

LAB University of Applied Sciences
Technology, Lappeenranta
Double Degree Programme
Construction and Civil Engineering

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TIMBER FRAMING IN REVIT 2020

Bachelor's Thesis 2020

ABSTRACT

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The purpose of this thesis was to solve the problem of creating a timber framing of the walls of the 4-level residential building using Revit by Autodesk for Maltese company Integrated BIM in the already existing model made by the team. The house is located in Los Angeles, CA, USA. The model was made in order to help builders on the building site.

The second purpose was to find the most convenient, rational and suitable approach for creating timber framed constructions for residential and low-rise commercial buildings in BIM basing on Revit 2020 without any experience under tight deadlines.

The thesis consists of a theoretical and practical part. In the theoretical part the main idea of BIM was considered as well as the usage of BIM concepts in timber framing. Internet, articles and books helped to handle with that.

In the practical part research on the best extensions for timber framing in Revit was done. Also, a deep review and comparison in a form of the table were made.

As the result, the most suitable option to cope with the problem was defined and applied to the study case.

Key words: Timber framing, Revit Extensions, BIM, modelling, USA

CONTENTS

ABSTRACT.....	2
1 INTRODUCTION.....	4
2 BUILDING INFORMATION MODELLING	5
3 CASE STUDY DESCRIPTION.....	6
4 HOW BIM SOFTWARE SHOULD BE USED IN TIMBER CONSTRUCTION ..	7
5 RESEARCH METHODOLOGY	9
6 OVERVIEW ON ORIGINAL REVIT TOOLS FOR WOODEN STRUCTURES	10
7 INFORMATION ABOUT EXTENSIONS FOR TIMBER STRUCTURES	17
7.1 Wood Framing Extension for Revit developed by AGACAD.....	17
7.2 ENRWOOD-FRAMING developed by ENRVISION.....	23
7.3 MWF Pro Wood developed by StrucSoft Solutions	26
8 COMPARISON OF TIMBER FRAMING MODELLING OPTIONS.....	32
9 SUMMARY.....	34
REFERENCES	37
APPENDIX 1.....	38

1 INTRODUCTION

Every big project consists of a lot of little time-consuming details, which could be annoying, but it should be done properly and fast in order to adhere deadlines. At first glance it might seem that the building on its 3D model consists just of a big quantity of large objects such as walls, doors and windows. But it is in this way, only if it is taken into account the architectural model. The structural model is more detailed and complicated.

One of such a detail is framing, especially timber framing. It gives a shape for the building and a structural support, that is why that part of the building could not be ignored and it definitely should be paid enough attention on it.

Unfortunately, it is extremely hard to do timber framing design and modelling in Revit due to not developed built-in functionality for such a task. That is why the decision is to consider all the possibilities which are available for everybody, compare them to each other and to choose the best one. As the result of the research, that approach in the real modelling case is going to be used.

The structural model is just a part for the whole BIM project and Revit by Autodesk is the most convenient and the main must-have BIM software for that project.

2 BUILDING INFORMATION MODELLING

According to previous studies and as stated in “Introduction of BIM Technologies in Construction” [2] BIM – Building information modelling is an approach for making drawings and plans, building, operating, maintaining and renovation, refurbishment or demolishing of the building much more effective. It includes a big digital data, which is made by gathering and processing all the relevant information concerning the building: architectural, constructional, logistical, economic and technological. The building is considered as a whole single object in BIM, which means that any modification of its characteristics leads to changes in all connected parameters (drawings, schedules, specification and other data sheets). All the database relating the whole lifecycle of the building is closely connected to 3D geometrical model. Both work as a mechanism where its every part is very important for the whole work to control the lifecycle of the building. In BIM, all the database is shared throughout all the participants which makes relationships between all project decision making members easier and more effective to totally handle the project.

Nowadays it is impossible to imagine any building project without BIM. Especially if it is about Open BIM conception – universal BIM collaborative approach to design, construction and maintaining based on open work standards and processes when all the main project participants share their data with each other usually using IFC format. It is the same as a rejection of using your cell phone. There is no point, because advantages of our modern technologies are obvious. BIM is a must-have tool which gives us an opportunity to control the whole facility on each stage of its life process. It helps to avoid errors which could appear due to overlapping project activities.

On the first glance, BIM is beneficial only economically. If it is taken a deeper look, it will be seen that it also has a big environmental and social positive sign. Using BIM helps not to waste materials, to use as much as needed, and as the result, to make less harm to the nature. Also, it could be preserved historical appearance much more effectively. BIM helps for better planning of infrastructure and other public facilities, which improves its quality and increases economic profit as well as social approval. BIM is a huge support for project participants, clients and society. [14]

3 CASE STUDY DESCRIPTION

The study case is an apartment building which will be located on 600 N. Gramercy Pl. Los Angeles, CA, USA. It is a four-storey building. The basement there and the ground floor serve as a parking zone. The last three floors are residential. The parking zone's structure is made from the reinforced concrete and the last three floors have the timber framed structure. It is not built yet, but when the model is done it will be. The client has provided a lot of drawings via BIM 360 TEAM, which are full of information needed to build both 3D models: architectural and structural. It is an exceptional and quite ineffective way of using BIM, because the drawings are not produced from the model, which is not according to BIM conception, but anyway, the case is still very close that is why it is acceptable for further research.

According to the documentation, which was received from the client, the whole wall frame on the upper floors should look like as it is shown in Figure 3.1:

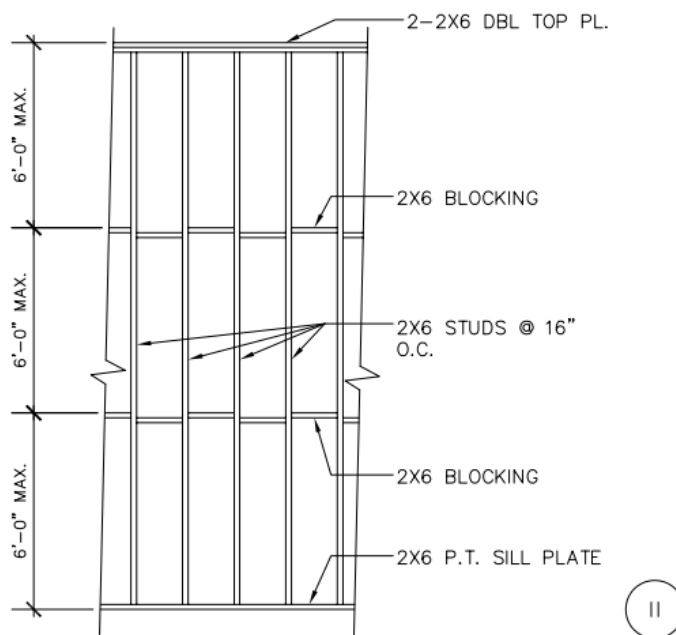


Figure 3.1 Structural detail of wall framing (Customer's explanatory note)

Not every frame will be 2x6, because according to the rules in the framing notes, three and four storey wood structures require 3x4 or 2x6 studs at 16" O.C. max in bearing partitions below two stories. As the walls are less than 6", 3x4 studs are used.

4 HOW BIM SOFTWARE SHOULD BE USED IN TIMBER CONSTRUCTION

Nowadays timber constructions gain a very big popularity in the building industry due to the modern trends focused on green solutions and its role is growing each day, due to that wood is a warm and an organic material.

In some countries, wooden houses are one of the main cultural part. For example, one of them is the United States of America. There are a lot of neighborhoods which fully consist of timber houses no matter if it is a countryside or metropolis. The wood could be easily formed, modified, shaped, and adjusted as it is a very compliant material. According to statistics around 90% of the new houses there in 2018 year were made from wood [4].

In compliance with “Timber framing – rapid and reliable” [1] the invention of balloon framing and platform framing reduced construction costs, which afforded to build faster, and as the result it turned into a very good option for the poor. Relative to the concrete, it is much cheaper. Using wooden structures, it is not needed to build up deep foundations or to use heavyweight materials. Using of concrete really slows down a building process which affects the final price. Undoubtedly, that invention brought up speed and convenience to construction. Despite of its disadvantages, it has a lot of advantages, which are available when it is properly used and they could lead to maximum efficient usage.

Lumber framing always played a big role in the building industry and today that role is only growing, especially with people’s focus on the green solution, because wooden houses produce less CO₂, which make them very eco-friendly. Wood has very good thermal insulation properties, thus balancing temperature in the winter and summer. Due to that it could save heating and conditioning energy up to 60%. It is also very beneficial due to easily built construction and that it could be fully recycled. It could be used not only in residential houses, but also a big variety of types of buildings.

Wooden framing easily stands against earthquakes, that is why it is widespread in corresponding regions, and it is not needed to pay much money for that relative to brick houses [5]. As the world is moving forward to BIM ideology, digital

wooden framing solutions are becoming more and more important. It goes without saying, that BIM reduces costs and increases the quality of future constructions. BIM software makes all these goals come true. It is a must-have tool for every architect, which makes it possible to realize key decisions on each project as efficiently as possible. It is suitable not only for architectural specialists, but also for structural engineers, who could facilitate and speed up the working process. BIM software saves 90% of the time needed to manually put every stud and plate in the needed corners and to produce shop drawings. BIM software is a very useful on every stage of the building process, because using these tools helps not only to build, but also to estimate costs and to sketch alternative options for the project and that it is important to make everything according to all the requirements and constraints. Thereby, it is perfect to think over the whole strategy of development of our project from the beginning until the end. As can be seen, its benefits concentrate not only on one certain part of the building lifecycle.

While designing the project, it could be compared the solutions for different layers in floors and walls, using different timber types, shapes and sizes. That is why it is very easy to look into details and update the framing in every part of the building as well as automatic production of schedules for every item, all the dimensions and literally every kind of information. Fabrication of the elements goes also very smoothly using BIM data, because it could be exported it to the milling machines and cut everything as accurate as it is possible. With BIM it is not needed to buy an extra material and elements, because now it is not needed to count everything manually by ourselves. It also helps to bring elements on the site in right order which helps us to avoid time-consuming operations with sorting. It is a very valuable ability which makes construction very efficient. As for in-use stage, BIM is extremely useful for maintaining the object or for making solutions for renovations. Today with BIM all the operations with the project on each stage of its lifecycle save time, money and efforts. Framing tools are very flexible, powerful and it is absurd to ignore such an opportunity, which obviously promotes rapid development of every project. Not less important, that they are easy to use, thus it becomes available to not too experienced engineers. They save not only the time, but also, they help to avoid strong mistakes while designing and if they were already made - to adjust them in time at every project stage. [3]

5 RESEARCH METHODOLOGY

Research on the main topic of the thesis is based on comparison of actual approaches for creating timber framing in Revit 2020. Firstly, a review on the basic functions which are available in the initial and Revit® Extensions by Autodesk are going to be done. Also, different extensions by other side authors, which are available on today's market are considered. They will be compared with each other concerning some aspects which are important for daily users:

- Set of tools and functions
- Convenience, accessibility and logicity of the interface because it will significantly save time and effort spent on the project
- Distribution Terms & Costs
- Easiness of performing frequent operations, because fast adaptation will increase the effectiveness
- Quantity of actions to complete a typical operation
- Familiarity of use
- Realism and attractive appearance of the finished structure

The case study was done in the following phases:

Firstly, determination of the problem: the task was to complete the frame of the house with very tight deadline. That is why, it was obvious that it is not possible to do that manually, as it is not effective and very time-consuming. After, research questions should be identified, because I do not have any experience working with frame in Revit. The next step was to start an investigation on the best option to solve the problem. Information in the Internet was collected, watching tutorials and reading an articles. After analysis of all the available options, a decision was made that the best option will be to start working on the problem using extensions for Revit. Next, working with the best solutions in that field should be tried and the best one should be chosen by evaluation and deep comparison.

6 OVERVIEW ON ORIGINAL REVIT TOOLS FOR WOODEN STRUCTURES

Revit has a very rich set of basic tools which afford us to build almost whatever could be wished. It could be used either them or official Revit Extensions by Autodesk, which includes timber framing. Unfortunately, these extensions are no longer available for 2019th and 2020th versions of Revit. Its production stopped on 2018th version.

The company is working with 2020th one, which made it impossible and pointless to consider official Revit Extensions as a participant in the research on the best solution for timber framing. That is why my decision is to start the overview with the tools which exist directly in Revit. All the examples are going to be presented using units of imperial system, because the company is mostly directed on the projects in the USA.

It is better to show the performance of each approach for wooden framing creating a simple 1-story building – it is enough to create just the main basic elements to demonstrate all the functions and tools. At the beginning a basis for further modelling is going to be prepared, that is why firstly it is needed to go to north elevation to put several levels to the project. The first thing is needed to be done is to create the floor slab. Let it be made from concrete and let it have 1 feet thickness. The next step, it is needed to add some wood framing family to the project, that is why it will be two elements: timber columns and beams, which in the further actions could be easily transferred to the studs and plates. Bottom plates on the floor have to be put, therefore beams are going to be used for that. For example, 8"x2" beams are fine and it have to be put around the whole area of the slab in that way that it is going along its edge (Figure 6.1). Now it is a framework on which it will be placed the horizontal beam system on

which the floor of the house is going to be placed.

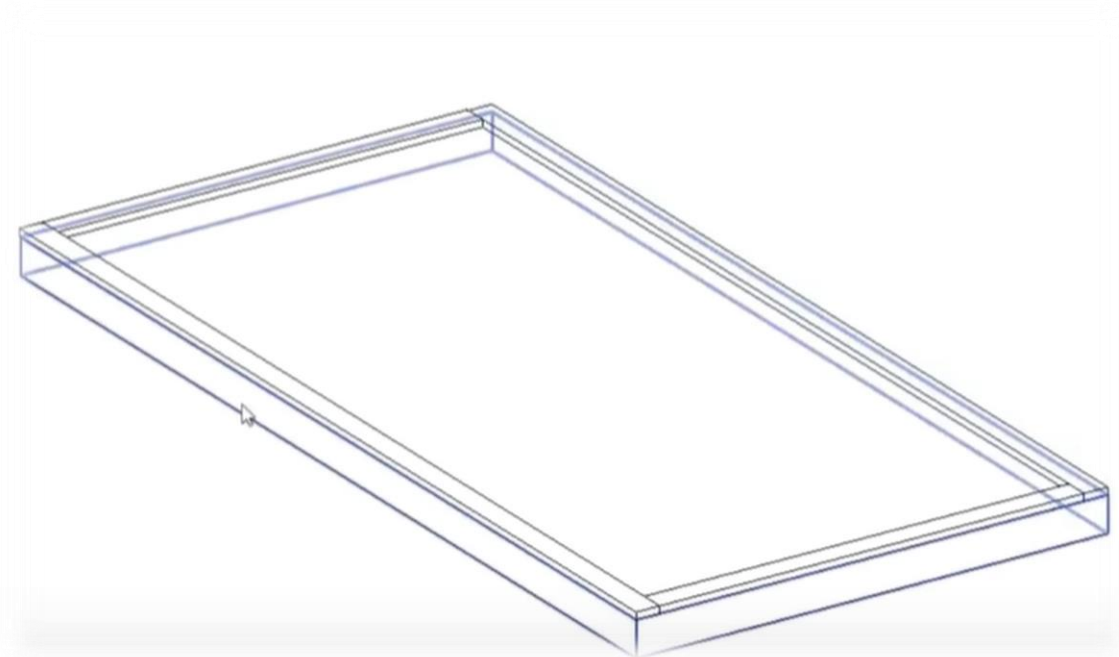


Figure 6.1 Initial framework for further beam system

Then it has to be duplicated one of the previously loaded beams and to make a new one 2x6". It has to be placed also around the area of the concrete floor as shown in Figure 6.2:



Figure 6.2 Arrangement of vertical side elements of the beam system

In the next part it is needed to use the tool called “array” which affords us to multiply the beam and spread it along the floor. (Figure 6.3)

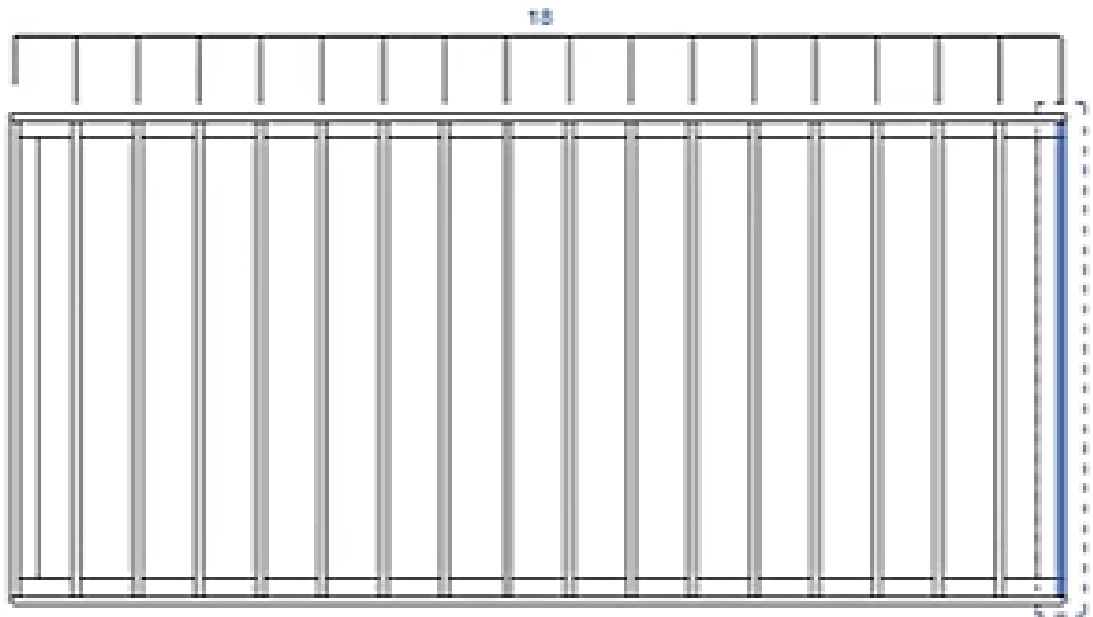


Figure 6.3 Spreading of the vertical elements along the floor

After, the beams could be covered with the 1' 0" plywood. Therefore, now it is a complete wooden floor structure. The bottom part is finished. (Figure 6.4, 6.5)

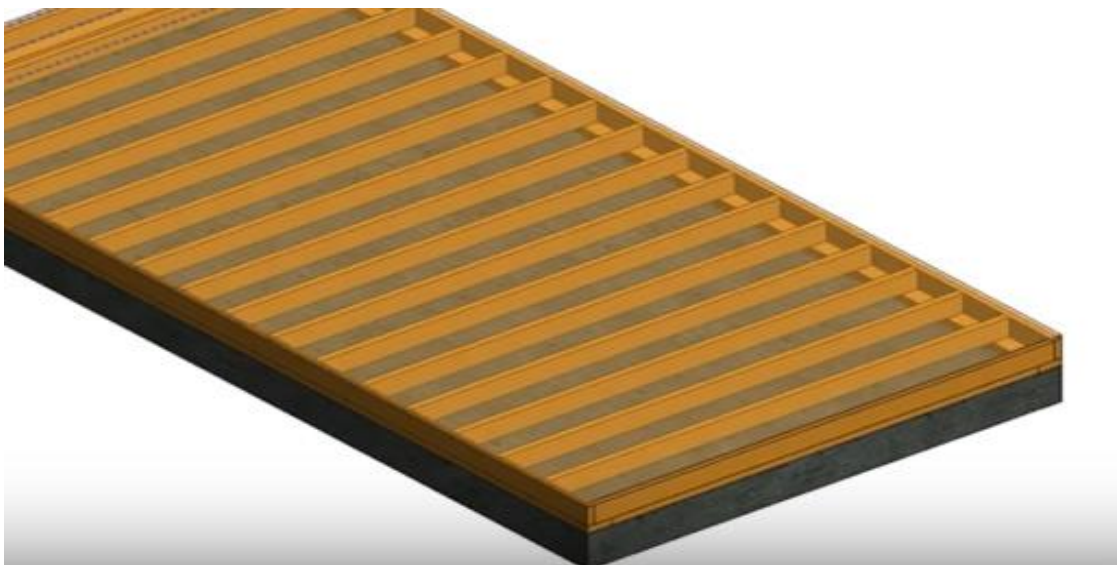


Figure 6.4 Completed floor's beam system

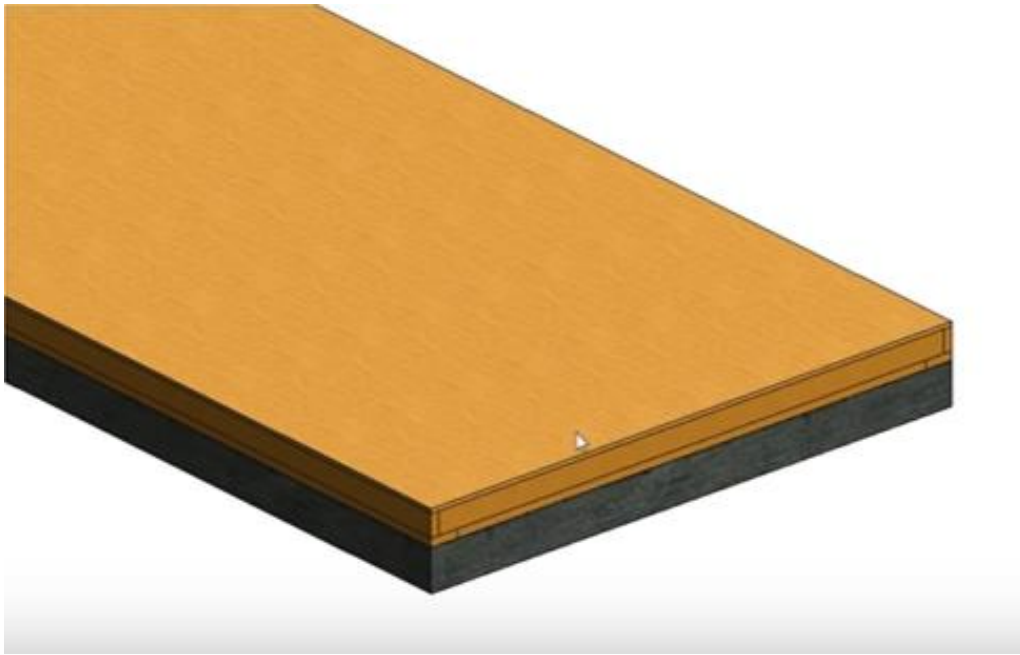


Figure 6.5 Fully completed floor

Consequently, for the walls, 7" walls with 6" air layer is going to be created and it will be covered from both sides with $\frac{1}{2}$ " plywood. It has to be placed around the area of the floor as shown in Figure 6.6:

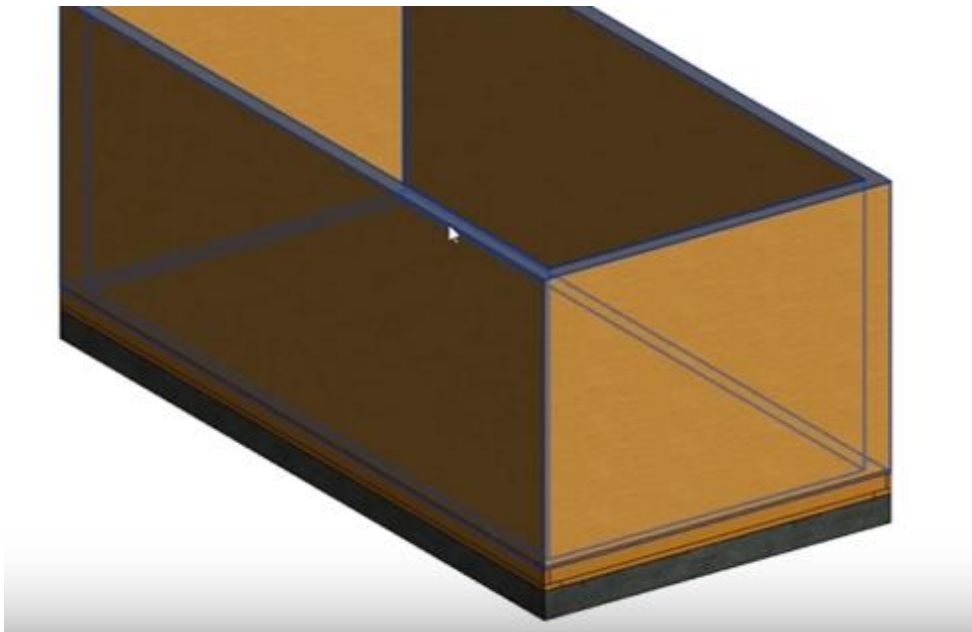


Figure 6.6 Arrangement of the walls around the perimeter

These walls are needed because it is much easier to put the framing inside it rather than just to guess where the right place for them should be. Thus, the next

step is to place something in the nature of pillars in the corners for further framing, and it is needed to use structural columns for that purpose. (Figure 6.7)

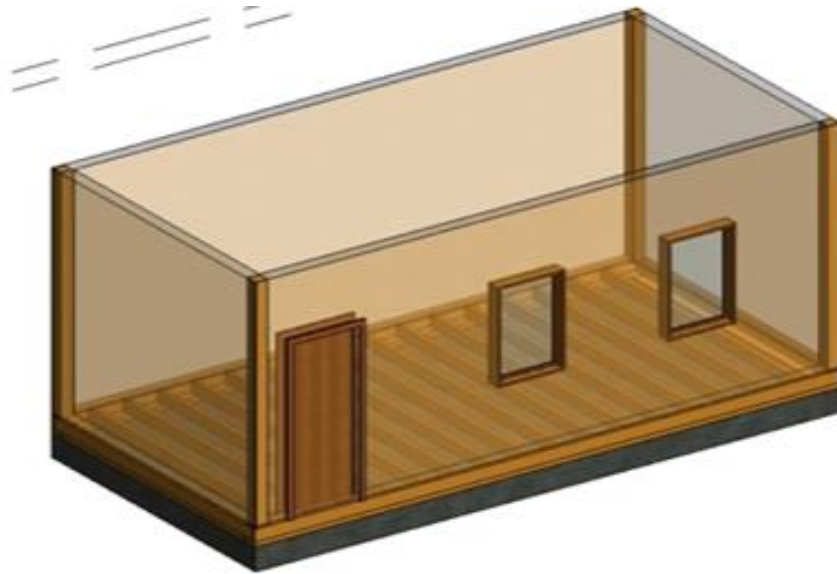


Figure 6.7 Arrangement of corner's pillars

Then, 2x6" studs are going to be put to the north wall using the same tool as before "array". (Figure 6.8)



Figure 6.8 Arrangement of studs

Next, it has to be done the same on the west wall and copy both to the rest of the walls in the following way as in Figure 6.9:



Figure 6.9 Completed arrangement of studs

For today it is the best thing to do something the same in Revit.

That already looks acceptable, but it is not finished yet, because top plates are needed to be put over the studs and some in between of the top and the bottom ones. 2x6 beams are going to be used for that. (Figure 6.10)



Figure 6.10 Arrangement of top plates

Then it is needed to just copy it and put it in such a way, that it will support the windows, because it needs some construction. (Figure 6.11, 6.12)



Figure 6.4 Arrangement of window bracing



Figure 6.5 Detailed view of window bracing

Thereby, now it is the foundation, floor and walls, which is enough to demonstrate that approach.

As it has been mentioned before, Autodesk will not deliver any extension connected with timber framing, that is why it has been just shown the optimal way to perform high productivity in wooden structures without additional help.

7 INFORMATION ABOUT EXTENSIONS FOR TIMBER STRUCTURES

Nowadays, the market offers us some solutions for timber framing, which could make our life easier and to optimize our working methods as well as to improve our workflow in BIM [6]. That is why customers do not have to waste time on the time-consuming actions and they can easily switch to alternative way outs delivered by other companies. The most popular one was chosen for today based on the customers reviews in Autodesk's and other architectural forums [11] [12] [13].

7.1 Wood Framing Extension for Revit developed by AGACAD

If you have ever tried to build framing yourself, then you can confirm with no doubt, that it could be very boring and monotone. In that case, everybody dreamt about some boost. The first extension that is going to be considered is Wood Framing by AGACAD. As claimed by its developers, everything in their products is a mouse click away, and it is going to be checked it on the same case, that was an example for previous chapter [7] [8]. Thus, just to be clear, the floor and the walls have to be put, as before, but for now these many actions do not need to be repeated to build a really qualitative wall framing.

Firstly, TOOLS 4 BIM Dock should be installed on the computer. It is a sort of a menu screen where all the available addons for Revit by AGA CAD could be seen. (Figure 7.1.1)

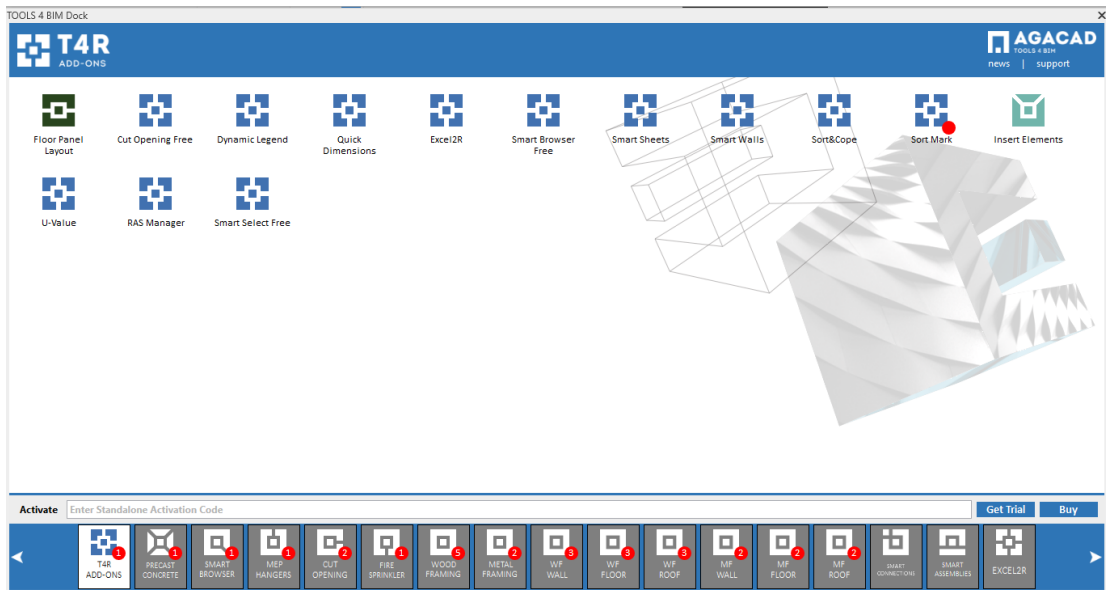


Figure 7.1.2 TOOLS 4 BIM Dock

Each addon has a certain set of tools. For instance, for the wood framing it has the following structure form: (Figure 7.1.2)

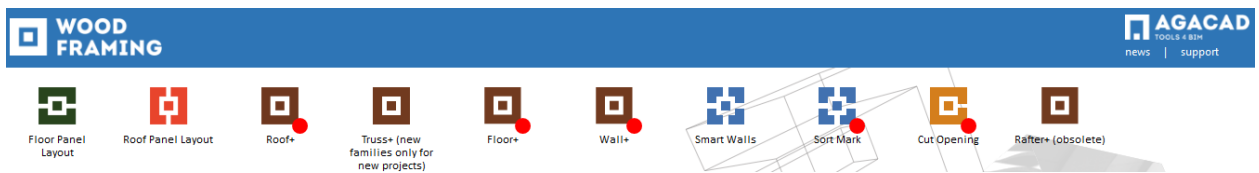


Figure 7.1.3 Wood Framing section from TOOLS 4 BIM Dock

After all the tools for wood framing are downloaded and installed, directly in Revit a new tab T4R: Wood Framing will be seen. There a lot of new tools will be seen for each part of the building, but only the “Wall plus” tools are needed. Framing of the walls could be started with “Wall plus” quick and easy. (Figure 7.1.3)

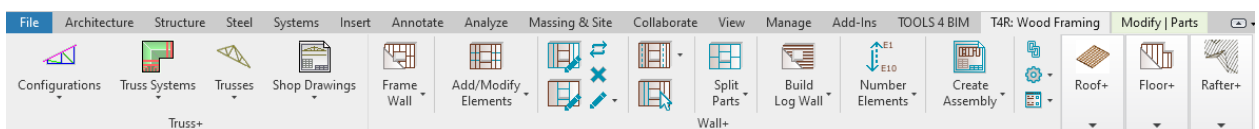


Figure 7.1.4 T4R: Wood Framing top main tool bar

It has a big quantity of sub-tools, but not every of them is needed. In case if a more complex structure needed to be built with, for example, details, then it could be easily done with these sub-tools, because they are very intuitive.

Thus, coming back to the case, when the walls have already been erected, there are a few steps left before the walls are framed. To have everything configured perfectly, the first thing which is needed to be done, is to go to the “Link Wall” sub-tool. (Figure 7.1.4)

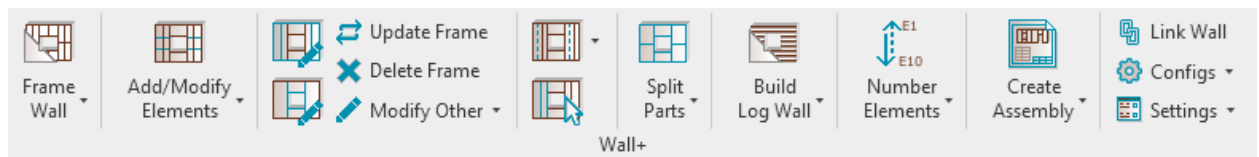


Figure 7.1.5 Wall + tool sub-bar

It needed to find the wall types which were used to model the house and to set a proper configuration. In this case, 5” wall is needed to be chosen, which has 3 layers. It will be seen that the framing layer and framing configuration are

modifiable. As it is seen, framing layer for structural layer is set automatically as it is a structural layer. (Figure 7.1.5)

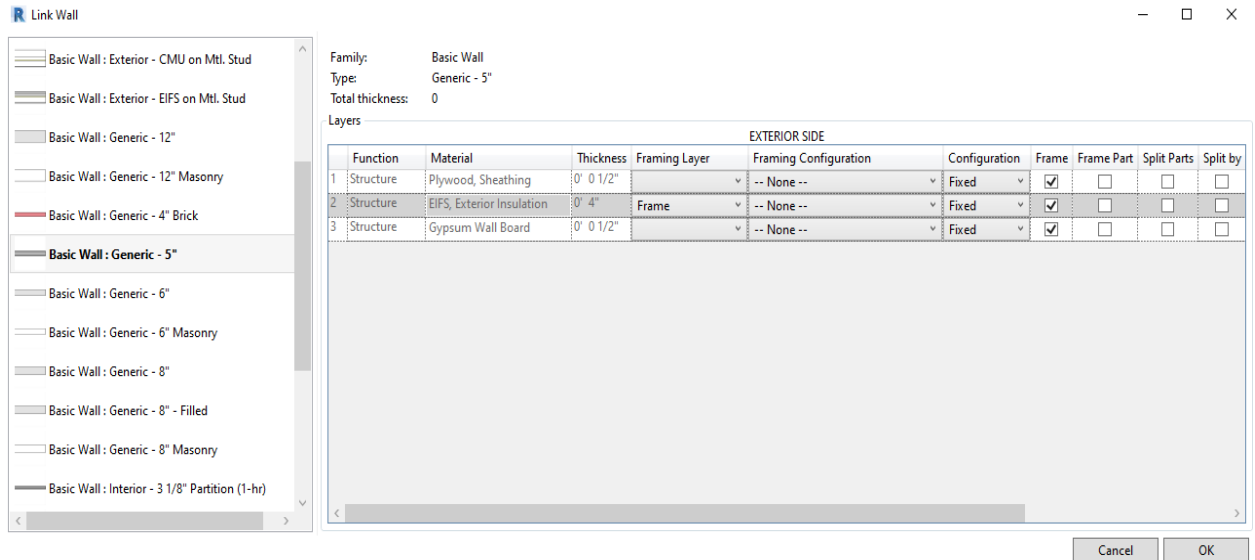


Figure 7.1.6 Link Wall window

For others it has to be set up a framing layer called “Sheathing”. Framing configuration is needed only for the structural layer, which means for the study case that just for the 2nd one. (Figure 7.1.6)

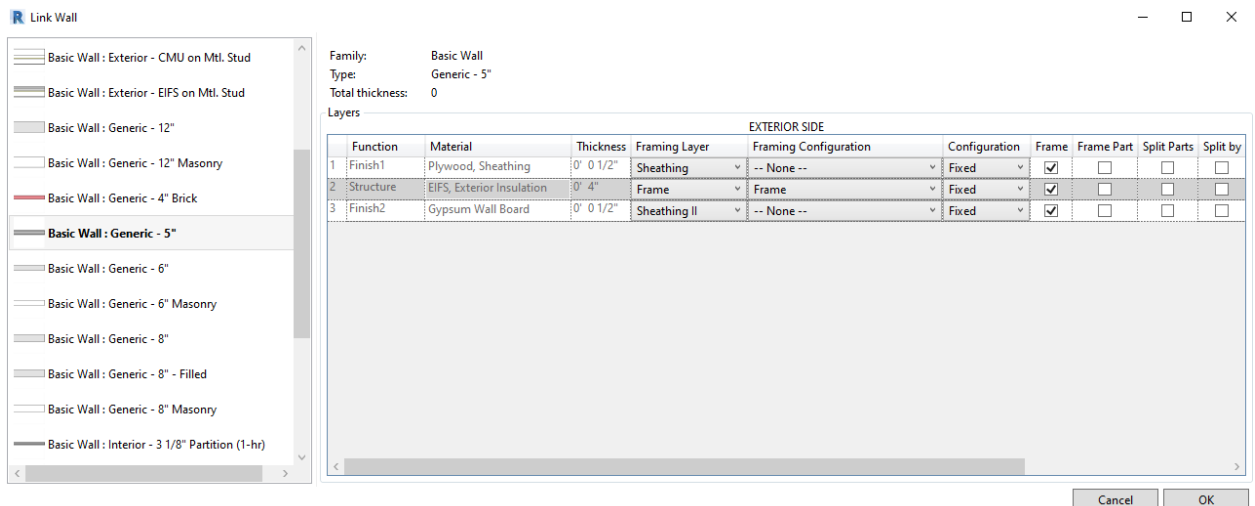


Figure 7.1.7 Layer menu from Link Wall

It is needed to be selected the wall which is needed to be framed, then “framing configuration” is needed to be chosen on the “Wall +” Tab. It works as a standard which will be different for each of the projects. Proper settings are needed to be set to “framing configuration” just once for each project, next time that does not need to be done. User interface is divided into three parts. The top pane is for configuration types and their versions. It has seven different configuration types, which basically are needed for the deeper control of the framing parameters. For this case configuration type “Frame” is enough. It could be saved as many configurations for each type as needed and could be used in different wall types. (Figure 7.1.7)

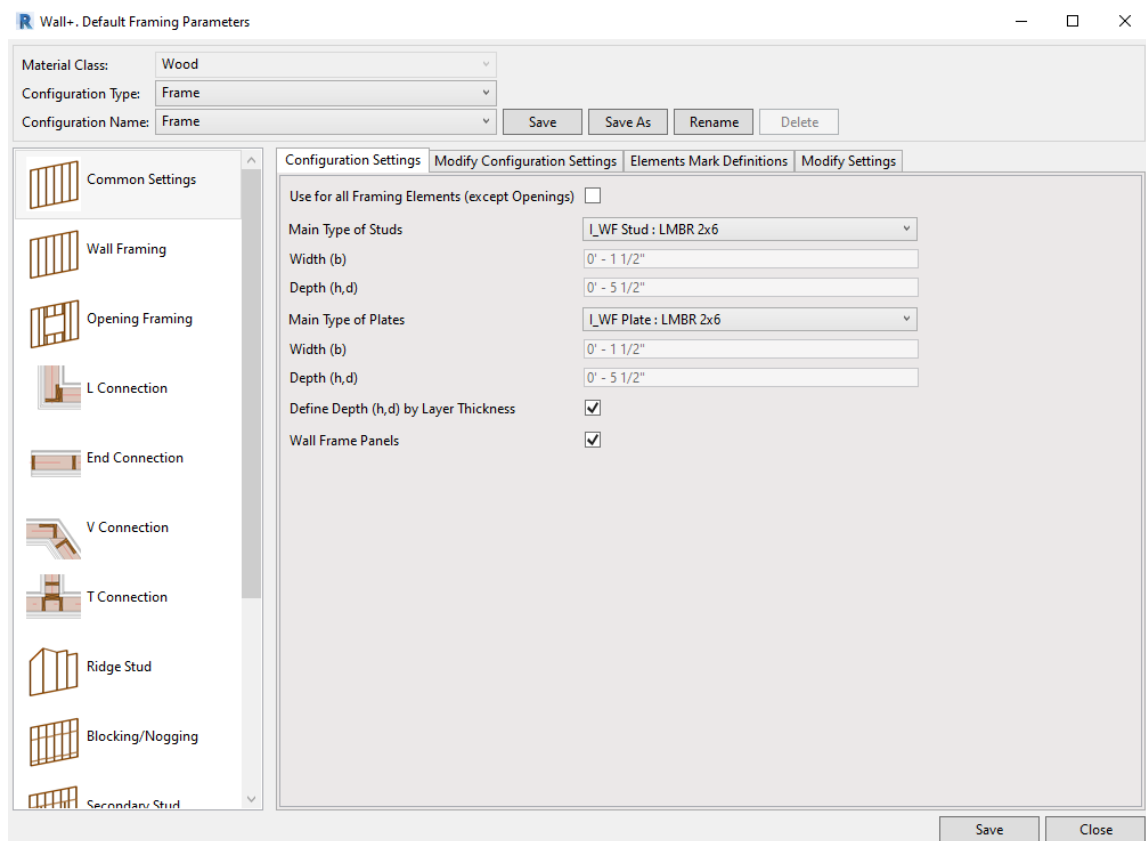


Figure 7.1.8 Settings in Wall + Framing Parameters

Different settings of chosen configuration types could be browsed there. On the left pane different elements of future framing could be seen, and different framing configuration settings on the right pane as well. Each element has a really big variety of settings, which afford us to build every kind of framing.

When the configurations are finished, the last step could be started. Everything is done to be ready to frame the first wall. It is needed to select one of the walls and to go to “Wall +” and to press “Frame Wall”. For better accessibility “Wall +” Tab could be dragged down to the main working space. Framing process will take around several seconds, depending on the power of the computer. (Figure 7.1.8)

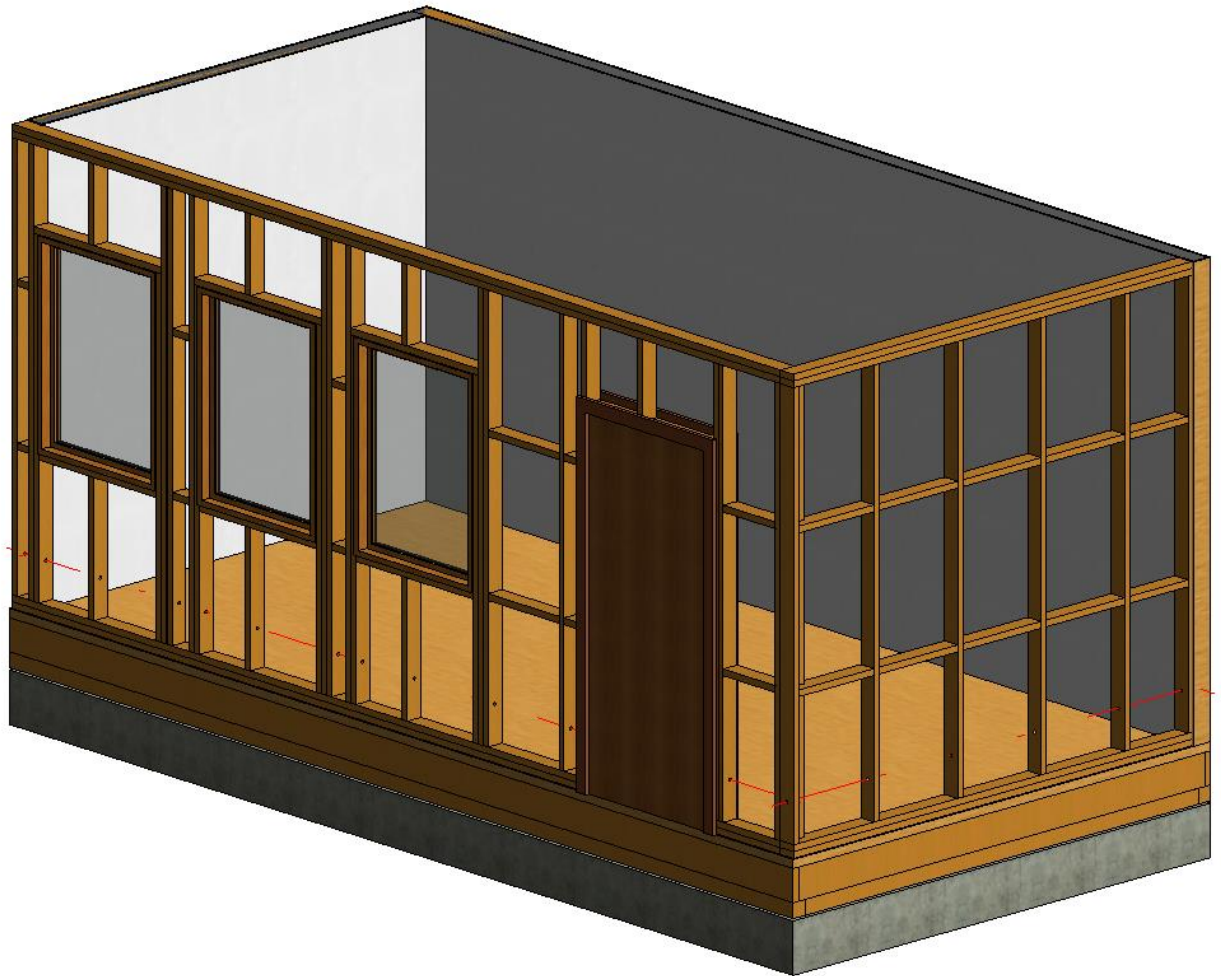


Figure 7.1.9 Completed wall framing

As a result, it is a really good framing. For big projects it is really a great opportunity to create framing for every wall in the project. Not less important to admit, that everything in Wood Framing Wall+ is a mouse click away, which means, that it could be saved 90% of the time, needed to do the same operations manually. The price for that extension is € 2.500,00 for 12 months, which is not too much for big companies, but could be very tangible for small start-ups.

7.2 ENRWOOD-FRAMING developed by ENRVISION

The second one extension is going to be reviewed is ENRWOOD-FRAMING developed by ENRVISION. That extension could be tried with 10 days trial, which is enough to understand all the functions there. It is needed just to install that extension with exe-file, then it is ready to use. It has a very simple upper main tool bar. In accordance with ENRVISION's instructions [9], for the study case only "F Wall" and "F Building" is needed. (Figure 7.2.1)

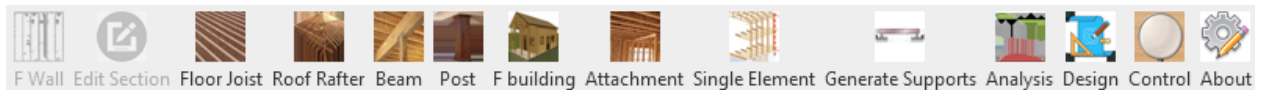


Figure 7.2.1 ENRWOOD-FRAMING main tool-bar

Thus, to create framing using that extension, firstly it is needed to choose "F Wall" tool and a wall framing data screen will be seen. (Figure 7.2.2)

Framing Single Wall ✕

Options

Wall Name: 356784

Stud Spacing (in)

Fill By Plates

Manual Sections

Select Section

Name :2x6

Width :1.5 Depth :5.5

Manual

	Element	Section	Edit
▶	Top Plate Section	2x6	<input type="button" value="Edit"/>
	Bottom Plate Sec...	2x6	<input type="button" value="Edit"/>
	Stud Section	2x6	<input type="button" value="Edit"/>
	Header Section	2x6	<input type="button" value="Edit"/>
	Fill Section	2x6	<input type="button" value="Edit"/>

Figure 7.2.2 Settings for wall framing

After, it is needed to change framing data from that form and to click "Framing Wall" button to apply our framing. Framing will be created automatically: (Figure 7.2.1)



Figure 7.2.3 Completed Framing

“F Building” tool will create walls in the same wall, the difference is that it frames the whole building, including rafter, floor etc.

The section of the beams could be also changed, using tool “Edit Section” (Figure 7.2.4)

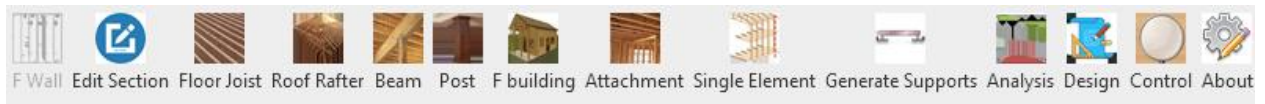


Figure 7.2.4 Edit Section tool on the main tool-bar

Then the next form could be seen: (Figure 7.2.5)

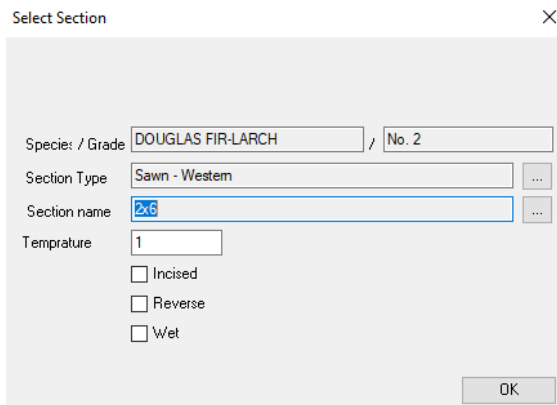


Figure 7.2.5 Element's Section Settings

That extension has very rich section library: (Figure 7.2.6)

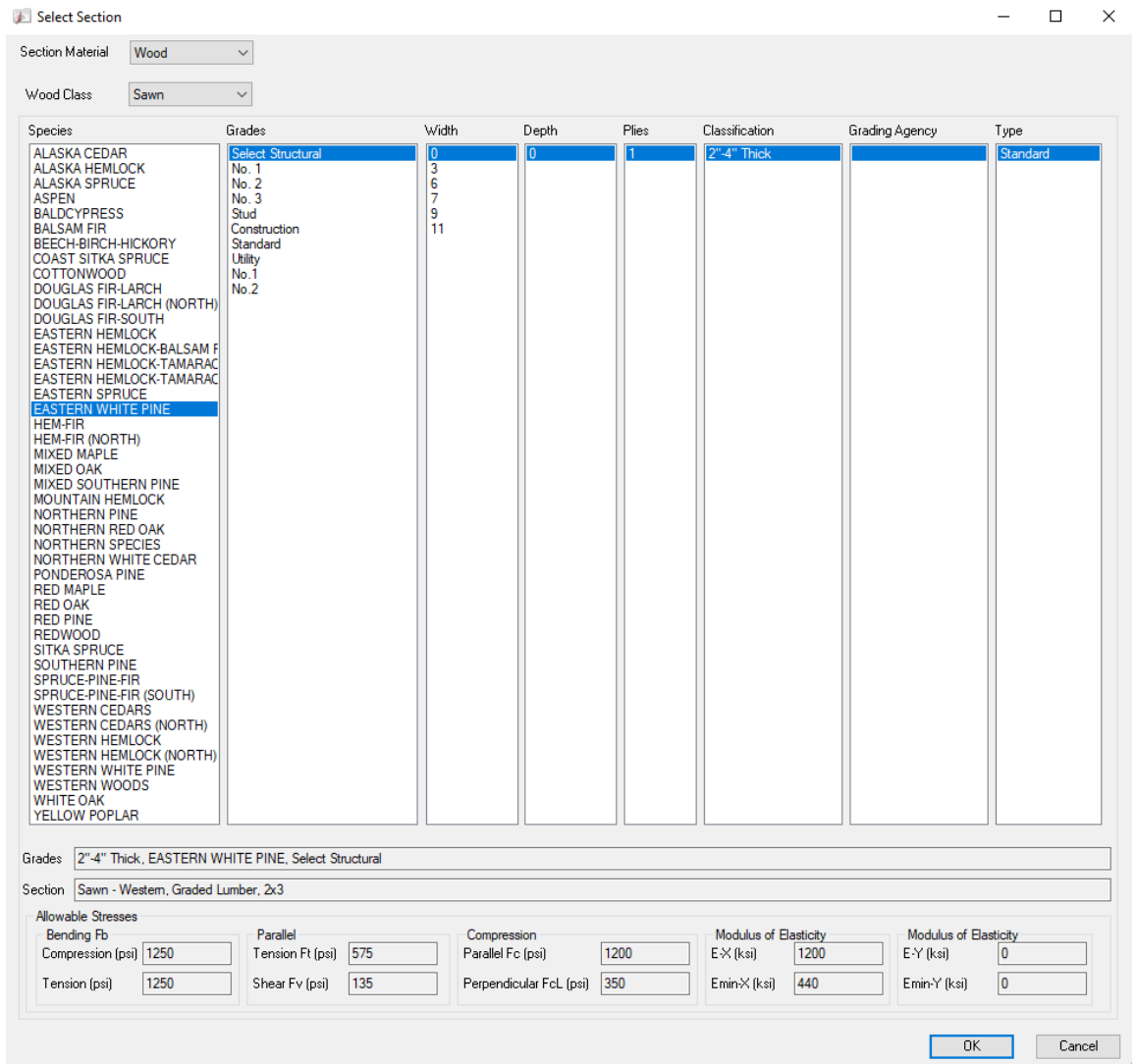


Figure 7.2.6 Element's section library

That extension does not suit the needs, because there is no option to create any different form of framing – just a standard one. It has a very big quantity of problems, mistakes, errors, which interrupts the workflow and prevents from being effective. Also, their web-site seems to be no longer supported as well as their extension, that is why this extension inapplicable for today's market. But it costs only € 499,00, which is appropriate for companies, but even that price is too big. The biggest problem of that extension is that there is no any big variety of choice and it is not possible to customize the timber framing.

7.3 MWF Pro Wood developed by StrucSoft Solutions

The last extension for Revit is MWF Pro Wood developed by StrucSoft Solutions. Their official webpage tells [10] that it is a modeling tool for exact situations as case study, which allows us to build a complex custom framing including every single aspect of wooden framing as different materials, layers, type of structures. That add-on also could do production of sheets, quantities, schedules much easily. As in AGACAD extension it also automatically detects all the openings like windows and doors, and frames it in that way, that the user set it before. It is also possible to configure connectors, add nails, hangers, bolts, service holes and other fastenings if needed. As in AGA CAD extension, the group of selected walls could be easily framed and it is not needed to frame manually each wall one after another.

Thus, to launch that extension, just an installer is needed. After it is needed to activate it, otherwise all the tools will not be available. It is a bit tricky, but there is an opportunity to find an instruction at the official web page, after it will not cause any more questions.

As it was in AGA CAD, the first thing everyone has to pass through is customization of settings, because they directly depend on the project. It is more about creating conducive conditions for further framing, that is why it is needed to load in some data to the project.

The main tool tab in that extension is as follows in Figure 7.3.1:

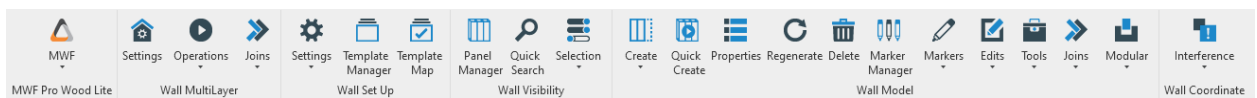


Figure 7.2.1 MWF Pro Wood main tool tab

For the good start, firstly it is needed to click on “Settings” above the “Wall Set Up” and choose “Load Data”. (Figure 7.3.2)

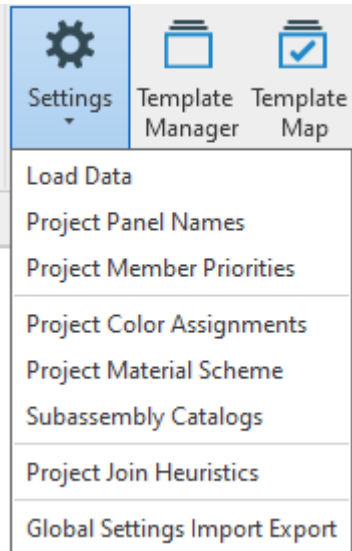


Figure 7.2.2 Settings pop-up window

The pop-up window looks as shown below in Figure 7.3.3:

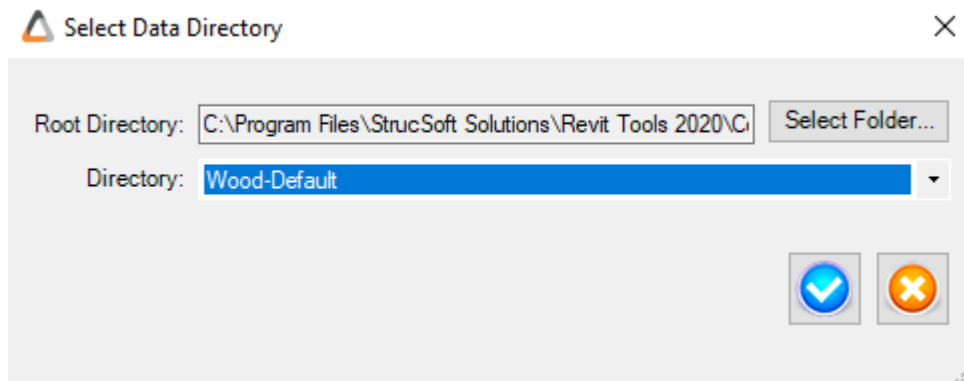


Figure 7.2.3 “Select Data Directory” pop-up window

It is going to load in framing markers, join markers, split conditions, different rule sets etc.

The next thing some studs that are going to be used in this project are needed to be loaded in, consequently from the insert tab it is needed to load a family and right down there in the end MWF PRO wall folder will be seen, then “Imperial” should be clicked and the “MSF dimensional lumber” should be grabbed there for horizontal members and “lumber column” for the vertical members. After right

families are loaded, right dimensions for the project could be selected. For both horizontal and vertical elements, it will be 2x4 and 2x6 respectively. (Figure 7.3.4)

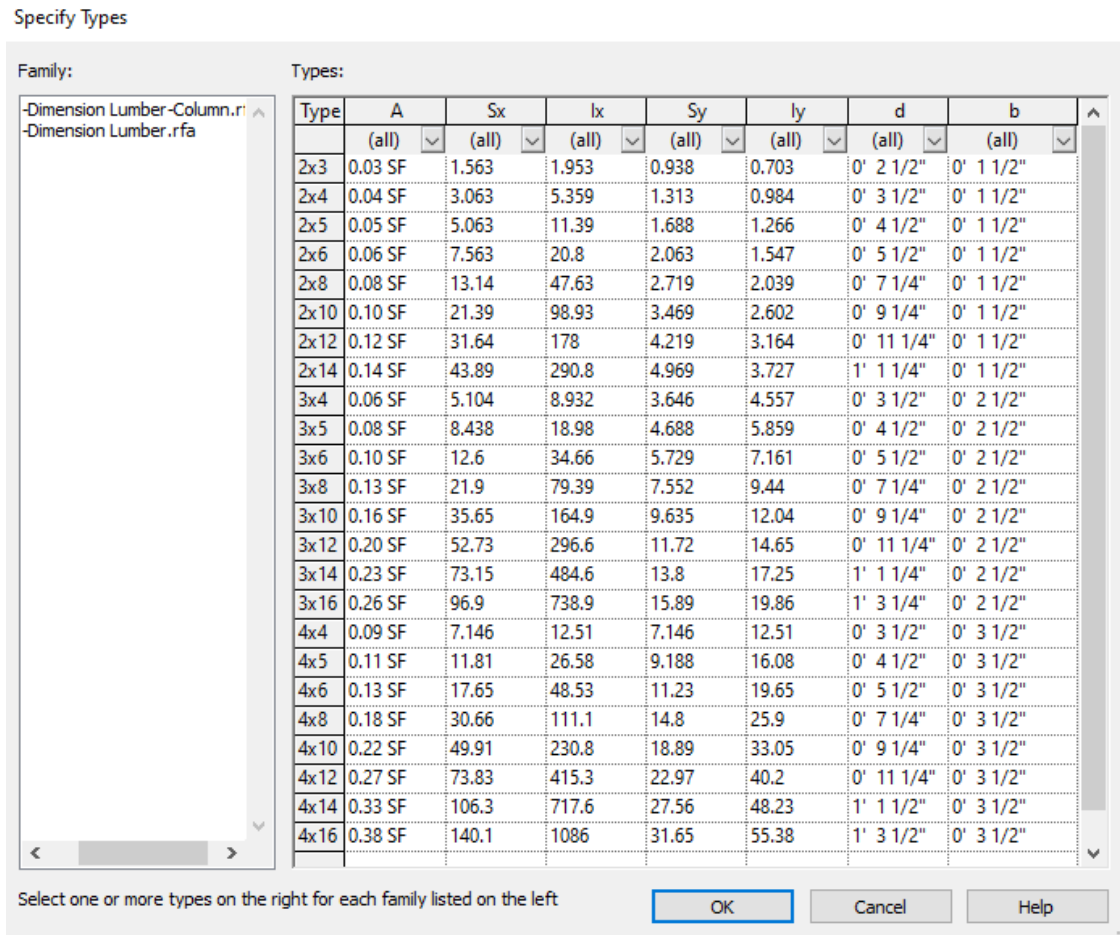


Figure 7.2.4 Stud's dimensions

When it is done, the templates are ready to be created. MWF works in a reverse engineering type manner where something that is already existing is taken, such as a default template panel and it changed to look exactly the way is needed. So, now it is going to be started with framing. Firstly, it is needed to be select the desired wall and clicked "Create" on the MWF main tool tab. The general menu could be seen there, where the desired values for some different parameters could be set. (Figure 7.3.5)

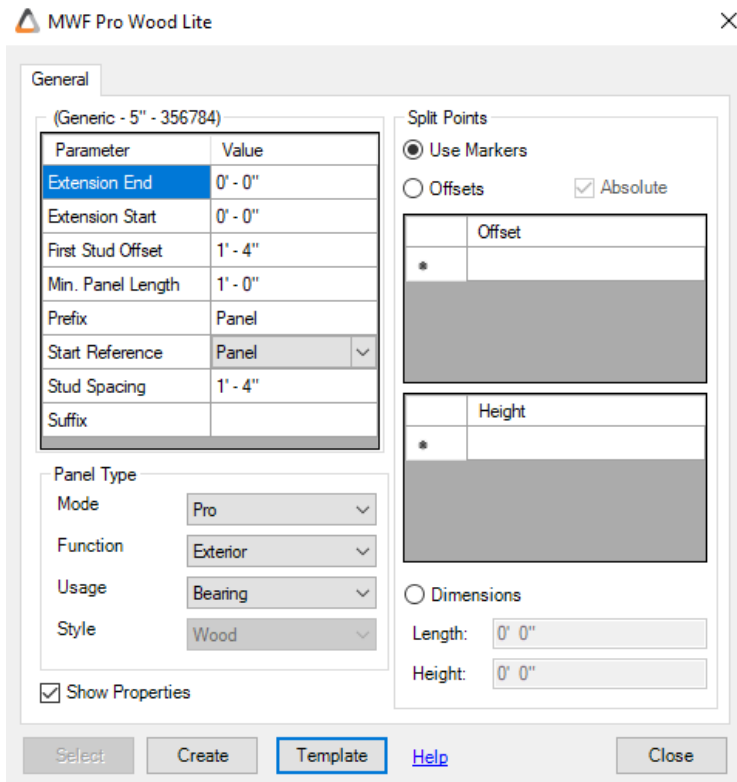


Figure 7.2.5 Framing parameters

But firstly, it is needed to go to the "Template" and to choose 2x4 default template for the beginning. MWF is reading this wall, it is seeing those openings, and it is putting all of the members inside in a right way.

MWF will create framing as it follows in Figure 7.3.6:



Figure 7.2.6 The result of the first framing try

Everything suits us, except that middle horizontal plates, or as it is also called bracing, which are missing, but according to the drawings they should be there, which means that the template should be updated. Thereby, what is needed to be done, is to select the needed walls, then go to “Properties” on the top main tool bar.

There are tons of different settings, which afford us to make full customization of the framing, as it is in AGA CAD. Therefore, it is needed to go to “Miscellaneous” to edit “Horizontals”. (Figure 7.3.7)

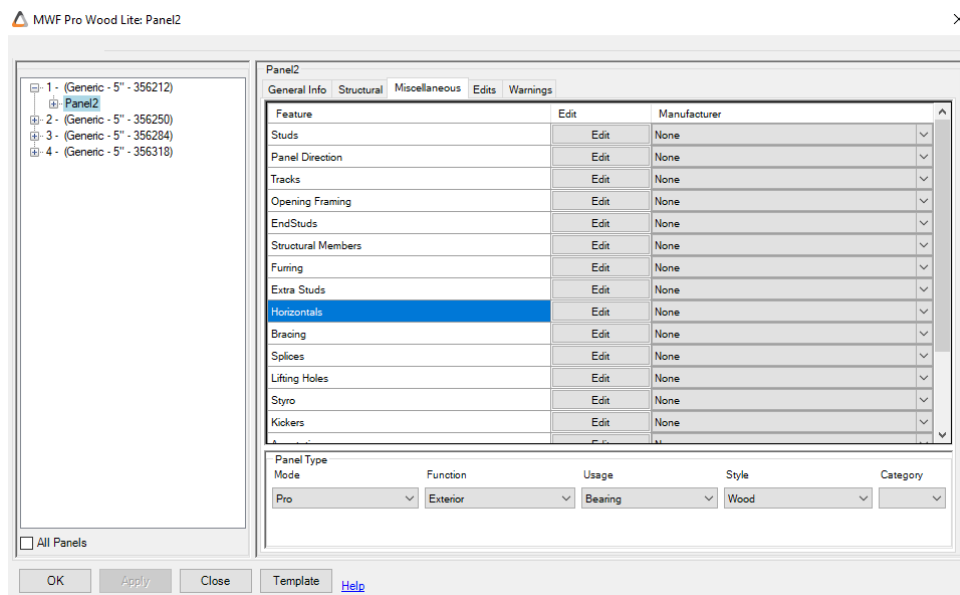


Figure 7.2.7 Framing settings for already existing walls

There the desired offsets are needed to be set and to choose the needed family of plates as shown in Figure 7.3.8.

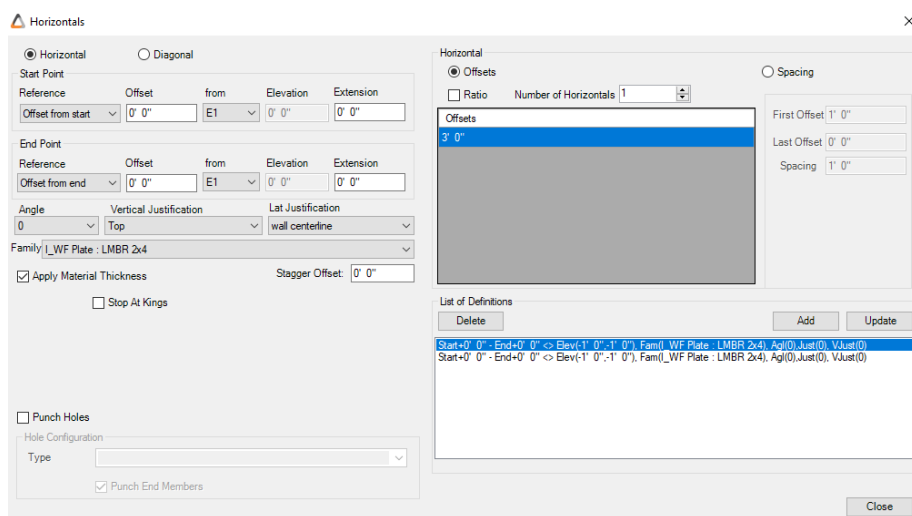


Figure 7.2.8 Settings of horizontal offsets

After applying the result will not be long in coming. (Figure 7.3.9)



Figure 7.2.9 Completed framing

For that extension the price will be € 2.250,00, which is almost the same as for AGA CAD extension. Anyway, the price is quite huge if you want to use only its modelling functions – it could be less. If you want to use it for more complex tasks, as, for instance, production of shop drawings or collaboration with fabricator, because all the inside data could be exported to CNC machines for fabrication, then it will distinctly save your time.

The result is almost the same as in AGA CAD extension and the functions there are more or less very similar. Of course, there are some differences, but they are not crucial.

8 COMPARISON OF TIMBER FRAMING MODELLING OPTIONS

As it was told before, a deeper comparison of these three extensions in a form of the table. It will have 8 aspects of comparison, with some points out of 5, after they will be summed up and it will be made a conclusion based on the total result, the maximum of which is 35.

- Set of tools and functions – assessment will be based on how many functions it has.
- Convenience, accessibility and logicity of the interface – assessment will be based on the way all the tools are located inside the extension.
- Distribution Terms & Costs – assessment will be based on the price which is paid for the product for a certain period regarding those tools and functions which it provides.
- Easiness of performing frequent operations – assessment will be based on the personal feeling of how much complex completing of one or another tool.
- Quantity of actions to complete a typical operation – assessment will be based on the speed of achievement of the final result.
- Familiarity of use – assessment will be based on the time needed to understand how the extension works.
- Realism and attractive appearance of the finished structure – assessment will be based on the perception of the final result.

Extensions Aspects	Wood Framing Extension for Revit developed by AGACAD	ENRWOOD- FRAMING devel- oped by ENRVI- SION	MWF Pro Wood developed by StrucSoft Solu- tions
	Points (out of 5)		
Set of tools and functions	5	1	5
Convenience, accessibility and logicity of the interface	5	2	4
Distribution Terms & Costs	4	2	4
Easiness of per- forming fre- quent opera- tions	4	3	3
Quantity of ac- tions to com- plete a typical operation	3	5	4
Familiarity of use	2	4	3
Realism and at- tractive appear- ance of the fin- ished structure	5	3	4
Total (out of 35)	28	20	27

Table 8.1 Comparison Table of Revit Extensions

As it could be seen, AGACAD's extension and MWF's one have almost the same quantity of points, both performed very well, but AGA CAD is a winner in that competition. Of course, both of them claim quite impressive opportunities, but AGACAD's extension really is better than the rest of others, because it was easier and more familiar. That is why a decision was made to frame walls in Gramercy project, using AGA CAD extension, which was approved by the management in Integrated BIM. All the figures in Appendix 1 show the result of using AGA CAD's extension for timber framing for the walls on the 2nd, 3rd and 4th storey in the study case.

9 SUMMARY

In the conclusion I want to say, that it was truly a fruitful experience to make a research on my thesis topic. I can say with no doubt, that I have gained a very valuable practice experience. I do believe that it is going to help me in the future. I have studied the market very carefully and picked out the best ideas how to cope with the issue that I have faced during going through the project. It was beneficial and useful for the company which I have contributed to.

As the result, I have achieved a solution of the predefined problem successfully and I am glad that I have managed to compare all the approaches for timber framing in Revit. I do believe that my efforts will help someone who could face with the similar problem to simplify their workflow.

In the end of my work, I have found out that even the worst extension for timber framing for Revit is better than to do it manually. I Have proved that extension by ENRVISION could be very useful in addition for the manual approach. As for two other extensions, it goes without saying, that they could and should exist separately, as it is a full-fledged way of solving any timber framing issue in BIM. The comparison table showed that extension by AGA CAD is a little bit better, but I do not see a big difference – they both have a huge potential for industry. Despite of that both have user-friendly menus and a really big quantity of options that is why you will definitely need some sort of tutorial.

I would rather say that it more depends on each engineer, that difference is more in the personal sense of usage. Nevertheless, I am convinced that if you want to do timber framing in your model, you definitely have to try these two extensions, because undoubtedly it is a very powerful and flexible tool. It helps for much faster decision-making in your project on each stage of the project and to avoid undesirable mistakes. Moreover, nowadays every engineer has to be in touch with the latest technologies and industry trends.

I am very thankful for that experience, because I could not even imagine that I am going to learn as much as I did. I really feel that I have improved quite a lot myself in the field of research, writing and modelling. I am sure that I am going to use the gained skills in my future career.

FIGURES

- Figure 7.2.1 Structural detail of framing (Customer's explanatory note), p. 6
- Figure 7.2.2 Initial framework for further beam system, p. 11
- Figure 7.2.3 Arrangement of vertical side elements of the beam system, p. 11
- Figure 7.2.4 Spreading of the vertical elements along the floor, p. 12
- Figure 7.2.4 Completed floor's beam system, p. 12
- Figure 7.2.5 Fully completed floor, p. 13
- Figure 7.2.6 Arrangement of the walls around the perimeter, p. 13
- Figure 7.2.7 Arrangement of corner's pillars, p. 14
- Figure 7.2.8 Arrangement of studs, p. 14
- Figure 7.2.9 Completed arrangement of studs, p. 15
- Figure 7.2.10 Arrangement of top plates, p. 15
- Figure 7.2.5 Arrangement of window bracing, p. 16
- Figure 7.2.6 Detailed view of window bracing, p. 16
- Figure 7.2.7 TOOLS 4 BIM Dock, p. 18
- Figure 7.2.8 Wood Framing section from TOOLS 4 BIM Dock, p. 18
- Figure 7.2.9 T4R: Wood Framing top main tool bar, p. 18
- Figure 7.2.10 Wall + tool sub-bar, p. 19
- Figure 7.2.11 Link Wall window, p. 19
- Figure 7.2.12 Layer menu from Link Wall, p. 20
- Figure 7.2.13 Settings in Wall + Framing Parameters, p. 21
- Figure 7.2.14 Completed wall framing, p. 22
- Figure 7.2.15 ENRWOOD-FRAMING main tool-bar, p. 23
- Figure 7.2.16 Settings for wall framing, p. 23
- Figure 7.2.17 Completed Framing, p. 24
- Figure 7.2.18 Edit Section tool on the main tool-bar, p. 24
- Figure 7.2.19 Element's Section Settings, p. 24
- Figure 7.2.20 Element's section library, p. 25
- Figure 7.2.21 MWF Pro Wood main tool tab, p. 26
- Figure 7.2.22 Settings pop-up window, p. 27
- Figure 7.2.23 "Select Data Directory" pop-up window, p. 27

Figure 7.2.24 Stud's dimensions, p. 28

Figure 7.2.25 Framing parameters, p. 29

Figure 7.2.26 The result of the first framing try, p. 29

Figure 7.2.27 Framing settings for already existing walls, p. 30

Figure 7.2.28 Settings of horizontal offsets, p. 30

Figure 7.2.29 Completed framing, p. 31

TABLES

Table 0.1 Comparison Table of Revit Extensions, p. 33

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APPENDIX 1

