

Report on Building Damage in Northern Ibaraki Prefecture by
The 2011 off the Pacific Coast of Tohoku Earthquake
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2. Schedule and Visiting Sites (see Route Map)

March 23, 2011

- (1) Kita-Ibaraki City
- (2) Takahagi City
- (3) Hitachi City
- (4) Hitachi-Naka City

March 24, 2011

- (1) Kasama City
- (2) Daigo-machi
- (3) Hitachi-Ohmiya City
- (4) Mito City

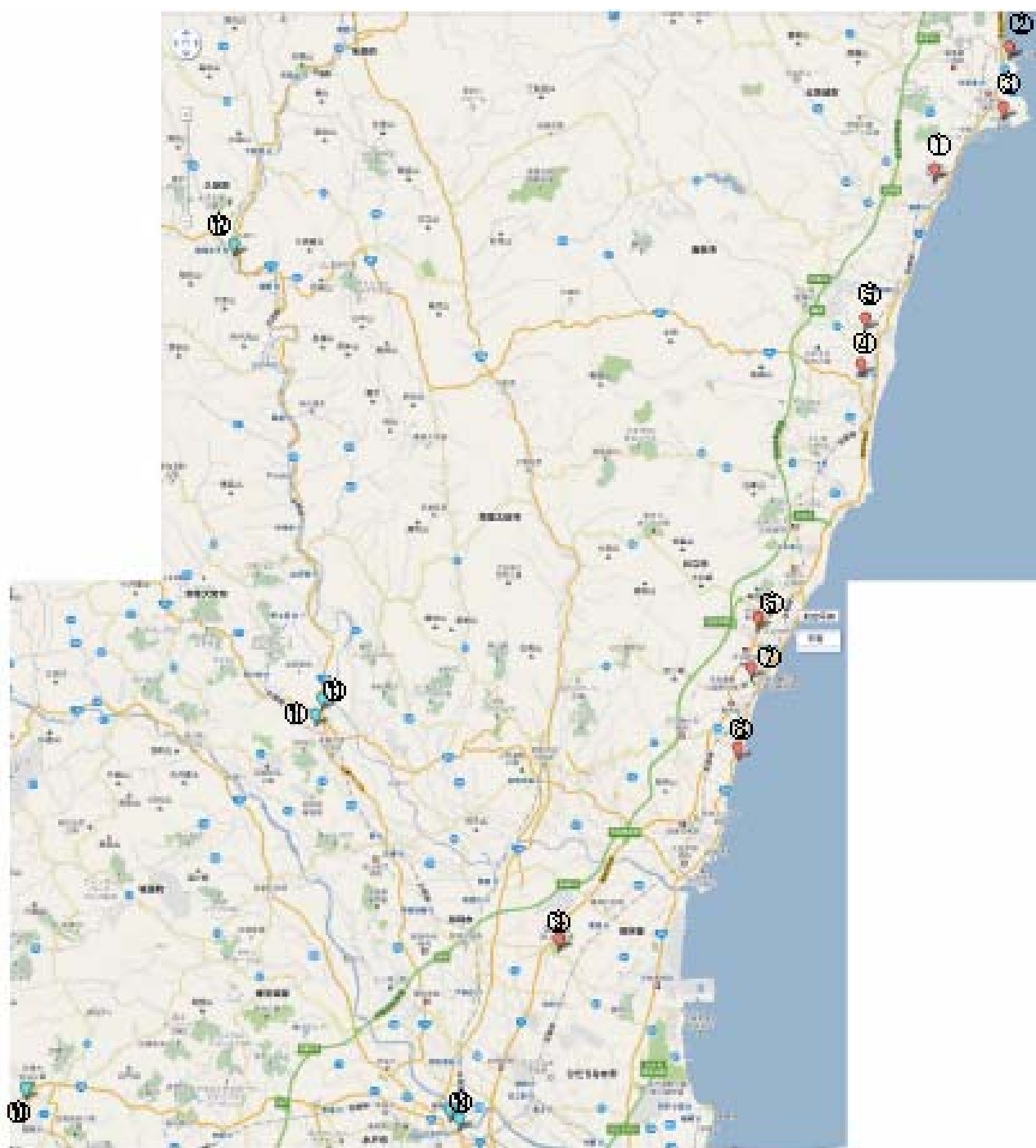


Fig. 1: Route Map (Numbers in the map indicate buildings visited)

4. Observed Damage

4.1 Kita-Ibaraki City

(1) Kita-Ibaraki City Municipal Office (No. 1 in the route map)

According to the municipal disaster center, 86 buildings (houses) were completely destroyed, 126 buildings (houses) were half destroyed; Almost of them were damaged by tsunami attacks. The municipal office building was not damaged. The tsunami damage was very bad in Hirakata and Ohtsu Ports. The facilities in a sewage purification factory in Hirakata Port were severely damaged. Municipal elementary and junior high school buildings had not been retrofitted at the time of the earthquake, but the damage was relatively light. There were seven gymnasia; all had been retrofitted before the earthquake and the damage was slight. Hospitals and fire stations were partially damaged in the earthen floor..

(2) Hirakata Port (No.2 in the route map)

Several detached houses were damaged. The tsunami height, amplified by the cliff around the harbor, reached as high as 10 m.



Photo 1: Shear cracks on Fisherman's Cooperative Association Building.



Photo 2: Damage of houses due to tsunami attacks.

(3) Ohtsu Port (No.3 in the route map)

In the Fisherman's Cooperative Association Building, longitudinal cracks were observed along the cover concrete of columns, flexural cracks in girders (Photo 3), and diagonal shear cracks in walls (Photo 4).

The damage by tsunami was severe in the port.



Photo 1: Cracks in a column and a girder in the Fisherman's Cooperative Association Building.



Photo 4: Diagonal cracks in walls in the Fisherman's Cooperative Association Building.



Photo 5: Damage of houses due to tsunami attacks.

4.2 Takahagi City

(1) Takahagi City Municipal Office

According to the Construction Department of the municipal office, 80 percent of the damaged buildings (houses) in the city were timber construction, and many buildings (houses) suffered damage in roof tiles. Quick damage inspection on public buildings was carried out from March 13 to 16, and inspection on privately owned buildings from March 17 to 19. Municipal elementary and junior high schools had not

been retrofitted at the time of the earthquake, but damage was slight in school buildings. Those buildings designed and constructed in accordance with the New Seismic Design Procedure (the 1981 revised Building Standard Law Enforcement Order), suffered slight damage; one exception may be cracking in the foundation of a mezzanine type house. The damage by tsunami attacks was slight in this area.

The results of quick inspection of public and private buildings are as follows; among 1,171 buildings inspected, 200 buildings were dangerous (red stickers), 324 buildings were cautious (yellow stickers), and 647 buildings were “inspected (probably safe but need further examination).

(2) Takahagi City Municipal Main and Second Buildings (No.4 in the route map)

Many shear cracks were observed in the main (constructed in 1958) and second (constructed in 1964) municipal buildings; the entrance into two buildings was prohibited (Photos 6 to 8).



Photo 6: Shear failure of columns in Second Municipal Building.



Photo 7: Damage of an end wall in Second Municipal Building



Photo 8: Main(left) and Third (right) Municipal Buildings (light cracking in Main Building and damage in exterior wall panels in the Third Building)

(3) Shimo-Teduna District (No.5 in the route map)

Soil liquefaction, half destruction of houses, fall of roof tiles were seen in Shimo-teduna district (Photo 9).



Photo 9: Damage in a detached house and fall of masonry walls and roof tiles.

4.3 Hitachi City

Department of Building Guidance of Hitachi City Municipal Office reported heavy damage in Kuji Coast by tsunami attacks; the wave height was estimated to be 4 m. The fall of roof tiles was reported in many places throughout the city. No damage of municipal elementary and junior high schools was reported.

(1) Hitachi City Municipal Office Building (No. 6 in the route map)

A connecting corridor between two Municipal Buildings, constructed in 1965, suffered light cracking (Photo 11).



Photo 10: Damage of a protruding part of Hitachi City Municipal Office Building



Photo 11: Cracking in the connecting corridor of Hitachi City Municipal Office Buildings

(2) Hitachi City Municipal Central Gymnasium (No. 7 in the route map)

Damage of Municipal Central Gymnasium was observed in the second story column (Photo 12). Crushing and spalling of concrete was observed at the top and bottom of second story exterior columns. Bracing members in the ceiling buckled and also fractured at the welding (Photo 13). Shear cracks were observed in the entrance walls (Photo 14). Glasses and interior finishing panels fell down.



Photo 12: Damage observed in Hitachi City Municipal Central Gymnasium

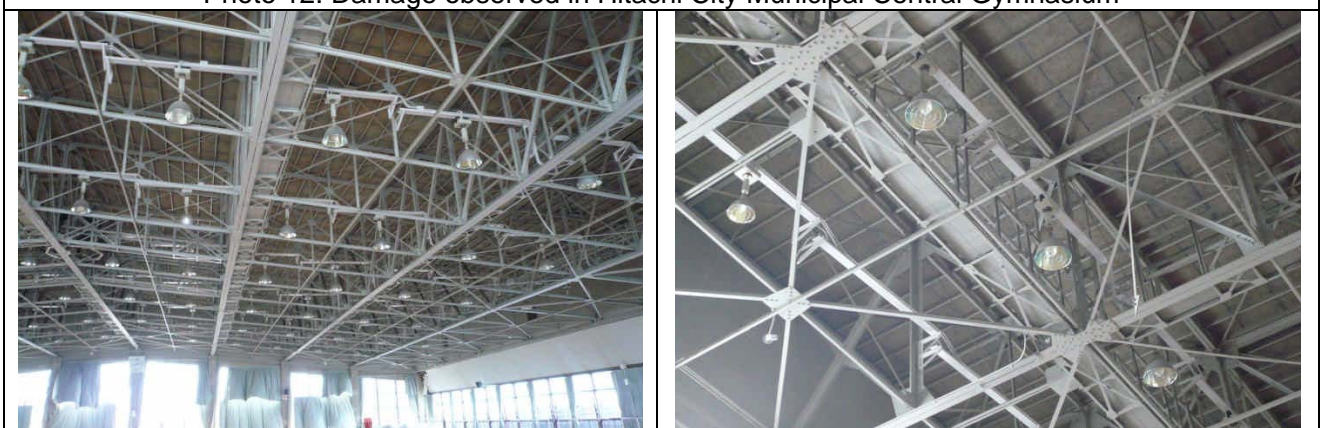


Photo 13: Damage on brace members (left: buckling, right: fracture)



Photo 14: Damage in entrance walls in Hitachi City Municipal Central Gymnasium

(3) Kuji Coast of Hitachi City (No. 8 in the route map)

Tsunami attacks caused heavy damage in Kuji Coast.

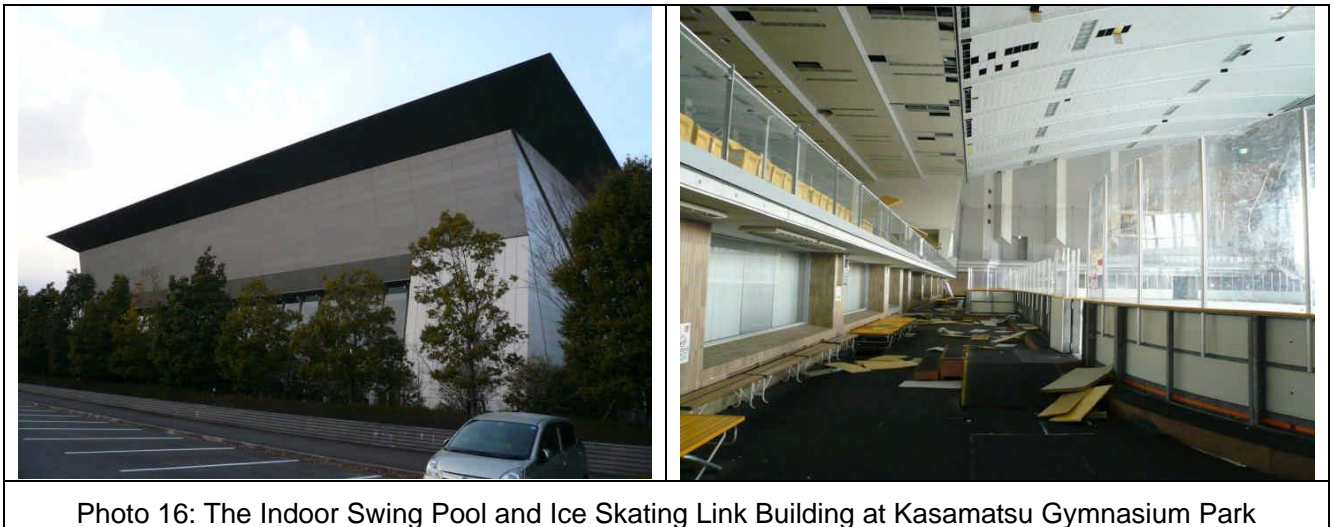


Photo 15: Tsunami damage in Kuji Coast

4.4 Hitachi-Naka City (No. 9 in the route map)

The ceiling panels fell down in the Indoor Swimming Pool and Ice-skating Link at Kasamatsu Gymnasium

Park (Photo 16).



4.5 Kasama City

(1) Branch Municipal Office Building of Kasama City (No. 10 in the route map)

The Branch Municipal Office Building of the Kasama City suffered severe damage by ground shaking. First story columns failed in shear and some columns lost vertical load resistance. Some columns in the second story also failed in shear. Shear failure was also observed in columns with a wing wall. The dimension of columns were 550 mm deep in the direction of shear failure, longitudinal reinforcement was either 10 bars or 12 of 22 mm plain bars, lateral reinforcement was 9 mm diameter plain bars at 250 mm on centers. Clear height was either approximately 780 mm or 1800 mm.



Photo 17: Damage of the Branch Municipal Office Building of Kasama City

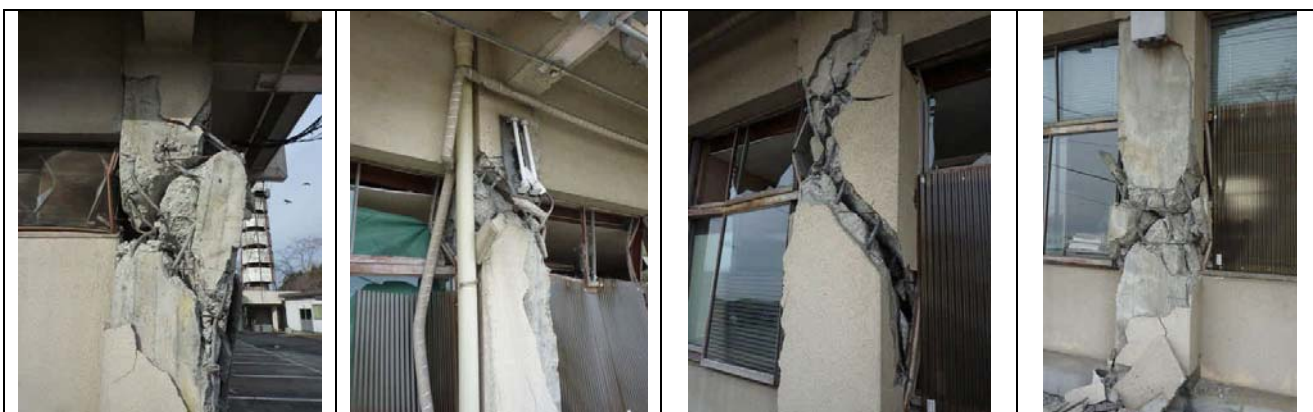


Photo 18: Shear failure of columns in the Branch Municipal Office Building of Kasama City



Photo 19: Shear failure of a column and a column with a wing wall of the Branch Municipal Building



Photo 20: Shear failure and loss of gravity load resistance of columns in the Branch Municipal Building of Kasama City

4.6 Hitachi-Ohmiya City

(1) Hitachi-Ohmiya Civil Engineering Service Building (No. 11 in the route map)

The Hitachi-Ohmiya Civil Engineering Service Building, constructed in 1968, was retrofitted before the earthquake. The settlement due to cracking in girders, shear cracking in columns and concrete crushing of columns was observed. The longitudinal reinforcement was diameter 22 mm plain bars, and lateral

reinforcement diameter 9 mm plain bars.



Photo 21: Over view and inside of the Hitachi-Ohmiya Civil Engineering Service Building



Photo 22: Cracks in a girder and a column in the Hitachi-Ohta Civil Engineering Service Building



Photo 23: Flexural crack and concrete crushing in columns of the Hitachi-Ohta Civil Engineering Service Building

(2) Hitachi-Ohta Fire Fighting Headquarter Building (No.13 in the route map)

The roof of a tower for training fell on the roof of the Hitachi-Ohta Fire Fighting Headquarter Building during the earthquake.



Photo 24: Overall view and fall of training tower roof in the Hitachi-Ohta Fire Fighting Headquarter Building



Photo 25: Before (right) and after (left) of the Hitachi-Ohta Fire Fighting Headquarter Building

4.7 Daigo-Machi

Daigo-machi Municipal Office Building (No. 12 in the route map) suffered minor cracking in walls. Most damage in the town was deformation of roads and landslides. The fall of roof tiles was relatively small in the number.



Photo 26: Overall view of Daigo-machi Municipal Office Building and cracks in a wall



Photo 27: Cracks in walls in Daigo-machi Municipal Office Building

4.8 Mito City

In Kohdo-kan Park (No. 14 in the route map), minor damage was observed in traditional buildings. Damage was observed in the gymnasium building of Mito First High School.



Photo 28: Damage of Confucius Mausoleum Entrance Gate, and collapse of Alarm Bell Building



Photo 29: Damage in Gymnasium of Mito First High School and its foundation