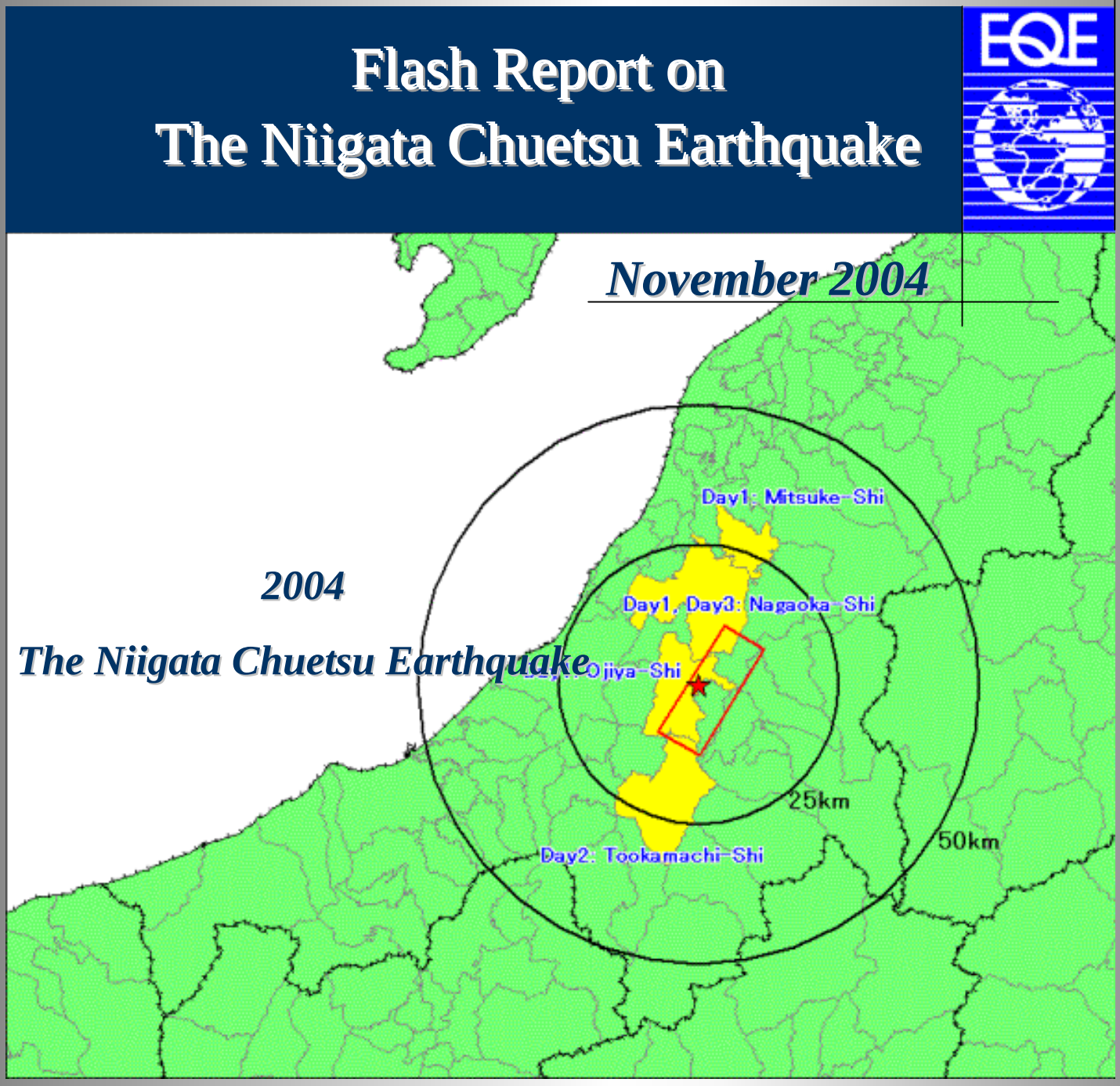
Flash Report on
The Niigata Chuetsu Earthquake



ABS Consulting

【Summary】

On 23 October 2004, an earthquake with the magnitude of 6.8 occurred in Niigata Prefecture, located about 200 km NNW from Tokyo (Figure 1). The epicenter was located at 37.17N, 138.52E. According to the report from the Fire and Disaster Management Agency issued on 29 October, 35 were killed, and 2,374 were injured.

3 engineers from ABS Consulting, Hiroyuki Minami, Yohei Kaga, and Tomohiro Kubo, conducted a field survey in Niigata from 25 to 28 October. The surveyed areas include Ojiya City, Nagaoka City, Mitsuke City, and Tokamachi City that all experienced a seismic intensity of 5+ to 6+ on the scale of the Japanese Meteorological Agency (JMA).

Figure 1[1]

■Earthquake Motion

The Peak Ground Acceleration (PGA) was 2515.4gal, and that is the highest PGA on record. Kawaguchi-machi experienced the intensity of 7 on the scale of the JMA. “Intensity 7” had not been recorded since the Kobe Earthquake. The Niigata Chuetsu Earthquake, occurred at a shallow level with the relatively high magnitude, has demonstrated how threatening an inland earthquake is.

However, the relationship between earthquake motion and damage was not simple. For example, the intensity was 6+ at the Ojiya-city, but the remarkable damage was limited to old wooden houses. The JMA’s “Damage standard set for describing earthquakes according to seismic intensity” describes the intensity 6 + as “Majority of seismically vulnerable houses collapse. Many of the walls and columns of seismically designed buildings may fail,” but this description does not match to the surveyed damage. This gap occurs because no proper calibration was conducted when the JMA accepted a new method of deriving an intensity level. Before the Kobe Earthquake, the intensity of an earthquake at a given city was determined by the designated staff at the city with reference to the standard set. In the new method currently used, the intensity is calculated based on the record measured by a seismometer placed at the city center. Further investigation on this calibration problem should be taken.

■Damage on the buildings

The number of reported fire accidents was remarkably small. The lessons from the Kobe

[1] CIA World Factbook

Earthquake could have helped. Verification on the fire control conducted in Niigata should be conducted for future measures.

The region hit by the earthquake is famous for very heavy snowfall. If the earthquake had occurred in the middle of winter, the damage could have been much larger. The snow in the region is wet and accumulates on roofs more than 2m, which gives 600kg per $1m^2$. This structural characteristic, withstanding heavy snowfall, could be one explanation of the small damage at the region despite the strong shaking. The snow load considered in the calculation of design seismic force is 35% of that in the calculation of short-term load, but this standard should also be reviewed.

None of the surveyed damage was new in the structural engineering point of view. In other words, the damage could have been mitigated if the caution urged by experts had been seriously considered.

■Risk Communication

The lack of risk communication between local governments and residents was revealed at some cities and towns. The information on aftershocks, evacuation centers, and relief goods should have been conveyed to the residents in effective ways. It is recommended to reserve satellite phones and digital radio transmissions and consider using hazard maps to tell residents “where to go” and “where not to go”.

【Acknowledgement】

ABS Consulting would like to thank all the local government staff and the residents we visited for their kind response to out inquiries, even though they were in the midst of the recovery work.

Field Survey

【Earthquake】

The main shock and series of aftershocks had their origins at 5 to 20 km deep under Uonuma Hill where a lot of earthquakes have occurred at a shallow level. The Headquarters for Earthquake Research Promotion has reported earthquakes in 1904 (M6.1), 1933 M6.1), and 1961 (M5.2).

According to the JMA, the main shock occurred at 17:56, 23 October, with the magnitude of 6.8 had Kawaguchi-machi experience the JMA intensity of 7. A number of after shocks also followed, and five of them exceeded the JMA intensity of 6-. An after shock with M6.0 occurred at 18:11 caused Ojiya-city to have the intensity of 6+, and another aftershock with M6.5 hit Tokamachi-city at 18:34 with the JMA intensity of 6+.

This region is geologically folded and consists of thrust faults which have been formed by compressive stress coming from the west-northwest and east-southeast. The reference points placed by the Geographical Survey Institute (GSI) show that Ojiya-city raised 24 cm and moved 9cm to southwest, and Yamato-machi, Minami Uonuma-gun, subsided 4cm and moved 10cm to northwest. This movement explains that thrust fault(s) triggered the main shock and after shocks. The GSI also has reported that there is a fault, which rapture zone is 22 km long and 17 km wide, slipped approximately 1.4 m. However, the exact location and movement of the fault(s) is still under investigation.

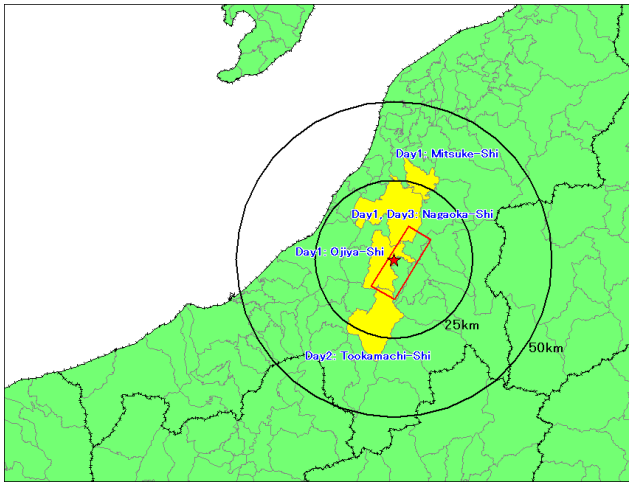


Figure 2

【Buildings】

<Ojiya-city>

Shopping center's walls facing south were dropped off (Photo O-1). It is assumed that the walls were pushed out by the swing of the ceiling. Dropped ceiling panels were also seen at the other shopping center.

Photo O-1

The exterior materials and show window of a steel framed structure were damaged (Photo O–2). Photo O-3 shows the damage on the finishing material on a exposed column of another steel framed building.

Photo O-2

Photo O-4

PhotoO-3

Photo O-5

The RC buildings, which had noticeable damage, were all pre-1981 (the standards for earthquake-proof was revised in 1981). Photo O-4, O-5, and O-6 show a building in which the damage concentrated at the ground floor. A soft story at the ground floor and the lack of strength in columns could be a possible explanation of this damage. On the other hand, the building located across the street shows no damage (Photo O-7).

Photo O-6

Photo O-7

At the cemetery, gravestones were falling towards east and west (Photo O-8).

Photo O-8

The damage inside of a building involve fall-down of furniture （PhotoO-9,10）。

Photo O-9

Photo O-10

<Nagaoka-city>

Photo N-1 shows the soft ground area. Settlement and cracks on the road were extensively seen. Differential settlement caused some buildings to collapse. Photo N-1 shows a building which ground floor used as a storage area was collapsed due to the insufficient amount of walls.

Photo N-1

Takamachi Danchi showed in Photo N-2 is a relatively new housing complex area developed in a shape of tableland. The edges without retaining walls experienced landslides that had the road break and fall. 2x4 construction and wood panel construction dominated this area. While those house located at the edge experienced severe damage, those houses at the center pat of the area showed minor damage.

Photo N-2

<Tokamachi-city>

The severe damage on RC structures was noticed at the center of Tokamachi-city (PhotoT-1, 2, 3, 4). On the other hand, damage on wooden structures was relatively small. This difference probably comes from the characteristics of a seismic period of ground motion.

Photo T-2 shows the damage on a column of an RC building, and Photo T-1 shows the whole figure. The interval of hoop bars was 30 cm. The building located across from Photo T-1 also experienced shear failure in a column at the ground floor (Photo T-3, 4).

Photo T-1

Photo T-2

Photo T-3

Photo T-4

Photo T-5 shows the damage occurred at a short column formed by a hanging wall.

Photo T-5

A concrete block structure (CMU Wall structure) shows severe damage in Photo T-6.

Photo T-6

A reinforced building in the city center showed no noticeable damage. The show window was not affected at all (PhotoT-7,8).

Photo T-7

Photo T-8

Photo T-9 and T-10 show a building constructed after 1981. An RC wall had a shear failure.

Photo T-9

Photo T-10

Old steel structures experienced drop-off of the exterior walls (Photo T-11).

Photo T-11

【Infrastructures】

■Road

A number of settlement and cracks on roads and landslides occurred and caused closures at many locations (Photo I-1, 2). In Nagaoka-city, a large landslide crashed into the route 589 (PhotoI-3) and ripped the road down to Shinano River.

Photo I-1

Photo I-2

Photo I-3

■Railroad

Shinkansen (bullet train) was derailed at Nagaoka-city, and it was the first derailment in the long history of Shinkansen. The piers of Shinkansen were affected as showed in Photo I-5, I-6, and I-7. Other railroads were also closed due to settlement of the ground, bent rails, or tilted poles and signals.

Photo I-4

Photo I-5

Photo I-6

Photo I-7

【Lifeline】

■Electricity

According to Niigata Prefectural Government, on 23 October, 278,000 houses experienced blackout due to the damage on electric poles and

lines. Even after three days from the main shock, some areas were still suffering from blackout.

Photo I-8

According to Tokyo Electronic Power Company, the Kashiwazaki Kariwa nuclear power plant had the JMA intensity of 5-. No damage was reported that could cause a shutdown of the plant.

■Gas

According to Hokuriku Gas Corporation, 85 breakages were reported by 22:00, 23 October, and 23 of the breakages occurred on buried pipes. A day after the main shock, gas supply to 56,000 houses in Nagaoka-city and other cities was stopped. This shutdown was a safety measure to prevent a secondary accident.

No noticeable fire accident occurred. Further studies should be taken to compare with the Kobe Earthquake where fire caused tremendous damage.

■Water

Water supply was cut off because of a failure in pumps due to the blackout and damage on pipes due to liquefaction and ground subsidence. 109,904 houses were suffering from the disruption of water supply the day after the main shock. 5 days after the main shock, 15 cities were still facing the difficulty of water supply.

Manholes at many locations were floated up by liquefaction (PhotoL-1, 2).

Photo L-1

Photo L-2

■Telecommunication

Right after the main shock, NTT East Corporation limited calls to Niigata because the number of calls was causing congestion. NTT East Corporation started its emergency voice mail service (dial 171). In Ojiya-city, mobile phones were still not usable even 6 days after the main shock.