PROPOSAL OF THE EXCEL-BASED DATA MANAGEMENT FOR THE BASIC FRAMEWORK AS RIVER MANAGEMENT

Yuichi KOBAYASHI[1], Ichiro KOBAYASHI[2], Seigo OGATA[3], and Ryuji KAKIMOTO[4]

[1]Graduate School of Science and Technology, Kumamoto University
(Kurokami 2-39-1, Chuo-ku, Kumamoto City, Kumamoto 860-8555, Japan)
E-mail:188d9225@st.kumamoto-u.ac.jp
[2]Faculty of Advanced Science and Technology, Kumamoto University
(Kurokami 2-39-1, Chuo-ku, Kumamoto City, Kumamoto 860-8555, Japan)
E-mail: ponts@gpo.kumamoto-u.ac.jp
[3]Technology Research Department, Advanced Construction Technology Center
(Oak-Otowa Bldg, Otsuka 2-15-6, Bunkyo-ku, Tokyo 112-0012, Japan)
E-mail: ogata@actec.or.jp
[4]Graduate School of Science and Technology, Kumamoto University
(Kurokami 2-239-1, Chuo-ku, Kumamoto City, Kumamoto 860-8555, Japan)
E-mail:kakimoto@kumamoto-u.ac.jp

Abstract

In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) advocated Construction Information Modeling / Management (CIM) in 2012, and started efforts to improve the productivity of construction production systems using 3d models.

However, CIM's efforts have been in many cases of utilization on the part of the contractor, which is mainly led by construction consultants and construction companies. There are few cases used by orderers who should be the main user.

The Kyushu Regional Development Bureau（KRDB）of the MLIT focused on the points that suitable human resources and environments are necessary for utilization of the CIM. And we started efforts on the use of CIM in the river field, called River CIM. In the CIM of KRDB a basic framework in river managements was set up, and efforts to utilize it was stated such as for information sharing among stakeholders and for considering necessity of countermeasure works. The purpose of this effort is to use data by orderer to river managements by considering maximum simplification and operability of data.

We proposed a model space in a previous study, and showed that it could be used for examinations by combining different data such as vector, elevation data and object.

As a continuation study, we also proposed a deployment model that places multiple existing data (plan, Embankment section, deep-shallow survey map, boring data, aerial photograph, etc.) in the correct position defined in the World Geodetic System in model space, and showed usefulness to examinations.

In this paper, we focus on the basic framework in the River CIM as a method of using CIM in a maintenance management stage by orderers, and analyze and consider the data management method. Based on the results, we propose a management method using CIM in the stage.

Key Words : *CIM, river, data management, orderer, numerical data, Excel*

1. INTRODUCTION

In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) advocated Construction Information Modeling / Management (CIM) in 2012, and started efforts to improve the productivity of construction production systems using 3d models.

Based on the results and challenges of CIM, the MLIT published the CIM implementation guidelines for the purpose of facilitating the implementation of CIM for all stakeholders involved in construction businesses in March 2017 [1)].

Until now there have been many cases where the trial results of the CIM were used by contractors such as construction consultants and construction companies, there are few cases used by orderers who should be the main user. As part of trial activities of CIM by orderers, the following can be mentioned. The application to river management based on results of river regular vertical cross section survey using Airborne Laser Bathymetry (ALB) [2)]. And adding functions of photography and laser surveying to the surveillance camera in a dam removal project for confirming sediment movement at the time of flood [3)].

The Kyushu Regional Development Bureau（KRDB）of the MLIT took into consideration the points that suitable human resources and environments are necessary for utilization of the CIM [4)]. And we focused on the use of CIM in the river field, called River CIM. In the River CIM of KRDB a basic framework in river managements was set up, and efforts to utilize it was stated such as for information sharing among stakeholders and for considering necessity of countermeasure works. The purpose of this effort is to use data by orderer to river managements by considering maximum simplification and operability of data.

We proposed a model space in a previous study [5)], and showed that it could be used for examinations by combining different data such as vector, elevation data and object [6)]. As a continuation study, we also proposed a deployment model that places multiple existing data (plan, Embankment section, deep-shallow survey map, boring data, aerial photograph, etc.) in the correct position defined in the World Geodetic System in model space, and showed usefulness to examinations [7)].

In this paper, we focus on the basic framework in the River CIM as a method of using CIM in a maintenance management stage by orderers, and analyze and consider the data management method. Based on the results, we propose a management method using CIM in the stage.

2. THE STATUS OF RIVER CIM AND THE EFFORTS OF THE KRDB IN THE MAINTENANCE AND MANAGEMENT STAGE

(1) The status of River CIM in the operation and maintenance stage

MLIT has published a guideline to introduce CIM to the construction field. This guideline has been published in 9 fields including river field as well as common chapters such as roads, bridges, and tunnels. In this paper the river field is targeted. It is because shapes of rivers are constantly changing. This characteristic is distinguished from other fields. River fields contains artificial structures such as gutter gates and drainage machines, and all of them must be managed.

Moreover, the management of change of the river is important in an operation and maintenance stage. In particular, the management of change of the river means the change of slope, the scouring and deposition of the riverbed, and the erosion of the side, and so forth. In the operation and maintenance stage, it is important to collect data of each stage from the investigation to the design and the construction stage, and to make them usable after development of the condition at which necessary information can be confirmed immediately.

The annual revision of the guideline is carried out in the chapter of the river field. However, the discussions about the operation and maintenance stage is few [8)]. Some of the attribute information to be taken over from each stage is described in some.

(2) Initiatives of the KRDB

In the KRDB, we have been studying the introduction of CIM for the purpose of introducing CIM to construction production systems, labor saving and improving civil engineering technology.

The objective of this approach is that tenderers to use CIM by themselves. The River CIM has the following 4 items from the viewpoints of labor saving, efficiency, and quality assurance.

- The officials can easily use it.
- Make it as simple as possible.
- Build successful experiences for CIM utilization.
- Make cost as low as possible.

The area of managing a river which can be expected to utilize CIM is mainly in the five fields shown in Table 1. The first area to introduce CIM was the river management. The reason for this is that the tool to manage the "base sheet to manage the river" has been already introduced as shown in Figure 1[3)]. The basic rules for river management were shared to all officials through the sheet. As a result, it is considered that the barrier to the introduction is low because the usability will not be changed so much as long as the basic rule of the river management base sheet is inherited when CIM is introduced.

The KRDB has formulated a "basic framework" that centralizes components and methods to visualize the basic sheet of river management. In the next chapter, we describe the outline of the basic framework and the merits and disadvantages.

Table 1 The area of managing a river.

Field	Examples of utilization
River Management	Base sheet to manage the river
Embankment Management	Continuous grasping of Embankment heights
Structure Management	3-D Design and analysis
Water disaster prevention	Flood simulation
River development	Environmental information diagram, River development plan

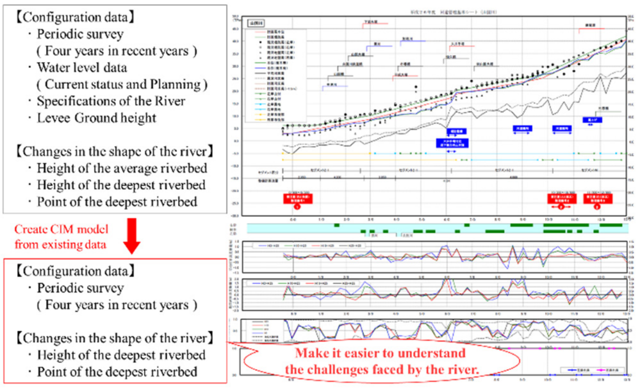


Fig.1 Base sheet to manage the river.

3. BASIC FRAMEWORK

(1) Overview

The basic framework is utilized as an equipment intended to grasp whether an imminent danger of the River exists or not. In order to improve the use of the oderer, the concept of "2.5-dimensional" is adopted, which makes the components of the data simple and does not increase the capacity and does not make the operation heavier. The 2.5-dimensional view is the same as the model of the previous study.

As shown in Figure 2, the basic framework for visualizing the river Management basic sheet has four kinds of plans, cross-section, deepest riverbed, and MMS data (Mobile Mapping System) as a component of the data.

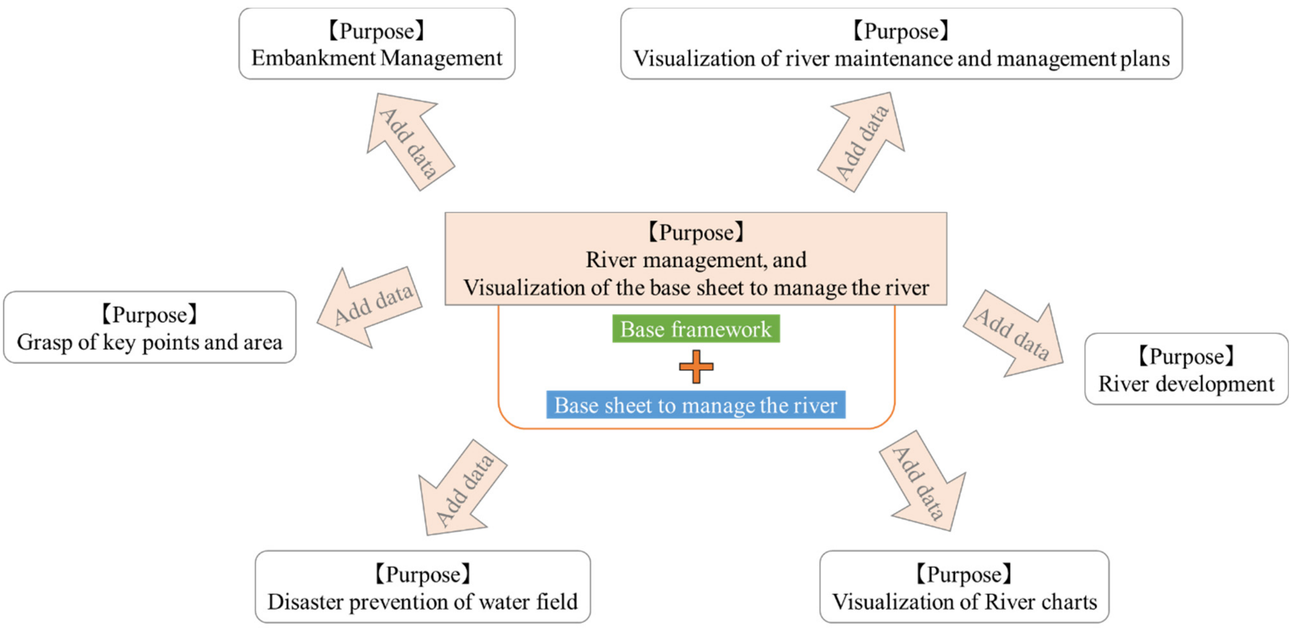


Fig.2 The basic framework and applied type.

(2) Analysis of Basic Framework

a) Advantages

The advantages of the basic framework are the following two points.

Firstly, as shown in Fig. 3, it is possible to add/delete necessary data to/from the basic framework constructed with the limited data based on respective purpose. This allows the data to be checked and manipulated without a high-performance PC. This was regarded as "applied type" in the KRDB.

Secondly the data can be added and accumulated to the basic framework according to the improvement of the technical level by the penetration of CIM to the PC performance and the tenderer (office staff). This makes it possible to increase the accuracy of the base framework. In the KRDB, it was regarded as "development type" to gradually accumulate data into the basic framework.

b) Disadvantages

The use of the basic framework is considered to have two disadvantages.

The first point is the file format of the base framework. The concept of the applied type and the development type described in the preceding paragraph assumes that various data is added to the basic framework and confirmed. On the other hand, the current basic framework has a specification of the data format using 3DPDF. 3DPDF does not have the ability to add or delete data.

The second point is that the tenderer is unable to utilize and manage CIM data. This is not the characteristic only of the basic framework. It is hard to say that tenderer can utilize electrical data submitted by contractors. The reason for this is that there are few people who can handle the data of the CIM that has been delivered. Even if there is a person who can handle it, there are no adequate PC and the software.

4. BASIC FRAMEWORK IMPROVEMENTS AND EXCEL-BASED DATA MANAGEMENT SUGGESTIONS

(1) Basic concepts

In this proposal, when data is added to the basic framework, the original data which is the basis of data management is constructed using the Excel that the tenderer routinely uses in anticipation of the application type and the development type in the future. Figure 3 shows the concept. The original data such as the shape, position, color, and other information drawn in the drawing are converted into numerical data. Then the data can be reviewed through the tools for creating 3D model automatically. The original data is the basic one that the shape can be drawn by CAD, as shown in Figure 4 (for example, vector data and columnar solid data) . The object to numeration is information such as shape and position. In addition, the raster data, such as aerial photographs, are targeted at the same scale as the position information and the display.

Table 2 shows the software, functions, and file formats used. The reason for selecting this software is that Excel is used on a daily basis in the work environment of the tenderer. In addition, Autodesk software has been introduced in the KRDB, and it is easy to cooperate between software.

The flow of adding data to the base framework is shown in Figure 5. First, we construct a conventional basic framework data with Naviswoks. Next, the data of additional elements is entered into Excel, and after the format is set, it is drawn to AutoCAD Civil 3D with the automatic modeling tool. Then, the data of the DWG format which was created is browsed by Navisworks, and each examination is performed.

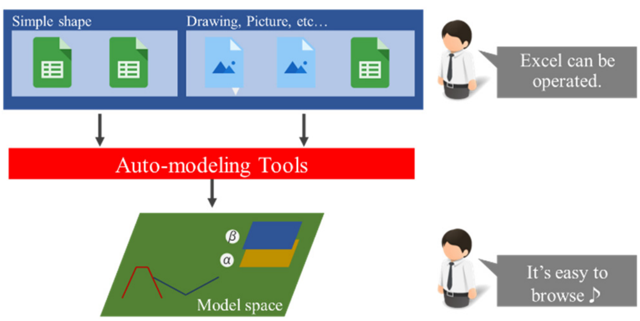


Fig.3 Base concept.

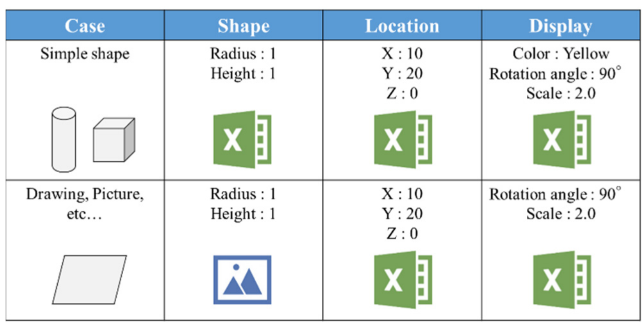


Fig.4 Object case and Infomation.

Table 2 Software overview.

Sofware	Extention	Function
Excel	xlsx, csv	Table calculation
Autodesk Civil 3D	dwg	Creating and editing objects
Navisworks Manage	nwd	Viewing and adding objects

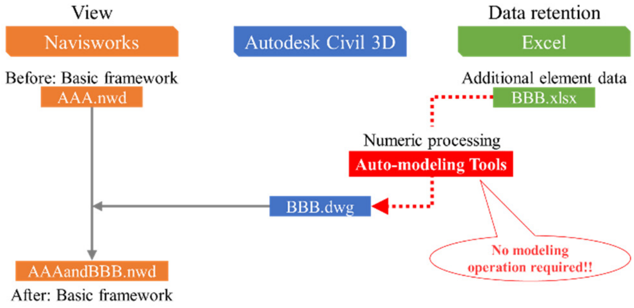


Fig.5 Base sheet to manage the river.

(2) Auto-modeling Tools

The authors developed a tool for drawing to AutoCAD Civil 3D using VBA (Visual Basic for Applications) in Excel with the numerical information shown in Figure 6.

The main data for the primary framework is CAD data. Therefore, knowledge and skills of CAD software are necessary to add data. On the other hand, it is possible to create a three-dimensional model by grasping the knowledge of Excel and the information to be organized (Figure 7).

The maintenance of civil engineering structures compares current and existing data as one of the indicators to judge secular change. In the construction of the basic frame, the conversion might be necessary by the difference of the coordinate system and the difference of the survey acquisition year to enter existing data. This proposal was tackled by improving convenience with automatic conversion by the developed tool.

(3) Effect by digitizing

a) Automate drawing

Vector data such as diagrams section can be plotted automatically using polygon data by the concept and method described above. For example, in the basic sheet of river management, the location of the deepest riverbed is described. As shown in Figure 7, ebb-water-route-line connecting the deepest riverbed of each cross section can also be automatically plotted.

b) Understanding Danger Points

The numerical data takes a difference with the data acquired last year as shown in Figure 8. It can be utilized for confirming the change shown in Figure 9 a), or confirming whether the standard height is secured as shown in Figure 9 b). In the confirmation of the standard height, it is possible to enter the threshold of the standard of the planned high water level into the automatic modeling tool beforehand, and to judge value of the dangerous point. In addition, by digitizing the data, the arrow can show the incremental of the variable which was not posting automatically in the drawing.

c) Automatic quantity calculation

In order to move from the maintenance stage to the next stage of the survey, the budget needs to be secured. After the risk points are identified using the digitized information, the quantity to implement the measures needs to be clarified. By using the numerical data of the periodic survey results and the planned high water level, it is possible to determine the capacity of the river volume as shown in Figure 10.

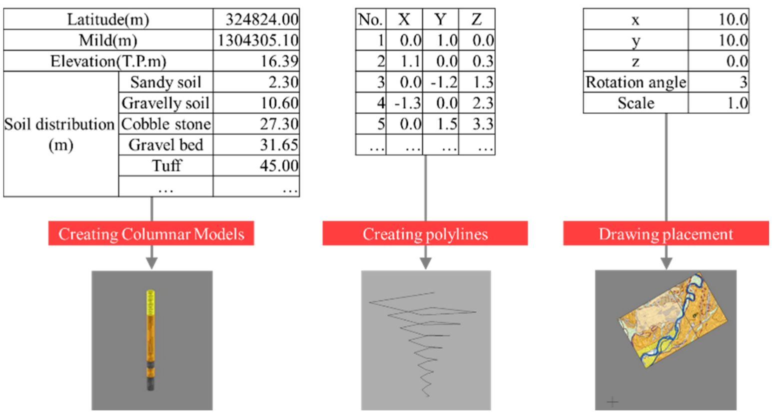


Fig.6 Creating a 3-d model from numerical data.

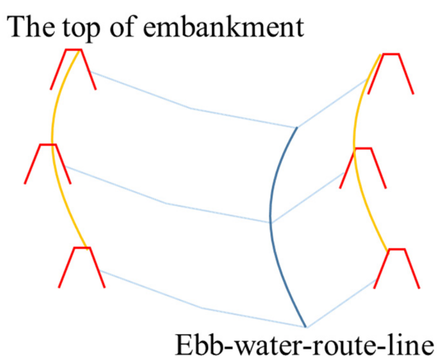
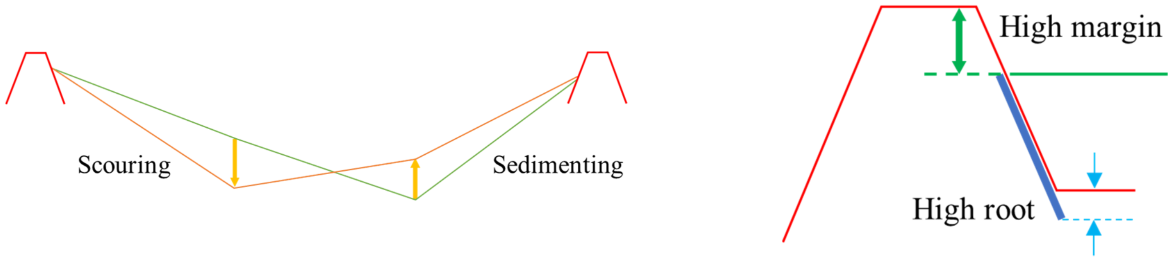


Fig.7 Base sheet to manage the river.



a) Highlight of deformation. b) Highlight of various standard height.

Fig.8 Keep track of dangerous points and area..

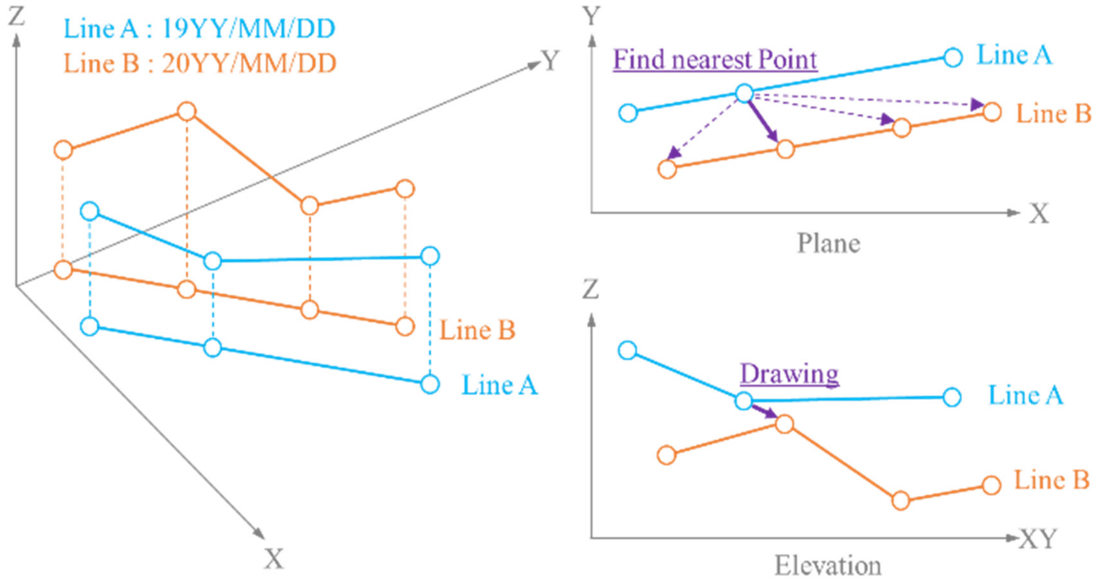


Fig.9 Find nearest points and drawing.

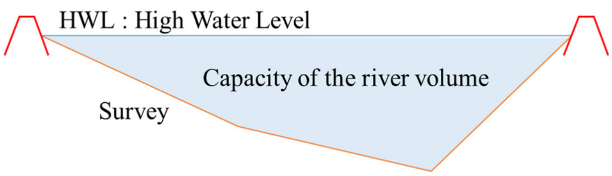


Fig.10 Determin the capacity of the river volume.

5. APPLICATION CASE

(1) Outline of the target area and the constructed model

As a case study, we targeted the Yamakuni River, which sources from Yamakuni-tyo, Nakatsugawa City, Oita Prefecture. The Yamakuni River is a first-class river with a basin area of 540km^2, extending the stem river flow. The interval application is 500m from 21.0km to 21.5km.

The data used in this case is the diagram design of the planned embankment, the periodic cross-sectional survey, and the boring data.

Figure 11 is the figure which respective information is plotted three-dimensionally on the two-dimensional plan with the automatic modeling tool based on all the digitized information.

The blue in the figure is the diagram design of the embankment, the red is the periodic cross-sectional survey, and the solid of the cylinder is boring data.

(2) Result of application

a) Automatic drawing of ebb-water-route line

Figure 11 extracts the deepest riverbed position from the digitized data of the three sections of the periodic cross-sectional survey drawing, and draws it with a spline that connects each point smoothly. This makes it possible to understand the prevalence in the riverbed.

b) A variable grasp of periodic cross-sectional survey

The numerical data of the periodic cross-sectional survey figures in 2006 and 2013 were compared and the variant was confirmed. As shown in Figure 12, it is easy to confirm the changed part by drawing the largely changed part with a red line in the place. Table 3 shows a list of places where variable numbers are large. By managing the digitized data, it has become possible to easily confirm the amount of change in the Excel and the three-dimensional model.

c) Confirmation of the depth of the root insert

The root depth of the seawalls was calculated from the cross-sectional view of the planned embankment and the digitized data of the periodic cross survey. The red line shown in Figure 13 is planned embankment and black line is a periodic cross-sectional survey diagram. The bottom end of the embankment plan is the minimum of the elevation, and it is possible to calculate by comparing it with the target value of the point where the highest water level is near from the number values (Table 4).

d) Cooperation with other models

The Hirata district of Yamakuni River was modeled in the InfraWorks of Autodesk for the town development by the past research. The vector data of the sections created by the automatic modeling tool was difficult to recognize when it was converted into InfraWorks. It is difficult in InfraWorks to enlarge the size and shape of the vector data (Figure 14). Therefore, in the automatic modeling tool, the data is recognized by converting from vector data to cylindrical solid data.

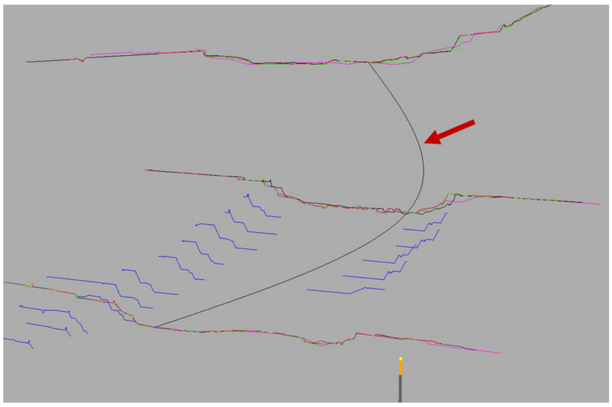


Fig.11 Automatic drawing of each line.

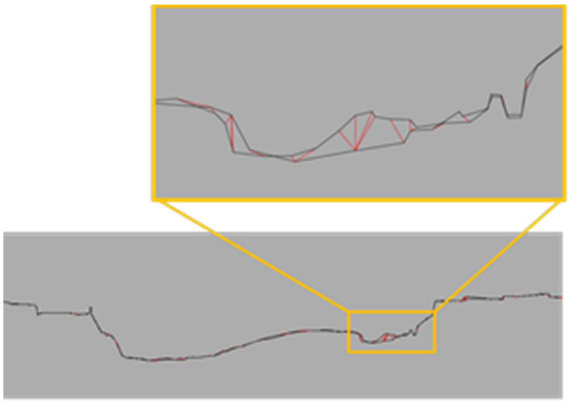


Fig.12 Visualizing the amount of variation

Table 3 Calculate the displacement of the elevation.

No.	① 2006	② 2013	③ = ① - ② Variable quantity
1	80.3	81.9	-7.62
2	81.9	80.6	-1.28
3	79.6	78.5	-1.17
4	75.2	74.1	-1.12
5	74.2	75.2	-1.01
…	…	…	…

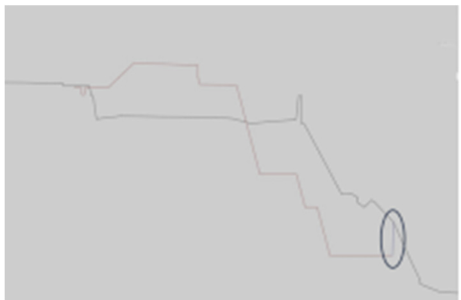


Fig.13 The root depth visualization

Table 4 The amount of change in root depth

	X	Y	Z
Lowest end of Embankment	13571.14	52161.65	72.78
The digitized data of the periodic cross survey	13571.2	52165.3	74.21

Elevation difference (ΔZ) : 1.47 m

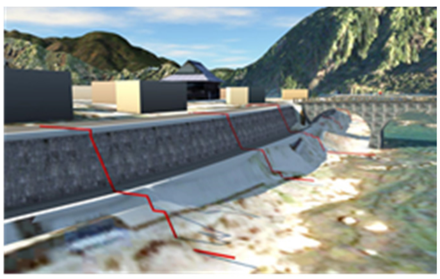


Fig.14 Comparison with the current situation and the plan.

6. CONCLUSION

In this paper, we developed an automatic modeling tool based on the concept of data management by utilizing the application type and the development type of basic frame which encompasses the concept of CIM. By this, we have proposed a method to improve productivity in the operation and maintenance stage by making it easy to create and read 3d models.

In this proposal, vector data and simple three-dimensional shape data can be used to quantify them for each study. In recent years, three-dimensional surveying has become popular due to the policy of the MLIT, and surface design, construction, and inspection using point cloud data have been carried out. It is necessary to establish an environment in which data can be managed that can be used for maintenance and management in an environment that is easy to utilize data, not limited to this proposal. In addition, the construction of an environment that makes it easy to utilize new technologies for the entire parties concerned, and human resources who can handle data on the side of the orderer are also needed. In order to do this, it is necessary to focus on the creation of a system and the development of human resources that the orderer can actively move.

On the other hand, we do not carry out the trial of the proposed method to the tenderer. Therefore, it is necessary to introduce to the actual business and to organize the data which should be used. In the river maintenance, it is necessary to examine the cooperation with existing management methods such as inspection data of patrol data and structure, and existing River Management Data Intelligent System (RiMaDIS).

ACKNOWLEDGMENT: We would like to express our gratitude to Ministry of Land, Infrastructure, Transport and Tourism Kyushu Regional Development Bureau Yamakuni River Office, TOKEN C.E.E.Consultants Co., Ltd., Ariake Surveying Development Co.,Ltd. for providing various data, and writing this paper.

REFERENCES

1) Ministry of Land, Infrastructure, Transport and Tourism : CIM Deployment Guidelines (Case) Part 1, 2019, http://www.mlit.go.jp/common/001289030.pdf, Accessed on May 31, 2019.

2) Toshio, W., Kazuhiro, Y. : Fukui cim model with a focus on river management, *Public works management journal, 487, 78-84,* 2018.

3) Fumio, Y., Takuji, N., Yoichi, F., and Ichiro, K. : POSSIBILITY OF USING MONITORING CAMERA WITH SURVEYING FUNCTION IN RIVER CHANNEL MANAGEMENT OF DAM REMOVAL PROJECT, *Journal of Applied Computing in Civil Engineering, Vol.70, No.2, I_227-I_234*, 2014.

4) Sayoko, H, 2018, http://www.jacic.or.jp/movie/jseminar/pdf/movie20170828_harada.pdf, Accessed on May 31, 2019.

5) Yuichi, K., Takuji, N., Ichiro, K., and Seigo, O. : A STUDY FOR MANAGEMENT IMPLEMENTATION ON IMPROVEMENT PROJECT OF TRAFFIC CONNECTION IN SHIN-SUIZENJI-STATION AREA, *Journal of Applied Computing in Civil Engineering, Vol.73 No.4, I_45-I_54*, 2017.

6) Ichiro K., Yuichi K., Yusuke T., and Yoshida, F. : A PROPOSAL FOR USING 2-D DRAWING DATA IN MODEL SPACE, *Journal of Applied Computing in Civil Engineering, Vol.67, No.2, I_85-I_94*, 2011.

7) Yoichi, F., Yuji, H., Ichiro, K., Junki, M. : Consideration for River CIM Management Model Using Combination of Various Existing Data, *Journal of Applied Computing in Civil Engineering, Vol.71, No.2, I_79-I_86,* 2015.

8) Ministry of Land, Infrastructure, Transport and Tourism : CIM Deployment Guidelines (Case) Part 3, 2019, http://www.mlit.go.jp/common/001289032.pdf, Accessed on May 31, 2019.