ICT construction of a mountain tunnel that obtained Collaborative Safety 2.0 certification

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Introduction

Humans and heavy machinery work together in a limited space during the construction of mountain tunnels, and there is a high risk of accidents involving contact with heavy machinery, which can directly lead to serious accidents once they occur. To reduce this risk, rules for people approaching heavy equipment have been established at the site, and safety training is provided to ensure that everyone is aware of them. Thus, this does not address human error, and the eradication of accidents involving contact with heavy machinery has not yet been achieved. Therefore, in order to prevent accidents involving contact with heavy machinery during tunneling, we introduced a risk reduction system for contact involving heavy machinery based on Safety 2.0 (ICT-based cooperative safety between humans and heavy machinery) to a mountain tunnel site and obtained the cooperative safety certification.

1. Outline of the site where the cooperative safety certification was obtained

The Takimurozaka Tunnel, located in Kumamoto Prefecture, is a road tunnel with a main shaft length of 4,834m and an evacuation shaft length of 4,898m. This section of the tunnel consists of the 2,679m main shaft on the west side and the 3,069m evacuation shaft. A risk reduction system for contact involving heavy machinery was introduced in the excavation of the main shaft (excavation cross-sectional area: 107m^2).

2. Risk reduction system for contact involving heavy machinery

(1) Human-heavy machine mutual recognition system
In order for people and heavy machinery to work together, it is necessary for the heavy machinery operator to be able to detect the approach of people and for people to be able to detect the approach of heavy machinery. Therefore, AI cameras that recognize people were installed at the rear and sides of heavy machinery, and a device (monitor and alarm lamp) was installed to detect the entry of people into the blind spot of heavy machinery and notify the operator (Fig.1). In addition, sequential lights were installed on the rear of crawler-type heavy equipment such as backhoes, and red LED running lights were installed on the front and rear of tire-type heavy equipment such as wheel loaders, in order to visually inform workers near the heavy equipment of its movement (Photo-1).
(2) Location information management warning system
In order to thoroughly enforce the prohibition of entry during removal work, we developed a location information management warning system that issues an alarm when a person enters an off-limits area. In this system, a transmitter (EXtx tag) is attached to the helmet of a worker, and a receiver (EXBeacon) is installed at the boundary of the off-limits area to manage the location information of the person (Photo-2). The system will sound an alarm when a person enters an off-limits area and notify the heavy machinery operator.
In addition to a loudspeaker, red LED face illumination was installed as a method of quickly and clearly communicating the alarm to all workers even in situations where voices are drowned out or visibility is poor. When an alarm is issued, the area around the face is illuminated in red with a loud warning sound (Fig.2). This allows heavy machinery operators to recognize that a person has entered the face work area or that a heavy equipment operator has disembarked.

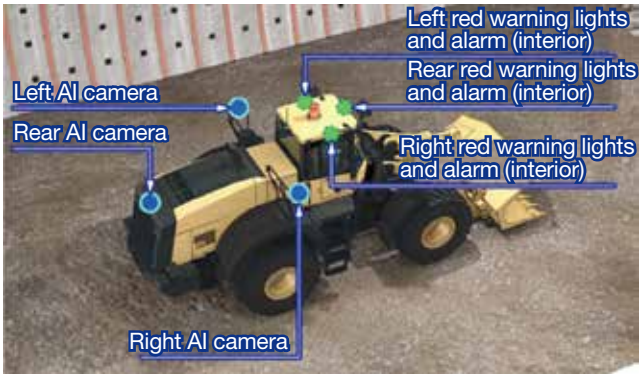

Fig. 1 Human-heavy machine mutual recognition system

Photo 1 Left: Sequential lights. Right: Red LED running lights

Photo 2 Left: Transmitter (EXtx tag). Right: Receiver (EXBeacon)

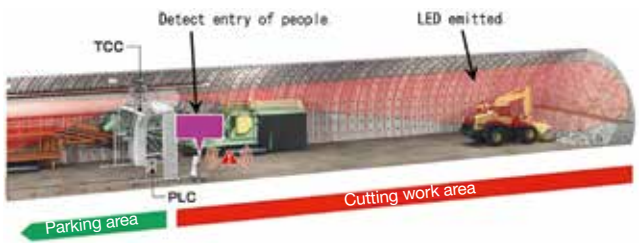

Fig. 2 Location information management warning system