Report of Field Trip to Shobara, Hiroshima

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Trip Route: Matsue City→Shobara City→Hiroshima City→Matsue City
Organizer: Japan Landslide Society (Kansai Branch)

Debris Flows at Shobara

At July 16, 2010, massive debris flows occurred shortly after storm rainfall at Shobara, Hiroshima. Debris flows destroyed road, houses and vegetation nearby the gulley. Unfortunately, this debris-flow hazard took one life when destroyed one house located at the foot of slope. The debris flows obtained most of their volume by scouring a mass of topsoil and channel bed, and destroyed extensive vegetation (Fig.1).

Fig. 1 A gulley after debris flow that occurred at Shobara, Hiroshima, Japan

We investigated the source area of one channelized debris flow (Fig. 2). It is a translational shallow landslide. According to the exposed main scarp, the bedrock is weathered andesitic rock. Topsoil layer located on the upper part of slope is thin, about 40cm to 100cm in thickness. This layer is composed of completely weathered andesitic rock, vegetation root system, and humus layer (Fig. 3). Variously, topsoil layer located on the lower part of slope is thicker, about 1m to 1.5m in thickness. This layer is composed of pumice, volcanic ash, and humus layer (Fig.4). The flow path has a terrain with 30° to 45° degree slope.

Undoubtedly, intense rainfall is the triggering factor. Before the occurrence of massive debris flows, the maximum precipitation is 91mm within one hour (Masahiro, 2011). The rapid infiltration of rainfall, causing topsoil layer saturation and a temporary rise in pore-water pressure, is believed to be the mechanism of this shallow landslide. Because the porous nature of topsoil layer located on the lower part slope, piping holes are visible under biggish hydraulic gradient (Fig. 5).

Attentively, concentration of runoff from the storm mobilized talus and other debris in tributary channels and scoured material from the main channel into a debris flow, which maybe occur under next heavy rainfall. In addition, the flank of landslide forms the exposure face of topsoil. The topsoil should be partly failure under other triggering factors (heavy rainfall or earthquake) along the flank of landslide.

Fig. 2 View of debris flow area from the crown of landslide

Fig. 3 Topsoil layer located on the upper part of slope

Fig. 4 Topsoil layer located on the lower part of slope

Fig. 5 Piping holes in the topsoil layer located on the lower part of slope

Debris Flows Mitigation and Slope Stabilization

The local government immediately undertook necessary mitigation methods after the debris-flow hazard.

At the mouth of valley, concrete check dams were built to store debris-flow sediment (Fig. 6 and Fig.7). Although concrete check dams are expensive to construct, they go a great way with controlling channelized debris-flow frequency and volume.

Fig. 6 Concrete Check dam with low-flow center section

Fig. 7 Upstream view of a concrete check dam

Biotechnical slope protection method was used along the road (Fig. 8). This type of seeding is the application of seed in water slurry that contains fertilizer, soil binder, and mulch. Seeding with grasses reduces surface erosion, which can under certain conditions lead to landslides. If not controlled, surface erosion and small, shallow slope failures can lead to larger problems that cannot be controlled.

Compared with shotcrete, this type of slope protection can reduce the environmental consequences of landslide-mitigation measures, and is more visually pleasing and environmentally friendly. At some rock slope area, these are tools composed of steel robs or cables that reinforce and tie together a rock face to improve its stability (Fig. 9).

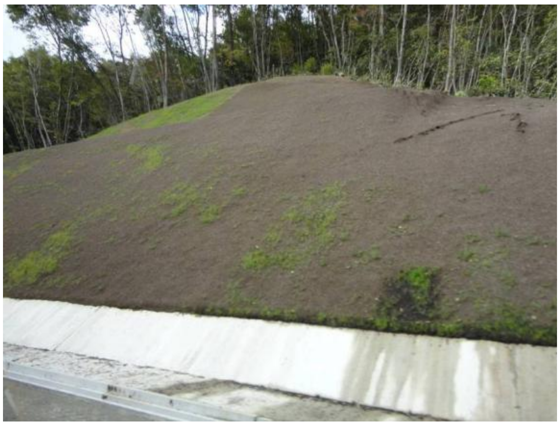

Fig. 8 Biotechnical slope protection

Fig. 9 Anchor & biotechnical slope protection

Gabion walls were constructed at small-scale landslide area along the road (Fig.10). The gabion retaining walls were composed of stacked gabions which are wire mesh and boxlike contains filled with cobble-sized rock that are 10 to 20 centimeters size. Gabion walls are inexpensive and are simple and quick to construct. Because of their coarse fill, they are very permeable and thus provide excellent drainage.

Fig. 10 Gabion wall along the road