Workflows between BIM and TAI-Programs in bridge construction

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ABSTRACT: Model-based generation of bill of quantities should replace the quantities determination from 2D-plans and subsequent by hand filling of bill of quantities in bridge construction. In this way errors are avoided and time is saved. Therefore, software solutions must be tested and evaluated.

Complete thesis: *www.uibk.ac.at/ibt/lehre/abgeschlossene-masterarbeiten/*

KEYWORDS: BIM, TAI, Bridge Construction, Construction Management, Bill of Quantities, Digitalisation

1 INTRODUCTION

In building construction model-based bill of quantities (BOQ) are already used. TAI-software provide therefore templates, root projects and element catalogs. For bridge construction the possibilities of modelling, information exchange and TAI-software are not given or not mature. Hence the goal of this thesis is to test and evaluate different software for modelling and TAI in bridge construction based on a test project.

2 MAIN BODY

The used modelling software are closely examined in six sub points from the import of an axis to the export of a IFC-model. The programs´ ability to model an axis-based bridge and to provide the resulting building parts with the alphanumeric information required for the tendering process is examined.

The TAI-applications used are tested in ten subpoints from the import of the IFC-model to the completed bill of quantities. The standard workflows of the examined software are hereby changed to the use case of bridge construction.

2.1 MODELLING

The following modelling applications abilities in bridge construction are tested in their 2023 versions through a test project.

- Autodesk, Revit® with © Sofistik Bridge + Infrastructure Modeler Plugin
- © DICAD, Strakon

The axis-based modelling is done through the extrusion of parametrical cross-sections between placements along an imported or manually created axis. Revit® offers secondary axes, which can be derived from the main axis, and variables like the slope can be assigned to the axis. Strakon doesn't offer similar global features. Placements are positioned on critical points along the axis in both programs. Between those placements the cross-sections are extruded along the axis. Hereby, Revit® utilizes the © Sofistik Plugin for parametric cross-sections. These allow every Point of the cross-section to be parametrised and linked with variables. Strakon on the other hand enables a very fast creation of cross-section in the 2D-interface or through importing pdf- or dwg-files. Therefore, the points and lines of the cross-section can only be locally parametrized or connected to other axes. Building parts of the superstructure (frame, edge beam etc.) but also the wingwalls are modelled this way. In bridge modelling there are also structures needed that are placed on a placement of the axis but not bound to the rest of the axis like the abutment and the footing. The two software use different approaches for these building parts. Revit® has the feature of substructures which allows to place parametric families on placements of the axis. In Strakon there is no such function and so the abutments and footings are modelled as objects (free modelling) and cut of with the frame. In both programs the overhanging isolation is created through free modelling. After that, the building parts are enriched with information like material, framework and reinforcement degree. In the Strakon 2023 version surfaces of parts that where extruded along the axis can´t be parametrized. Therefore, dummy objects for the surface areas have to be modelled. At last, IFC-models are exported with the IFC-classes of building construction, as IFC Bridge is not certified at the time of this thesis. [1]

2.2 TAI-software

The following TAI-programs are used for the processing of this master thesis.

- Ib-data GmbH, ABK-8
- Nevaris, Success X
- RIB, iTWO 5D

ABK-8 and Success X use the "Elementmethode" based on the ÖNORM A 2063:2-2021 for the model-based BOQ, iTWO 5D takes another approach. This approach is a multi-stage interactive process. In the model-based generation of BOQ the information of imported IFC-models is linked with service items, allowing the information to be transferred quickly and without errors into the bill of quantities. The "Elementmethode" puts elements between this step. The elements reflect the building parts on the TAI-programs side. There are element catalogs on the basis of the "LB-HB" for building construction. For bridge construction where the tendering process refers to the "LB-VI", there are no element catalogs in January 2024 available. Hence, they have to be manually created.

In all programs, the IFC-models are imported first, with the programs providing different options for checking the quality of the models. In a next step a bill of quantities has to be generated. ABK-8 and Success X do this indirectly through the elements, which are filled with service item of the LB-VI. In iTWO 5D the bill of quantities is directly filled with performance items. In a next step the models´ information has to be interpreted. All programs have a different approach. ABK-8 uses a script-based file, Success X the IFC-referencing and iTWO 5D the QTO quantity detection. Subsequently the building parts from the models are assigned to the service items or elements. The resulting quantities are then displayed in a finished BOQ.

In all programs, the intermediate steps of assignment and interpretation can be automated with repeated use.

3 EVALUATION

The evaluation is divided into two parts, firstly the modelling and secondly the TAI-workflows. The evaluation is a comparison between the possibilities of the different programs. Consequently, this thesis doesn't raise the claim of a complete market analysis.

3.1 EVALUATION MODELLING

The axis-based modelling of a bridge is well performed by Strakon and Revit® with the Sofisik Plugin. However, BIM doesn't only require a three-dimensional model but even more the alphanumerical information that are assigned to the building parts. The requirements for this process are currently (January 2024) way better solved by the heavyweight Revit® with the help of © Sofistik Bridge and Infrastructure Modeler. Especially the option of assigning surfaces to building parts that are created along the axis and extensive export settings give Revit® with the plugin the edge in this case.

	Revit®	Strakon
Achse – Trasse		
superstructure – cross-section		
substructure – N/A		
free modelling		
further settings		
IFC-export		

Tabelle 3-1: Evaluation modelling

3.2 EVALUATION TAI

ABK-8 and Success X both use the "Elementmethode", which is standardized in the ÖNORM A 2063:2021. [2] This method requires "BIM-Allgemeine Elementkataloge" (BAEK) and parameter lists. There are only templates for these in superstructure work and not infrastructure or bridge construction. Therefore, they have to be manually created for bridge construction. iTWO 5D uses a different approach. There are no BAEKs needed and therefore it is less dependent on the use case (house, bridge…). There is no change to be made in the standard workflow. Also, iTWO 5D is specialized in model-based working and integrates the viewer in all steps of the process. As a result, iTWO 5D performs best in this work for the TAI-workflow in BIM. Success X can set itself apart from ABK-8 through a better implementation of the "Elementmethode" and the best interpretation options of all three programs.

	ABK-8	Success X	iTWO 5D
Import			
BAEK – Ausstattung			
Parameterlisten			
Interpretation			
Listen			

Tabelle 3-2: Abstract from evaluation TAI

4 CONCLUSION

The axis-based modeling of a bridge already works well in Rebit with the help of the © Sofistik plugin as well as with Strakon. However, unlike Strakon, the 2023 version of Revit® and © Sofistik offers more advanced options for enriching components with alphanumeric information and also more export settings.

ABK-8, Success X and iTWO 5D enable model-based bill of quantities creation. ABK-8 and Success X are based on the "Elementmethode" standardized in ÖNORM A 2063:2021. This provides BAEKs and parameter lists for building construction. For bridge construction, however, these must be created manually. iTWO 5D, on the other hand, is very flexible for the application case and specifically geared towards model-based working methods. Furthermore, the viewer is best integrated into the work process. As a result, iTWO 5D performs best in this study for the BIM workflow in bridge construction.

5 OUTLOOK

The modeling of this work is focused on the BIM workflow and could be extended by increasing the level of detail to work on a comprehensive as-built model for bridge construction. This could be used to investigate performance assessment and facility management. The „Forschungsgesellschaft Straße-Schiene-Verkehr" is already working on a BAEK based on the LB-VI. [3] On this basis, this thesis could be relaunched and lead to a different evaluation. The workflows could be further developed in order to create and approach with templates, patterns etc. that can be used in practice.

Another option would be to consider cross-disciplinary tendering with Success X and iTWO 5D. Both allow the import of several IFC-models.

6 REFERENCES

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