UNMANNED CONSTRUCTION SYSTEM FOR DISASTER RESPONSE

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In Japan, we have a lot of earth-flow disasters caused by volcanic eruption, typhoon, earthquake etc.. After the disaster strikes, it is necessary to conduct recovery works, such as removing the rubble and/or building embankments, ASAP. However, there are possibilities of second disasters in such construction site, so conventional methods are dangerous for operators of normal construction machines. Therefore, the new construction method, *The Unmanned Construction System* (UCS), was developed as the solution to protect operators (Fig.1). In the system, construction machines are teleoperated remotely by operators from a safe area. This is a unique and innovative system developed in Japan. In this presentation, a brief history and future technical trends of UCS are introduced.

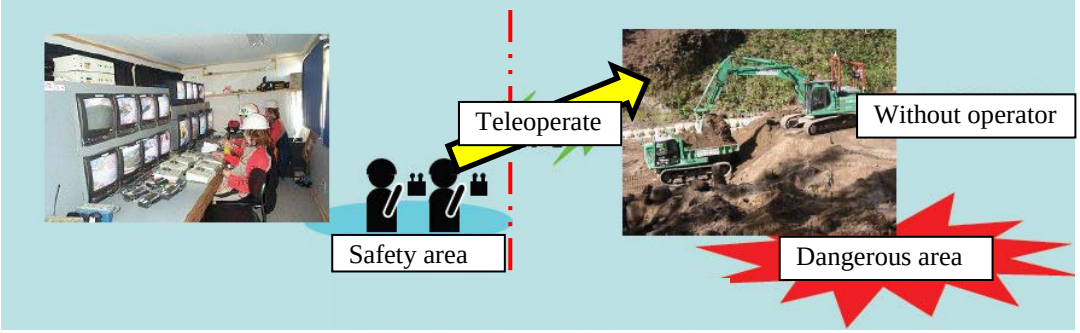

Fig.1 *Unmanned Construction System* (UCS)

The first UCS was used in the recovery work on the bridge over the Joganji river in 1969. In this case, an underwater bulldozer was used via cable with direct viewing of the operator from 10-30m. Afterwards, some machine manufacturers released cable-type (or radio-control-type) construction machines, such as hydraulic excavators and dump trucks, which was supposed to be used in direct viewing situation. These were easy to be re-built from normal construction machines, so that they were deployed quickly to various conditions. Even today, they are used in disaster environments in the case of very urgent and short distance from safety areas.

In 1993, Mt. Unzen erupted, and the UCS with non-direct viewing was deployed for the first time to conduct recovery works of the disaster. In this project, over 10 machines were teleoperated in the disaster field that was 100m away from the safety zone with monitor viewing. In the recovery work, huge amount of rock, soil and sand (more than 100,000m3) was removed, and 32 protection embankments were built. Through the Unzen project, the UCS was progressed to "general construction technique" that includes civil engineering, mechanical engineering, information and communication technology, and surveying technology. Until now, the UCS technology has been used in various disaster sites, more than 150 sites in Japan, e.g. the volcanic disaster at Mt. Aso in 2000, the earthquake disaster in Niigata prefecture in 2004, the earthquake disaster in Miyagi-Iwate in 2008, the typhoon disaster in Kii peninsula in 2011. In addition, the UCS was used at Fukushima nuclear power plant to remove the debris in high radiation condition in 2011.

UCS still have some technical problems. One major problem is low-work-efficiency caused by the tele-operating system. To solve this problem, the following assistance-technologies are required:

- Assistance of spatial perception of operators
- Environmental measurement technology to collect information on the target site
- Machine control system and machine guidance system to support the operator’s work

To tackle the above, recently, some next-generation-technologies are developed, such as a virtual operating room that can reproduce a realistic driving environment, an automatic measurement device of ground stiffness, a control and guidance system based on GNSS. In the future, further developments and technology fusion are expected to improve the UCS system.