December 2017 No.79
Japanese Infrastructure Newsletter

IDI QUARTERLY

Infrastructure Development Institute—JAPAN

Next-generation construction production system centered on automation of construction machinery "A4CSEL"

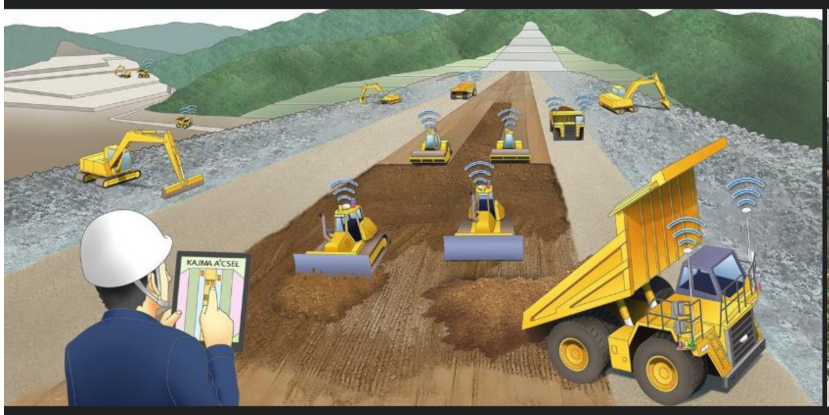

Image of next-generation construction performed by "A4CSEL"

Cooperative works by automated machines

Automated dump truck

Automated bulldozer

Automated vibration roller

CONTENTS

Infrastructure Development Institute – Japan (IDI)
Suido-cho Bldg, 3-1, Suido-cho, Shinjuku-ku, Tokyo, 162-0811, JAPAN
Tel: +81-3-5227-4107 Fax: +81-3-5227-4109 E-Mail: idi17@idi.or.jp Website: http://www.idi.or.jp/english/00index.htm

The 19th Infrastructure Technology Development Award 2017

The Japan Institute of Country-ology and Engineering(JICE) was established as a public interest corporation to promote construction engineering in Japan by conducting cutting-edge research and development activities.

As more incentives should be provided for construction technology researchers and research institutes to enhance the level of construction engineering more effectively, JICE commenced Infrastructure Technology Development Award with Coastal Development Institute of Technology (CDIT) under the auspices of the Ministry of Land, Infrastructure, Transport and Tourism(MLIT).

Thirty-six technologies competed for the 19th Infrastructure Technology Development Award.

In principle, the applicants' technologies should have been developed within the past five years and applied to the real sites within the past three years.

As a result of examination, institutes and researchers with the following technologies were awarded 19th prizes.

The grand prize is "Next-generation construction production system centered on automation of construction machinery A^{4}CSEL" .

And the three excellence prizes were awarded to "RE-PIER METHOD for efficient seismic retrofitting of piled piers in service", "Restoration for Preservation of Himeji Castle Main Keep, National Treasure of the Heisei Era", and "Network Compatible Unmanned Construction System".

The grand prize and one of the three excellence prizes are introduced below.

For any inquiries/ comments please contact
JICE :
Homepage: http://www.jice.or.jp/
(Japanese version only)
E-Mail: webmaster@jice.or.jp

Next-generation construction production system centered on automation of construction machinery "A4CSEL"

("A4CSEL" for performing autonomous construction work using general purpose construction machinery)

1. Background of Technology Development

In the construction industry, productivity is lower than that of other industries, and in recent years i-Construction utilizing ICT has been promoted in Japan. In addition, the aging of skilled technicians, the decrease in young workers, and the occupational safety due to mixed work of construction machinery and workers remain as challenges. Robotization and automation are being promoted as one of the solutions, but in the current information construction system and the unmanned construction system with remote control etc., it has not reached a fundamental solution to the two problems of productivity and safety improvement. In order to meet all tasks of labor saving, productivity and safety, we developed the next generation automated construction system named " A4CSEL (Quad-ACSEL: Automated /Autonomous/Advanced/Accelerated Construction system for Safety, Efficiency, and Liability) ".

2. Detailed Description of the Technology

We have applied the next-generation construction system constituted of three types of automatic construction machineries in the dam construction.

- Haulage and unloading the material by automated dump truck: Automatic haulage and unloading the material to the prescribed position (Fig. 1).
- Spreading and shaping the material by automated bulldozer: Automatic spreading and shaping the materials after receiving the signal that the automated dump truck leaves (Fig. 2).
- Compaction the material by automated vibration roller: Automatic compaction work with the flexibility to cope with a non-rectangular area where buried instruments are installed (Fig. 3).

Fig. 1 Automated dump truck.

Fig. 2 Automated bulldozer.

Fig. 3 Automated vibration rollers.

Fig. 4 Construction image of "A^{4}CSEL"

3. Advantage of the technology

Using our development system, multiple automated construction machines are able to work only by human instruction by a tablet terminal simultaneously, unlike unmanned construction systems by remote control, such as disaster restoration sites. As a result, it will realize improvement both of productivity and safety of the construction (Fig. 4).

- Automation of construction machines by installing measuring equipment and control PC in general-purpose construction machinery.
- High accuracy and precision construction by automatic control algorithms based on operation data of skilled workers.
- Equipped with a safety measure system with contact prevention function by multiple means such as obstacle recognition technology

4. Applicability

- The cooperative works by our developed three kind of automated machines are demonstrated in the embankment area at the dam body (Fig. 5).
- Utilization not only for dam construction but also for general construction work confirmed.

Fig. 5 The cooperative work of automated dump truck and bulldozer

5. Installation Record

- Gokayama Dam construction work July 2014 - May 2015
- Oitagawa Dam construction work April 2016 - May 2017

Technology Developer: Kajima Corporation
Joint Developer: Komatsu Ltd.
Contact: Satoru Miura, Kajima Corporation
E-Mail: miuras@kajima.com,
TEL: +81-42-489-6502
FAX: +81-42-489-8440

Network Compatible Unmanned Construction System

(Emergency ICT System for Large Scale Unmanned Construction)

1. Background of Technology Development

The importance of the implementation of unmanned construction by remotely controlled construction machinery has been recognized since the restoration work after the Mt. Unzen Disaster followed by other large-scale reconstruction works. The object is to develop a system which can provide the operator with accurate and beneficial information in a poor-reality desolate environment, and to do this as quickly as possible. Following the Great East Japan Earthquake, restoration sites under harsh conditions increased significantly, and there was a demand to develop technology enabling the concentrated introduction of plenty of construction machinery. We developed relevant technology to resolve various issues and the technology was incorporated into the Aso Bridge District Slope Disaster Prevention Work.

2. Technical Content

The Network Compatible Unmanned Construction System was customized and developed on site to transmit bulk data consisting of operating information, visual information and ICT data of the construction machinery into IP (Internet Protocol), using fiber optics cable and Wi-Fi LAN (see figure 1).

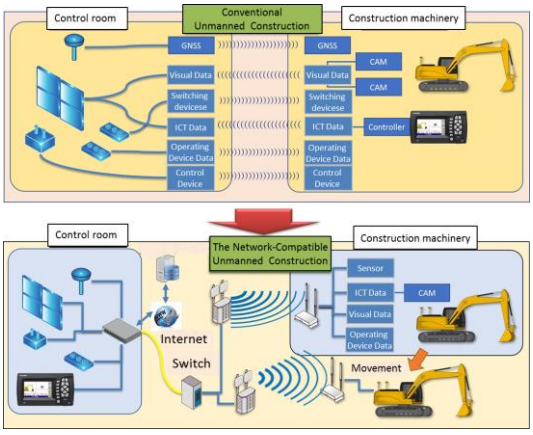

Figure1: Comparison with conventional systems

Furthermore, in an effort to develop new technology for the Network Compatible Unmanned Construction System, we created the CAN-LAN converter for the ICT construction machinery, the high precision image transmission system for sophisticated operations video, the autonomous operation system by remote control system, and real time management system of construction machinery using IoT. These systems may be combined and arranged according to the site conditions (see figure 2).

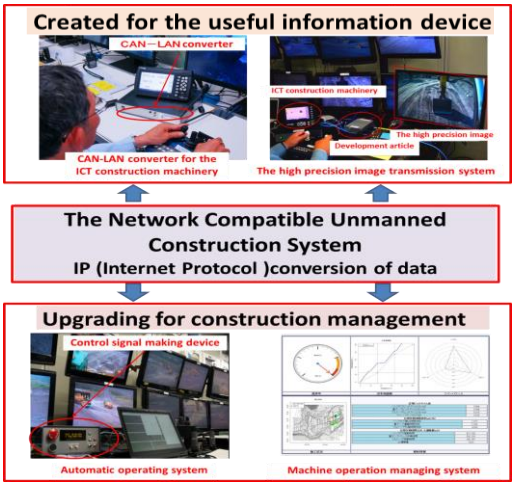

Figure 2: New technology development and implementation

To quickly launch an unmanned construction system, we first develop a sophisticated remote control room furnished with a set of configured remote control system equipment, and achieve early commencement of unmanned construction (see figure 3).

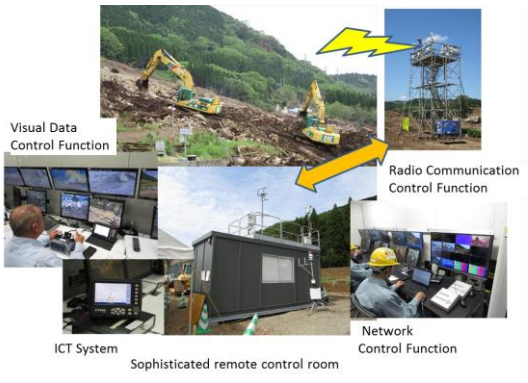

Figure 3: Sophisticated remote control room

For the first time in the history of our country, an unmanned construction system with i-Construction was used in all phases of the difficult emergency disaster restoration work.

3. Coverage of Technology

Overall disaster restoration work and construction in bad conditions in hazardous areas (tunnels, repositories, nuclear plant decommissioning sites, etc.)

The network technology is widely applicable to such sites using i-Construction.

4. Effect of Technology

IP conversion of data of both the construction vehicle and control room mitigates the distance limits between the construction site and remote control room, making it possible to build the remote control room at a distance of several hundred kilometers from the site. Compared to conventional methods, it requires fewer transceivers, lowering wireless equipment costs by 40%. (Actual record of the Aso Bridge District Slope Disaster Prevention Work)

The sophisticated remote control room allowed construction activity to start in only two days and shortened the construction period by 12 days. (Actual record of the Aso Bridge)

By applying the overall system, it provided the operator of the remote control room with useful information, alleviated the burden and improved accuracy, so that the construction period was shortened by two months (25%) from the original schedule. (Actual record of the Aso Bridge)

Through the network, all information was gathered in the remote control room, allowing construction machinery to be monitored in real time, achieving the overall implementation of i-Construction. (Actual record of the Aso Bridge)

5. Social Significance and Evolution of Technology

This development allows for the easy implementation of the latest network technology and extends the possibility of a speedy incorporation of unmanned construction, while improving disaster application capacity in complicated and difficult situations. As a result, the i-Construction environment is well in place, greatly contributing to futuristic technology with its goal of productivity improvement in civil engineering.

6. Performance of Technology

Aso Bridge District Slope Disaster Prevention Work, May 2016-March 2017

And four other cases

Applicant: Kumagai Gumi Co., Ltd.

Technology Developer: (Kumagai Gumi Co., Ltd.) Kitahara Seirou, Asuma Tsubasa

Joint Developer: Kyoei Machinery Engineering Co., Ltd., (YK) E-. MEC

E-Mail: skitahar@ku.kumagaigumi.co.jp (Mr.kitahara)

TEL:+81-3-033260-2111

About IDI and IDI-quarterly

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IDI provides consulting services for mobilizing International Assistance to developing countries, promoting international exchange of information and human resources, and supporting globalization of project implementation systems targeting both developed and developing countries in the field of infrastructure.

IDI has been publishing the free quarterly journal "IDI Quarterly" since1996 for the purpose of introducing information relating to public works and construction technologies developed in Japan to foreign countries. We have distributed the journal to administration officials in more than 90 countries around the world by e-mail.

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- Manuscript fee will not be paid.
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