Geotechnical investigation of sediments in the presence of gas hydrate site off Sakata, eastern margin of the Japan Sea

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Gas hydrate, which is widely distributed in the continental marginal seas and permafrost regions around the world, has attracted great interest from industry and academia because of its potential as a future energy resource, but it is necessary to examine the geotechnical engineering of gas hydrate layers to study the mining and recovery methods. Two types of marine gas hydrate around Japan, the pore-filling type hydrate in sandy horizon and the massive nodular type of hydrate in shallow sediments, have been identified in the Pacific Ocean, the Japan Sea and around Hokkaido, respectively. Studies on the mechanical behavior of sediments containing shallow gas hydrate have been reported less frequently than those of pore-filling type hydrate. We report the results of the geotechnical survey conducted at a knoll off Sakata in the eastern margin of the Japan Sea, called the Sakata Knoll, where the presence of the gas hydrate was suggested.
The geotechnical research cruise (PS21) was conducted in August 2021, combining in-situ piezocone tests (CPT), PS logging and core drilling. CPT were carried out to about 12 m below the seafloor (mbsf) at the reference site (about 555 m water depth, CPT2101) outside the distribution area of the bottom-simulating seafloor (BSR) and 17 mbsf at the presence of hydrates site (about 530 m depth, CPT2102) inside the distribution area, respectively. Near the CPT site, core drilling reached to approximately 60 mbsf and samples for laboratory test were collected, and PS logging was conducted.
At the reference site, cone tip resistance, friction sleeve, and pore water pressure from CPT and velocity of compressional waves from PS logging increased linearly with depth in the CPT test. At the hydrate site, the same trend of increase with depth was observed, but the measured values were all higher than those at the reference site. In addition, there were several large peaks and strong variation in the measured values. The decrease in pore water pressure corresponding to the peak in tip resistance suggests that a sedimentary layer with a large grain size exists at the hydrate site. This indicates the existence of a layer where the vertical movement of fluid is easier to occur at the hydrate site than at the reference site.
Comparing the results of the laboratory tests with the converted values from the CPT, the measured values of sediment strength and fine grain content at the reference site are in good agreement. On the other hand, when comparing the results at the hydrate site, the results coincided with both up to the shallow sediment (about 5 mbsf), but as the depth increased, the CPT conversion values were higher than the laboratory test for sediment strength and lower for fine grain content. The presence of tiny gas hydrate that collapses during the collection of sediment samples may affect the in-situ measurement at the hydrate site.
The CPT is useful for the Sakata Knoll because it can be obtained continuously and is generally well correlated with the values obtained from the laboratory soil tests. At the gas hydrate sites, the geotechnical investigation is considered to be useful for the estimation of the gas hydrate zone, since it shows clearly different trends from the reference sites. Since the collection and measurement of sediment samples is time-consuming, the combination of both methods will lead to an efficient understanding of the characteristics of the area.

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