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2007 Niigata Chuetsu-oki Earthquake, Field Reconnaissance Report

- **Visiting Date:** 20th-21st, July, 2007.
- **Participators:** Gakuho WATANABE, Kahori IIYAMA, Naoya KAWANO
- **Surveyed Locations:** Niigata Prefecture Ojiya City, Nagaoka City (visited in 7/20)
  Kashiwazaki City, Kariwa City (visited in 7/21)

1. Introduction of 2007 Niigata Chuetsu-oki Earthquake

At 10:13 in morning, 16th July 2007, strong earthquake hits the Niigata area where epicenter was located at Chuetsu-oki (LAT: 37.5N, LNG: 136.6E, hypocenter depth is approximately 17 km). Brief location of epicenter is shown in Figure 1. The magnitude of this earthquake was 6.8, estimated by Japan Meteorological Agency. It has been reported that 11 people died and 1300 people injured. For the houses, 963 are completely collapsed and 1,013 are partially collapsed. Figure 1 shows the map of the surveyed point.

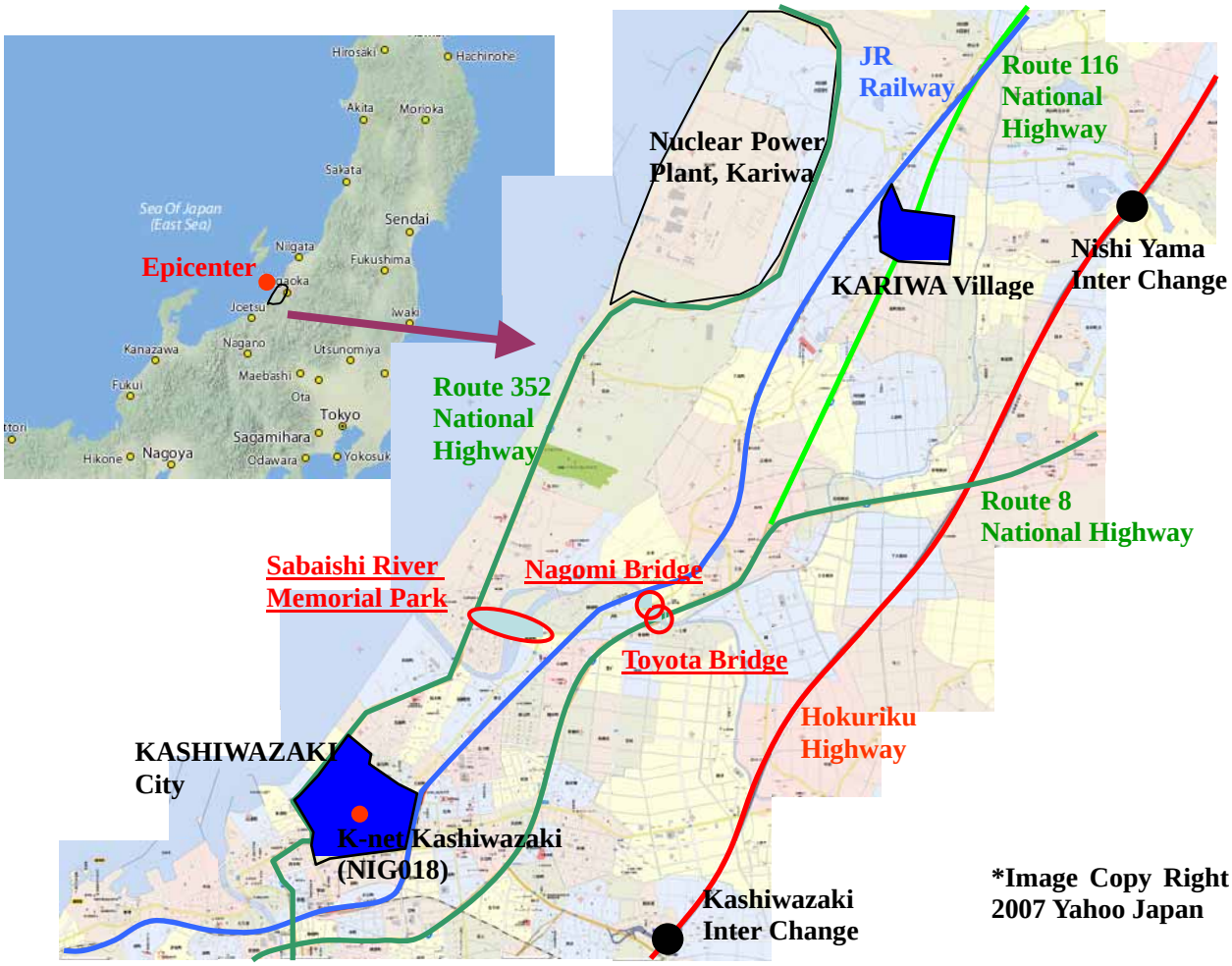
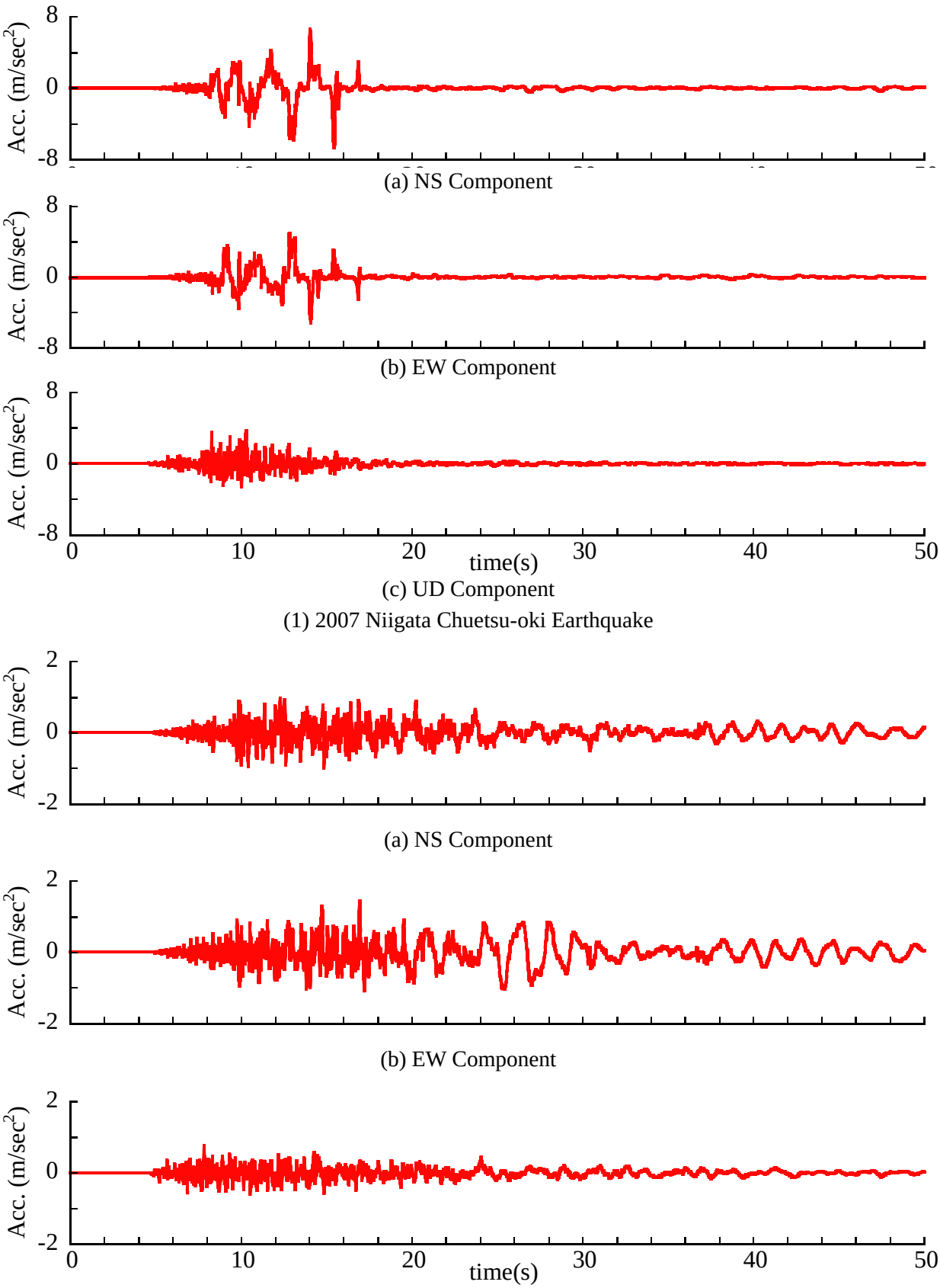


Figure 1 Surveyed Location

2. Measured Ground Motions

Figure 2 (a) shows the time histories of ground accelerations measured at Kashiwazaki city, K-net: NIG018, (refer to Figure 1 for the location). K-net is the name of system which sends the ground accelerations measured with accelerometer offered by National Research Institute for Earth Science and Disaster Prevention, NIED. For the reference, the ground accelerations measured during 2004 Niigata Chuetsu Earthquake at Kashiwazaki K-net are also illustrated in Figure 2 (b). The maximum ground accelerations during 2007 Niigata earthquake in NS, EW, and UD was 6.67 m/sec^2, 5.14 m/sec^2, 3.69 m/sec^2, respectively, where as 2004 Niigata earthquake was 0.98 m/sec^2, 1.44 m/sec^2, and 0.76 m/sec^2, respectively. From the preliminary investigation of the ground motion, it is found that there is a long pulse components included in the acceleration, like JR Takatori record during 1995 Kobe Earthquake.

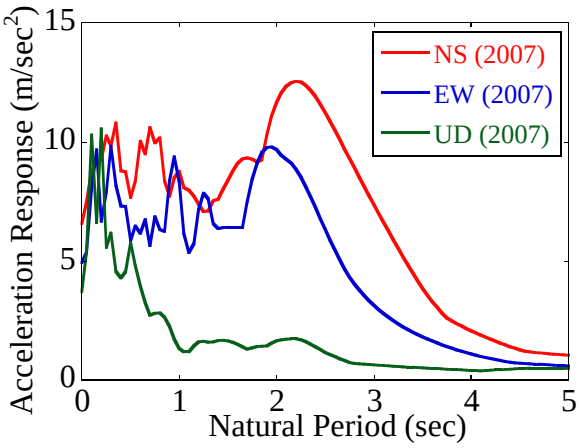
Figure 3 shows the acceleration response spectra of NIG018 assuming damping ratio as 5 %. Predominant period of horizontal component is about 2.2 seconds. Figure 4 shows the comparison of acceleration response spectra for Kashiwazaki records during 2004 and 2007 Niigata Earthquake. This acceleration response spectrum is normalized by peak ground acceleration.



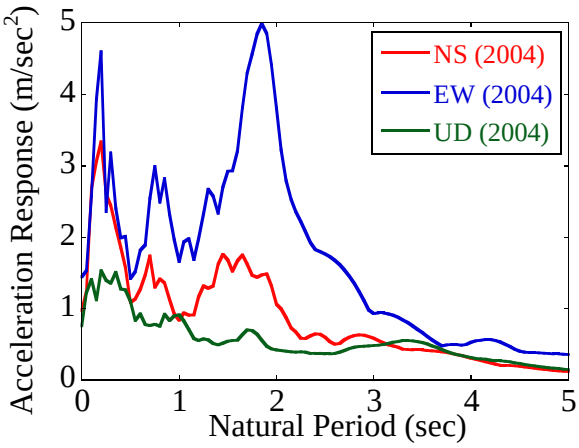
(1) 2007 Niigata Chuetsu-oki Earthquake

(2) 2004 Niigata Chuetsu Earthquake

Figure 2 Ground Motion Records at Kashiwazaki City (K-net: NIG018)

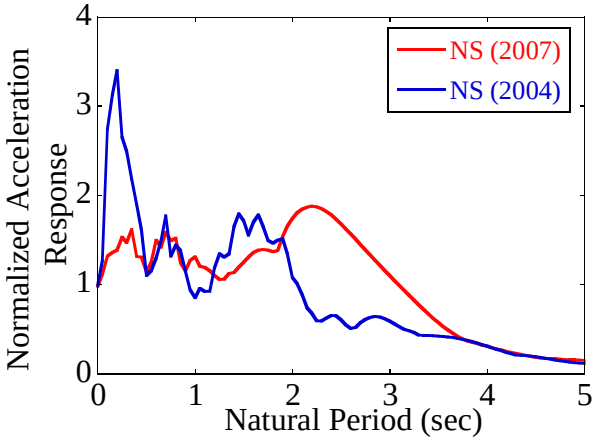


(a) 2007 Niigata Chuetsu-oki Earthquake

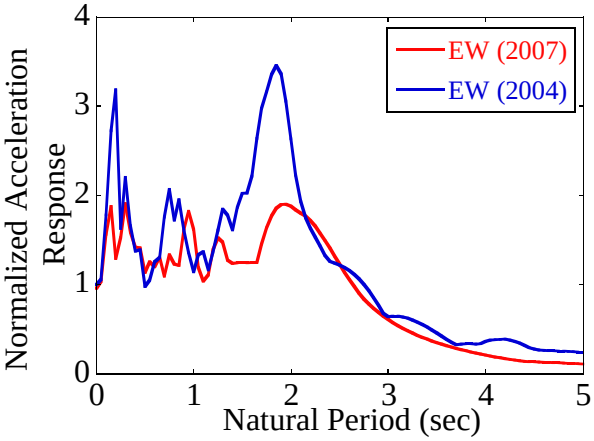


(b) 2004 Niigata Chuetsu Earthquake

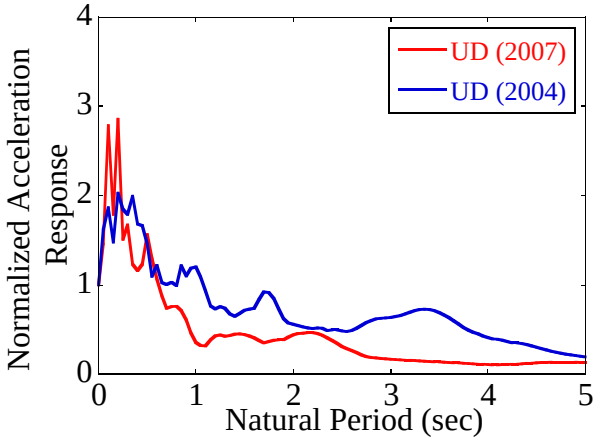
Figure 3 Acceleration Response Spectra of Kashiwazaki Record (K-net: NIG018)



(a) NS Components



(b) EW Components



(c) UD Components

Figure 4 Comparisons of Normalized Acceleration Response Spectra of Kashiwazaki Record (K-net: NIG018)

3. Damage Observation on the Route 8, National Highway

1) Toyota Bridge

Photo 1 shows the damage on bridge called 'Toyota Bridge' along the National Highway, Route 8 (refer to Figure 1 for the location). Toyota Bridge is 3-span continuous curved bridge and deck is supported by elastomeric bearings, having dimension of 700 mm x 700 mm x 250 mm (=27.6' x 27.6' x 9.8'). It is consisted of a rubber and steel plate, and the ratio between those is one. The total length and width of the deck is 160 m and 12 m, respectively.

From the observation, the backfill soil has settled approximately 400 mm (=15.7'), and the abutment has moved toward the river side, approximately 200 mm (=7.9'). Since the abutment has moved toward the river, the gap of expansion joint between the abutment and the deck has completely closed. The elastomeric bearing has permanent deformation of 200 mm (=7.9') which corresponds to the shear strain of 160 %.

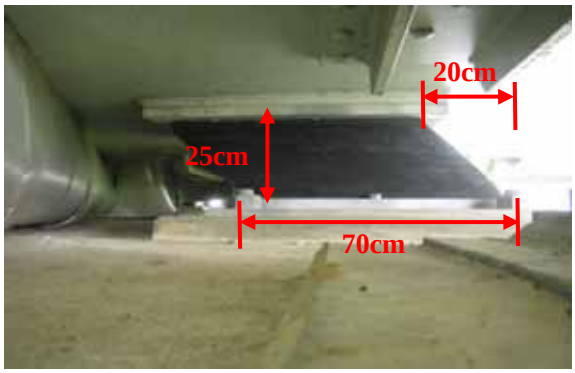
(a) Toyota Bridge

(b) Side View of Abutment A1

(c) Settlement of Backfill Soil

(d) Closure of Expansion Joint

(e) Sliding of Abutment



(f) Permanent Deformation of Elastomeric Bearing

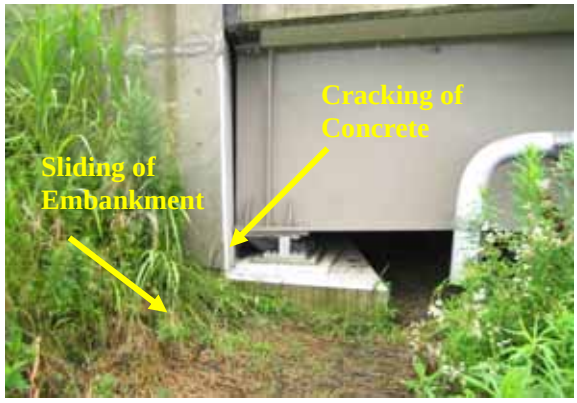
Photo 1 Damage observation of 'Toyota Bridge', National Highway, Route 8

2) Nagomi Bridge

Photo 2 shows the damage on bridge called ‘Nagomi Bridge’ which is located parallel to the Toyota Bridge (refer to Figure 1 for the location). This is straight bridge, where deck is 100 m long and 10 m wide. This bridge also supported by elastomeric bearing, however the dimension is not measured.

The damages were similar to the Toyota Bridge, that the backfill soil has settled and this results the permanent deformation of elastomeric bearing, and closure of the expansion joint gap. The rubber installed among the expansion joint has squeezed out. In the base of abutment, cracking of concrete is observed which can be estimated that this has progressed during the event.

(a) Nagomi Bridge



(b) Sliding of Embankment

(c) Cracking of Concrete, Abutment (close up)

(d) Squeeze out of Rubber among Expansion Joint

(e) Permanent Deformation of Elastomeric Bearing

Photo 2 Damage observation of ‘Nagomi Bridge’, National Highway, Route 8

4. Damage Observation in the Sabaishi River Memorial Park

Photo 3 shows the damage at the 'Sabaishi River Memorial Park' which is located at the small land near to Kashiwazaki City (refer to Figure 1). Since it was located near to the river, liquefaction and soil boiling is observed around this area. The settlement and sliding of embankment is observed at the bridge and the revetment seems had slide toward the river. In addition, on the side of slided revetment, the electric pole has tilted toward river due to the settlement of revetment.

(a) Soil Boiling near the Pavement

(b) Liquefaction of Parking Area

(c) Revetment

(d) Sliding of Revetment

(e) Tilting of Electric Pole

Photo 3 Damage observation around Sabaishi River Memorial Park

5. Damage Observation in the Kashiwazaki City

In the Kashiwazaki city, a large number of Japanese traditional wooden type houses are totally or partially collapsed, as shown in Photo 4. Most of the Japanese wooden houses are designed with have heavy roof in order to protect against the typhoon. However this produces the long fundamental period of houses, having period around 2-3 seconds. Referring to the response acceleration spectra in Figure 3, it should be noticed that the acceleration measured in the Kashiwazaki city (NIG018) have peak acceleration at around T= 2 seconds. The damage may be caused due to the resonance of structural and ground motion and this brought tragedy. The settlement of the ground is observed in the city center. There was no visible damage is observed for the structure even the ground has settled nearly 300 mm (=11.8‘).


(a) Complete Collapse of House along the Street Market


(b) Partial Collapse of House


(c) Settlement of Ground

Photo 4 Damages at Kashiwazaki City

Acknowledgment:

The accelerogram records of Kashiwazaki record is provided by K-net service (NIED) are used in this report.

The field reconnaissance is supported by Center for Urban Earthquake Engineering (CUEE), 21st Century COE Program in Tokyo Institute of Technology.

The authors would like to thank to all staff who involved for this investigation.