The debris flow in Kanbarasawa

【December 6th, 1996, Otani village, Kitaazumi district, Nagano prefecture】

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The large-scale debris flow arose in Kanbarasawa , Otani village, Nagano Prefecture at around 10:40 a.m. on December 6th, 1996. The destruction at an altitude of around 1300m became a trigger for this debris flow, and it flowed over five waves (or eight waves (when small waves are included). one of two valley closing constructions which did not have deposited silt right after the concrete cast was completely destroyed and the other was half destroyed by the first wave which was the biggest. After the debris flow passed the 2 check dams downstream with no deposited silt, the check dam under construction and the watercourse construction, it reached the Himekawa River. This debris flow hit the construction sites of disaster related project etc, which Ministry of Construction (now Ministry of Land, Infrastructure and Transport), Forestry Agency and Nagano Prefecture ordered. In this disaster, there were fourteen fatalities, and nine people were injured. The position of Kanbarasawa in Honshu is shown in Figure 1.

Figure1 The position of Kanbarasawa

1. Event

The debris flow was generated from the destruction at around 1300m altitude in Kanbarasawa on December 6th, 1996. It flowed over five waves, and one valley closing construction was completely destroyed and one was half destroyed. The construction field was hit directly. There were fourteen fatalities, and nine people were injured. Figure 2 is an expanded map of the accident scene.

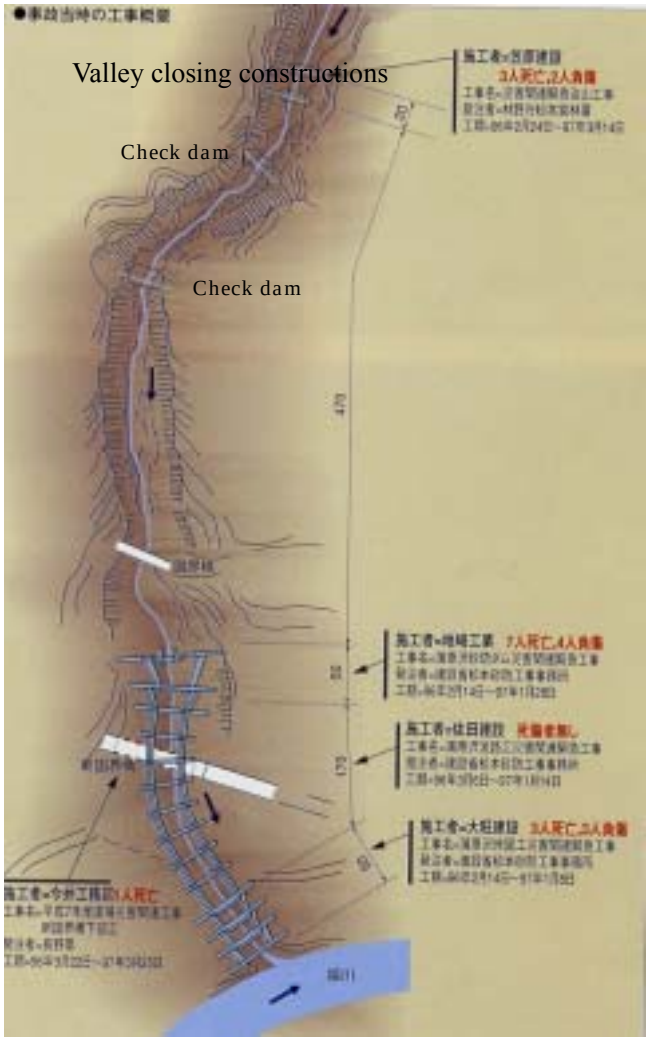

Figure2 (Source: Nikkei construction)

2. Course

（1） The climate before the accident occurred

Around Kanbarasawa the cold waves attacked the shore on December 1 ～2, 1996. The temperature became less than 0℃ and the 35 cm snow depth was recorded. The precipitation was 32 mm. Then, the cyclone passed the Sea of Japan on December 5 th. When the debris flow was generated, the precipitation in the Otani observatory over 24 hours was 49 mm. Then, the precipitation was not recorded from the 5th, 21 o'clock, to the time the debris flow was generated. And, because of the passage of the cyclone, the temperature increased to about 10℃, and the snow depth lowered from 18cm to 6cm over 5～6 day during which temperature exceeded 0℃. There was a 109mm amount of rainfall over a 24 hour period, when in the Otari observatory 49mm of rain fall and the calculation of snowmelt quantity by the degree-hour method were calculated. This was not an especially big than a mount of rainfall (largest 24 hours was 360mm amounts of rainfall: Destruction generated in heavy rain which was generated in Kanbarasawa on July 11th, 1995).

（2） The situation in the disaster

The debris flow arose from the landslide on the right side slop near the 1300m altitude. The 39000m3 gravel which was destroyed in the upper section destroyed the valley closing constructions of afforestation (one was completely destroyed, one was half destroyed) and it got over 2 check dams, and it became the debris flow which were over 5 waves (or 8 waves (when small waves are included)), and attacked the lower section. It is said that the first wave was a scale of 3m height and 9.1m speed per second. Figure 3 is a photograph of the destruction field.

（３）Safety management of main contractor and subcontractor.

1) Installation such as the alarm facility.

The alarm facility such as siren etc. for carrying out the urgent communication to the workers in the case of detecting the generation of debris flow etc. was not in place. And, the way of signing was not determined either.

2) On the standard for the work stop.

In "Katsuba-Kanbara liaison council", installed for communication adjustment between businessmen who constructs what the Ministry of Construction orders, caution and shunt standard by amount of rainfall had been set. When the amount of rainfall exceeded the standard, contact could be made to the member workplace. In the meantime, there were some workplaces which had not adjusted communication network depending on the amount of rainfall between other workplaces.

3) Arrangement of installation of the machinery monitoring equipment and monitoring person

The arrangement of installation of the machinery monitoring equipment and monitoring person for detecting generated debris flow was not carried out.

4) Measures for the refuge

The following were not carried out: Improvement of the emergency communication system on the assumption of the case in which the debris flow is flowing under the work, execution of the fire drill and installation of the escape facility

Though the four rainfall which exceeds shunt communication standard was generated in the day, the refuge was not carried out, since it was not under work.

Figure 3

(Source: Nikkei construction)

3. Cause

The primary causes which the debris flow arose are divided into landform condition and geotechnical condition. As a landform condition, the reason was “the extension destruction” (that more and more large-scale destruction occurs as a trigger of the former destruction which occurred

previously) of the slope which became unstable because of the destruction which occurred on July 11th, 1995 and that the landslide was the erosion front, the steep slope. As a geotechnical condition, the Kanbarasawa watershed is located in the western edge of Fossa Magna (right on the upper Itoigawa-Shizuoka tectonic line). It is a boundary between weak nature of andesite lava and strong sandstone bed. As a trigger, there was the fact that snowfall and snowmelt flowed and were supplied to the landslide as underground water through the boundary between weak nature of andesite lava in which the water permeability is high and strong sand bed in which the water permeability is low.

4. Immediate Action

(1) The beginning of the accident occurrence

Hashimoto Ryutaro, the Prime Minister, asked the Self-Defense Forces for the urgent dispatch to the disaster rescue area. The field disaster countermeasure headquarters were stationed, and the search for the missing persons was undertaken by 1600 persons. Afterwards, 3 sensors which detect generation of the debris flow were installed in the swamp from the confluence with the Himekawa River about 800 m upstream.

(2) The restart of the disaster recovery construction.

In the disaster recovery construction, the full-automation construction was adopted by utilizing lessons of the debris flow. After the large-scale fire drill on August 19th, 1997 was carried out, on the 22nd, the construction was resumed after an interval of about 8 months. The construction is intended to ensure the safety of the workers and the maintenance of the check dam. For example, in the Kanbarasawa check dam, to begin with, the gravel which was piled up in the mountain stream was removed by using the heavy machinery with the remote control operation. Besides, the construction of the stopped left bank division was carried out. In the subordinate layer on the left bank, the sandbags piled by the crane instead of the mould were used and the high workable concrete was injected. Not sandbags but concrete blocks were piled up when the dam went above the fixed height, and by pouring high workable concrete, mould and compaction of the concrete were prevented. People are completely prevented from entering the mountain stream by this method. And, large change was also carried out on the caution and refuge system. In the new system, not only standard amount of rainfall when people refuge was lowered, but also the monitoring by men was done thoroughly. Two monitoring huts were established, and the slope- judging people and auxiliaries (two people each) were stationed. When the fog descended and the field of view from the monitoring hut was bad, the construction was stopped. The safety management was done thoroughly. Based on this thorough safety management, Kanbarasawa check dam was completed.

5. Countermeasure.

There are three main countermeasures. Firstly, grasping the watershed situation and informing the construction party: On construction object watershed and nearby watershed, it is necessary to obtain information such as meteorological phenomena, landform and geologic feature, distribution of the dangerous place in landslide disaster, and landslide disaster generation which arose in the past before beginning construction. It is required that temperature and snowfall which were not included in the survey items are also grasped, based on this lesson. It is necessary to estimate the way of monitoring on the basis of the information. Secondly, the development of forecast and detection technique of the debris flows: Though the forecast of debris flow generation by amount of rainfall has been carried out until now, it is necessary to forecast temperature and snowmelt. Also, it is necessary to examine the system which detects the debris flow generation. Thirdly, the ideal

way of caution and refuge system: It is necessary to lower the current standard amount of rainfall level for caution and refuge, when the unstable slope exists. It is desirable that the standard is set by the divisions based on the landform and the range of construction when lowering the standard of the caution and when refuge is carried out.

6. Generalization.

The recognition of conventional debris flow was changed completely by this debris flow. Firstly, it was the debris flow that arose in winter. Secondly, there was no indication phenomenon such as roar, muddy stream or reduced discharge. Thirdly, as a landform condition, the reason was the slope which became unstable by the past destruction and that the landslide was the erosion front, the steep slope. As a geotechnical condition, it is said to be a boundary between weak nature of andesite lava and strong sandstone bed. The debris flow in Kanbarasawa can be said to be a rare example of belonging to “Unknown Phenomenon”.

7. Knowledge.

1. The standard for caution and refuge is established in proportion to the construction field with the possibility natural disaster arises. The landform and geotechnical condition vary if the construction place differs a little.
2. After the rainfall which exceeds the standard of amount of rainfall, when snowmelt is anticipated or the work is carried out after earthquake, the watchman should be stationed or people should move to the place where there is no possibility of the disaster by debris flow.
3. The development of synthetic method of debris flow forecast and detection system (not forecasting the current downpour, but groundwater supply by the snowmelt of temperatures, snow depth etc are also considered.)
4. In the disaster recovery construction in the emergency, the full-automation installation method is introduced.

8. Background.

Otani village in Nagano prefecture is on the western edge of Fossa Magna (the big fault in Japanese Island) and is right upper Itoigawa-Shizuoka tectonic line, and it is known as a frequent zone of the landslide. In December, 1988, in prefectural road in Otani village, the workers under road construction were buried in the destroyed gravel. Five workers died and one person received the serious wound. On July 11th, 1995, by local heavy rainfall, destroyed gravel etc. occurred and the access to the village was cut. Over 1000 homes and 3000 persons (integrating the nearby area) were evacuated. By the helicopter of Self-Defense Forces and prefectural police, about 150 tourists who had come to the hot spring in the village and villagers were evacuated. In that downpour, the slope where this disaster occurred was destroyed. On June 25th, 1996, in Otani hot spring in the village, 5 inns became isolated since the gravel of the prefectural road was destroyed and closed the bridge. Since there is the fear that the debris flow arises afterwards, the construction work of the check dam was started by Ministry of Construction (now Ministry of Land, Infrastructure and Transport) in February, 1996, and it would be completed in January, 1997. Debris flow attacked the construction field where the near completion area.

9. Sequel

Three persons from Ministry of Construction River Bureau length, Director General of Forestry Agency, Nagano prefectural governor in those days asked Erosion -Control Engineering Society to examine the cause of this debris flow and the preparation (caution and refuge) to understand the debris flow in construction fields in the future.

10. On the Side

After the disaster, the search for people which were buried in the gravel was carried out by police and fire fighting and Self-Defense Forces. The search was hindered by much gravel and the danger of secondary disaster, so it made slow progress. As the principle of searching in far-reaching area, two principles severely conflicted. One was searching eternally until all the missing people were discovered. The other was searching in some range by the constant members. Finally, the day when the remains of the final missing person were discovered was May, 1997 after the snowmelt. The national tax covered the search cost. The Kanbarasawa memorial was erected in order to remember 14 persons who died in the disaster by the debris flow and to convey the memory of this disaster to future generations.

<Reference>

”Construction Accident” (Nikkei Construction, Nikkei BP)

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