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HDS027-P14 Room:Convention Hall Time:May 24 16:15-18:45

Experimental Study on the Damaging Mechanism of Cable by Submarine Landslides

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1.Introduction

Submarine communication cables are frequently broken by submarine landslides and turbidity currents. When the cable was cut, the economic loss is vast for cable restoration and the stop of information transmission. However, there are considerable points are not clear because the submarine cable breaking occurred under the surface of water. For the prevention and mitigation of the sea area disaster around Japan, the study of submarine landslides is necessary.

The aim of this study is to quantitatively evaluate and analyze the impact forces against the submarine cable. From the viewpoint of lifeline disaster prevention, the estimate of impact forces to cable by submarine landslides is very important to contribute to the marine development and use in the future.

2. An experiment method and condition

An experimental apparatus to study submarine landslide was developed and used in this study. This apparatus is a cylindrical water tank of 1.9m in height, 1.8m in diameter, and 0.4m in width. Cylinder bottom has shear stress sensor, pore water pressure sensor, and normal stress sensor. By putting the mixture of water and soil into this apparatus, and making it rotate, it is going to reproduce the submarine landslide. It can be rotated at the speed from 0.013m/s to 0.78m/s.

In addition, the impact forces to the cable are able to be measured by setting up the cable model that puts the strain gauge in the apparatus while the submarine landslide is moving. The cable model is a pipe made of the vinyl chloride of 22mm in the diameter. As for the real submarine cable in the spot, the transformation to the cable extension direction is not forgiven so that it is considered to be the infinite length. Therefore, both ends of the cable model are fixed perfectly in the submarine landslide apparatus.

Experiments were carried out to clarify the three influences: (1) Influence by the velocity of submarine landslide; (2) Influence by the volume of submarine landslide; (3) Influence by the setting height of the cable.

Silica sand No.7 was used for those experiments. This silica sand has following features. Soil particle density = 2.63g/cm^3, Maximum density = 1.566g/cm^3, Minimum density = 1.026g/cm^3, Maximum void ratio = 1.563, Minimum void ratio = 0.679, D_{50} = 0.1mm, D_{30} = 0.079mm, D_{10} = 0.056mm, uniformity coefficient = 1.82, coefficient of curvature = 1.09.

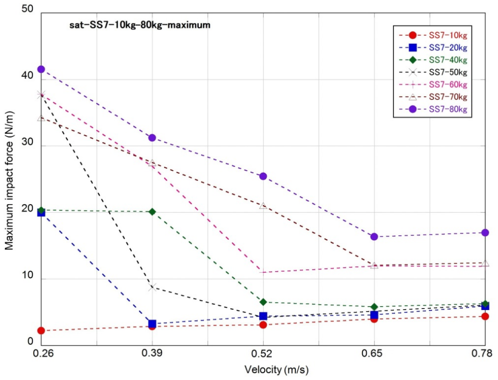
3. Consequence and consideration of experiments

First, experiments that 10kg~80kg of saturated silica sand No.7 rotated by 0.26m/s~0.78m/s were conducted.

The figure shows the relation between maximum impact forces (N/m) and landslide velocity (m/s). As a result of those experiments, the impact forces to the cable model became greater when landslide velocity became slower. The impact forces decreased to a critical velocity and then increased with landslide velocity. In addition, the critical velocity became faster when the volume of landslide became larger. Here are some reasons to consider: (1) Non-turbid Soil mass movement strike against the cable model; (2) As landslide velocity became fast, soil mass movement was became current of low density. In other words, soil mass movement shows aspect of submarine landslide when slow velocity. However, soil mass movement shows aspect of turbidity current when fast velocity.

The impact forces to the cable model became larger with the increase of the volume of the landslide, and the impacting time became longer.

However, clear tendency wasn't found from the difference of the setting height of the cable model. More experiments by various setting height of cable is necessary in future work.


sat-SS7-10kg-80kg-maximum
SS7-10kg
SS7-20kg
SS7-40kg
SS7-50kg
SS7-60kg
SS7-70kg
SS7-80kg
Maximum impact force (N/m)
Velocity (m/s)
0
10
20
30
40
50
0.26
0.39
0.52
0.65
0.78