϵ_c , is given by the following equation;

$$\epsilon_c = \frac{C_c}{1+e_0} \log_{10} \frac{\sigma_{v0}' + \Delta p}{p_0} + \frac{C_\alpha}{1+e_0} \log_{10} \frac{t}{t_0} \quad (1)$$

where, e_0 , C_c , C_α , t and t_0 are natural void ratio, compression index, secondary compression index, elapsed time and time at the beginning of secondary consolidation, respectively. Defining $\beta = C_\alpha/C_c$ and the load increment ratio, $n = (\sigma_{v0}' + \Delta p - p_c) / p_c$, Eq.(1) is shown as follows;

$$\epsilon_c = \frac{C_c}{1+e_0} \left\{ \log_{10}(n+1) + \beta \log_{10} \left(\frac{t}{t_0} \right) \right\}$$

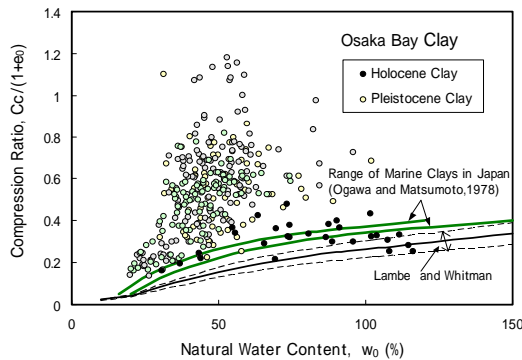


Figure 1. Compression ratio, $\frac{C_c}{1+e_0}$ with natural water content

(2)

In Eqs.(1) and (2), the compressibility of clay layer is presented mainly by the compression ratio, $C_c/(1+e_0)$.

An important problem of Pleistocene clay is its extremely large compressibility. In Figure 1, the compression ratios of Osaka Bay Pleistocene clays and Holocene clays at the site of KIX are plotted with the natural water contents, where the range of compression ratio of typical clays by Lambe and Whitman (1969), the range for Holocene marine clay in Japan (Ogawa and Matsumoto, 1978) are also plotted for the comparison. As shown in Figure 1, the compression ratio of Pleistocene clay range from 0.2 to 1.2 and the average is about 0.6, which are two or three times those of Holocene clay or typical clays.

The importance to consider the secondary compression is another problem of settlement of Pleistocene clay. In Eq.(2), the value of β ranges between 0.03 and 0.07, not dependent on the soil type (Mesri, 1977). In the case of the reclamation or the embankment construction on Holocene clay, the value of n is often

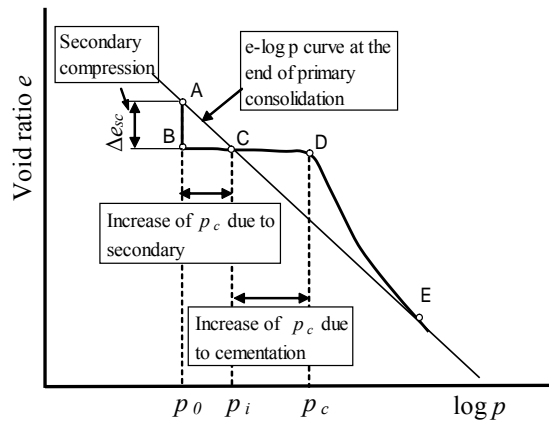


Figure 2. Secondary compression and cementation