The 2016 Kumamoto Earthquake and the Restoration Work Using the Advanced Unmanned Construction Technology

Naoto YAMAGAMI[1] and Shigeo KITAHARA[2*]

[1] Kyushu Regional Development Bureau, MLIT, Japan
[2] Information and Communication Technology Promotion Office, KUMAGAI GUMI CO., LTD, Japan
*Corresponding author. E-mail: skitahar@ku.kumagaigumi.co.jp

INTRODUCTION

The 2016 Kumamoto Earthquakes are in a series of earthquakes, which are a foreshock earthquake observed at 21:26 on April 14, 2016 with a magnitude 6.5 at a depth of about 11 kilometers, and then main shock earthquake with a magnitude 7.3 observed at 1:25 on April 16, 2016 with a magnitude 7.3 at a depth of about 12 kilometers. The casualties by the 2016 Kumamoto Earthquakes were 267 people died and 2,804 people wounded as of April13, 2018. More than 200 thousand houses were damaged, and more than 200 thousand people were forced to live in shelters. Kumamoto prefecture estimated that the gross amount of the loss run into 3 trillion 7,850 billion yen.

This loss was the largest one in natural disaster occurred around the world in 2016.

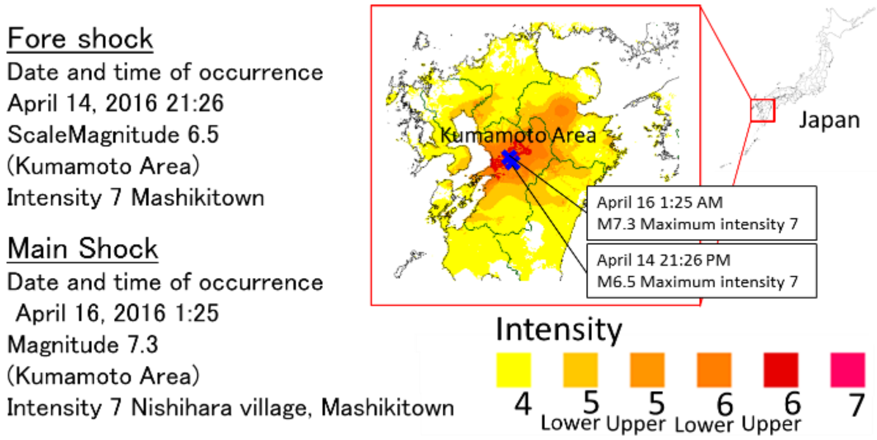

Fig. 1 Diagram of seismic intensity distribution and the epicenter

Damaged Infrastructure and Efforts of Ministry of Land, Infrastructure and Transport (hereinafter called MLIT) to Disaster

After the earthquakes, 172 deformations of river embankments such as cracks and subsidence were confirmed in relatively large river system under control of MLIT. Approaching the verge of rainy season, urgent restoration works were required without a moment's delay

MLIT has carried out urgent restoration works 24 hours a day on 11 relatively large deformation points in 172 damaged points of river embankments, and worked it out and accomplished the restorations on May 9 before the rainy season in 2016. In addition, considering causes of the damages, methods of restoration and monitoring on the completion of restoration, full-scale restoration works have been done on 52 points required to restore and accomplished by the end of May before rainy season in 2017.

Efforts at Aso Bridge District

Currently, permanent measures for slope stabilization have been and are being taken to restore infrastructure of transportation as soon as possible at Aso Ohashi district where large-scale landslide has occurred. During eight months from May to the end of December, 2016, MLIT has been doing emergency works by advanced unmanned construction machines to avoid secondary disaster by the aftershock under extremely unstable large-scale slope. The following introduces efforts by this unmanned construction in detail.

Efforts to large-scale landslide at Aso bridge district gave us precious opportunity to compile variety of unmanned construction technologies applied to various disaster responses and more to show new adaptability of the unmanned construction. The scale of the large-scale landslide at Aso bridge district run up about length 700 meters and about width 200 meters, and the sediment discharge was estimated about 500,000 cubic meters. Many crown cracks and terrace scarps occurred on the head of the landslide. Since the post failure ground surface was steep slope, there was a danger of further collapse caused by rainfall or aftershock. Since it was the most important task to avoid any secondary disaster under the above circumstance, the latest unmanned construction technologies were introduced into the rehabilitation works, as monitoring and sensing movement of the post failure ground surface and the surrounding.

Firstly, it was forced to move forward to consolidate the road base as stirring and mixing soil amendment additive in situ. Subsequently, a full-fledged construction of retaining embankment could commence in July of that year, where was utilized unmanned construction system that was composed of multiplexing of connected devices with high-speed and wide-bandwidth data transmission in comparison to the conventional system. This unmanned construction system made it possible to remotely operate up to fourteen construction machines at the same time and to build retaining embankment composed of upper and lower stages. Moreover, this system enabled us to do rounding and remove large boulders at the crown of the landslide, and to remove soil at the post ground surface by remotely operating several construction machines. Accordingly, emergency construction works could be completed to avoid secondary disaster. Currently, manned works have been and are implemented to build permanent fix works such as protection net and inserting rebar.

Fig. 2 A bird's eye view of unmanned construction conducted at Aso bridge district

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