Geotechnical properties of soil samples obtained from seabed ground in deep sea

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Soil samples were recovered from Nankai Trough in which the large amount of methane hydrate is expected based on the extensive distribution and high amplitude BSRs. In this paper, the geotechnical properties of samples are presented based on the results of laboratory tests. The soil index tests, consolidation tests and triaxial compression tests were conducted to obtain the geotechnical parameters which are necessary for deformation analysis of seabed ground in deep sea.

The Research Consortium for Methane Hydrate Resources in Japan was established to undertake research in accordance with Japan Methane Hydrate Exploitation Program prepared by the Ministry of Economy, Trade and Industry. In this Consortium the Engineering Advancement Association of Japan is doing research on Environment Impact. In the Research Group for Environment Impact, we are investigating if the deformation of seabed ground occurs in production of methane gas from methane hydrate. To produce methane gas from methane hydrate safely and without damaging the environment, we need to address many wide-ranging environmental issues. One of them is to assess seabed deformation during methane gas production.

In this study, the core samples in Tokai-oki site at a water depth of 720m were used. The sandy soil could not be recovered much caused by soil escape during coring. The clayey soils were mainly used in this study.

The fine contents are more than 85%. The dry densities increase with depth, therefore the water contents decrease with depth. But the change or trend of the other properties are not recognized. Based on this grain size and plasticity chart, the soils recovered from the well are classified as CL and CH according to JGS standard method.

The one-dimensional consolidation properties of the soil were measured by incremental loading and unloading test up to the axial stress of 5MPa. From the consolidation tests, the compression index of 0.19-0.31 and the swelling index of 0.025-0.044 were obtained.

The consolidation yield stress (p_c) can be determined from the loading stage of consolidation test. The difference between p_c and in-situ overburden pressure (p_0) is 270kPa in shallow case. So, it can be estimated that the unloading of 30m thick of soil layer could have occurred in the past. The value of over consolidation ratio (OCR) is approximating to 1.0 below 100m depth. From the change of void ratio from initial condition to in-situ stress condition, de/e_0 can be calculated. This value indicates the quality of sample is very poor if greater than 0.14 under the value of OCR is 1 to 2. The qualities of samples recovered below 40m are not good due to the stress release induced by the entire sampling procedure. The permeability of soil can be estimated from consolidation test. The general range of permeability of the samples is from 10^{-7} to 10^{-8}cm/sec.

Undrained K_0 triaxial compression test were performed simulating in-situ stress history to minimize the effect of sample disturbance. The radial strain of triaxial test specimen was measured by the lateral strain meter and the confining pressure was controlled not to deform in radial direction. K0 value of 0.45-0.55 in normally consolidation state and 0.53-0.66 in over consolidation state under in-situ overburden pressure were obtained and these values agreed well with those estimated from OCR. The excess pore water pressure during compression test became high as the depth of sample recovery was increased as getting close to normally consolidation state. The increasing rate of undrained shear strength is 0.7 for normally consolidation state and 3.4 for the sample recovered from near seafloor (OCR=3.2). These values are higher than those obtained for general marine clays. The low activity of the samples must have much effect on the mechanical properties.