

## Disaster Survey Report:

# Washed Away of Bridge by the Great East Japan Earthquake

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The Great East Japan Earthquake of M9.0 hit the Tohoku area on March 11, 2011. The huge earthquake followed by tsunami caused tremendous casualties and damage of structures across the Tohoku and Kanto areas.

Washed away of bridge by tsunami was recognized in the Indian Ocean Earthquake in 2004, but we lost a couple of hundred bridges washed away by the tsunami due to the Great East Japan Earthquake. In the history of Japan, we had some records on the washed away of bridges by tsunamis as well as floods and high tidal waves. Unfortunately, a very few have been reported in detail.

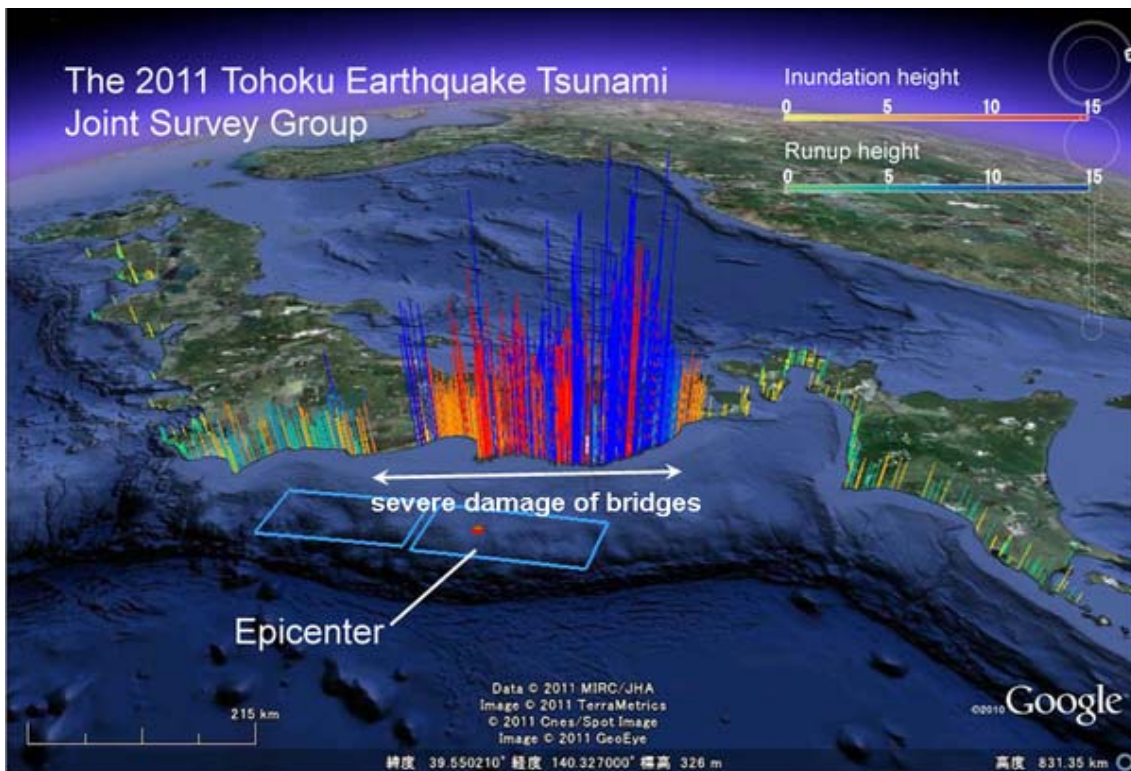


Fig.1 Height of Tsunami and the area where severely damaged bridges were observed

Fig.1 shows the height of Tsunami investigated by JSCE joint survey group. Very high and strong tsunami waves caused so many bridges washed away in such a large area from the northern part of Iwate prefecture to the north part of Fukushima prefecture, more than 200 km long. Our tentative

survey shows that at least 280 bridges were washed away in the above area where 3164 bridges were located in the inundation area by the Tsunami. JSCE has launched a research committee to investigate the damage of bridges by the Tsunami. The first goal will be to classify all 3164 bridges into two categories; without damage and damage (including the cases of girders washed away) taking account of the estimated tsunami height at its location as well as dimensions of bridges. The second goal will be to specify the force of tsunami in the JSCE concrete code. Based on the expected results, any bridge which may suffer from tsunami could be evaluated on the safety against tsunami. The chairman of this committee is Prof. Kyuichi Maruyama of Nagaoka University of Technology.

The damage of bridge due to the tsunami shows, of course, different faces. Geometrical feature plays a key role for the run up of tsunami. Fig.2 shows how the area suffered from the tsunami looks like. Two bridges above the river named Tsutanigawa were washed away. The bridge in the upstream is located about 1800m away from the coastal line, but the tsunami came up and washed away PC girders of the bridge (Tsutanigawa bridge: railway bridge). Different from other damaged bridges, RC piers were damaged as shown in Figs.3 and 4. PC girders with 40 length were pushed down and damaged seriously as shown in Fig.5. The reason why RC piers were impaired by the tsunami may attribute to the fact that this bridge had extra devices implemented to prevent falling down of girders after Miyagi-ken-Oki earthquake in 1978. The devices might restrict the horizontal movement of girders, and consequently the force of tsunami taken by girders was transferred to RC piers up to failure or tilt of piers.

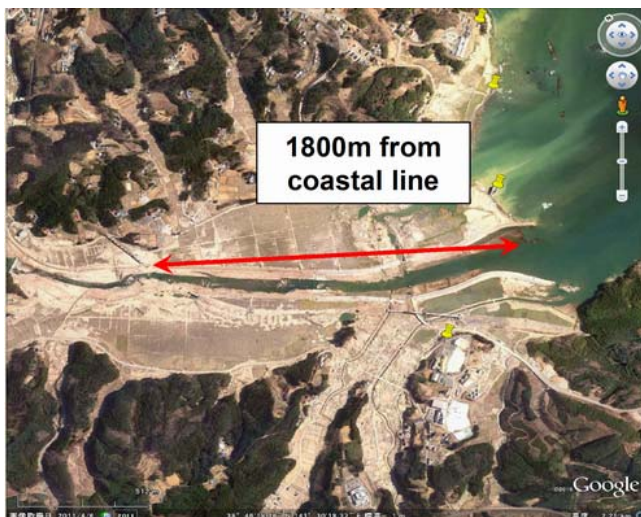


Fig.2 Location of Tsutanigawa bridge



Fig.3 Inclined piers (Tsutanigawa bridge)



Fig.4 Failed pier (Tutanigawa bridge)



Fig.5 PC girder (Tsutanigawa bridge) washed away and damaged by tsunami

Fig.6 shows the schematic view of Utsu-ohashi bridge (road bridge, national route 45) located 7 km south to Tsutanigawa bridge. Seismic strengthening had been conducted, but was in vain against the tsunami. The PC girders were connected each other to prevent falling down by earthquake (Figs. 7 and 8). Nevertheless, connected PC girders fell down to the ground due to the rupture of the devices (Figs.9 and 10). The seismic strengthened RC piers show almost no damage.

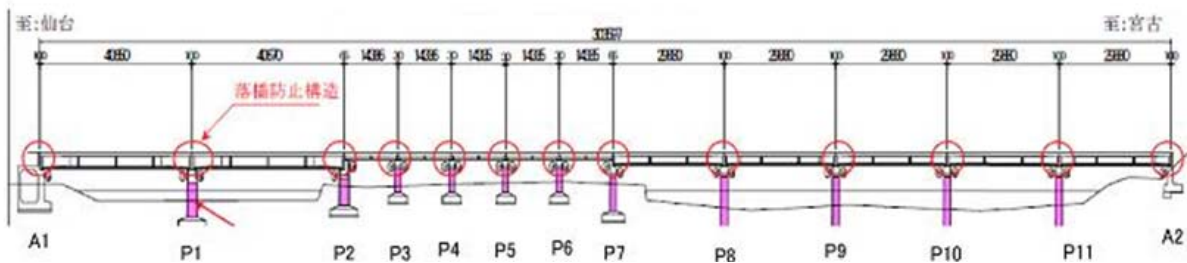


Fig.6 Utsu-Ohashi bridge



Fig.7 Device to prevent falling down of girders



Fig.8 Seismic strengthening of piers (Utatsu-ohashi bridge)



Fig.9 Falling down of PC girders (Utatsu-ohashi bridge)



Fig.10 Rupture of devices

In order to clarify the influence of tsunami on bridges, the research committee is formed by coastal engineers, structural engineers as well as concrete engineers. As mentioned earlier the final goal is to establish the design system to provide sufficient safety of bridges against great tsunami.