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海底地すべりのケーブルへの衝撃力および運動機構についての模型実験
Model test of the submarine landslide impact forces acting on cables and the motion mechanism

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Communication cables, which cross the oceans between continents all over the world, are sometimes damaged due to the occurrence and motion of submarine landslides, causing interruption of data transmission, and even of international communications. When cable failure occurs, the economic loss is vast for cable restoration coupled with temporary or permanent breach in information transmission. Submarine landslides are usually triggered by many factors which include rapid sedimentation, retrogressive failure, earthquake and tectonic activity, gas hydrate dissociation and wave loading. These activities cause severe damage to transocean fibre optic cables. Direct observation of this phenomenon is still not enough because these events occur deep beneath the sea surface, and direct observation of submarine landslide would be extremely expensive and difficult because of its unpredictability. Many features of submarine landslides and the damage they cause to communication cables are unclear. The aim of this study is to use experimental approach to analyze and understand the motion mechanism of submarine landslides and its effect on communication cables. Our interest in submarine landslides lies in disaster mitigation of communication cables. An experimental apparatus to study submarine landslides was developed for this purpose. The apparatus consists of a wheel-shaped hollow disc of height 1.8m, an axle shaft at the center and a trough with a width of 0.4m at the inner circumference. Submarine landslides is simulated by using silica sand-water mixture in the lower part of the trough as the wheel rotates in a anticlockwise direction on the axle shaft with silica sand-water mixture in the same direction of motion, all controlled by a speedometer. Using this apparatus, with silica sand no.7-and no.8-water mixtures for these experiments, normal stress, shear stress, pore water pressure on the bottom of the apparatus and impact force on a communication cable model were measured using high definition transducers, sensors and data loggers. Experiments were carried out considering four factors: (1) the effect of motion velocity of submarine landslides; (2) the effect of submarine landslide volume; (3) Material composition of submarine landslides; and (4) the effect of different cable diameters. From data obtained from series of experiments, the friction angle of submarine landslides and impact force on a communication cable was obtained. In addition, small plastic balls which have specific gravity similar to silica sands were used as tracers to observe the characteristic bulk movement of soil masses during the experiments; results obtained were compared with the friction angle and impact force on a cable. Result obtained from the experiments show that four critical values of velocities and five stages of soil mass flow evolution conditions exist in these experiments. Impact force on the communication cable model is high for submarine landslides with low motion velocity, but decreases until the velocity gets to a critical value where liquefaction occurs, and subsequently increases in a linear fashion with velocity. On the other hand, friction coefficient is positively correlated with velocity of soil mass, but shows different tendency before and after the critical value of velocity. Also, large diameter cables are subjected to high impact forces. When the diameter of the cable is increased by 10%, the impact force also increases by 50%. The experiment with setting height of 20mm showed the high impact force. Conversely, experiments with higher setting height (40mm and 80mm) showed low impact force. This may be due to the influence of different relative densities of submarine landslide sediments. Although it is difficult to simulate the flow conditions which occur in deep water, we hope the test results provide some hints for communication cable design and cable positioning in the ocean.

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