7/20/2007 Ver. 1.0
7/21/2007 Ver. 1.1
7/23/2007 Ver 1.2 (Added particle distribution curve)

Preliminary report of the July 16, 2007 Niigata prefecture Chuetsu Off shore (Niigata-ken Chuetsu-Oki), Japan, Earthquake

Based on the reconnaissance conducted from July 17-19, 2007
(Strong motion records by K-NET are acknowledged.)

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Related Links:

The Headquarters for Earthquake Research Promotion
http://www.jishin.go.jp:80/main/oshirase/20070716_chuetsu_oki.htm

ERI (English):
http://www.eri.u-tokyo.ac.jp/topics/niigata20070716/index-e.html

DPRI
http://sms.dpri.kyoto-u.ac.jp/chuetsuoki070716.html
http://wwwcatfish.dpri.kyoto-u.ac.jp/~goto/eq/20070716/report0.html
http://www.eqh.dpri.kyoto-u.ac.jp/~masumi/eq/niigata.pdf

Japan Geotechnical Society (Japanese)
http://www.jiban.or.jp/organi/bu/somubu/19niigatachuetsu/niigatachuetsusokuho.html

K-NET (NIED)
http://www.k-net.bosai.go.jp/k-net/

Niigata prefecture (Japanese)
http://bosai.pref.niigata.jp/bosaiportal/0716jishin/higai/index.html
http://bosai.pref.niigata.jp/bosaiportal/0716jishin/photo/photo.html

General information

A large earthquake occurred (preliminary Mj 6.8, D=15 km) at 10:13AM on July 16, 2007 in Chuetsu region, Niigata, Japan. The epicenter was located off shore of Kariwa village and Kashiwazaki city (Fig. 1). Preliminary results of the source inversions show a reverse fault with the NE-SW (strike: 34, Dip: 51, Rake: 74 degrees) (http://wwweic.eri.u-tokyo.ac.jp/topics/20070716/), and the rupture propagated to North and South directions.

The instrumental JMA seismic intensity (Fig. 1) was 6+ (IX in MMI) in Kariwa village, Kashiwazaki city, Nagaoka city, in Niigata prefecture, and Ohzuna-machi in Nagano prefecture.

Ten people were killed and more than 1284 were injured and more than 10,000 were evacuated (as of 7/20/07, Niigata Prefecture). The number of totally collapsed houses were 949 in Niigata. Major lifelines, gas, water, electricity, have been damaged and suspended for more than a day. Electricity was recovered after a day in most of the area. Water supply has not been recovered for four days (as of July 20, 2007). In Kariwa village, one of the world largest nuclear power plants (7 reactor's total 8,200,000 kW), which reportedly suffered damage due to unexpectedly large strong shaking (recorded 6.8 m/s^2, designed with 2.7 m/s^2)

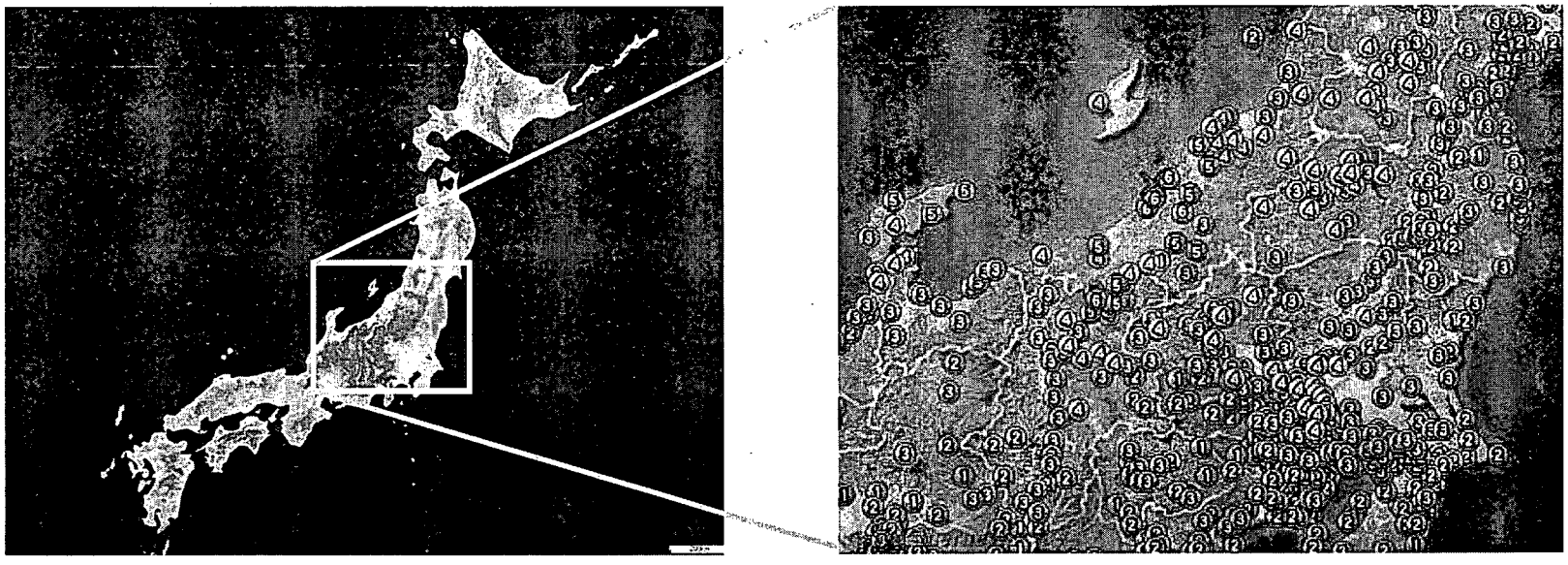
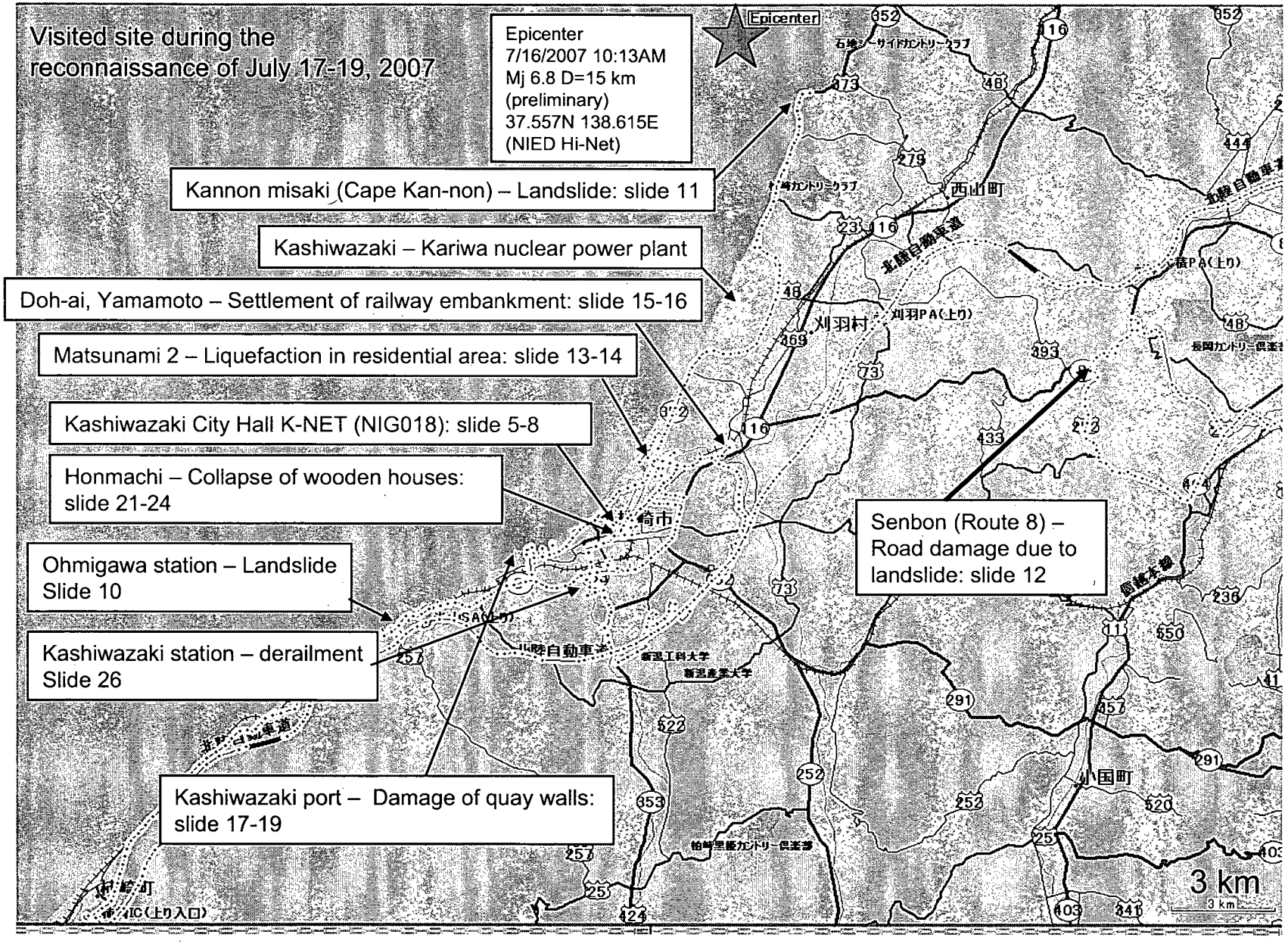


Figure 1 Location of the epicentral area


Visited site during the reconnaissance of July 17-19, 2007
Epicenter
7/16/2007 10:13AM
Mj 6.8 D=15 km
(preliminary)
37.557N 138.615E
(NIED Hi-Net)
Kannon misaki (Cape Kan-non) – Landslide: slide 11
Kashiwazaki – Kariwa nuclear power plant
Doh-ai, Yamamoto – Settlement of railway embankment: slide 15-16
Matsunami 2 – Liquefaction in residential area: slide 13-14
Kashiwazaki City Hall K-NET (NIG018): slide 5-8
Honmachi – Collapse of wooden houses: slide 21-24
Ohmigawa station – Landslide Slide 10
Kashiwazaki station – derailment Slide 26
Kashiwazaki port – Damage of quay walls: slide 17-19
Senbon (Route 8) – Road damage due to landslide: slide 12
西山町
刈羽村
小国町
3 km

Recorded K-NET strong motion (Fig. 2) shows spiky response in the horizontal records which is typically seen for dense sands under the state of cyclic mobility caused by a liquefaction. Peak accelerations are observed in the time period of 25 - 28 seconds when the spiky response is dominant. Their values are 6.67 and 5.13 and 3.69 m/s^2, respectively, in the NS, EW and UD directions. Duration of shaking is about 10 seconds. Soil profile at the site also indicates dominancy of dense sands at shallower depth < 5 m (Fig. 3).

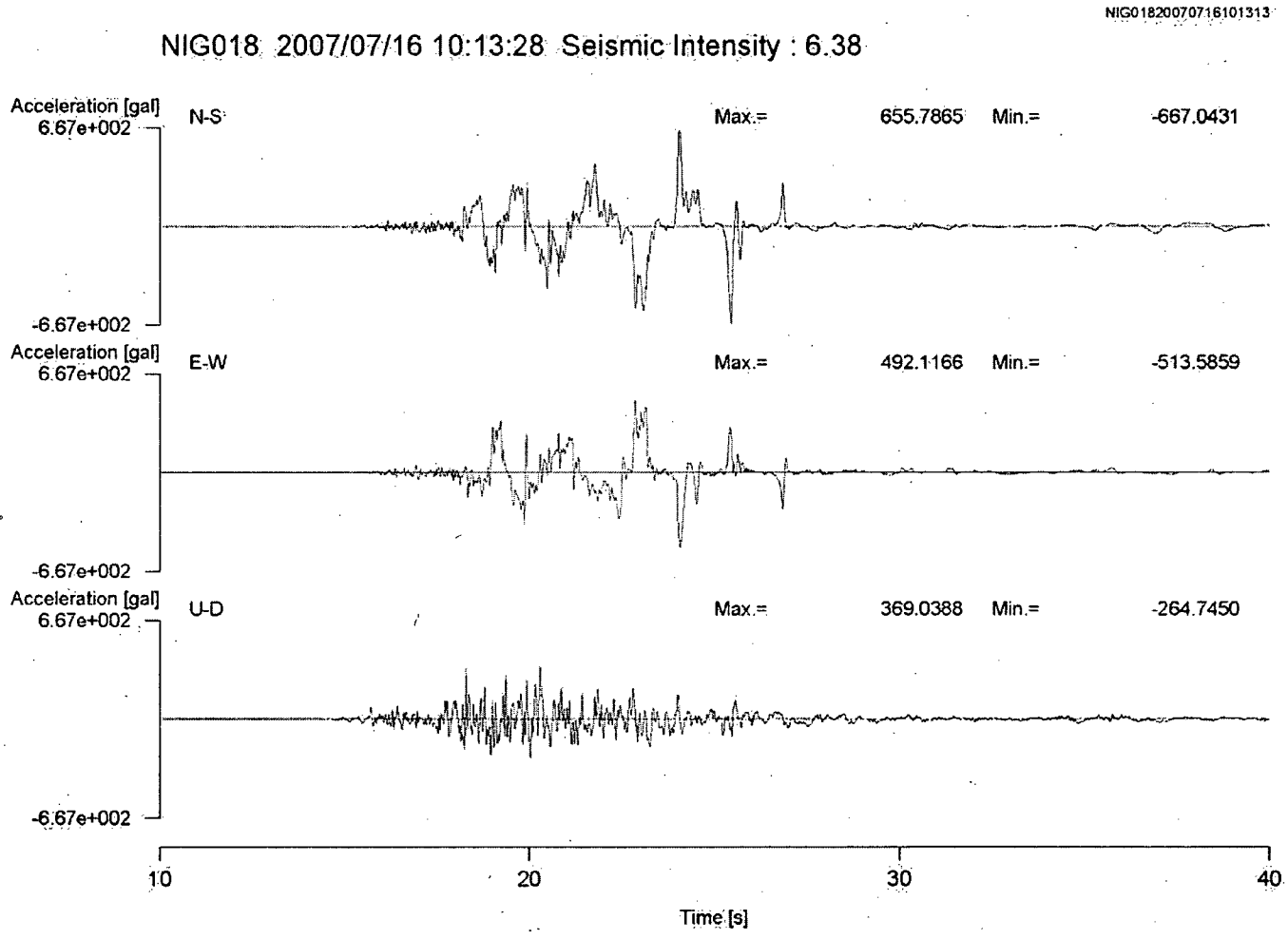
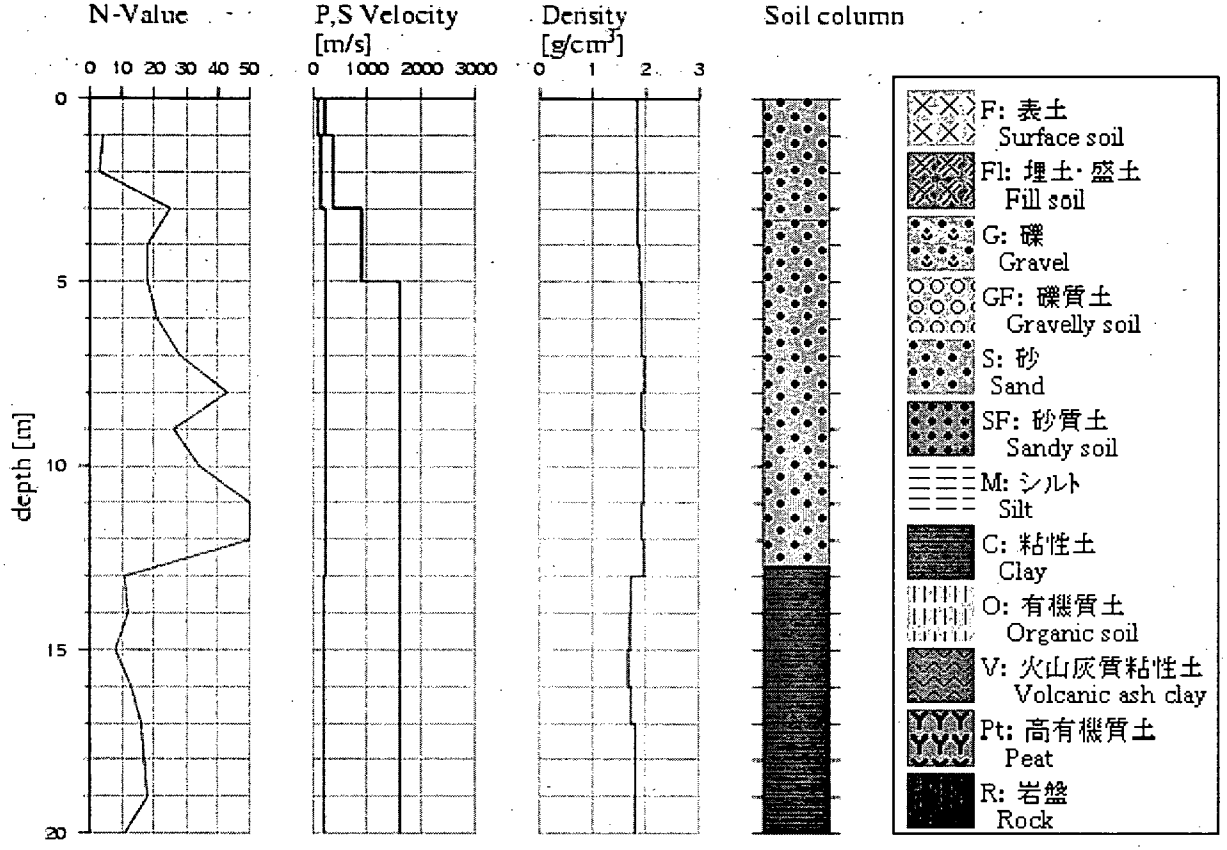


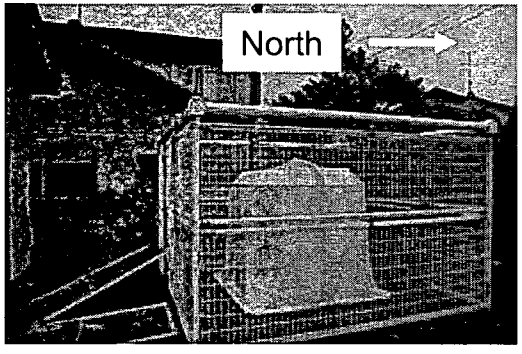
Figure 2 Acceleration record of NIG018, K-NET, 10:13AM, July 16, 2007



From P wave velocity, the ground water level is expected to be about G.L.. -4 to -5 m. The ground water level at the event has to be investigated. The amount of precipitation in July, 2007 in Kashiwazaki is 46 mm that is 21 % less than the average year(220 mm) (JMA AMEDAS).

On plotting STP N-value, K-NET site has no information regarding the energy ratio. This will be investigated later.

Figure 3 Soil profile at Kashiwazaki, NIG018, K-NET (after NIED).



NIG018 (K-NET) site Behind trees: 37.3724N, 138.5579E. Elevation: 10.00m

Near the K-Net site, major cracks on road asphalt may indicate occurrence of lateral spreads toward down-slope. (Fig. 5).

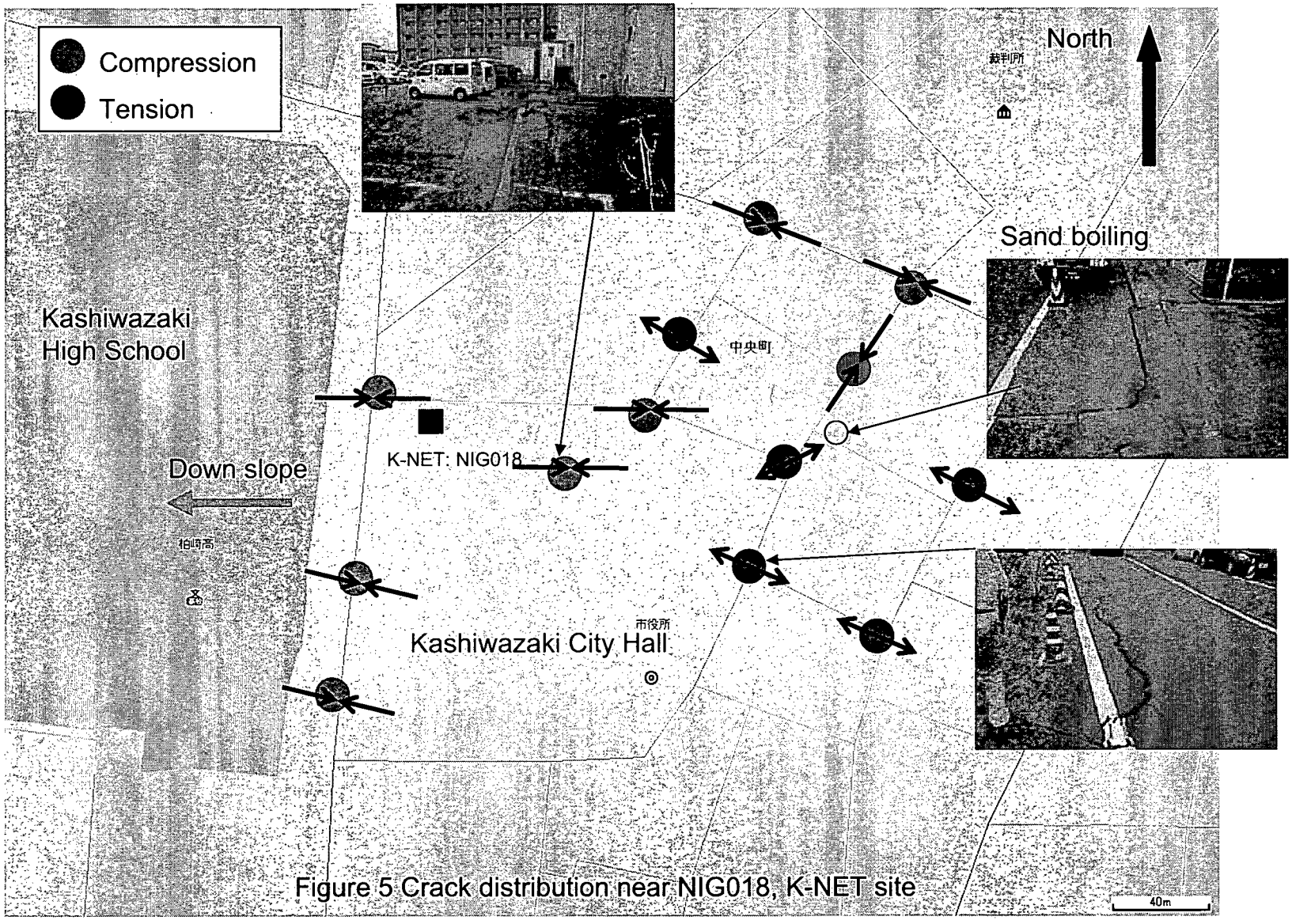


Figure 5 Crack distribution near NIG018, K-NET site

The acceleration time histories of 2003 Niigata-ken Chuetsu earthquake recorded at NIG018 show no spikes due to cyclic mobility (Fig. 4).

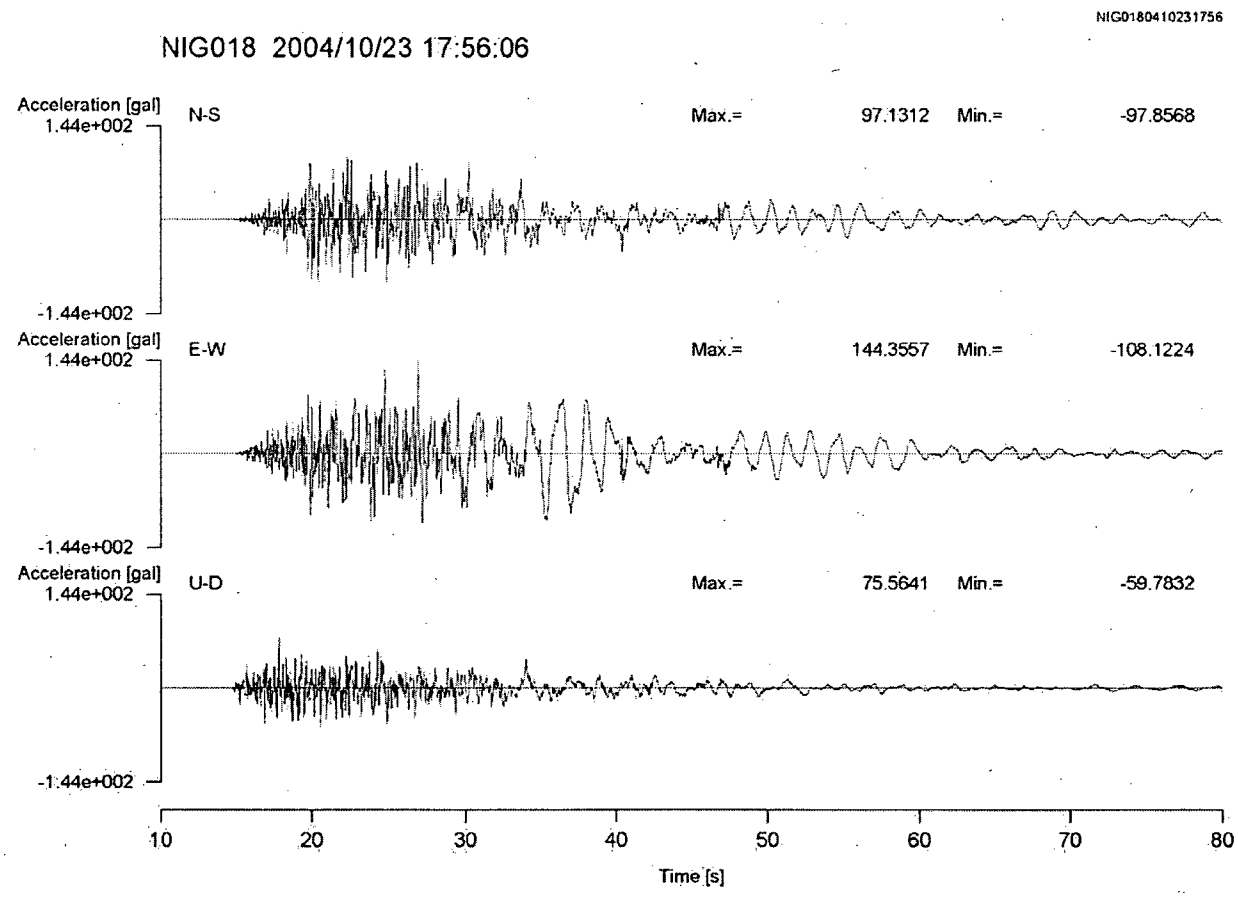
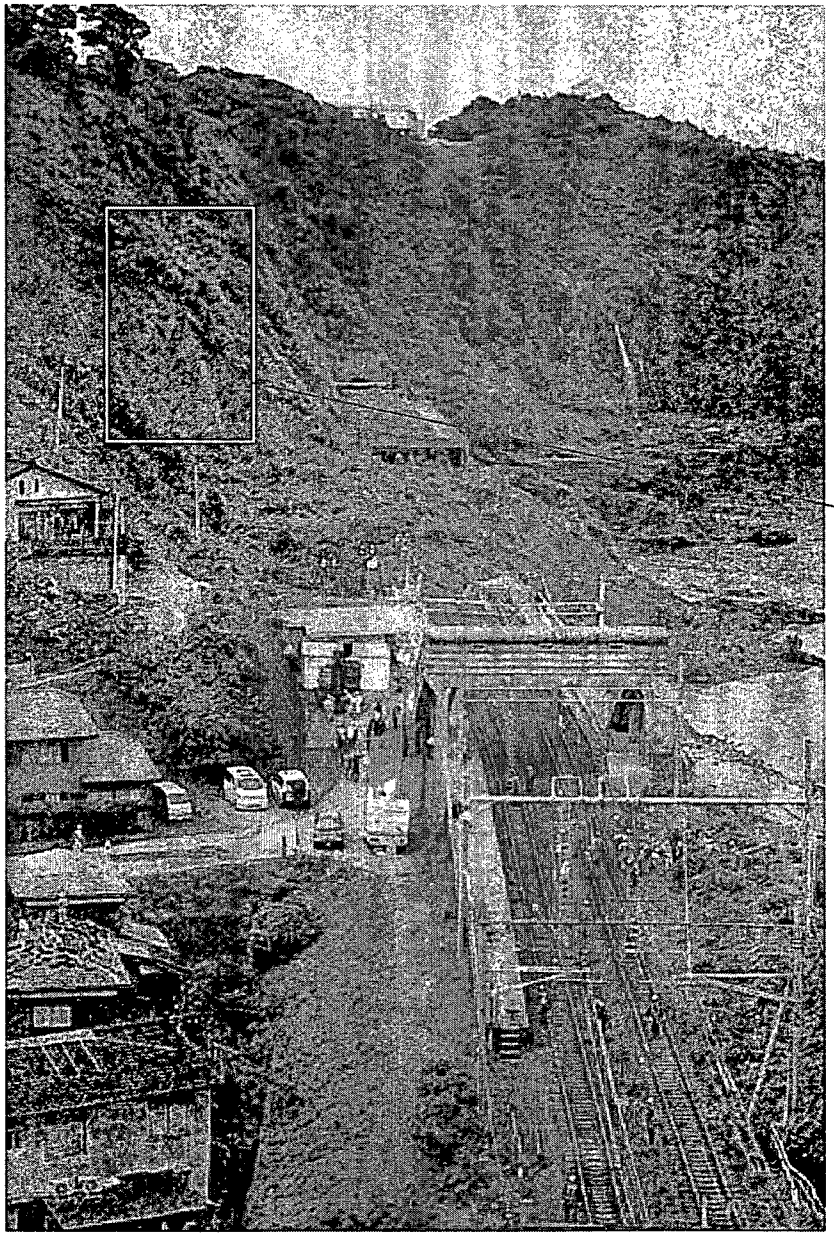
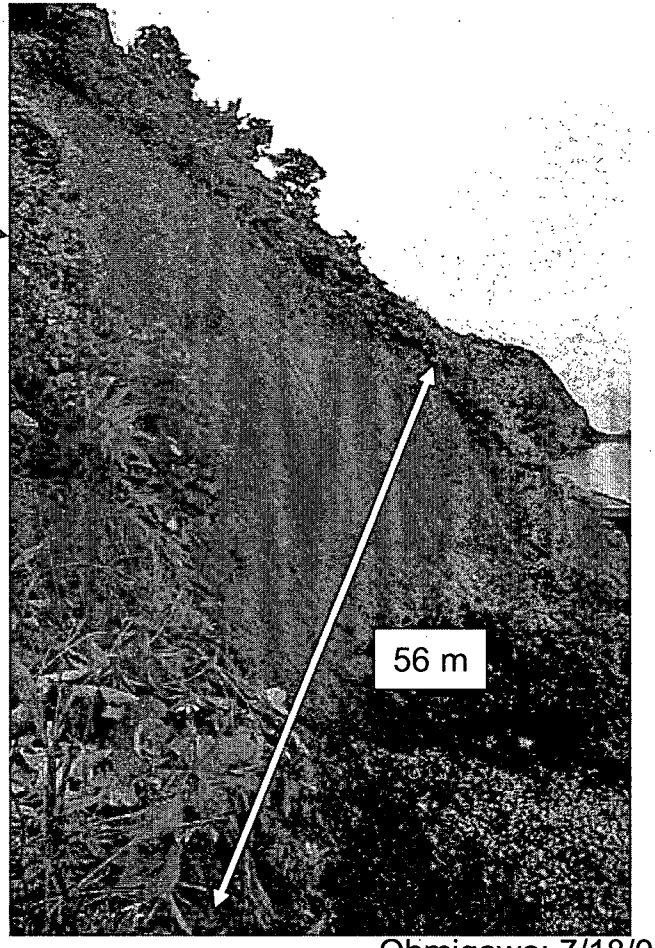


Figure 4 Acceleration time history of 2003 Niigata-ken Chuetsu earthquake recorded at NIG018, K-NET, 17:56, October 23, 2004

Photographs

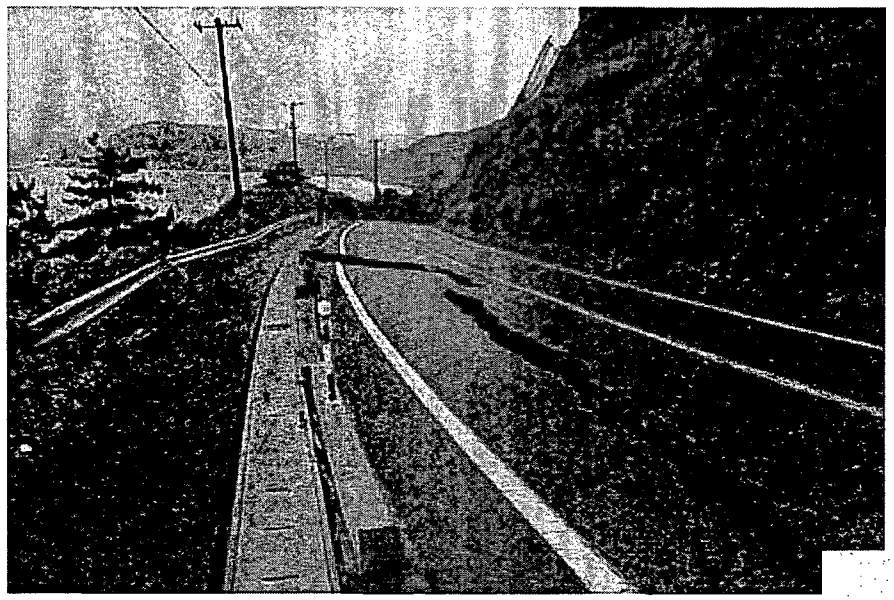


Two landslides near the Ohmigawa station of JR Shin-Etsu line covered rail tracks by the coast line. According to a fisherman who was in the sea for catching oysters near the site, the landslide started simultaneously with strong shaking and, in his impression, duration of sliding was in a very short time.



Ohmigawa: 7/18/07

Landslide at Kan-non misaki (Cape Kan-non)



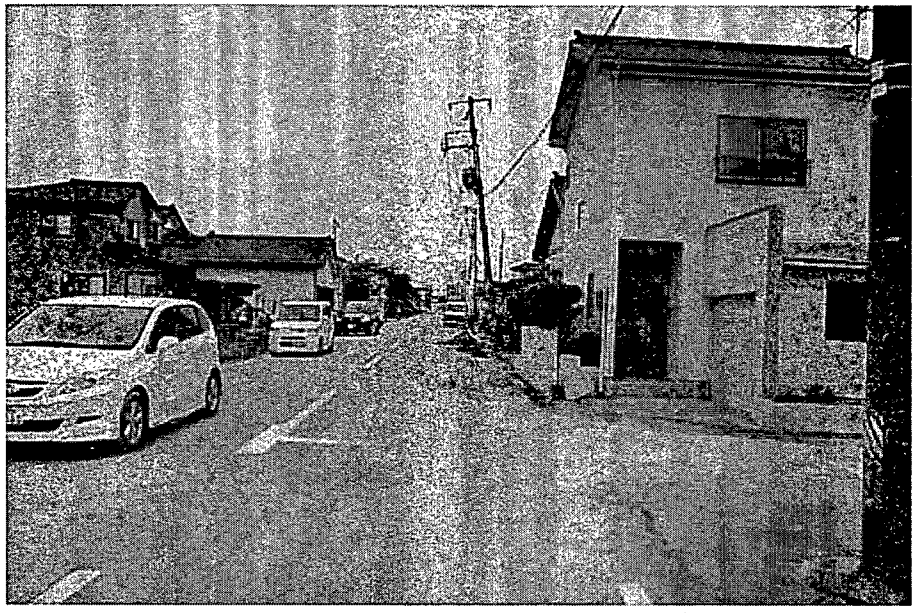
Two landslides were occurred in the North of Kan-non misaki, the nearest land from the epicenter. The landslides covered the Route 352.

Kan-non Misaki: 7/17/07

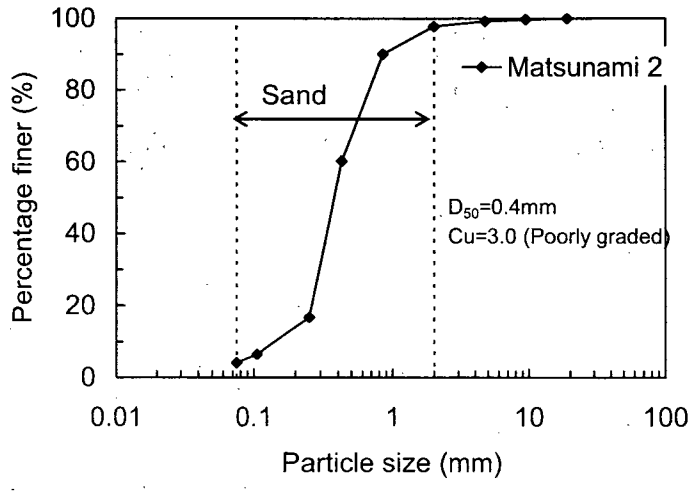
Major arterial road, Route 8, which connects Kashiwazaki to Nagaoka was damaged at Senbon due to landslides. Slide started at about 60 m above the road pavement. Width of broken road was about 80 m.

Damage on utility poles, asphalt roads, houses due to liquefaction were found in Matsunami 2, Kashiwazaki city. The site which was originally farm lands and sand dunes was developed as a residential site in 1973-1976. The area is 14 ha and east part of the developed land suffered heavy damage due to liquefaction. Eye witness accounts of evidence confirms the occurrence of liquefaction after the large shaking with an eruption of muddy water at 2 m high.

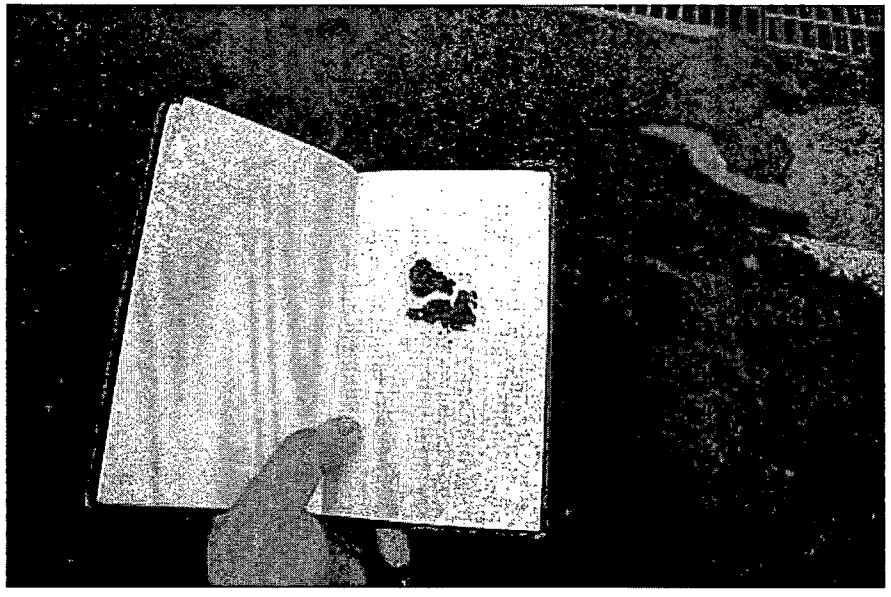
Matsunami 2: 7/17/07



Utility poles were settled and tilted, but no manholes were uplifted.

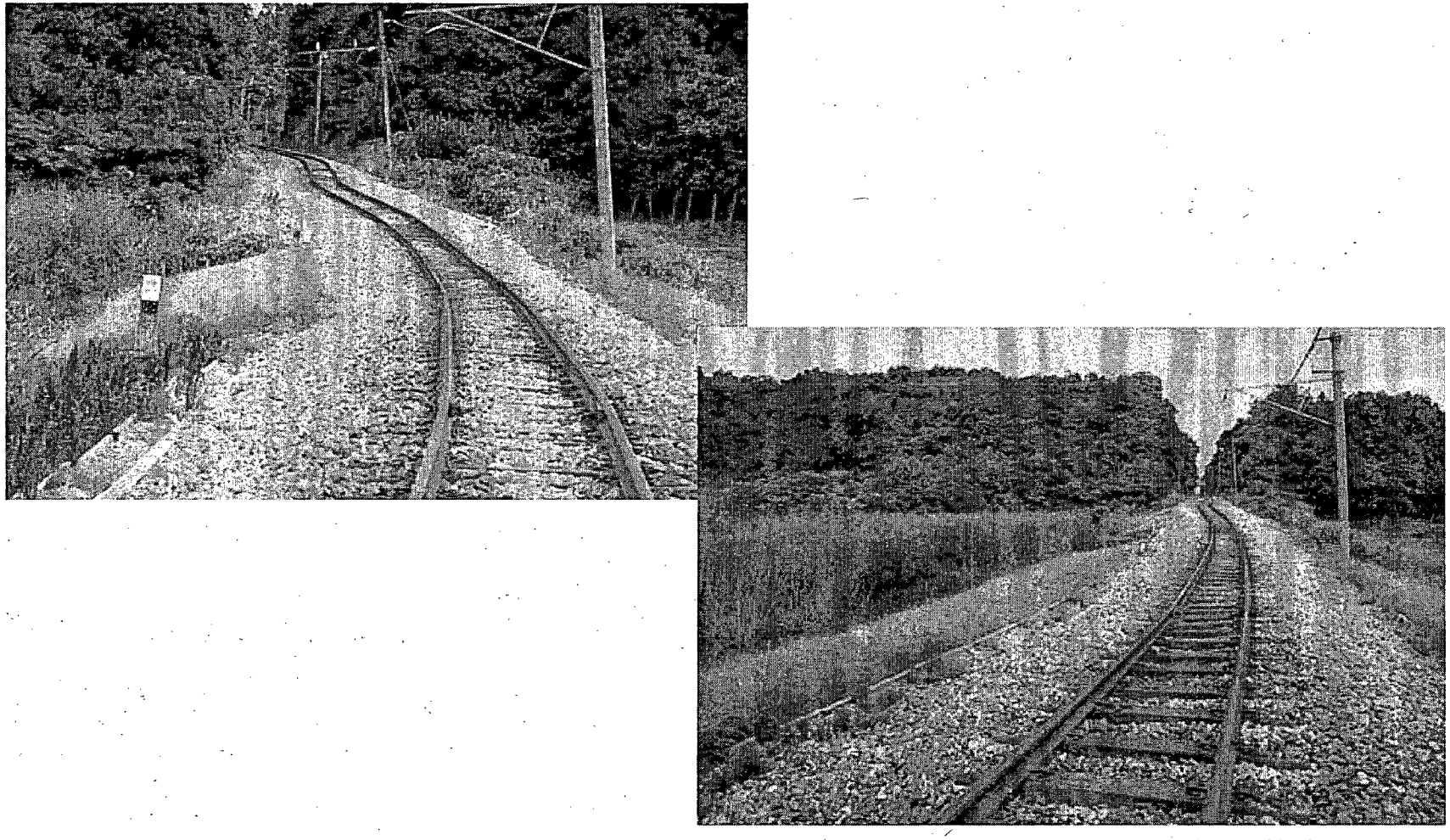


Erupted sand was medium to coarse sand



Matsunami 2: 7/18/07

Settlement of a railway embankment due to the loss of the bearing capacity of its base ground was found in Doh-ai. The railway is crossing a pond with distance of 125 m and that part was settled. Evidence of liquefaction was NOT? found?? (need confirmation). Cross sectional dimension of the embankment after deformation is 6.8 m at the crest, and 16 m at the toe. Its height after deformation is 1.2 m.

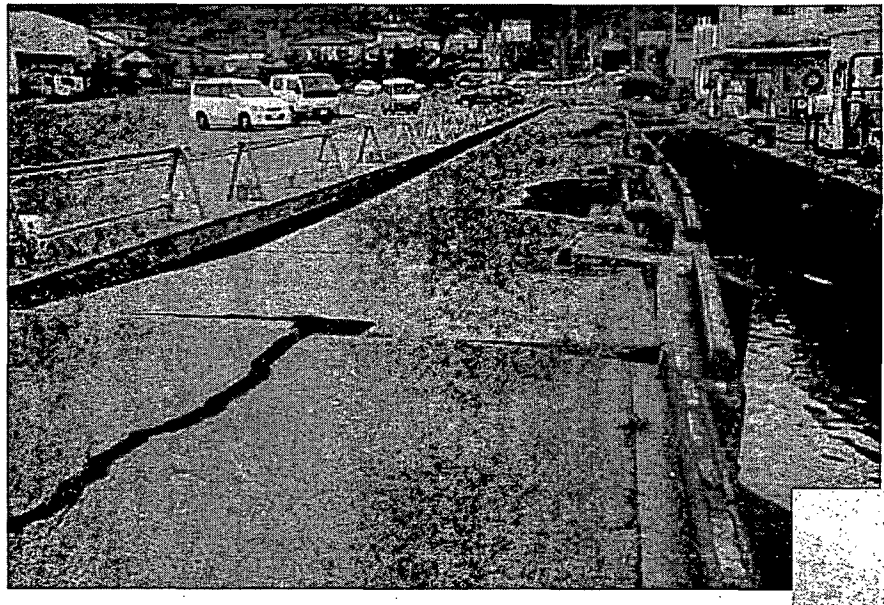


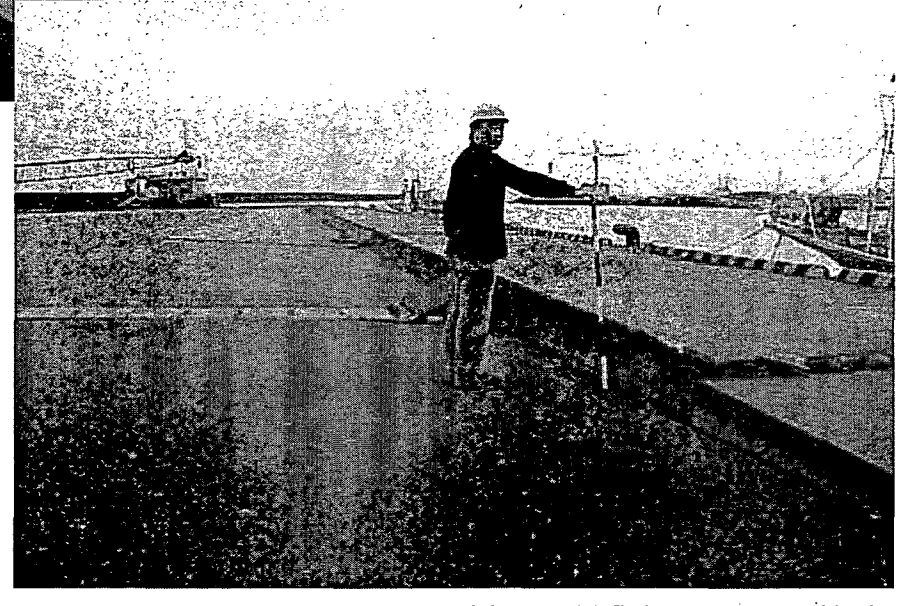
Doh-ai: 7/18/07

Road pavements near the railway settlement were damaged due to a possible liquefaction of filled material for constructions of swage pipes and manholes. This indicates that a predominant soil in this area is cohesive and low permeable material.

Doh-ai: 7/18/07

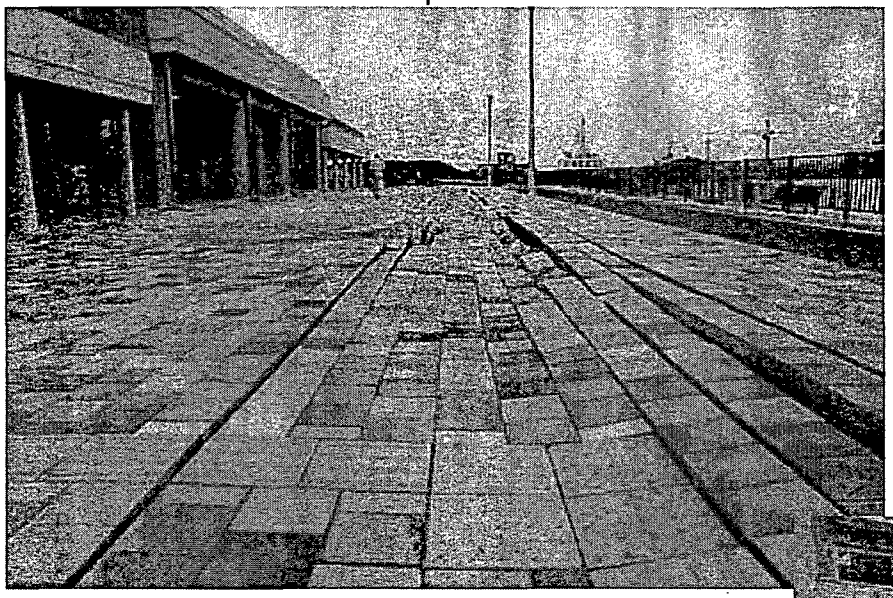
Kashiwazaki fishery port
Minor to 50 cm of settlement of apron was found.
Deformation toward sea < 1m: Sheet pile type quay wall with tie rods



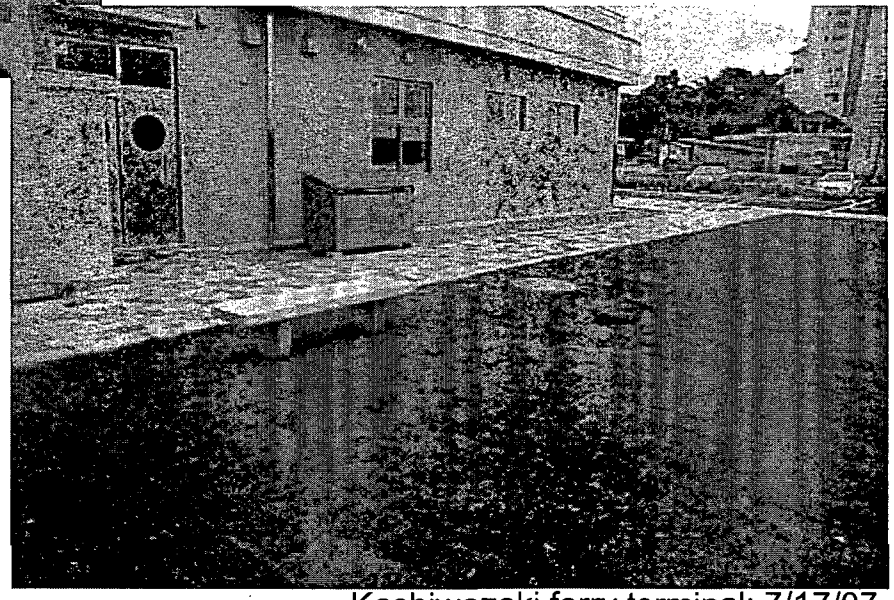


Kashiwazaki fishery port: 7/17/07

Kashiwazaki ferry terminal building:
Building suffered no damage but evidence of liquefaction was found.
Pavement blocks were separated and settled.

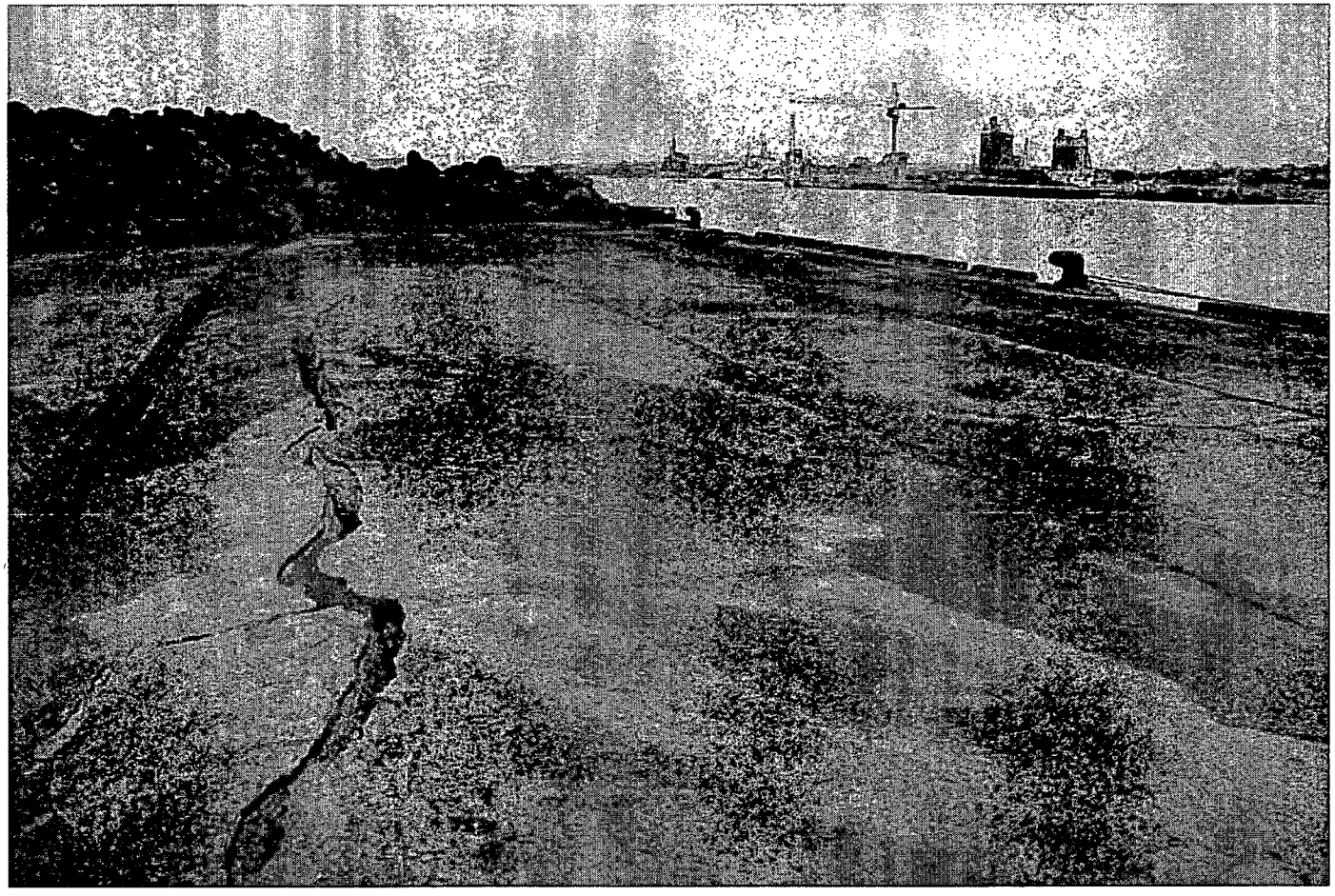


Sand volcanoes at the back of the building



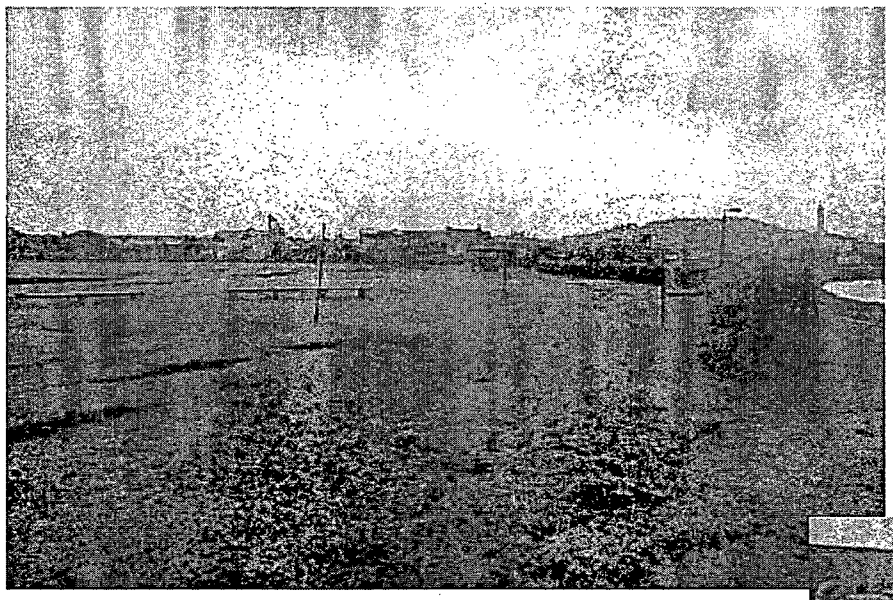
Kashiwazaki ferry terminal: 7/17/07

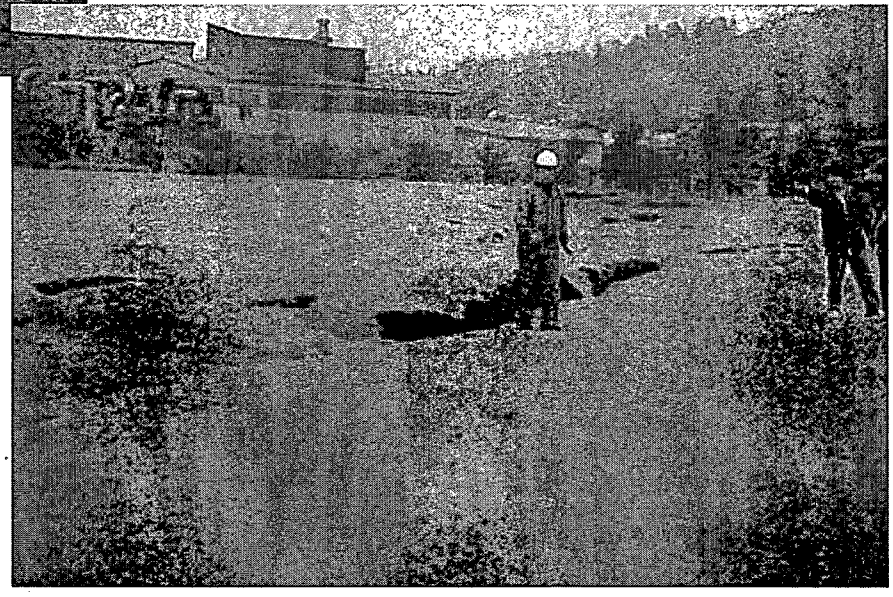
Damage of a sheet pile type quay wall with tie rods
Broken concrete slab indicates that tie rods connected sheet pile walls pulled anchoring piles toward sea.



Kashiwazaki fishery port: 7/17/07

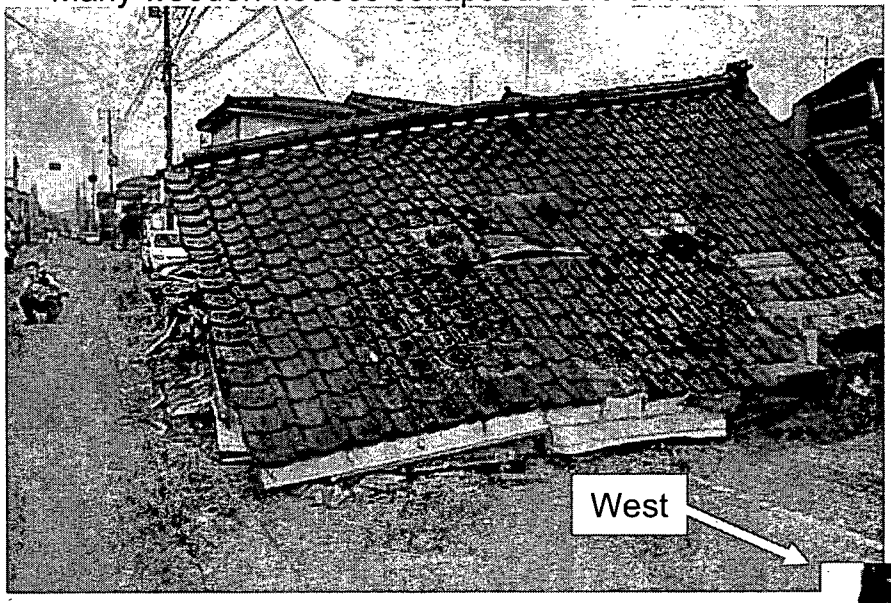
Large ground fissures due to liquefaction were found in the Sabaishigawa kaishu-kinen park, Makihara, Kashiwazaki. The park was constructed on a sandbar along the Sabaishi river.



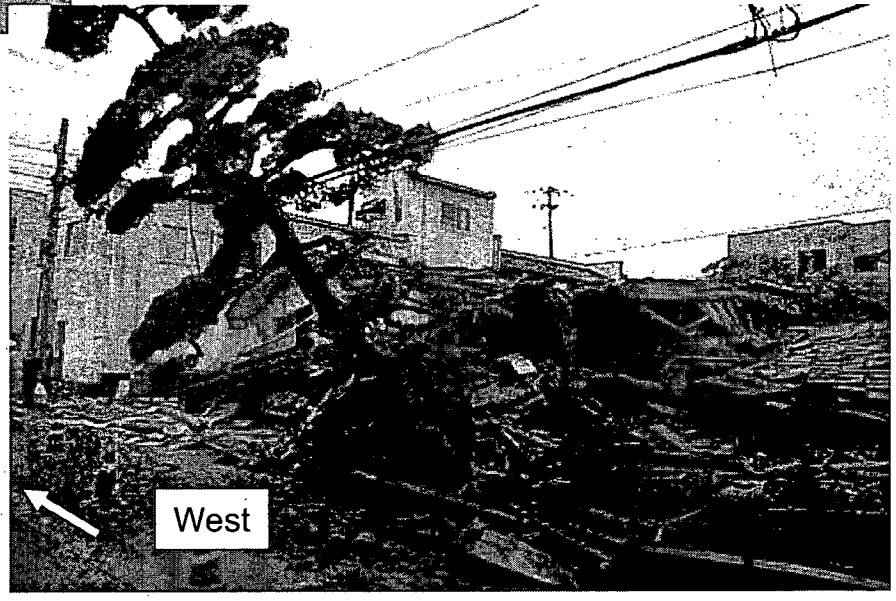


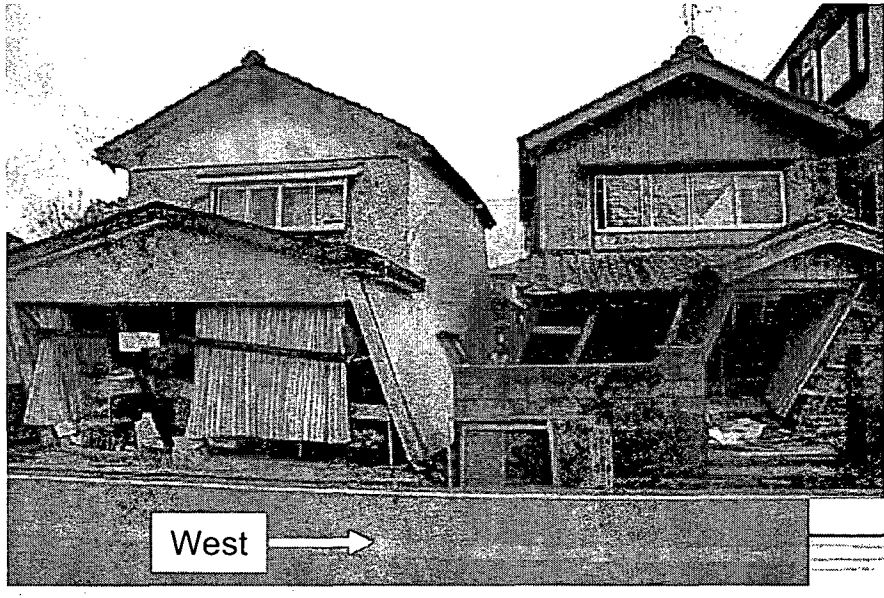
Sabaishigawa kaishu-kinen park: 7/17/07

Near Higashi Honmachi 2 and 3
Many wooden houses collapsed. One of the most damaged area in Kashiwazaki.



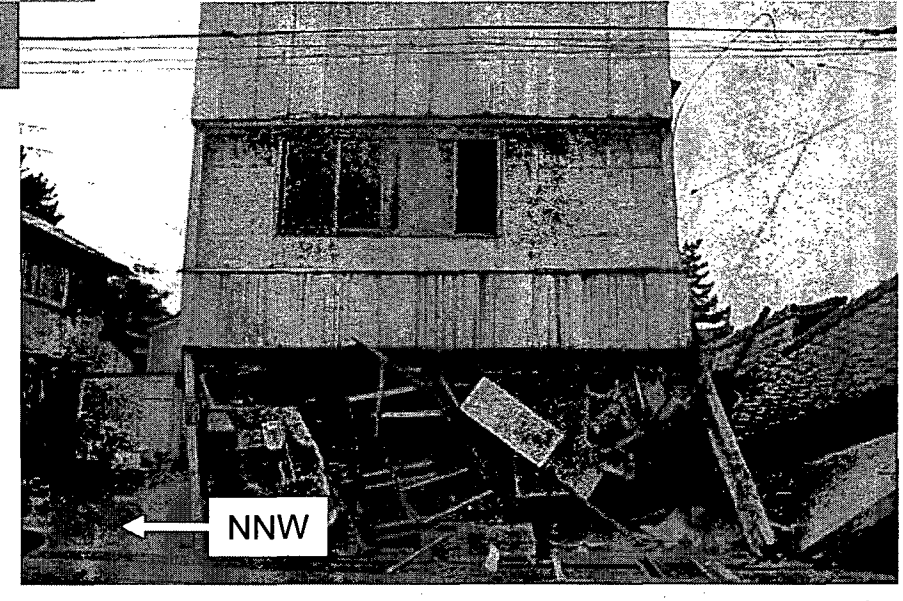
Typical collapse pattern of wooden houses





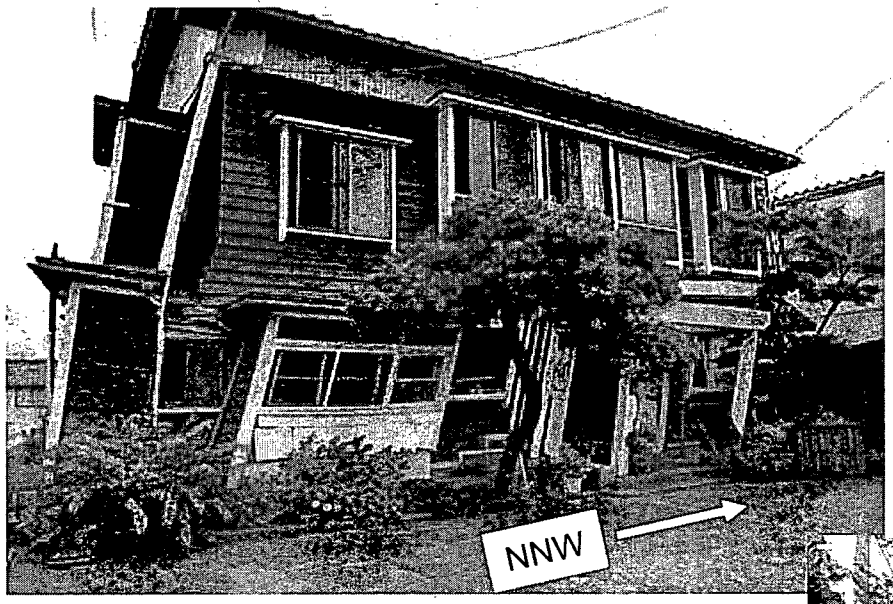
First floor of wooden houses shown above tilted into the opposite direction each other. This indicates that houses were shaken with their natural period.

Old steel frame building were also damaged



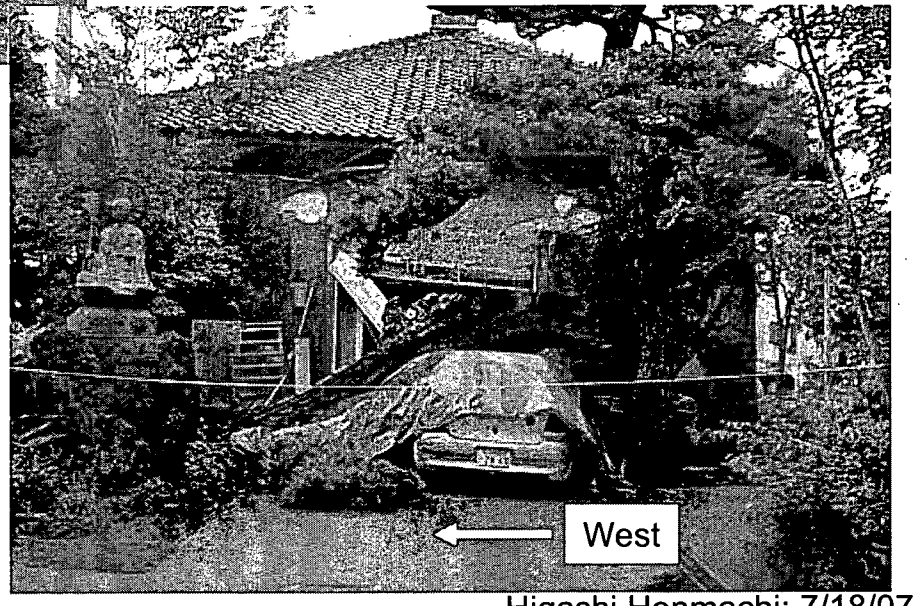
Higashi Honmachi: 7/18/07

Damage to cultural properties



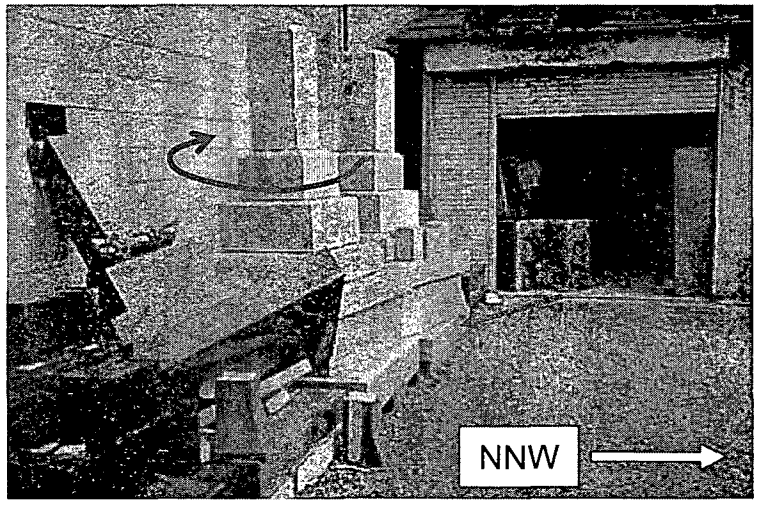
Two story wooden building used as a museum

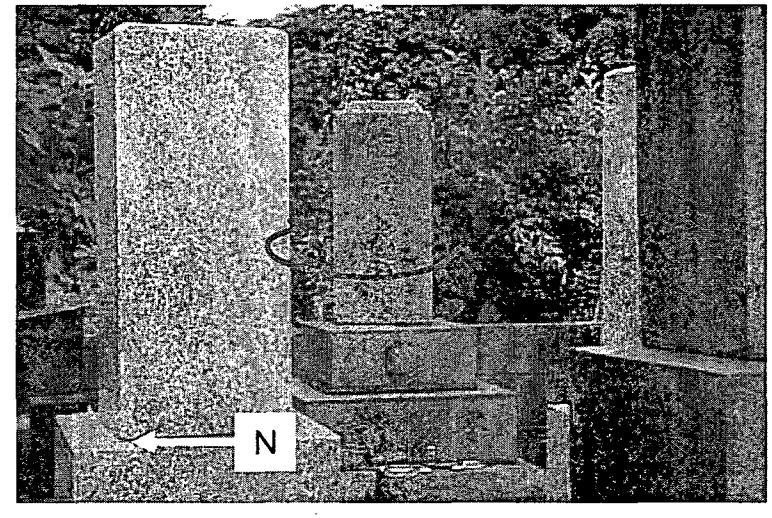
Collapsed entrance roof of the Enma-do, temple

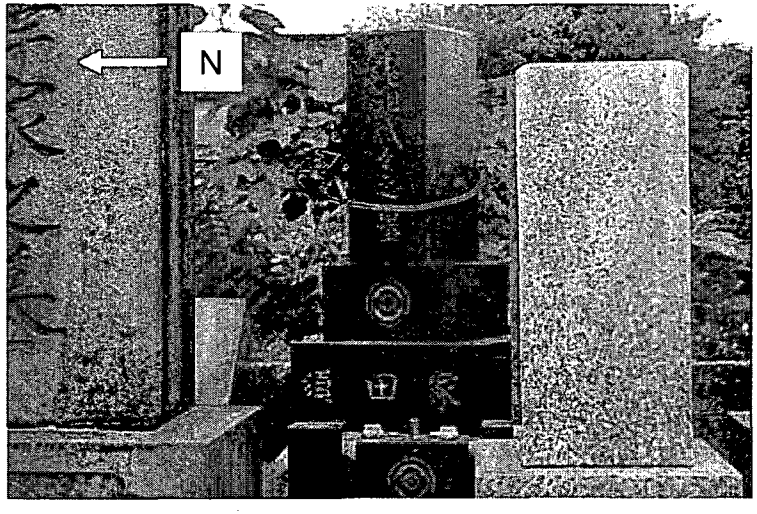


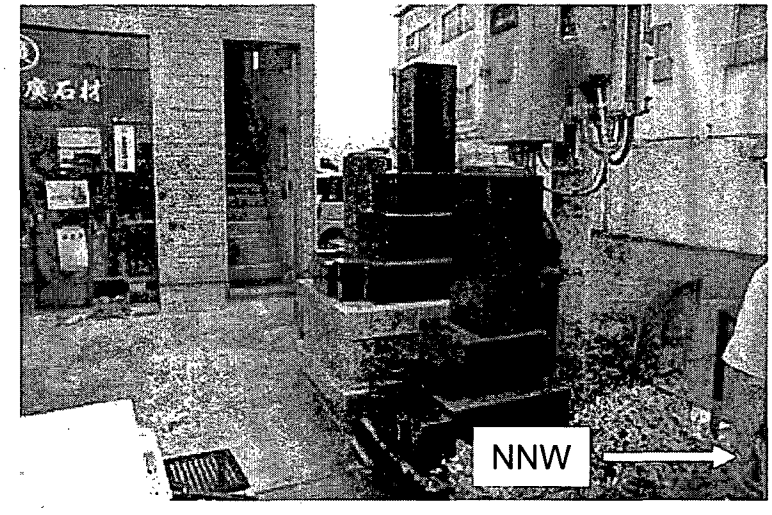
Higashi Honmachi: 7/18/07

Many Japanese-style tomb stones were rotated in the clockwise direction in Honmachi. However, some collapsed to the east and some slid to the west.



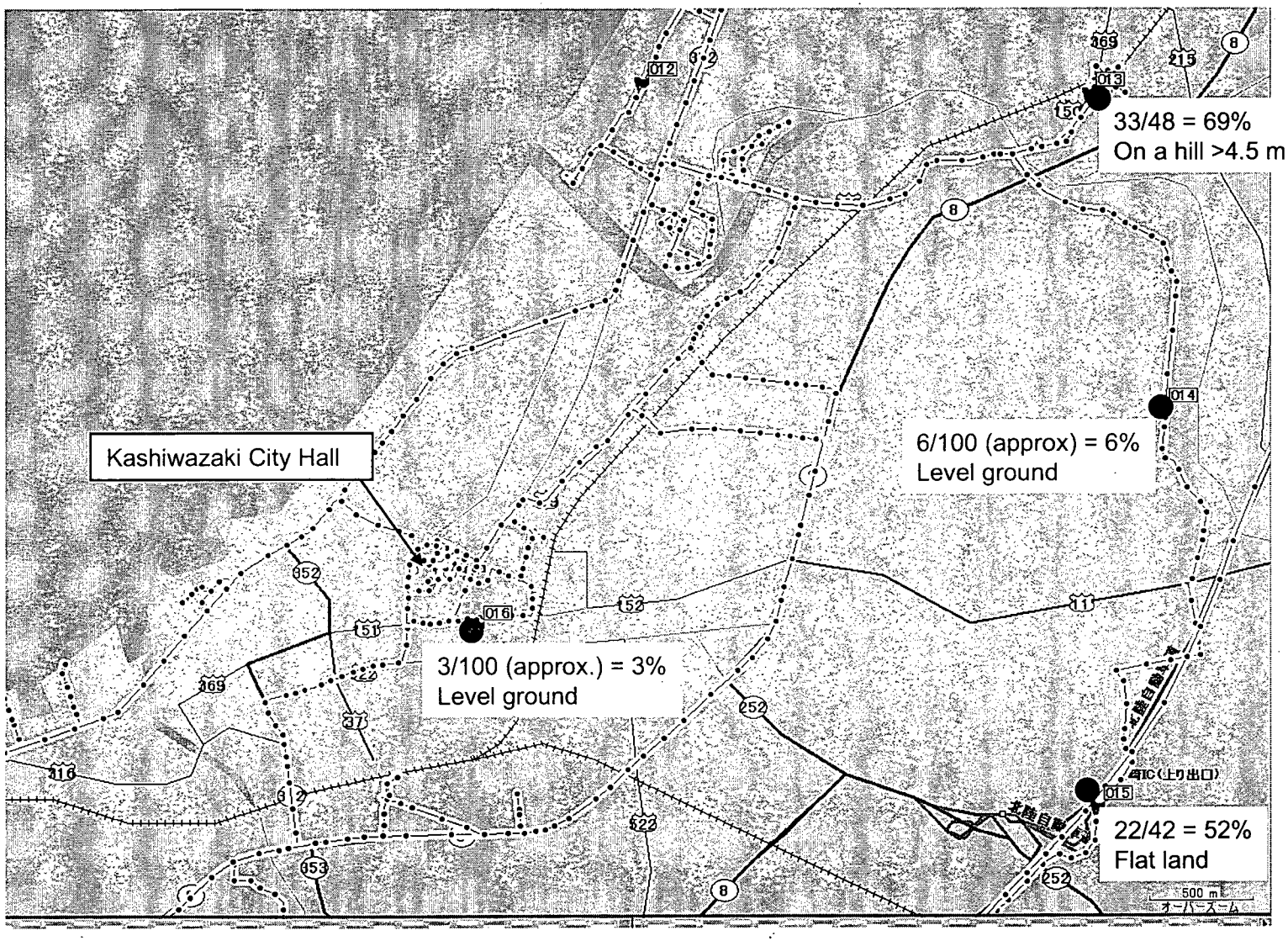




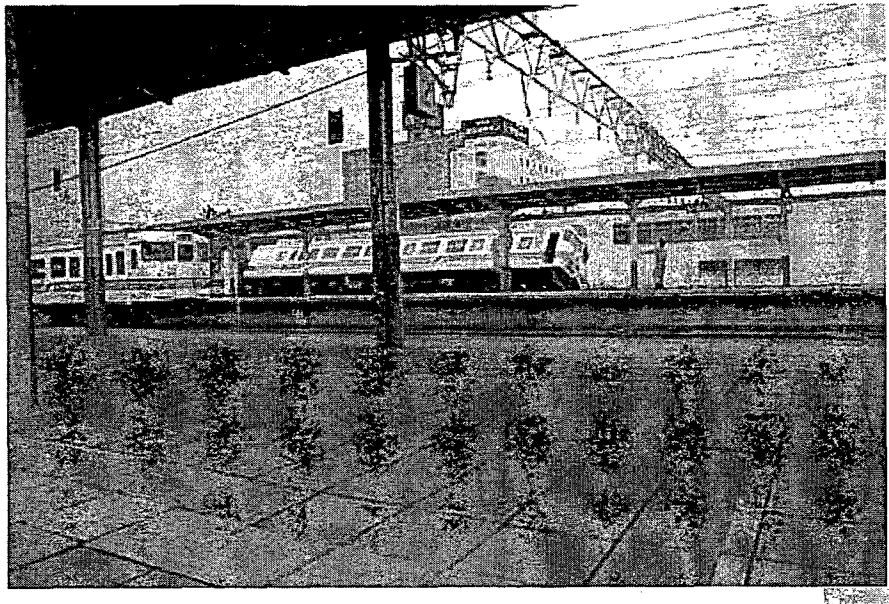


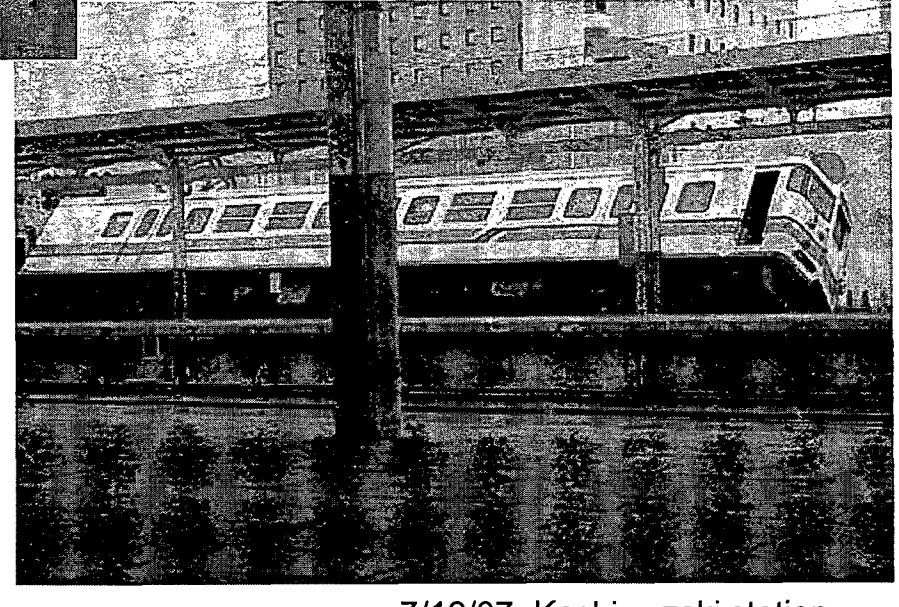
Higashi Honmachi: 7/18/07

Overturning ratio of tomb stones (Number of overturning)/(Number of standing)



In Kashiwazaki station, first car of local lines, which consisted of two cars, derailed just before leaving at the station. Some passengers were on board, but no one was hurt.





7/19/07: Kashiwazaki station

Preliminary observation

- K-NET record shows high spikes due to cyclic mobility caused by a liquefaction of dense sands. Pavement cracks due to tension and compression may indicate direction of ground deformation near the K-NET station.
- Landslides caused major damage on railways and roads.
- In Matsunami, Kashiwazaki, liquefaction caused damage to foundation of residential houses. Utility poles were settled, but no manholes were uplifted.
- In Doh-ai, Kashiwazaki, a relatively small embankment for rail tracks of were settled < (approx) 1 m due, may be, to the loss of bearing capacity of the base ground. The embankment was constructed in a natural pond. Uplifted manholes near the site indicate that a predominant soil in this area is cohesive and low permeable material.
- In Kashiwazaki port, Sheet pile type quay walls with tie rods were damaged, but not totally collapsed. Sand boiling was observed.
- In Makihara, lateral spread occurred in a park constructed on a sandbar.
- In Higashi Honmachi, many wooden houses collapsed toward west. Tomb stones were rotated in the clockwise direction.