



## Experiments on Damage and Measures of Bridges by Tsunami

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## Summary

Many bridges suffered serious damage in the 2011 Japan Tohoku Earthquake off the Pacific coast. In this earthquake, the damage to bridges caused by the tsunami was more serious than that due to the tremors themselves. In particular, the superstructures of large bridges were swept away by the tsunami. Kesen Bridge is one of the largest bridges damaged by the tsunami, having 5 spans, and with a total length of 181.5 m. All of the superstructures of the 5 spans were carried upstream approximately 300 m. Consequently, an important route for the region was blocked off, causing significant delays in the relief and restoration of the damaged area. The authors conducted hydraulic experiments in order to understand the forces that tsunami exert on bridges, and to consider corresponding measures for bridges that will be effective against tsunami. With respect to one such measure, an experimental study was performed to determine whether the force of a tsunami can be reduced by attaching fairings to a bridge, two types of fairing being investigated.

**Keywords:** tsunami; bridge; damage; 2011 Tohoku Earthquake off the Pacific coast; fairing; hydraulic experiment

## 1. Introduction

The 2011 Tohoku Earthquake off the Pacific coast inflicted serious damage on the Tohoku district of Japan, and many human lives and large amounts of property were lost. Although many bridges suffered damage from this earthquake, the most serious was that in which the superstructure was swept away by the tsunami.

As a result of such damage, important routes were blocked, causing significant delays to relief and restoration. It is therefore necessary to implement tsunami resistant as well as earthquake resistant design. However, tsunami resistant design has yet to be established. Since further large earthquakes in Japan are predicted, measures are required.

Since the occurrence in 2004 of the tsunami caused by the earthquake off the west coast of northern Sumatra, researches have been making advances relating to the effects of tsunami on bridges. Kosa et al. [1] conducted a survey of the damage to bridges resulting from the tsunami accompanying the Sumatra earthquake. In addition, verification by numerical analysis was performed for bridges damaged. In the study by Nii et al. [2], experiments were conducted to evaluate the tsunami forces acting on a RC simple girder bridge. In their study, Zhang et al. [3] conducted experiments in which fairing was installed on the side of a RC simple girder bridge that was damaged by the Indian Ocean Tsunami. This experiment demonstrated the effectiveness of the fairing.

In this paper, in order to elucidate the tsunami forces that act on a bridge, the authors conducted hydraulic model experiments on the Kesen Bridge, a steel girder bridge. In addition, the authors verified the effect of fairing installed on a bridge, focusing on the effectiveness of two types of fairing with different shapes: box-shaped fairing, which is installed so as to surround bridge girders, and L-shaped fairing, which is installed on the side of bridge girders. We verified whether it is possible to reduce the force of a tsunami by installing these fairings.