Title of the Keynote Lecture

Modeling of Soil-Structure Interaction under Earthquake and Tsunami Load with Reinforced Foundation

Abstract

Many coastal protection facilities, such as breakwaters, river dikes and seawalls, were damaged by the 2011 Off the Pacific Coast of Tohoku Earthquake, Japan and the subsequent tsunami. Focusing on the breakwaters in particular, the cause of the damage due to this disaster can be classified into many patterns: 1) scouring of breakwater foundation due to overflow; 2) force of leading wave of tsunami; 3) force of backwash of tsunami; and 4) seepage flow due to the difference in water level on the sea side and harbor side. The extensive damage or collapse of such geotechnical structures, due to increase of seepage force and scouring by overflowing tsunami, emphasize the importance of developing tsunami-resistant soil structures. Development new technology is essential for the construction and retrofitting of breakwaters, which can render resiliency to breakwaters against earthquake and tsunami related compound disasters.

This paper describes a new technique for reinforcing breakwater foundation using protective gabion on the top of rubble mound, reinforcing the foundation with steel sheet piles, and using impermeable materials between mound and breakwater to reduce the damage to breakwaters due to combined effects of earthquake and tsunami. The effectiveness of the proposed technique and soil structure interaction during earthquake and tsunami loading were evaluated through physical and numerical modeling.

As a part of the physical modelling for such soil-structure interaction problem, a series of 1g shaking table tests and centrifuge model tests were performed first. In addition, a hydraulic model testing apparatus was developed, which can simulate the soil-structure interaction during tsunami overflow and the resulting seepage and scouring. Model tests were performed for various model configurations. Comparisons were made between conventional foundation and reinforced foundation models. It was observed that the reinforced foundations were very effective to make the breakwater resilient against both the earthquake and the tsunami-induced damage. Finally, numerical simulations were performed to make clear the mechanism of reinforcement and evaluate the performance of the reinforced soil structures under the earthquake and tsunami loading.

Bio

Hemanta Hazarika is currently a professor in the Department of Civil Engineering and Department of Interdisciplinary Science and Innovation, Kyushu University, Fukuoka, Japan. He obtained his B. Tech degree in Civil Engineering from the Indian Institute of Technology (IIT), Madras, in 1990. He obtained his master degree in Civil Engineering in 1993 from Nagoya University, Nagoya, Japan, and received his Ph. D. degree in Geotechnical Engineering from the same university in 1996. Professor Hazarika’s research activities include soil-structure interaction, stability of soil-structures during earthquakes and tsunami, ground improvement, application of recycled waste and lightweight materials in constructions, stability of cut slopes, landslides and their mitigation, application of Artificial Intelligence (AI) in geomaterial modeling.

He has more than 180 technical papers in various international journals and conferences and symposia. He has authored four books on Soil Mechanics: First one is the “Soil Mechanics Fundamentals” (Published by CRC Press) which is in English, and the second one is the Japanese version of his first book. The third one is the second edition of his first book named “Soil Mechanics Fundamentals and Applications” and was published in March 2015. The fourth one is the Japanese version of his second book. He also edited three books in his research areas: (1) “Geotechnical Hazards from Large Earthquakes and Heavy Rainfalls”, (2) “Earthquake Hazards and Mitigations”, and (3) “Scrap tire derived geomaterials – opportunities and challenges-”.

He served as the secretary of the ISSMGE technical committee No. 4 (then TC4 and present TC 203) on “Geotechnical Earthquake Engineering and Associated Problems”. He was also serving as the chairman of the Japanese Geotechnical Society technical committee on “Integrated Approach to Risk Management of Geodisasters and Climate Change Adaptation”.

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