FUNCTIONALITY TEST OF STAAD.PRO EXPORT AND IMPORT COMMANDS - STUDY FOR BIM-BASED MODELING WORKFLOW

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Abstract: Demand for BIM implementation is rising around the globe and its use is widely studied with a bias towards the AEC industry. But the benefits of BIM are inviting other industries as well. Interoperability is a strategic attribute for a BIM project due to the collaboration between various disciplines and experts. In such a context, this paper intends to test the interoperability of Staad.Pro, a FEM software used in industrial plant projects. Aiming test and evaluate its interoperability tools, Staad.Pro proved not to be very capable of interoperating and its flow with other software aren't user friendly. Despite this, its relationship with Advance Steel presents to be promising when working with a steel structure.

Keywords: BIM; STAAD.PRO; FEM; WORKFLOW

TESTE DE FUNCIONALIDADE DOS COMANDOS DE EXPORTAÇÃO E IMPORTAÇÃO DO STAAD.PRO – ESTUDO PARA FLUXO BIM DE MODELAGEM

Resumo: A demanda pela implementação do BIM está aumentando em todo o mundo e seu uso é amplamente estudado com um viés para a indústria AEC. Mas os benefícios do BIM também são convidativos a outras indústrias. A interoperabilidade é um atributo estratégico para um projeto BIM devido à colaboração entre várias disciplinas e especialistas. Nesse contexto, este trabalho pretende testar a interoperabilidade do Staad.Pro, um software FEM utilizado em projetos de plantas industriais. Visando testar e avaliar suas ferramentas de interoperabilidade, o Staad.Pro mostrou-se pouco capaz de interoperar e seu fluxo com outros softwares não é amigável. Apesar disso, sua relação com a Advance Steel se apresenta promissora quando se trabalha com estrutura metálica.

Palavras-chave: BIM; STAAD.PRO; FEM; Fluxo de Trabalho

1. INTRODUCTION

Once there is no software able to support all disciplines (Architecture, Structure, Piping etc) involved in a building design and production and their tasks, interoperability rises as a key characteristic of a BIM process. For Eastman *et al.*, 2011, interoperability represents the need to interchange data between applications and expert professionals [1].

One of the most important characteristic of a Building Information Modeling (BIM) is the interoperability, and a daily project process of building is not a job for just a single workman. According to Hasheminasab, 2019, a lot of experts are needed to collaborate for a building project [2]. A model needs different modules, and those modules are often made up of a different set of software.

In such a context, it is mandatory to study and understand how the interoperability between applications works and its weaknesses. That's crucial to plan the workflow within the BIM execution and define the set of software for a firm.

In accordance with Fakhimi *et al.*, 2017, there's a tendency of the oil, gas and petrochemical industry (OGPi) to utilize BIM, but most researcher have limited their works within the Architectural, Engineering and Construction industry (AEC) [3]. This motivates the current research to drive its attention into applications generally used into a non-building industry, like AutoCAD Plant 3D.

The present study aims, through practice and the uses of Staad.Pro, a Bentley's software, to identify it's potential and possible workflows to use this software within a BIM workflow.

The main goal of this paper is to evaluate the functionality of the Staad.Pro's interoperation and get to know its limitations. Secundary goals are: Identify native Straad.Pro's interoperation tools; and other Bentley's solutions.

2. METHODOLOGY

For this study, the following software was used: Staad.Pro CONNECT Edition V22; AutoCAD 2023; AutoCAD Plant 3D 2023; Advance Steel 2023; MicroStation PowerDraft CONNECT Edition V10; iTwin Analytical Synchronizer CONNECT Edition V12; Revit 2022.

It was used a model file provided by Bentley on their own Staad.Pro course available to download at (https://communities.bentley.com/products/ram-staad/m/ram-staad-training-datasets/275678), using the file named as "SPPM_Properties_DONE". This model is composed by analytical and physical model of a structure formed by steel and concrete beams and columns.

By first it is needed to identify the formats Staad.Pro exports natively and the formats the chosen set of software runs. The second step is to export using the Staad.Pro and test the files by running them within the other applications, analyzing the results.

In addition to native functions, there is a possibility to interoperate with ISM (Integrated Structural Modelling – a Bentley proprietary extension) through iTwin Analytical Synchronizer. This is a Bentley's solution to interoperate the Staad.Pro's

models with other software like Revit and *vice-versa*. It is through the iTwin they can provide an IFC model.

A table was made to summarize the applications and their supported extensions and can be found at the Results and Discussions section.

3. RESULTS AND DISCUSSION

It was identified some native tools to export in distinct extensions named below: DXF, STP and ASA. The DXF file format can be exported as a 2D or 3D drawings. Once the interest is for a BIM-based purpose, the 2D DXF wasn't tested. The ASA format wasn't tested due to not being supported in others applications utilized in the present paper. While the STP extension follows the CIS/2 standard, a data exchange format for structural steel project information [4].

It's also possible to identify the ISM tool, an extension that can be opened with Revit, using ISM-Revit Plugin, and with iTwin. With the last one it's possible to export to IFC format.

To move forward, it is necessary to get to know the formats with which the selected applications can work. The following Table 1 shows in the first line the software names and the first column shows the formats. It was considered the Revit with the plugin mentioned before.

Table 1. Software x formats

	Staad.Pro	Power Draft	AutoCAD	Plant 3D	Advance Steel	Revit
DXF	x	x	x	x	x	x
STP	x		x	x	x	
ISM	x					x
IFC					x	x

Then the exportation was made for all four extensions and then imported into the listed applications. Tests' results will be shown in the next subsections.

3.1.DXF

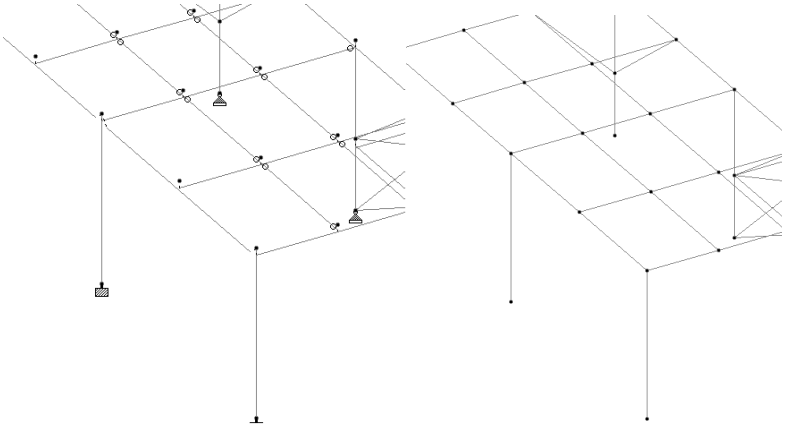
The present subsection covers the results of DXF usage tests.

First possible perception is that, although it is a 3D format, there is no volumetric information in the geometry, just grid lines and nodes from the analytical structure, but were noticed changes in the relation between pieces.

3.1.1 Staad.Pro

To test the capability of the Staad.Pro to work with DXF it was needed to open a new project and then import the DXF file. The results are the same as mentioned before. The figure below shows at left the original analytical structure in the Staad.Pro proprietary format, and at right there is the DXF file opened within Staad.Pro.

Figure 1. Staad.Pro using DXF

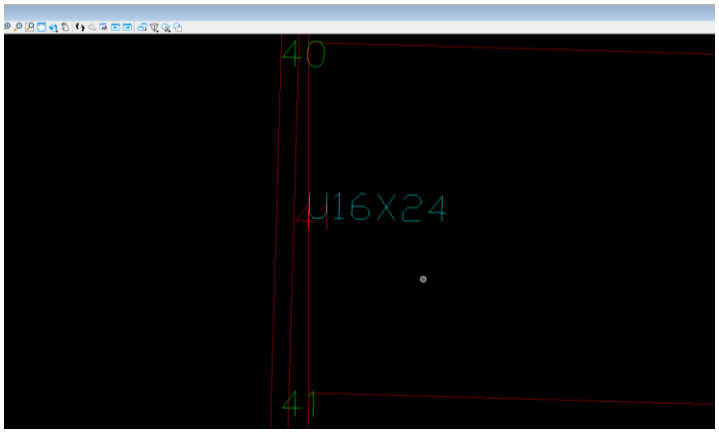


3.1.2 MicroStation PowerDraft

There is three ways to open an DXF file within the PowerDraft. First: Click on the file and select PowerDraft as the opening application. Second: Using the open option after initialize the software. Three: Import the DXF file when there is an open project already.

The first and second options have the same results. In these ways it is possible to open the DXF file and observe it with the same remarks mentioned before at the beginning of the current subsection, but now they have information about the section of the profiles and their materials. Bars and nodes are now identified. Both information is written to the canvas area as shown in the Figure 2.

Figure 2. PowerDraft using DXF



It is possible to notice that the text information follows a basic configuration using layers and colors. ID number and cross section of bars are overlapped.

It was also possible to notice that the axis that corresponds to the altimetric information changes between one software and another. Staad.Pro considers altimetry on the Y axis by default. While PowerDraft considers at Z axis.

The file could be modified and saved in DGN format or even in DXF format.

Opening the DXF file by importing within a new project it's perceived the greatest disadvantage, the drawing is no longer 3D due to PowerDraft limitations to compose drawings in 3D.

3.1.3 AutoCAD, Plant 3D and Advance Steel

These three applications have the same ways to open and same results because Plant 3D and Advance Steel are AutoCAD based software. It is possible to open the file normally by clicking or using the open option inside the software, but don't have support to import the DXF file.

3.1.4 Revit

Working with Revit is possible to import the DXF file, but the file isn't much useful. It has the analytical schema, but no information about cross section or nodes. It is not possible to use the imported drawing as reference to modelate.

3.2.STP

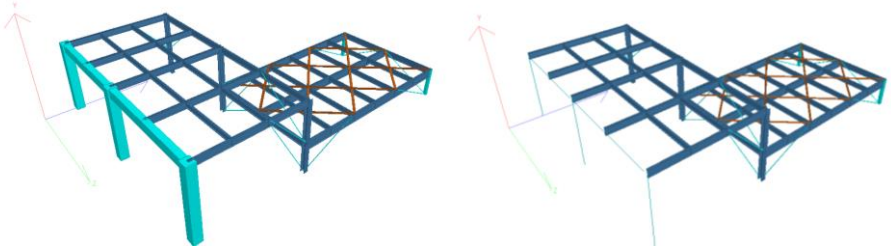
The STP extension provided by Staad.Pro follows the CIS/2 standard, specific for steel structures. Due to this characteristic, it has some consequences to discuss such as volumetric information for a better 3D viewing and the file cannot contain information about material other than steel.

3.2.1 Staad.Pro

Staad.Pro can import STP files and with this format it has information about cross sections, but just for the steel beams and columns. That file is also composed with volumetric information for physical viewing. Although it only has information about steel parts, it doesn't have the materials properly configured.

Concrete beams and columns are saved as analytical structures only. The analytical structure has no losses. Figure 3 bellow shows the difference between original file (left) and STP file (right) opened within Staad.Pro.

Figure 3. Original model vs STP CIS/2



3.2.2 AutoCAD, Plant 3D and Advance Steel

Those three applications support STP, but just Advance Steel succeed to import the file delivered by Staad.Pro. Due to the CIS/2 standard, AutoCAD and Plant 3D failed to import such a format because they don't support such a standard, in other hand Advance Steel is a specialized software to work with steel structures.

Advance Steel got volumetric, cross-sectional, material and analytical information corresponding to the original file. There is a single flaw: Concrete parts appear as steel profiles too.

3.3.ISM

ISM is initials for Integrated Structural Modeling. This extension promises to "share structural engineering project information among modeling, analysis, design, drafting, and detailing software applications". iTwin is used to manage such file [5].

Revit was the only software to be tested with this extension. To import ISM into Revit ISM-Revit plugin is needed. When using the plugin before importing it's necessary to make some configurations combining the profiles and materials with the corresponding families in Revit. Because of this, the import result will depend on the Revit library.

All the analytical, volumetric, cross-sectional and material information is kept with no loss, if the correct set up are made.

3.4.IFC

Industry Foundation Class (IFC) is developed by buildingSmart and allows end users to "collaborate and cooperate regardless of which software application they are using" [6]. The IFC enables collaboration flows by allowing other disciplines models to come together in one software.

To create an IFC file from an Staad.Pro file is needed to export into ISM and then open it within iTwin to export as IFC. But there is no option to configure the IFC and choose its standard.

Neither Staad.Pro nor iTwin is certified by buildingSmart as a software capable to work with IFC.

3.4.1 Advance Steel

This tool is capable to import IFC and could bring it but with some incompatibilities. The concrete beams were read as steel beams and the analytical framework is not equal to the original one.

3.4.2 Revit

Revit is capable to run IFC, but it doesn't permit modifications. The IFC model can be integrated to enable the cooperation among modelers from different disciplines. So, the model is just used as references in a process of co-creation.

3.5.Discussion

The process of a structural project goes along with the following steps: Modeling the structure, analysis and detailing. Within a BIM firm where an engineer uses the Staad.Pro to analyze a steel structure, their model can be detailed in Advance Steel, Revit or even in AutoCAD. The last one represents the worst situation due to be a CAD-based software. And the best option to detail is the Advance Steel because of its CIS/2 format support, even though it is a CAD-based application. Its additional tools have potential to integrate the structure model into the BIM process supported by Revit. The use of Revit is an option by using ISM, but IFC cannot help too much with this job due to be a read only model when inside Revit. The use of ISM could be more user friendly.

With this study is also noticeable that Staad.Pro is very restricted to receive models from other software. This increases the dependency on using the Staad.Pro itself to model and also the dependency on CAD software that export DXF.

For future studies, it is recommended to evaluate the capability of the Staad.Pro of receiving models by ISM using Revit, Tekla or OpenBuildings. It's also possible to recommend the study of a whole process of structural project within a BIM process using non-building industry software such as E3D, for example.

4. CONCLUSION

With all that was exposed in this article it is possible to conclude that the interoperability tools from Staad.Pro contains restrictions. The DXF is the most limited format with not much potential to integrate in a BIM-based workflow. CIS/2 worked well but is restricted to steel structures, so CIS/2 is not a good option if work with a mixed framework, concrete or timber structure are needed, for example. When working with steel structure, this one is the best option, once is specialized in this material. ISM demands a library and the flow using iTwin make it longer then the expected. Using IFC has the same problem of the need to step into iTwin.

Staad.Pro presents greater potential to work with steel structures within a BIM-based workflow. The most convenient workflow must be receiving the structure model made with an authoring software, dive into the structural analysis with Staa.Pro, and then exports the model to a detailing application, for example Advance Steel.

5. REFERENCES

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