Preliminary Report on Damage from Mid-Niigata Prefecture Earthquake in October 2004

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Photo 1 River blocked by enormous landslide that formed a lake near Higashi Takezawa in Yamakoshi village

The Mid-Niigata Prefecture Earthquake occurred on October 23, 2004. The main shock registered 7 on the Japanese seismic intensity scale of 0-7 in Kawaguchi town. Aftershocks of upper 6 on the scale were still occurring even after a week had elapsed. The earthquake caused heavy damage to Nagaoka city and Ojiya city, Horinouchi town, Kawaguchi town, Tokamachi city, Tochio town and Yamakoshi village.

A group consisting mainly of members from the Disaster Prevention Research Institute of Kyoto University hurried to the disaster-stricken area, where they carried out a few days of investigations beginning on October 28, when the people of Yamakoshi village temporarily returned home for a while. Because of the limited opportunity for investigations during the period of intermittent aftershocks, the damage is described in this report by way of photographs. The authors recommend that readers refer to the preliminary report on damage from the earthquake of this publication prepared by the JSCE's Emergency Damage Investigation Team (led by Prof. Kazuo Konagai of the University of Tokyo). Backup work, investigations and disaster-relief works were continuing during these investigations. The authors were impressed by the dedication of the many civil engineers and researchers carrying out this work.

Outline of the earthquake

- Time: 17:56 on October 23, 2004
- Epicenter: latitude 37.3° north and longitude 138.8° east
- Depth of hypocenter: 10 km
- Magnitude: 6.8 (maximum seismic intensity; 7 on the Japanese seismic intensity scale)
- The focal mechanism of the earthquake is in many ways unclear because of the complex geological structure of the area.

Features of damage

The earthquake was of the same epicentral type as the Hyogoken-Nambu Earthquake, but in this case the areas devastated were not large cities but farming areas. The fact that the earthquake struck the most landslide-prone area of Japan just after Typhoon No. 23 dropped rain on the area was one of the factors that amplified the damage. Features of the damage, centering on slope failures in the mountainous areas, are summarized below.

(1) Many large and small slips of land saturated with groundwater moved downhill at high speed. Rivers were blocked by the landslides and lakes were formed.
(2) Filled ground that had become saturated with groundwater failed and liquefied at lower depths.
(3) Liquefaction of alluvial soil layers where the groundwater level was high occurred in many places.
(4) Ridge slopes (convex slopes) failed.
(5) Surface layers of steep cliffs failed.
(6) Residential land failed, damaging both lifelines and structures.

These six features of the damage are explained below using photographs.

Photo 1 shows the extensive landslide that blocked the river, forming a lake, near Higashi Takezawa in Yamakoshi village. The landslide site is on the left. The landslide completely blocked the road on the right of the photo and the Imo River in the center. Figure 1 is an explanatory cross-sectional view of the landslide. Photo 2 shows the mudflow that surged into Higashi-Takezawa Elementary School on the other side of the river. Riverbed gravel and even fish were bulldozed out ahead of the mudflow and scattered around. Photo 3 shows the lake that formed in the Imo River when it was blocked by the landslide.

Photo 4 shows a collapsed house on filled ground near Uemura in Ojiya city. When groundwater levels are high, earthquake damage tends to be concentrated in areas developed on the filled ground.[1)] Damage to snow-resistant houses on ground of good quality was minor. Photo 5 shows a section of failed roadbed on filled ground; groundwater continued to flow from the damaged area. Failure occurred in many places where slopes had been filled to form rice paddies, and again spring water continued to flow out from the failure points. Photo 6 shows traces of sand boils in a rice paddy in the city of Ojiya. Many sand boils were identified in rice paddies on low land in the city. In addition, uplifted manholes were also found along roads.

Photo 7 shows a failed cut embankment along a road in Shiroiwa, Ojiya city. The embankment had been cut from land in the shape of an inverted 'V'. The blocks of failed stone consisted of sandy mudstone. When the photo was taken, efforts were under way to rescue a girl trapped among the blocks. Unfortunately, the rescue team gave up the search and left the site the same afternoon. The characteristics of slope failure originating at the top of high ridges closely resembles damage seen at Mt. Usu and during the volcanic earthquakes on Kozu Island in 2000.[2), 3)] Photo 8 shows the failed surface layer on a steep cliff-like slope in Yamakoshi village. Only the vegetation-covered surface layer slid down the slope. The failure surface exhibited a few cracks but no plant roots were identified, so this can be identified as a failure along the lateral root layer of the vegetation.[4)]

Photo 9 shows cases where failure of filled ground affected important infrastructure: the Japan Railways Shinetsu line and National Route 17. The filled ground that failed was a sloping area along the Shinano River. It will take time to restore the failed slope.

Social impact of the earthquake and prolonged landslide danger

The earthquake has had a considerable impact on the local community. With intermittent aftershocks continuing, disaster-relief activities are expected to be prolonged. Railways and roads connecting Niigata to the Tokyo metropolitan area were heavily damaged in particular. If the effects of the earthquake on the movement of people and goods continue for a long time, the regional economy will suffer a great deal. Further, where ground filled for residential use flowed outward, many wooden houses collapsed and this will pose considerable difficulties in the reconstruction of devastated areas. Damage to the Nishiki carp industry, for which the district is especially noted, is also of concern.

In Yamakoshi village, a very isolated community, lifeline amenities such as roads were damaged in places and here it will be especially difficult to restore areas where waterlogged ground flowed and to drain lakes created by massive landslides. There is also a need for measures against secondary disasters resulting from heavy rainfall and snow melt. In areas of Yamakoshi village with a landslide hazard, many cracks have been identified on slopes that did not actually slide during the earthquake. These slopes are in a very loose state as a result of the earthquake and will retain the potential to slide as a result of heavy rainfall and snow melt for a few years to come. This prolonged landslide danger is a matter of concern.

Photo 2 Higashi-Takezawa Elementary School damaged by mudflow

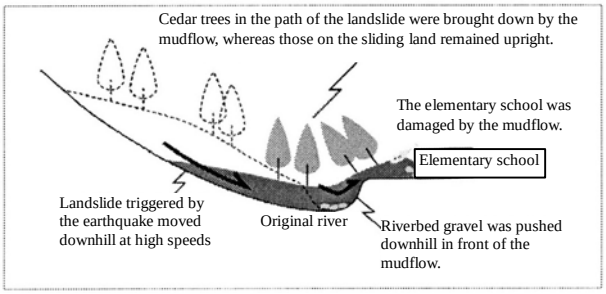

Fig. 1 Imo River blocked by massive landslide at Higashi Takezawa to form a lake

Photo 3 Lake formed by the Imo River after the landslide in Yamakoshi village

Photo 4 Collapsed house on land developed on filled ground near Uemura in Ojiya city

Photo 5 Collapsed road on filled ground; groundwater continued to flow from the damage

Photo 6 Traces of sand boils in a rice paddy in Ojiya city

Photo 7 Failed slope cut from 'V'-shaped land in Shiroiwa, Ojiya city. Efforts were under way to rescue a girl trapped inside the blocks.

Photo 9 Track hanging free on the Shinetsu line after failure of filled ground and blockage of National Route 17

Photo 10 Recovery work under way at damage site on the Kanetsu Expressway

Photo 11 Relief activities in Ojiya city using water tankers provided by Kawasaki city

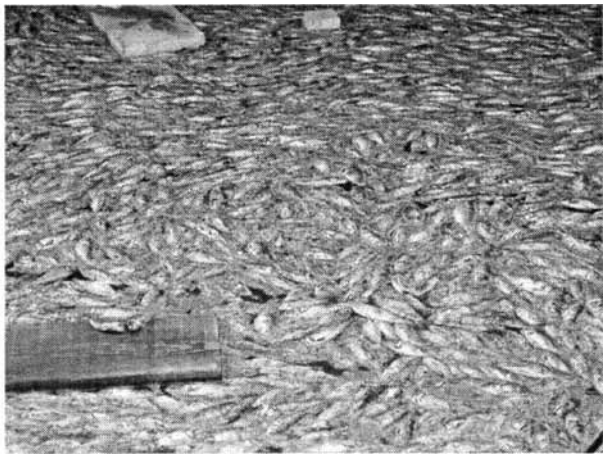

Photo 12 Damage to Nishiki carp production; large numbers of carp died leading to a foul stench.

Photo 13 Damage to houses after slope failed near Nanpei in Yamakoshi village
(Photo by Nakanihon Air Service Co., Ltd.)

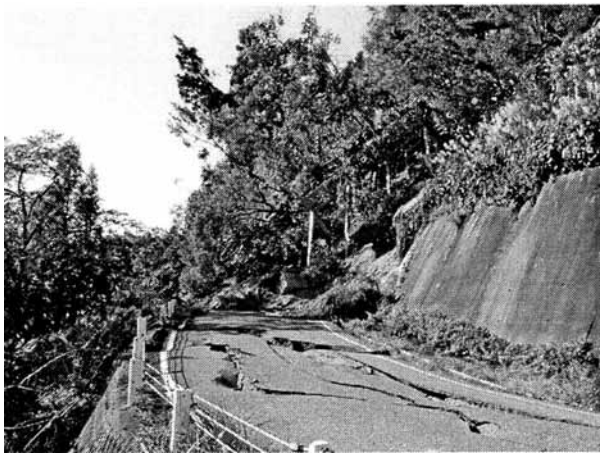

Photo 14 Road to Yamakoshi village blocked by failed slope

Photo 15 Failure of a dam formed after a landslide in the river gives rise to the danger of a secondary disaster
(Photo by Nakanihon Air Service Co., Ltd.)

Conclusions

On viewing the damage caused by this earthquake, the authors became painfully aware of the need to improve the civil infrastructure so that it provides amenity in daily life as well as safety in times of disaster. Earthquakes and other natural disasters that recur on a very long cycle require an approach to risk management that takes into account frequency of occurrence and the likely scale of destruction.[5] Regarding restoration efforts in and around Yamakoshi village, which was cut off by landslides, the authors note that the badly hit Nishiki carp breeding industry must be restored through slope engineering that harmonizes the environment with disaster prevention needs. [6]

Besides the authors, the investigation group was joined by the following people: Roy C. Sidle, Aurelian C. Trandafir and Shoji Toshida of the Disaster Prevention Research Institute, Kyoto University, Satoru Goto and Hidemasa Ohta of Yamanashi University, and Natsumi Hirata of Environmental Geology Co., Ltd. (titles omitted). The authors thank the local police and staff at the disaster countermeasures office for their help. Finally, they hope that evacuated residents will be able to return at an early date and that damaged areas will be fully restored.

References

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