Verification of Aseismic Design Method for Mooring Facilities Based on Past Examples of Earthquake Disasters

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1. Introduction

Aseismic design of port and harbor mooring facilities for Level 1 earthquake ground motion is performed by a method in which a reference seismic intensity (seismic coefficient) is calculated assuming that horizontal deformation of the quaywall is held to within an allowable value as a target, using the waveform of earthquake ground motion in the engineering bedrock, and the section dimensions are determined based on the calculated seismic coefficient. However, for quaywalls with water depths ≧7.5m, this seismic coefficient is constructed by calibration using numerical analysis and is not verified based on examples of disasters.

In this research, examples in which port and harbor quaywalls suffered/did not suffer disaster were collected from disaster reports, and the appropriateness of the existing design method was verified. Here, we report the results of verification of gravity-type quaywalls, which are a representative structural type of quaywall.

2. Disaster verification using limit seismic coefficient and acting seismic coefficient

As a large number of disaster reports for earthquakes have been compiled to date, the section dimensions, etc. of object facilities of verification were collected from this literature. The input seismic motion of each object facility was also estimated.

In disaster verification, the horizontal seismic coefficient of the design section of a facility is gradually increased, and the seismic intensity when the safety factor decreases to less than 1.0 due to any verification mode is defined as the limit seismic coefficient. The seismic coefficient (allowable deformation Da = 10cm) by the existing design method, which is calculated using the above-mentioned estimated earthquake ground motion, is defined as the acting seismic coefficient, and it is assumed that this ground motion acts on the object facility during an earthquake. In the disaster verifications, whether facilities suffer disaster or not was verified by judging whether damage was possible or not based on the magnitude correlation between the acting seismic coefficient and the limit seismic coefficient.

Figure 1 and **2** shows examples of the verification results. The ▲ symbol in the figures indicates that the facility suffered disaster, and the ▼ symbol indicates that the facility did not suffer disaster. When ▲ falls in the area where acting seismic coefficient > limit seismic coefficient (area within red lines), and when ▼ falls in the area where limit seismic coefficient > acting seismic coefficient, it can be said that consistency exists between the existing design method and the verification results.

Figure 1 shows the results when all the data for the object facilities of verification are plotted, whereas **Fig. 2** shows the results when the facilities with the water depth of <7.5m, which are not objects of calibration by the seismic coefficient calculation formula, are excluded from the plots in **Fig. 1**. In the water depth range which is the range of calibration by the seismic coefficient calculation formula, the results by the existing design method are generally consistent with the verification results. However, it is clear that seismic coefficients on the dangerous side will be calculated if the existing design method is applied in its present form to the range of shallower water depths. Therefore, improvement of the existing design method is considered necessary.

3. Conclusion

With the aim of constructing a rational aseismic design method which is consistent with the realities of disasters and reflecting that method in technical standards, the authors will continue verification work related to the aseismic design method in the existing standards, using the results of a survey of past earthquake disasters.

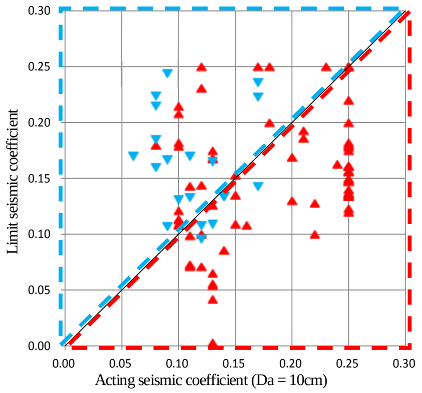

Fig. 1 Results of verification for full water depth range

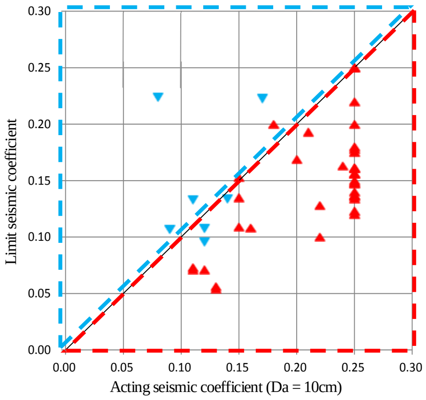

Fig. 2 Results for verification for water depths ≧7.5m
(excludes facilities with water depths of <7.5m from Fig. 1)

▲Acting seismic coefficient > limit seismic coefficient
▼Limit seismic coefficient > acting seismic coefficient