Productivity improvement in infrastructure development process using i-Construction

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1. Infrastructure development process

The development process, the infrastructure consists of the project execution process for planning, investigation, design, construction, maintenance, and procurement and the contract fulfillment process for individual projects involving cost estimation, bid contracts, fulfillment, inspection, and evaluation. It is necessary to review both aspects of the development process, corresponding to changes such as in the social and economic situation.

Recent tasks for the infrastructure development process include responses to natural disasters, which occur frequently and are intensifying, maintenance of numerous aging public facilities, and decrease in the workforce in response to the declining birthrate and growing proportion of elderly people. Although the construction industry plays an important role, the working population of the construction industry is decreasing, and as a result, there is rising concern about securing sufficient quality and maintenance for the infrastructure development in the future.

It is necessary to promote efficiency improvement, rationalization, and upgrades and improvements in productivity in each phase of the infrastructure development process, together with the reliable preparation of public and private human resources for the future. In this report, we introduce the current topics that we are working on as a part of work procedure innovation, regarding productivity improvement in the infrastructure development process.

2. Implementation of i-Construction

In November 2015, the Minister of the Land, Infrastructure, Transport and Tourism proposed “i-Construction”. With three major concepts, including the full utilization of information and communication technology (ICT), technical standardization, and equalization of construction periods, the i-Construction aims to optimize and upgrade the whole process from investigation and design, construction and inspection, up to maintenance. It will also increase the productivity of individuals working on construction sites, improve the administrative circumstances in companies, and raise the wage level of workers engaged in construction, while simultaneously ensuring security. As a part of the i-Construction promotion project, we are promoting research on improving the productivity at the sites of earthworks and concrete works.

Approximately 30% of the workers employed in the construction industry are 55 years of age or older, and aging in this industry is more serious than in other industries. It is almost certain that a large number of workers will leave their jobs in the near future. According to an estimation by the Japan Federation of Construction Contractors, on the assumption that the construction investment will be the same as the current investment level, it aims to acquire 900,000 new workers in the industry and save a manpower equivalent of 350,000 workers, to compensate for the lack of skilled workers by 2025. We have to enhance recruitment and human development measures, and prepare attractive construction sites for young people, by improving their productivity through the utilization of ICT.

According to the data on the skilled workers at construction sites grouped by construction type, almost 40% of workers in the projects implemented by the national government are in engaged earthwork and concrete work (Figure 1). In the case of tunnel construction projects, the number of workers per unit of construction volume has become approximately one tenth that of approximately 50 years ago, and the productivity of the workers has increased significantly. On the other hand, regarding earthworks and concrete works, the number of workers has remained constant for 30 years, and there is room for improvement.

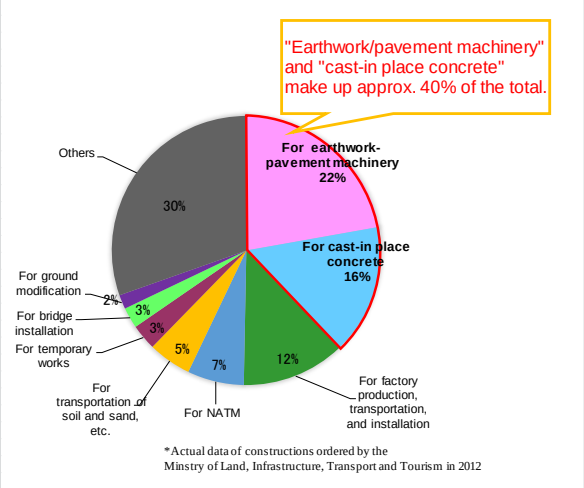

Figure 1: Proportion of skilled workers at construction sites by construction type

At the earthwork construction sites, three-dimensional design data are introduced for the automatic control of ICT construction machines to increase the construction volume of heavy equipment per day, and save manpower simultaneously. However, the early phases of construction, like the measurement and design phase, are still conducted using two-dimensional data, and three-dimensional data are created for construction separately. In addition, work completion drawings are created in a two-dimensional data format for inspection after construction. Therefore, construction works based on three-dimensional data and transactions between an orderer and a contractor based on two-dimensional data exist together in one construction case. The full utilization of ICT by the three-dimensionalization of all the processes from measurement to inspection is desired (Figure 2). For that purpose, it is necessary to develop measurement rules, allowing utilization of three-dimensional data collected by unmanned aerial vehicle (UAV) as a measurement result, along with inspection standards that can be used for progress assessments and completion inspections.

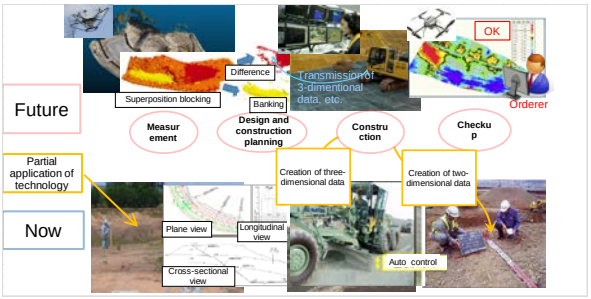

Figure 2: Overall earthwork productivity improvement with utilization of ICT

Regarding concrete works, it may be possible to improve the effectiveness of the work conducted at the site, and save labor in the formwork and reinforcing-bar placement by the introduction of labor-saving technologies such as pre-cast concrete. However, in some cases, pre-cast concrete is not adopted in the design phase because of the high costs. It is expected that the utilization of pre-cast concrete will shorten the construction period, and improve the quality and safety. We propose an evaluation indicator for such labor-saving effects of pre-cast concrete, while simultaneously promoting research on the technical standards for pre-cast concrete and their incorporation into design guidelines.

3. Promotion of CIM

With Construction Information Modeling/Management (CIM), a three-dimensional model is introduced in the planning, investigation, and design phases, and also collaboratively incorporated into the construction and

maintenance phases. As a result, information is completely shared by related parties of the overall project, and a series of production systems can be more effective and advanced. The goal of CIM is largely related to i-Construction.

Since FY2012, CIM has been deployed on a trial basis for the design and construction of projects implemented by Ministry of Land, Infrastructure, Transport and Tourism. While the effects and problems found in these trials are cataloged, a joint study team from industrial, academic, and governmental organizations, which was established in January 2015, aims at the preparation of CIM introduction guidelines in FY2016. We are promoting a research on how to create and use a CIM model in the maintenance phase, targeting bridges and rivers. It tends to consume time and money excessively. Thus, it is necessary to review the level of detail for the three-dimensional model to be created, along with the functions and attribute information to be attached, before the maintenance phase, considering an appropriate balance between the effects and costs. It is important to be used on actual construction sites, and aim to prepare one that allows the intuitive searching and viewing of information by connecting Geographic Information System (GIS) data and locations in the three-dimensional model.

4. Reception of merits

All of the related parties shall share the merits and convenience brought by a productivity improvement. Public and private organizations, or orderers and contractors, as well as contractors, subcontractors, and workers at the sites should be included in the related parties. If any one of these receives adverse effects secondary to the shifted burden, labor shortage both in the private and public organizations will not avoidable, and it may be difficult to deploy the infrastructure development process continuously. In addition, although ICT has progressed remarkably, and various tools and paraphernalia are becoming available, it is important to put these things to practical use at the actual sites sufficiently. Needless to say, we will continue to do our best to understand the actual conditions at the sites, and research to satisfy the requirements at the sites.