# Technology for Automatic 3D Model Construction using 2D CAD Data

(Research period: FY2018 to FY2020)

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*key words:* *BIM/CIM, 3D model, automatic construction*

## 1. Introduction

NILIM has been promoting the research on BIM/CIM (Building / Construction Information Modeling, Management), which is an initiative to accumulate, link, and share information throughout the construction production process including survey, design, construction, and maintenance. BIM/CIM aims to improve productivity through the use of 3D data. However, the use of BIM/CIM in maintenance has not progressed, and one of the reasons for this is the difficulty to create 3D models of existing structures due to the need for highly skilled workers and the large creation cost. To solve these issues, NILIM is developing a technology to create 3D models of existing structures in a labor-saving and low-cost manner. This paper reports on the automatic 3D model construction technology using 2D CAD data in the "Research on 3D model construction technology by AI using 2D CAD data," which was conducted as part of this technology development in the form of commissioned research to RIKEN Center for Computational Science.

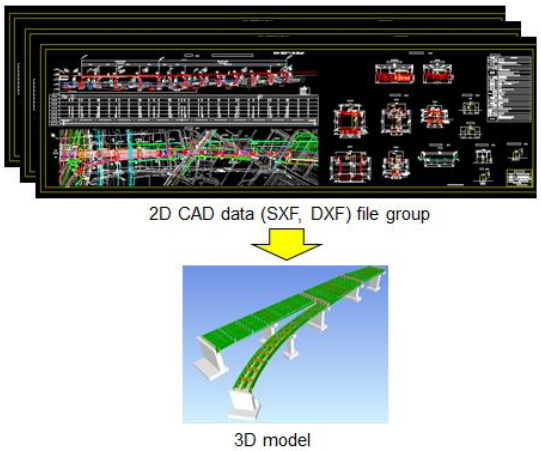
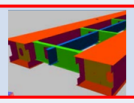
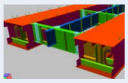



**Fig. 1: Technology for construction from 2D CAD data**

## 2. Detail level required for maintenance

The 3D model used for maintenance should be a model that accurately represents the external shape of main components, assuming that the 3D model will be used as a platform for integrated data management, inspection planning, etc. [2]. Therefore, this research will develop a technique to create 3D models with a target of detail level 300 as shown in the **Table**.

**Table: Definition of detail levels for 3D models**

| Detail level | Common definition | Sample (bridge) |
|---|---|---|
| 100 | A model representing the location of the object with symbols, lines, or simple shapes. |  |
| 200 | A model representing the structural form of the object. Representation of cuts and embankments in standard cross-section, or representation to the extent that the standard cross-section shown in the general drawing of each structure is created by sweeping it in the target range. |  |
| 300 | A model that accurately represents the external shape of the object, excluding the detailed structure of accessories, etc. and joint structures. |  |
| 400 | In addition to the detail level of 300, this model accurately represents the object including accessories, detailed structures such as joint structure, and bar arrangement. |  |
| 500 | A model that accurately represents the real shape of the object. | |

## 3. Automatic 3D model construction technology

The technology for automatic 3D model construction developed in this research is called "Top-down processing method," which automatically selects a template that is compatible with the structure from the 2D CAD data and automatically constructs a 3D model by setting parameters that indicate the shape, such as dimensions, to this template. The selection of template and the setting of parameters are conducted automatically by the production system, which is a kind of artificial intelligence (**Fig. 2**).

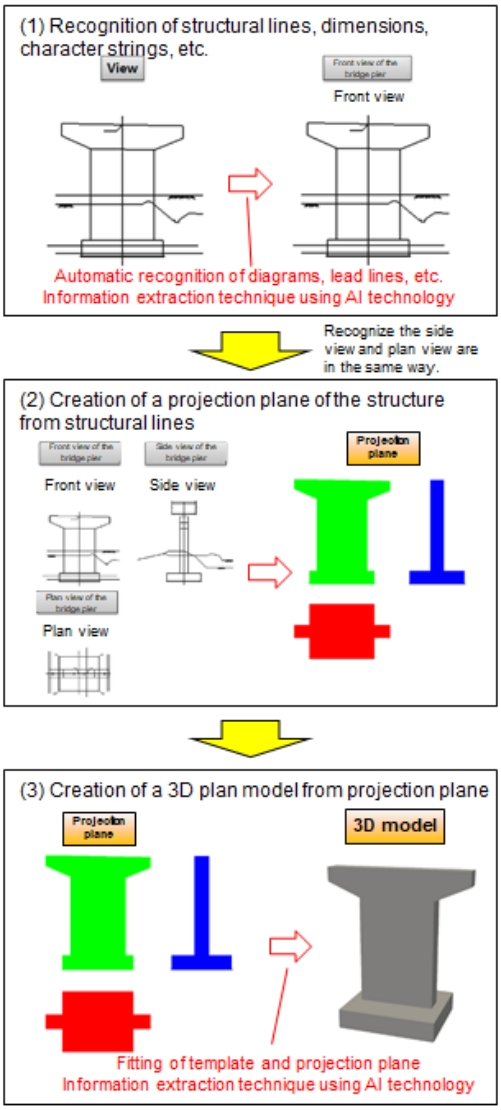



**Fig. 2: Automatic 3D model construction procedure (bridge pier)**

In this method, the structure and shape are the same to some extent.
This method is also highly compatible with civil engineering structures, and enables the modeling of the entire civil engineering structure on the whole, although some complex structures such as dams cannot be modeled.
The same technology can also be used to create 3D models of internal structures such as reinforcing bars.

## 4. Demonstration test on existing bridges

A 3D model of the substructure of the Shin-Arakawa Bridge managed by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), excluding the pile foundation, was created using the 3D model automatic construction technology.
**Fig. 3** shows the 3D model created by the automatic construction technology and the 3D model created by manual input for comparison. As a result of comparing the 3D models in **Fig. 3**, we confirmed that the two models generally overlapped and could be reproduced as 3D models.

## 5. Conclusion

In this research, we developed a basic technology to automatically create 3D models with AI by reading information from 2D CAD data, and accurately created a 3D model of the external shape for the actual bridge substructure.
In order to make this technology available to more people, we plan to make it available from the National Land Transport Data Platform.

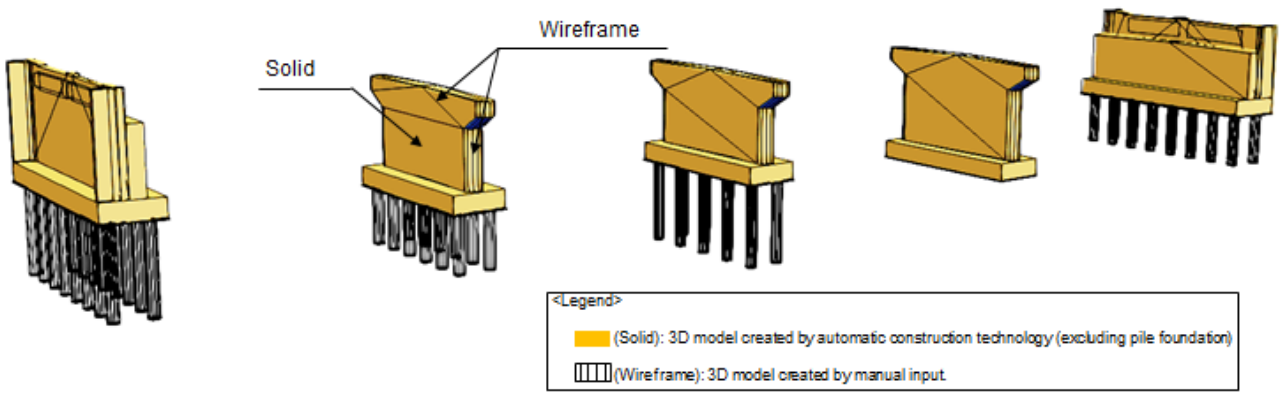



**Fig. 3: Result of automatic 3D model construction for existing bridge**

**☞See the following for details.**

1) Civil Engineering Journal, Nov., 2020, pp. 36-39
2) Civil Engineering Journal, Vol. 58, No. 4, pp. 20-23