

Tohoku Chapter, Architectural Institute of Japan
Reconnaissance Report (12) on Tsunami
The 2011 off the Pacific Coast of Tohoku Earthquake
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This report describes the damage of buildings by tsunami waves in Motoyoshi-machi and Ohtani Coast in Miyagi Prefecture. The damage was studied on March 19, 2011. One of the special characteristics of the earthquake disaster was that the damage of buildings by ground shaking was quite small in the region where tsunami waves did not attack; on the other hand, most houses were totally lost in the region of tsunami wave attacks.

In Motoyoshi-machi and Ohya Coast, those houses on the hill did not suffer damage, whereas many houses suffered heavy damage in the tsunami attack zone. The areas of different degrees of damage may be classified into three zones depending on the height of the construction sites (Fig. 1).

Zone A: Houses on the hill, no damage from tsunami nor by ground shaking;

Zone B: Houses where tsunami wave reached as high as 1 to 3 m, but some did and others did not suffer damage from tsunami wave; and

Zone C: Houses could not resist tsunami wave attacks and were completely destroyed and washed away.

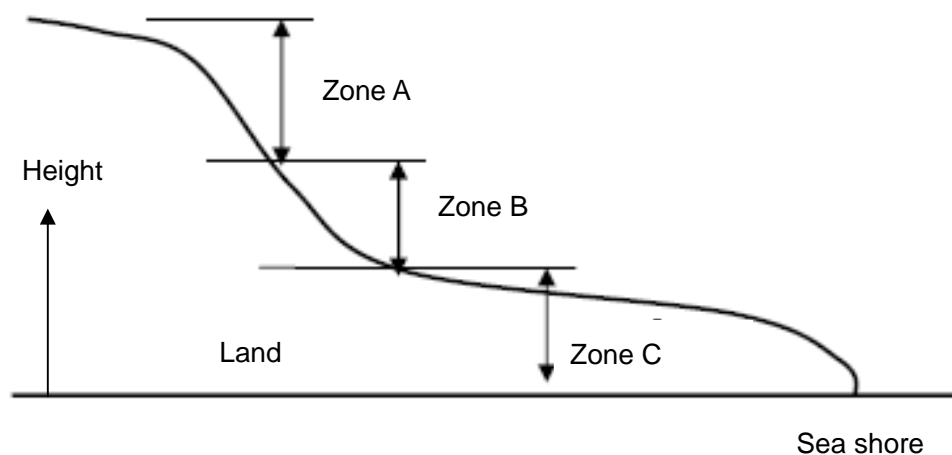


Fig. 1 : Tsunami Damage Zones

The zoning worked well in the Ohtani Coast as shown in Photo 1. Similar damage distribution was observed in Kesen-numa City.

A houses on the hill side (Photo 2) at the edge of Motoyoshi-machi toward the Ohtani Coast, suffered no damage. In the area lower than this hill side, tsunami water inundated above the floor (Photo 3); the inside of tsunami inundated houses was filled with flown out garbage (Photos 4 and 5).



Photo 1: Houses on the hill suffered no damage.



Photo 2: Houses on the hill suffered no damage (2).



Photo 3: The level of tsunami wave above the floor.



Photo 4: Inside of a house inundated by water.



Photo 5: The inside of a house filled with garbage

In the area of lower height, the flown out garbage fill the ground. Broken and wrecked houses were also flown out (Photos 6 and 7). Houses on the hill were not touched on the Ohtani Coast.



Photo 6: Houses were flown out.



Photo 7: Broken houses in the low land and an untouched house on the hill.



Photo 8: Untouched houses on the hill at the Ohtani Coast (1).



Photo 9: Untouched houses on the hill at the Ohtani Coast (2)

A view of the sea from a breakwater near the Ohtani Coast is shown in Photo 10. Flown out items were found in the tide-water control forest (Photo 11).



Photo 10: View of the sea near the Ohtani Coast.



Photo 11: Flown out objects in the forest.

A sofa was found on the breakwater bank (Photo 12). A view from the water break bank to the hill in the Ohtani Coast (Photo 13), in which an arbor is shown supported by four thin timber columns in the low land. The arbor was not damaged. A thin structural member did not attract wave pressure of the tsunami. The dimensions of the column was 200mm square.



Photo 12: A chair on the breakwater bank.



Photo 13: A view from the breakwater bank

A train runs on the hill (2.5 m high) behind the arbor shown in Photo 13. An automobile was flown out across the rail road (Photo 14); a tunnel in the photo was not damaged. The view from the tunnel to the opposite side is shown in Photo 15. A railway bridge collapsed, and in this area. A three-story hotel building on the hill behind the arbor in Photo 13 is shown in Photo 16; the second floor veranda is supported by three columns in the front, and the windows in the second story were broken. A view of the hotel from the hill side is shown in Photo 17. The second and third stories are of steel construction. From the damage in the second story, the tsunami wave height must have reached approximately 20.5 m (see Fig. 2). There was a concrete block warehouse at 10 m from the sea level (Photo 18); the building was undamaged. There was a timber house next to the concrete block warehouse, but the house was washed away leaving only the foundation (Photo 19). As can be seen in Photo 19, there is a reinforced concrete retaining wall near the concrete block warehouse. There is a two-story reinforced concrete old-age home

behind the retaining wall (Photo 20). The first story of the old-age home was inundated with tsunami water, but suffered no cracking. The first story of the old-age home is shown in Photo 21.



Photo 14: A view toward a tunnel.



Photo 15: A view from the tunnel side.



Photo 16: A view of a hotel building from the coast.



Photo 17: A view of the hotel from land side



Photo 18: A concrete block warehouse below the hotel building



Photo 19: A timber house was washed away leaving the foundation, next to the warehouse.



Photo 20: A two-story reinforced concrete old-age home



Photo 21: A car was brought into the first story of the old-age home.

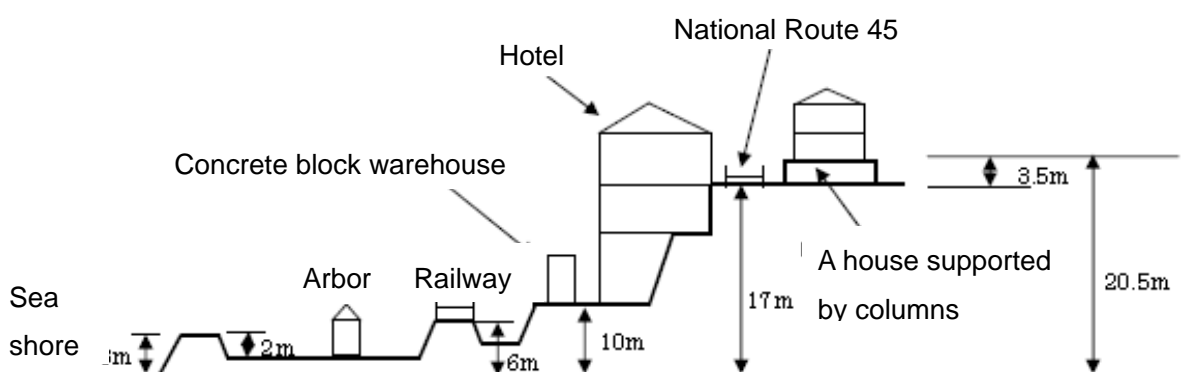


Fig. 2: Cross section of the land from sea shore to the hill

Behind the hotel and the old-age home, and across national route 45 (see Fig. 2), there is a two-story timber house standing on a one-story reinforced concrete elevated foundation (Photo 22); the tsunami wave came to the one-story foundation, but the timber house did not suffer any damage from tsunami wave attacks. The occupants of the house live an ordinary life. An adjacent timber house suffered heavy damage from the tsunami (Photo 23). Building a house on an elevated reinforced concrete foundation is a possible way to avoid tsunami wave attacks.



Photo 22: A timber house on one-story reinforced concrete foundation



Photo 23: Damaged adjacent timber house