Computerized Construction

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1. Introduction

In July 2008, the Ministry of Land, Infrastructure, Transport and Tourism enacted the Computerized Construction Promotion Strategy.

This promotion strategy considers the significance of computerized construction to be, "a general term for a new execution system which achieves high productivity and execution quality using ICT for construction execution." In other words, computerized construction is an execution method intended to achieve high productivity, quality etc., and has an extremely broad meaning extending from using the newest ICT to applying simple ICT.

But, according to the results of a questionnaire survey conducted during a trial execution of computerized construction by the Ministry of Land, Infrastructure, Transport and Tourism in 2008, while the term, computerized construction, is known on the client side in particular, specific technologies have not penetrated the construction field very much. For such reasons, we wish to introduce the general framework of computerized technologies by classifying and organizing such technologies used for trial executions which the Ministry of Land, Infrastructure, Transport and Tourism has performed since 2008 (total of 241 cases).

2. Computerized construction technologies

Figure 1 roughly systematizes computerized construction technologies used for past trial executions. If these groups of technology are first classified according to purpose, they can be divided into technologies which support mechanized execution and technologies which support execution control. Technologies in the former group are 1) machine guidance technologies (MG technologies) for construction machinery and 2) machine control technologies (MC technologies) for construction machinery, and these are technologies categorized as those mainly developed by the private sector. Technologies in the latter group are 3) finished work control technologies which apply ICT and 4) quality control technologies which apply ICT, and trial executions are being performed to verify their efficiency and reliability when applied to execution control by a contractor and to supervision and inspections by a customer.

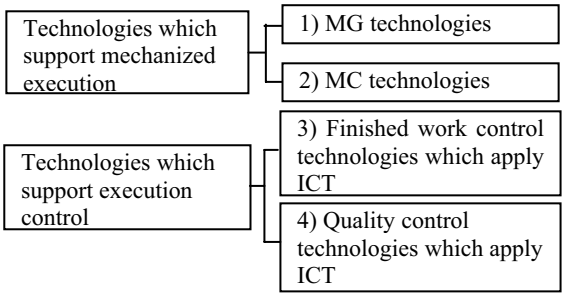

Figure 1. Classification of Computerized Construction Technologies

1) MG Technologies (machine guidance technologies)

These are technologies which combine measurement and positioning technologies such as TS (total station) or GPS (positioning system using satellites) etc. with angle sensors, inclinometers and other sensors to obtain data concerning the position and state of operation of a construction machine and provide the operator of the machine with information on an in-board monitor along with three-dimensional design data which has been input to the construction machine. Taking MG technology installed in a back hoe used for cutting work as an example, the object of the excavation is shown on a screen, replacing finishing stakes. It can, therefore, be counted on to eliminate stake installation work and speed up finishing work.

2) MC Technologies (machine control technologies)

This is technology which, in addition to the MG technology monitor display, includes a function which calculates the difference between the positions of the bulldozing blade, bucket, etc. of the construction machine with the three-dimensional design data and performs automatic control to achieve the stipulated execution precision. Taking MC technology installed on a grader etc. used for road work as an example, it automatically controls the excavation height. It can, therefore, be counted on to effectively reduce the work of installing and inspecting finishing stakes used as markers and effectively reducing redoing of work.

3) Finished work control technologies which apply ICT

This technology converts coordinate values obtained by TS, GPS or other measurement and positioning technologies (for example, three-dimensional

coordinate values, elevation and latitude and longitude based on GPS) to finished work values such as length or height, permitting the use of the coordinate values to control finished work. Taking the state of finished work control based on TS in the embanking work shown in Figure 2 as an example, by inputting three-dimensional design data to TS, the design values, measured values, and the difference between them of elevation and horizontal distances are displayed on the TS screen, permitting the operator to confirm that the standard values are satisfied as the measurements are performed.

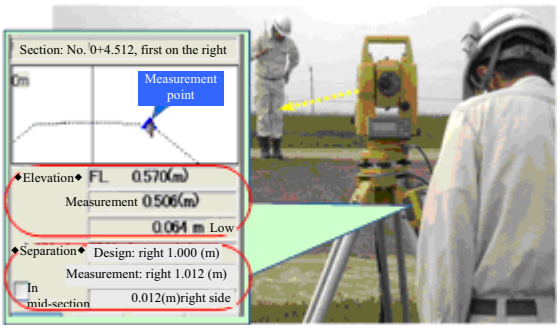

Figure 2. View of Measurement Based on TS used for Finished Work Control

4) Quality control technologies which apply ICT

This is a technology which uses measurement and positioning technologies such as TS or GPS to perform planar control of qualities such as density, strength, etc. at the same time as the execution. Taking embankment soil density control as an example, it is a method of measuring compaction frequency or acceleration response which are correlated with density and which can be measured at the same time as execution as quality control items to replace density.

3. Finished work control technology based on TS

The Research Center for Advanced Information Technology has been conducting research and development of finished work control systems based on TS since 2005.

As shown by Table 1, until now, contractors performed finished work control by, repeatedly for each control section, performing calculations to specify the location for finished work control, placing stakes etc. to mark the site and measuring the finished form using levels, measuring tapes, etc., recording these data in their field notebooks, and transferring the data to ledgers and section drawings in the office.

But in the case of finished work control systems based on TS, calculation and marker placement are unnecessary, and this method can be counted on to automate the preparation of ledgers from finished work calculation data, reducing preparation work. It makes it easier for the customer to confirm the finished work control performed by the contractor, and it is counted on to simplify the task of confirming finished work devised by the customer at any control section. Until now, we have 1) studied the functions of software installed in finished work control use TS and developed prototypes, 2) standardized data formats for input to TS, 3) verified the effectiveness of its introduction, and 4) enacted finished work control instructions using TS. Beginning in 2010, we will use it for standardization of directly managed earth works.

Table 1. Comparison of Conventional and TS Based Finished Work Control

	Conventional method	TS method
Specification of location of finished work control point	Manual positioning calculation and placing markers (stakes etc.)	Automatic positioning calculation so it is not necessary to place markers (stakes etc.)
Completed work measurement	Measuring height with a level and length with a measuring tape	Measuring three-dimensional coordinate values with TS, and automatically converting them to length, etc.
Preparing ledgers from measured data	Preparing ledgers by transferring data from field notebooks	Automatically preparing ledgers

4. Conclusion

This report has introduced the overall framework of technologies related to computerized construction. As stated in the introduction, these technology groups are extremely diverse, and details of each technology could not be introduced because of a shortage of space, but please refer to documents such as, “Construction ICT Overview Series (*kensetsu ICT zakkuri shirizu*) published by the ICT Introduction Research Committee at the Chubu Regional Development Bureau as a document clearly explaining their details.

We hope that people in each field will take an interest in such computerized construction related technologies and apply them to boost building construction performance.