

Analysis of damage to coastal dikes by tsunami

—Damage analysis to discover the direction of future countermeasures—

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1. Outline

In response to the damage by the Great East Japan Earthquake, the Central Disaster Management Council compiled an interim report on 26th June, 2012 and mentioned the principles, “With regard to coastal protection facilities, it is also essential that progress be made in the promotion of technical developments for, and installment of structures that will rigorously withstand tsunamis that are higher than those for which they were designed”¹⁾. We studied structures to ensure the toughness of facilities against tsunami by dividing the coastline from Aomori Prefecture to Chiba Prefecture into about 1,400 sections according to the facility structure, then analyzing the relationship of the state of damage, the structure specifications (landward slope gradient, toe of landward slope covered/not covered, etc.), and tsunami heights to hypothesize the facilities’ damage mechanisms. As one example, directions in preventing scouring by covering the toes of landward slopes of coastal dikes with three surface-armoring are showed here.

2. Relationship of tsunami overflow depth with state of damage

Figure 1 shows the relationship of tsunami overflow depth with damaged length rate (percentage of total facility length which is damaged) in 118 sections of coastline dikes with three surface-armoring. There were cases where 100% of the dikes were totally destroyed at an overflow depth of about 3m, while in other cases, even at overflow depth over 10m, the damage length rate was 0%, revealing that even under the same tsunami height, the state of damage differed greatly according to section (bottom part of Fig. 1). This could be caused by diverse on-site conditions or facility structures, and it means that a structure which has been effective on one coastline might not be effective on another coastline. It will be necessary to collect as many cases as possible, and clarify the variation in the data, to carefully study ways of handling the data according purpose of use. To scientifically discuss differences in the state of damage, the average values which also consider differences in the length of each coastline (top of Fig. 1) are also important, but in order to protect human lives at all cost, it is necessary to assess safety of

structures more strictly than the envelope curve shown in the bottom of Figure 1.

3. Differences in state of damage according to whether or not the toe of the landward slope is covered

Regarding the relationship of covering/non-covering of the toe of landward slopes with the total destruction length rate, the results of totaling data for each section by overflow depth from less than 2m to 4m etc. reveal that within an overflow depth range from 2 to 6m, the damaged length rate was lower when the toe of the landward slope was covered (top of Fig 1). It is necessary to conduct experiments to clarify why there were no differences at and above an overflow depth of 6m.

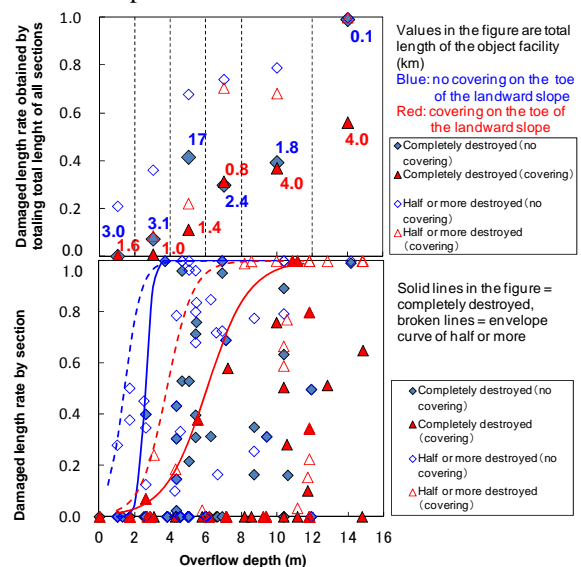


Figure 1. Differences in State of Damage of Coastal Dikes with Three Armored Surfaces With/Without Covering on Toe of the landward Slope

[Reference]

- 1) Report of the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the “2011 off the Pacific coast of Tohoku Earthquake”
<http://www.bousai.go.jp/jishin/chubou/higashinihon/Report.pdf>