

## Research Trends and Results

# Analysis of damage to road bridges by the tsunami caused by the Great East Japan Earthquake

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### 1. Introduction

The Great East Japan Earthquake damaged many road bridges, as the tsunami washed away their superstructures or washed away the soil behind the bridge abutments. Earthquakes accompanied by huge tsunami could occur again in the future, so to ensure the functions of road networks in the event of an earthquake disaster, establishing technology capable of appropriately evaluating the impact of tsunami when constructing or managing road bridges is an important challenge.

### 2. Study of design methods considering tsunami

For present day seismic design of road bridges, methods of verifying the impact of vibration considering restorability have been established, but specific required performance such as the allowed form of damage by giant tsunamis and methods of verifying this performance have not been established. So methods of considering tsunami acting force, forms of damage considering restorability, and verification standards that can control the progress of damage are being studied.

### 3. Study of tsunami acting force

It is necessary to correctly evaluate the acting force that a tsunami will inflict on a road bridge to perform design considering tsunami. Therefore, the NILIM has studied a method of evaluating tsunami acting force according to actual damage by the Great East Japan

Earthquake.

Among the bridges struck by tsunami, 85 bridges that are typical bridge types and whose specifications have been clarified were selected for analysis. The acting force was obtained using the tsunami water level and flow velocity at the locations where each bridge was constructed and which were calculated by hydraulic simulations, to calculate the water pressure and hydrodynamic force acting on the bridge girders based on hydraulic formulae. And resistance force was assumed to be the self-weight and the shear strength of the bearing anchor bolts. The figure plots the tsunami acting force/resistance force (equivalent to the reciprocal of the safety factor) with the lateral axis representing the horizontal acting force and the vertical axis representing the vertical acting force. The plot distinguished cases where the Great East Japan Earthquake washed away the superstructures of actual bridges and cases where this did not occur. The predicted damage to the bridges that were washed away conforms generally to the actual damage, so it is possible to judge tsunami damage using the tsunami acting force calculated using the hydraulic formulae. Among the concrete T-girder bridges and concrete slab bridges, even if the tsunami acting force/resistance force was less than 1.0, the actual damage included some that were washed away, although only a few. In the future, various specifications such as the state of damage caused by the Great East Japan Earthquake or the girder shape

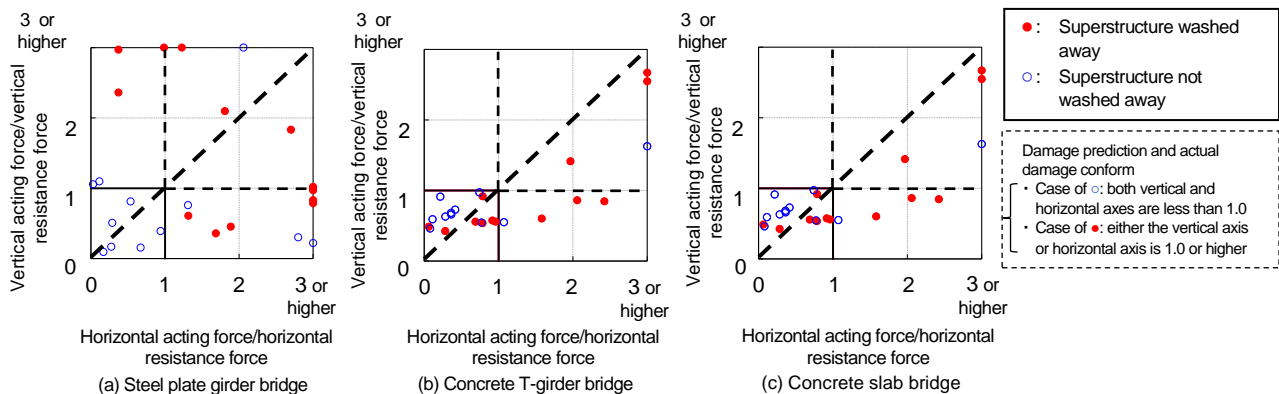


Figure. Evaluation of tsunami damage to a bridge

will be analyzed to abstract major factors determining the occurrence/non-occurrence of tsunami damage and to reflect the findings in the calculation of acting force.

#### 4. Conclusions

The NILM will continue to conduct research to systematize required performance to resist tsunami according to the disaster prevention position of each road bridge or the emergency restoration period after the damage, and to reflect the findings in road bridge design standards.

[Sources]

Web page of the Bridge and Structures Division

<http://www.nilim.go.jp/lab/gcg/index.htm>