Restoration efforts of the Aso Bridge District affected by a massive landslide

Sand control group, Kumamoto branch office, Kumamoto earthquake counterplan office, Kyushu Regional Development Bureau, MLIT

Overview of the landslide

<Date of the disaster>
1:25 a.m. April 16th, 2016
※ Occurrence of a quake

<Damage>
- Public infrastructure
  National Road no. 57 (Aso bridge area)
  National road 325 Aso Bridge
  Japan Railway Houhi Line

<Scale of landslide>
- Length of landslide approx. 700m
- Width of landslide approx. 200m
- Volume of earth and sand approx. 0.5 million m³
  (Estimation by aerial laser measurement soon after the quake)
**Damages by the collapse at Aso Bridge area**

- Collapse point at Kumamoto side
- Japanese railway Houhi Line
- Aso Bridge
- The Kurokawa River
- Direction of Oita
- Direction of Kumamoto
- Direction of Miyazaki

**Status of the collapse of slope**

**Before the collapse**

- Japan railway Houhi Line
- Aso Bridge

**After the collapse**

- Length of the collapse: approx. 700m
- Width: approx. 200m

- Photographed by the Harukaze, Kyushu regional development bureau, MLIT

- Photo ① Landslide at the top
- Photo ② Top of the collapsed cliff
- Photo ③ Cracks near the collapsed cliff
In regard to the massive collapse of the slope at Aso bridge area triggered by the Kumamoto earthquakes in 2016, emergency construction works are underway to prevent secondary disasters that could be caused by collapse of the remaining large volume of sand at upper area of the slope.

Overview of landside disaster

- Tateno, Aso village, Aso County, Kumamoto Prefecture
- April 16, 2016, Kumamoto earthquake
- Status of damages
  - National road no. 57, National road no. 325, Japan railway Houhi line
- Major countermeasure works
  - Earthworks and building of mounds, Slope protection works (Cost: Two billions)
- Start of the works: May 5th, 2016
- Due to the cracks as well as unstable earth and sand, left at the top of the slope, the works are undertaken by using construction machines for automatic operation.

Steps of the works

1. Installation of monitoring system
2. Developing passages for the works
3. Building of mounds
4. Elimination of unstable sand
5. Slope protection works

Elimination of unstable rocks left by gully erosion

- Kyushu Regional Development Office, MLIT
**Operation of the unmanned machine for construction works**

Operated by using four monitors for one unmanned machine

Images from the vehicle carrying camera

Operation desk for 14 unmanned machines

Heavy machines photographed from just in front

Monitoring other unmanned machine

Zooming

Monitoring camera (capable of multi angle operation)

**An overview of the unmanned construction system**

Networked system for unmanned construction

Images from the vehicle carrying camera

Operation room

Monitoring other unmanned machine

Zooming

Monitoring camera (capable of multi angle operation)
**Area of the works of eliminating unstable earth and sand**

Surface layer of andosol, deposited earth and sand (d(An)), and pumice found at the areas surrounding the collapsed points where the ground rises.

A cross section for elimination of earth and sand

(2) Upper border of the works
- Block ①-2: Upper border is defined up to the crack of the unstable block, due to the changes identified by dynamic observation, and the significant difference in level between the cracks behind.
- Block ①-1, Block①-3: Basically the area cut from the lower border at a stable gradient of one in two, with necessary adjustment depending on the status of the ground at the back during the works.

(1) Lower border of the works
- Lower border of elimination was defined by measuring the collapsed surface by UAV, and examining the status of pumice that could trigger falling of stones.

**Status of the works for eliminating unstable earth and sand**

Overview of method of construction [Safety climber method]
**Status of the works for eliminating unstable earth and sand**

**Before the works**
August 23rd

- Elimination of unstable sands, stones that may trigger falling of stones
- Start of works: August 31th by using three slope power shovel at height
- Completed in two months and half on November 10th

**Status of the works**
October 25th

**Elimination of unstable rocks left by gully erosion**

Before the rainfall, June 17th
After the rainfall, June 27th

Heavy rainfall on June 20th accelerated the gully erosion

**Rock climbing method of construction**

1. Unstable rock at the top of gully
2. Softening of exposed andesite bedrock
3. Sedimentation of collapsed sand in the gully