

PRELIMINARY RECONNAISSANCE REPORT ON
THE 2004 CHUETSU EARTHQUAKE (Mid Niigata Earthquake)

- Magnitude: M = 6.8 (JMA)
- Maximum intensity: 6⁺ (7)
- Affected area: Central part of Niigata Prefecture, Japan
- Time: 5:56 PM JST on October 23, 2004
- Other details: Within 40 minutes after the main shock, three aftershocks with magnitudes from M = 6.0 to M=6.5 hit the area; Peak horizontal accelerations of 1.5 g were recorded during the main shock at Ojiya-city

INVESTIGATION DETAILS

- Date: October 29 and 30, 2004
- Area: Ojiya, Kawaguchi, Tokamachi and Horiuchi
- Team members: I. Morimoto, T. Yamashita, T. Tochio, M. Kamei and M. Cubrinovski (Kiso-Jiban Consultants)

The inspection team was predominantly interested in the geotechnical aspects and related damages. This preliminary report serves to provide quick release of first-hand information and images from the area affected by the quake. The report is restricted to the investigated area/sites and discusses only damages examined in our field inspection.

GENERAL COMMENTS

A large number of landslides and rock falls took place during the earthquake on steep natural slopes and road cuts in the area. The roads and railway running along the mountain walls were crosscut at many places by slides and debris. The various slope failures and the damages associated with them appear to be one of the most prominent geotechnical features of this earthquake. Considering the failure mechanism and effects on the engineering structures, the observed slope failures can be generally classified in three groups: (a) large landslides, (b) failures of very steep natural slopes, and (c) slides beneath cuts and embankments causing collapse of roads and railways.

On our route, we encountered two major landslides in the area of Myoken-machi (Road No. 589) and in the area of Kawai on the Road No. 196. In both cases the debris contained rocks and large boulders. (*Section 1*)

Rock falls and failures of steep slopes were frequently encountered on the route. Typically, the failure of very steep natural slopes was relatively shallow, but over a wide area. In several cases the slide debris buried roads, railways and houses located near the foot of the slopes. (*Section 2*)

Very serious damages including partial and total collapses were caused by slides beneath cuts and embankments of roads and railways. Of the five case histories presented in *Section 3*, three involve steep slopes while two show failures in relatively gentle slopes. In most cases the slide debris reached the flat terrain and the run out distance was quite significant thus reflecting the large steepness of the slopes and/or a flow-like movement of the debris.

Embankments that were not affected by slope failures and slides generally performed well. No serious damages were found on flood protection river embankments. The largest damage was observed on the highway embankment near Ojiya IC where typical slumping mode deformation was observed. The embankment settled at the crest and moved laterally at the slopes causing uneven settlement of the road surface and movement or collapse of the retaining walls at the foot of the embankment slopes. Longitudinal cracks at the crest and separation of connections at the culvert underpasses showed movement pattern consistent with the slumping deformation described above. (*Sections 4 and 6*)

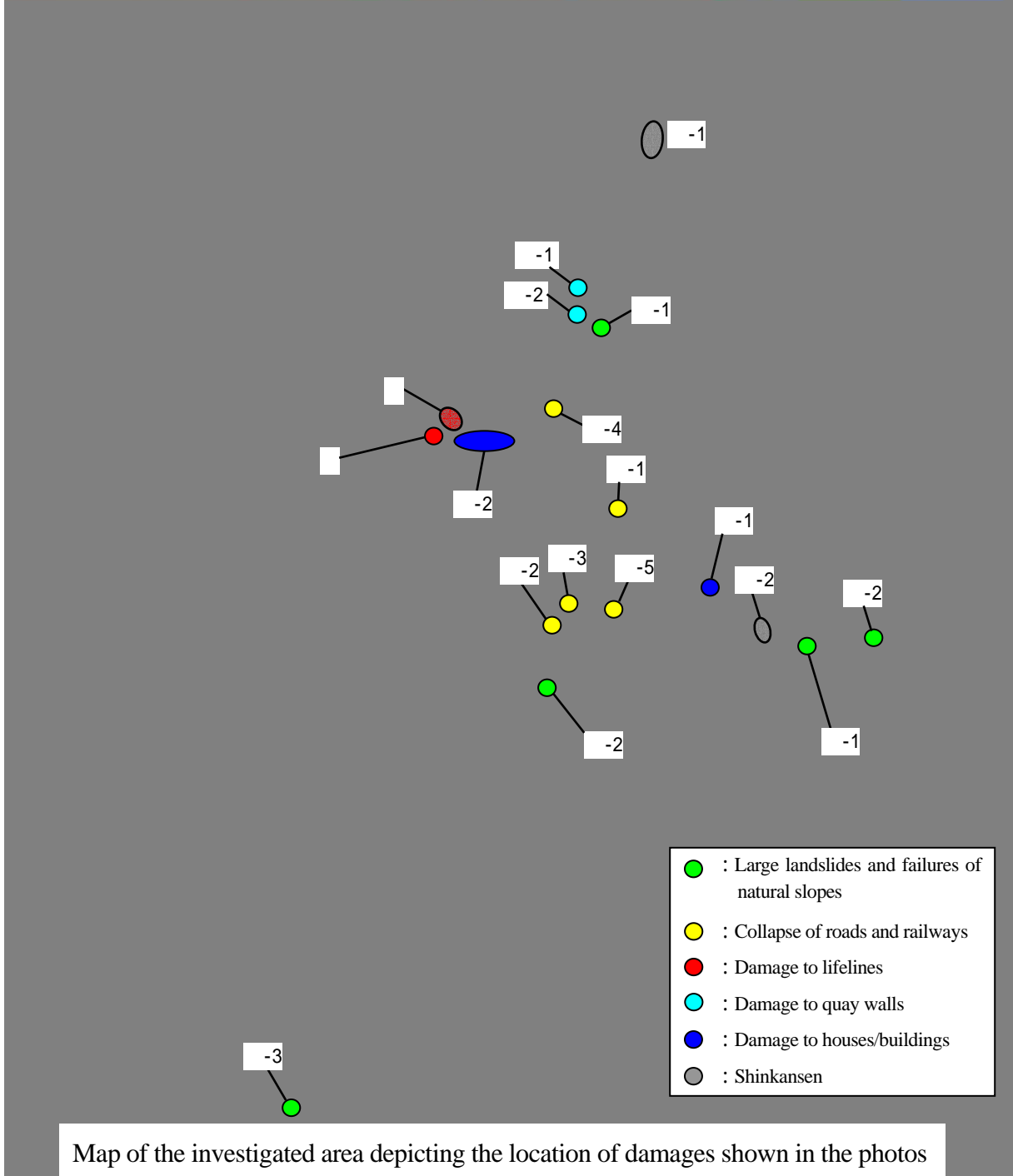
Quite serious damage was inflicted to lifelines as reflected by the fact that most of the affected area remained without water supply and a part of it remained without electric power even one week after the quake. In our field investigation, we observed numerous cracks and subsidence of asphalt pavement along buried pipelines and uplift of man-holes. Signs of liquefaction such as traces of sands or sand boils were often evident at these sites though they were rather scattered and not massive. Interruption of distribution lines including large tilting of distribution poles was observed at several locations in Ojiya area. The heaviest damage of distribution poles was found near Ojiya IC area where one pole was broken and fell down. Sand boils were found at this site and there was clear indication in the movement of the asphalt pavement that the ground moved laterally about 15-20 cm. (*Section 5*)

Evidence of liquefaction was found at many sites in form of sand traces on asphalt pavement and sand boils in vicinity of up-lifted man-holes, failed distribution poles and collapsed quay walls. Comparing with other recent earthquakes in Japan, however, it appears that liquefaction-induced damages were not so significant. (*Sections 5, 6 and 9*)

The damage to elevated sections of Shinkansen (bullet train) was briefly examined at two sites where derailment of a Shinkansen train running through the area at the time of the earthquake took place and also the site where piers supporting the elevated structure were damaged. (*Sections 8*)

In the area of Ojiya and particularly near the Echigo-Kawaguchi Station, a large number of wooden houses were heavily damaged or collapsed. Most of the damages were inflicted on old and weak structures while new wooden houses in the same area performed quite well (*Section 7*). An interesting case involving damage to apartment buildings caused by poor foundation performance is given in *Section 7*.

In the following, photos and brief description of damage features are presented.



1. LARGE LANDSLIDES

(1) Large landslide took place in the area of Myoken-machi where a section of Road No. 589 was crosscut and buried into slide debris. Part of the road collapsed into the river. The slide was about 250 m wide and the debris included rocks and large boulders. **Location -1**



(2) Large landslide crosscut and buried a long section of Road No. 196. The slide was about 400m wide. The debris included rocks and large boulders. **Location -2**



View from the other side of the river



The photo on the right shows view from the road (see the indication on the previous page).



Upper part of the slide (showing the scarp)

Debris in the mid part of the slide



Mid-lower part (on the left) and part of the road seen collapsed into the river (on the right).

2. FAILURE OF STEEP NATURAL SLOPES

(1) Failure of a very steep natural slope. The debris buried the railway at the foot of the slope and spread laterally about 50-60m. Location -1



View towards the buried railway (on the left) and in the opposite direction (on the right).

(2) Failure of steep natural slopes with debris partially burying a nearby house. Location -2



(3) Rock falls and partial collapse of a retaining wall. Location -3



(4) Slides and rock falls took place at numerous locations on steep slopes, mountain walls and road cuts.



3. COLLAPSE OF ROADS AND RAILWAYS

(1) A slide occurred underneath the railway embankment causing collapse of the embankment and partial collapse of the road running above it. The railways lost the support over a section of about 15 m in length. Location -1



Slide-induced collapse of the railway embankment and road running above it



Hanging railways over the collapsed portion of the railway embankment

(2) Collapse of a section of Road No. 117 due to sliding/flow and loss of foundation support. The slope above the road was not involved and/or affected by the sliding. The slope at this site was not so steep and it was much gentler than other slopes where collapses were observed.

Location -2

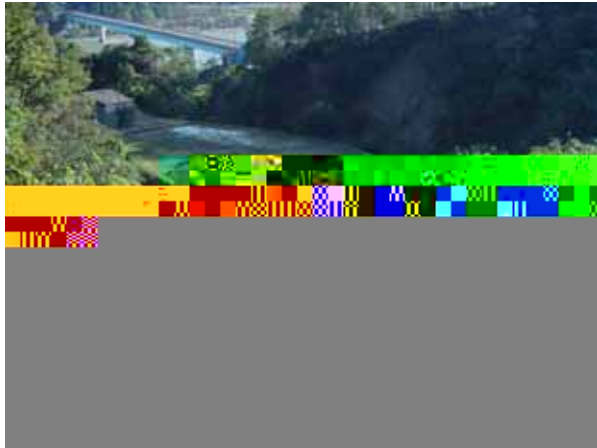


The debris reached the flat terrain (on the right photo).



The truck is running on a temporary road constructed along the original route. Plastic pipe and cables are seen in the debris.

(3) Another similar failure was observed in the close vicinity. At this location, however, the slope beneath the road was much steeper. Location -3



Large run out distance is seen until the debris reached the flat terrain (on the left photo)

(4) Down slope movement with partial collapse of the road. The slope was rather gentle at this site. Location -4



(5) A pair of slides with a width of about 20-30 m each occurred at steep natural slopes causing collapse of the road and large lateral and down slope movement of a storage house and a piece of farm land. Location -5



The storage house sunk into the open hole about 6-7 m below its original elevation (on the left photo). Collapse of the road is seen on the photos to the right and below.



Photos depicting the second slide

4. DAMAGE OF HIGHWAY EMBANKMENT

Uneven settlement due to lateral movement of slopes and subsidence of the crest of the highway embankment was observed at Ojiya IC area. Location



View of the highway from the top of the embankment.



Longitudinal cracks at the top of the embankment (due to lateral movement)



Lateral movement and collapse of the retaining wall at the foot of the embankment (Ojiya side)



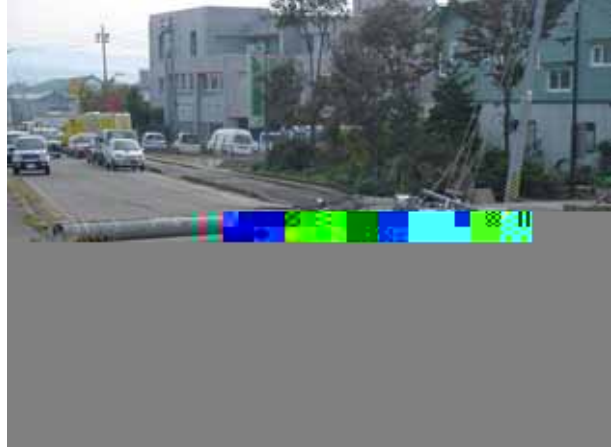
Lateral movement and collapse of the retaining wall (mountain side); Concrete culvert in the underpass of the highway



The culvert composed of two sections moved laterally towards the embankment slopes splitting the mid connection and creating opening from which fill soils fell down and partially buried the underpass. The concrete slab sunk about 15-20 cm.

5. DISTRIBUTION POLES AND UPLIFT OF MAN-HOLES

(1) Tilting of distribution poles was observed at several locations in the investigated area. Particularly large tilts and damages were observed in the highway area described in the previous section. One of the poles fell over. Sand boils were found near the overturned pole. **Location**



(2) Cracks on the surface and settlement of the asphalt pavement of about 10-20 cm were observed along buried pipelines. The uplift of the man-hole is about 80 cm. There were no signs of massive liquefaction or large sand boils. Tilting of distribution poles is also visible in these photos. **Location**



6. QUAY WALLS AND RIVER EMBANKMENTS

(1) Light damage of the embankment and collapse of small section of the revetment wall was found in the vicinity of Koshino Bridge. There were clear signs of liquefaction in the area.

Location -1



Cracks at the crest (area covered by the blue sheet); small lateral movement of the embankment (bulging on the right photo).



Cracks on the ground surface and sand boils were observed in the area between the embankment and the quay wall.



The quay wall moved laterally and part of it collapsed into the river. (Photo on the right)



Ground cracks and lateral movement toward the river near the top of the revetment wall.

(2) About 200 m towards south (on the same river bank, but on the opposite side of Koshino Bridge), another portion of the revetment wall (about 6-8 m in length) collapsed into the river. Large sand boils were found within the collapsed portion and in the backfills. Location -2



Collapsed portion of the quay wall (Koshino Bridge is seen in the background)



Ground distortion behind the quay wall;

Sand boils

7. SETTLEMENT AND TILTING OF BUILDINGS AND DAMAGE TO WOODEN HOUSES

(1) Two apartment buildings (4 story bldgs.), located about 50 meters from Echigo-Kawaguchi station, moved laterally and subsided about 15-20 cm. One of the buildings tilted about 1°.



Bldg. 1 shown in the photos above tilted about 1°.



Differential settlement observed at the entrance of Bldg. 2

(2) Damage to wooden houses (mostly old and weak structures) was the largest at Ojiya and particularly in the residential area around Echigo-Kawaguchi Station. **Location -1**



Heavily damaged and collapsed wooden houses near Echigo-Kawaguchi Station.

Location -2



Location



Collapsed old wooden houses in Ojiya and in the area of Ojiya IC



Kawaguchi: Damage in the underground passage of Echigo-Kawaguchi Station (uplift of floor and ground) **Location -1**

8. SHINKANSEN

- (1) The earthquake caused derailment of Shinkansen (the first one in 40 years of operation of bullet trains in Japan). **Location** -1



The derailment is evident in the dislocation of the connection between the two cars (mid photo). About 100 m south of the derailment site, damage of the top part of the columns supporting the elevated structure was observed.



Cracks and settlement (15-20cm) of the ground were observed in the foundation soils. Mud traces (about 1m high) were found on the column

- (2) Damage to piers of elevated section of Shinkansen **Location** -2



9. SAND BOILS



Scattered sand boils were seen in farm lands at several locations of the investigated area.



Sand boils and uneven settlement due to liquefaction observed at a parking lot.