

Engineering Manual No. 3 Update 01/2023

Supermarket

Project description

Program: Truss3D

File(s): FineTrial.tr3 available here: https://data.fine.cz/manuals/FineTrial.zip

The target of this manual is a step-by-step input guide for a supermarket as they have been built many times all over Europe. We also focus on the bracing truss group.

It is recommended that you already have worked the examples given in our Engineering Manuals 01 and 04 (a simple hip roof and a formwork truss), which acquaint you with basic functionality in Truss3D and Truss2D.

Theoretical background

Groups of bracing trusses are designed to ensure the spatial rigidity of the roof structure as a whole. It is mainly about ensuring the members of the trusses against deflection out of plane caused by horizontal forces (wind, earthquake, imperfections, etc.) and against the buckling of members in compression. It is generally considered that one bracing field is able to stabilize approx. 8-12 main trusses, depending on the size of the compressive force (span, load) and the layout of the longitudinal reinforcements (purlins, sheathing, etc.).

The design of bracing is performed in a different way compared to ordinary trusses. The procedure used in the program is based on EN 1995-1-1 and procedures recommended for DIN1052:2008.

The load on the bracing trusses is determined according to formula 9.37 of the EN 1995-1-1 standard. The inputs to this formula are mainly the span of the bracing truss (as the total span of the bracing system), the average design compressive force in the braced part and the number of braced trusses. The coefficient kf,3 has a value of 30 with regard to the recommendations of the standard. Design values of the load are always determined with regard to theload duration. The load is applied on the trusses in both possible directions.

The vertical bracing trusses / elements above the supports are loaded by the horizontal reaction from the bracing trusses, which is transmitted by these trusses to the substructure.

In the calculation the program only considers the forces from the stiffening of the main trusses, the external load (mainly wind load on the shield or friction load) must be added manually in the 2D program to the relevant load case.

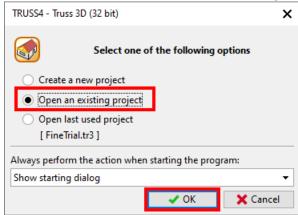
<u>This method of calculation assumes a fixed ridge, which can be ensured, e.g. by bracing or</u> <u>steel stripes. To use a different static scheme, it is necessary to change the support method</u> <u>in the Truss 2D program.</u> A different total span can be taken into account by changing the loading width.



Creating a new project

Initially we open an existing project to obtain timber and plates from pre-defined catalogues, then we create the real new project and adjust some more settings.

Run Truss3D and select "Open an existing project" from the wizard.



Navigate yourself to the path where you have saved the file "FineTrial.tr3", select the file and click on "Open".

Add FineSupplierTrial catalogue to your catalogues and confirm by clicking "OK"

Synch	ronization of loaded suppliers and Your company catalogue	(
•	Timber supplier "Test (Fine Itd.)" - supplier with the same properties (parameters) was not found in Your catalogue of companies. • add supplier to catalogue, a ctive supplier [user-defined] Nail plates supplier "Test (Fine Itd.)" - supplier with the same properties (parameters) was not foun in Your catalogue of companies. • add supplier to catalogue, a ctive supplier [user-defined] Nail plates supplier "Test (Fine Itd.)" - supplier with the same properties (parameters) was not foun in Your catalogue of companies. • add supplier to catalogue, active supplier [user-defined] Note: For adding a supplier into Your company catalogue, click on "Add to catalogue". The added supplier will be set as the active one. For using another supplier, change the "Active supplier" item.	d
	× Close	

If the window does not appear, it means the catalogue was found, then just check if the timber and nail plates supplier is chosen correctly in "Common properties". If not click on the appropriate supplier and change it.

<u>Common pro</u>	perties [Modify]
<u>Standard</u>	: <u>EN 1995-1-1 (EC5)</u> ; national annex : <u>Czech</u>
<u>Material</u>	: Roofing is <u>Clay tiles</u> Ceiling is <u>Plasterboard 12.5 mm + insulation 300 mm</u> material is <u>S10 (C24) - coniferous</u>
<u>Mounting</u>	: mounting mode is <u>below outline</u> offset of horizontal top chords is <u>120</u> mm truss spacing is <u>1000.0</u> mm Mounting properties are not automatically assumed to all trusses. They are only applied to new or regenerated trusses.
Thickness	: truss thickness is <u>50</u> mm
<u>Suppliers</u>	: timber <u>[user-defined] Test (Fine ltd.), (max.length 6000 mm)</u> nail plates <u>[user-defined] Test (Fine ltd.), (types: F10, F15, F20)</u> Metalwork <u>[catalogue] Test (Fine ltd.)</u> designer <u>[user-defined] Vlastník licence</u>



Now create a new project by clicking on _____ from the ribbon bar, select >File >New... from the menu or <Ctrl+N> on the keyboard. The project wizard will be launched.

Name the project, e.g. "Example_300", specify and accept the location where the file should be stored by clicking on " \rightarrow Next".

New project			×
- Project location			
Project location :			
C:\Fine_Examples			
Project file name :			
Example_300			
Complete location of project fit C:\Fine_Examples\Example_300\ Project location options [Mod Default project location setting C:\Fine_Examples Project directories sorting mo Project description mode Insert project identifier Insert date of creation	Example_300.tr3 <mark>ify</mark>] 		

On the tab "Truss properties" set the following values and entries.



New project						×
— Structure ———						
				П		
Empty structure	Rectangle	T shape	L shape	U shape	O shape	
Truss properties Dim	ensions of structure	Bottom detail				
Common properties						
Standard : EN	<u>1995-1-1 (EC5)</u> ; natio	nal annex : <u>EN 1995</u> -	<u>·1-1</u>			
	ofing is <u>Concrete tiles</u> iling is <u>Plasterboard 2</u> x	12.5 mm + insulatio	an 300mm			
	aterial is <u>S10 (C24) - N</u>		<u></u>			
	iset of horizontal top c iss spacing is <u>1250,0</u> m					
Thickness : tru	ss thickness is <u>60</u> mm					
Design entities - Out	of almo bushling					
Design options - Out Braces on top chords	· ·					
Brace generating mod	le: : Apply to	o all members				
Braces layout Braces on bottom ch		n given spacing, sp	acing <u>340</u> [mm]			
Braces on bottom ch Brace generating mod Braces layout	le: : Apply to	o all members n given spacing, spa	acing <u>2000</u> [mm]			
				🔶 Previous	🗸 OK	🗙 Cancel



"Dimension of structure"

New project					×
- Structure					
Empty structure Rect	angle T sha	ape L shape	U shape	C shape	
Truss properties Dimensions of	f structure Bottom det	tail			
Common propertiess of wall	s	- Dimensions of struct	ure		
Wall height:	4500 [mm]	Lx.0 = <u>54600,0</u> mm	Ly.0 = <u>24500,0</u> mm		
Wall thickness:	240 [mm]				
Wall plate location:	is not used 🔹				
Offset:	0 [mm]				
Width of wall plate:	200 [mm]				
Depth of wall plate:	50 [mm]	Rotation of structure			0,000 [°]
Side walls properties		۲ –			
Roof pitch:	20,000 fx [°]				
Inner support					
Cantilever:	500,0 [mm]				
- Front walls properties		– FÅ.O			
Front walls types: gable-e	nd truss 👻				
Roof pitch:	fx [°]				
Inner support					
Cantilever:	100,0 [mm]	¥ -	LX	0	-/
			🔶 Pre	vious 🗸 OK	X Cancel
			4110	+ 0K	



"Bottom details"

ew project							×
Structure							
Empty structure	Rectar	ngle	T shape	L shape	U shape	O shape	
Truss properties Dir	mensions of s	tructure	Bottom detail				
Default Vertically Horizontally Perpendicularly Intersection Parallelly							
Bottom chord end:				xtend to top chord			
Heel height measuri	ng direction:		V	ertically (parallel to axis Z))		
Heel height:	120,0	[mm]	Overhang type:	without overhang	 Automa 	atic wedge design	
 Edge cut: 	0,0	[mm]	In direction of:		 main and of 	one auxiliary plate	
			Overhang length:	[mm]	Uedge Wedge	Length:	[mm]
					🔶 Previous	🗸 ОК	🗙 Cancel



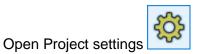
Now your window should look like this:

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Options		0 0,0 2	2000,0 4000,0 6000,0 6000,0 10000,0 12000,0 14000,0 16000,0 10	000.0 2000.0 221	00.0 24000.0 2500	0.8 2000.8 3008	0.9 3000.0 34000.0 3000.0 3000.0 46000.0 42000.0 44000.0 46000.0 48000.0 5006.0 5200.0 540 mm	Properties _
Structure	28101							
+ Add point Add wall								
O Roof	0'00292	-						
Trusses	9							
O Add truss	24100,0							
Add truss group	0 (0)27							
O Metalwork	220							
O Bracing	10002							
- F Generate	20							
O Results	0,0068							
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		Project info Name	ermation [Modify] : Example 300		itandard :		5); national annex : <u>EN 1995-1-1</u>	
		Description			Aaterial :	Roofing is Cond	rete tiles	
		Number	1			Ceiling is Plaste	rboard 2x12.5 mm + insulation 300mm (C24) - Nadelholz	
		Investor	:				(L22) - Nadelholz e is below outline	
						offset of horizon	ntal top chords is 120 mm	
						truss spacing is Mounting prope	<u>1230.0 mm</u> rities are not automatically assumed to all trusses. They are only applied to new or regenerated trusses.	
						truss thickness i		
	Nam			5	uppliers :	timber [catalog	uel_Test (Fine.ltd.). (max.length 6000 mm) loguel_Test (Fine.ltd.). (types: F10, F15, F20)	
	- 24					Metalwork [cata	elogue] Test (Fine Itd.)	
	the state					designer (user-o	<u>letinedi</u>	
	2							
Trusses: 0 (0)	Load cases: 0 Com	inations ULS /	/ SLS: 0 / 0	EN 1995-1-1 (E	(5)			ai

Eventually swap the content of the main workspace window and the auxiliary view window by entering <Ctrl+Tab> or clicking on the <>-arrow in the upper right corner of the auxiliary window.

Project settings - prerequisites

The following steps should ensure that we work with the same settings.



Project settings						×
● Standard	Standard:	EN 1995	i-1-1 (EC5)			-
Truss properties						
O Material	National annex:		EN 1995-1-1			
•••• O Thickness	Verifi enting an eth			destant standards		
• O Mounting	verification metho	od for comp	pression in supports	design standards		`
O Suppliers	Service class:		service class 2			-
 Design options 						
O Splices	Coefficient k _c	, (coefficien	t of crack influence)			
O Members	Use own valu	eofk (svs	tem strength factor)			
• O Nail plates						
Out of plane buckling					Factor k _{sys}	1,00 [-]
O In plane buckling						
O Details	Bracing style:		not specified			-
O Structure	Compressive force	or in ininter				
O Limit values						
• Deflections	split compressive	force autor	matically			
• Gable ladders						



Standard	Mounting mode	general geometry
Truss properties	Mounting mode:	
O Material	Mounting mode.	
O Thickness	Offset of horizontal top chords:	120 [mm]
Mounting	Truss spacing:	1250,0 [mm]
O Suppliers	nuss spacing.	1230,0 [[1111]
Design options		comatically assumed to all trusses. They are only applied to new or regenerated
O Splices O Members	trusses.	
•		
O Nail plates O Out of plane buckling	✓ Create end cuts	
	Symmetrical detail for single	
O In plane buckling O Details		
O Structure	All plies identical in multi-p	ly girders
-	Apex detail	prefer corner trusses
O Limit values		
O Deflections		
ect settings		
Standard	Splicing settings:	
Truss properties	Splicing method:	percantage of bay, move splices from details
O Material	Position in bay	25,00 [%]
O Thickness	r osition in bay	23,00 [/0]
O Mounting	Respect symmetry	
O Suppliers	Start at end points for horizon	ntal members
Design options	Start at the top for inclined m	embers
Splices	Allow splice in the middle of	bottom chord
O Members	Divide member in splice (ena	ble different timber depths for member)
O Nail plates	Splicing depends on maximal len	
Out of plane buckling	-pricing acpentar on maximum ch	,, , , , , , , , , , , , , ,
O In plane buckling		
O Details		
O Structure		
O Limit values		
O Deflections		
O Gable ladders		
O Advanced		
O Truss division		🛪 💉 🔨 🔽
O Supports		······································
Load generator		
O General	\square \angle \angle	γ \ / \ / \ \
O Imposed loads		$/ \setminus / \setminus / \setminus \setminus$
Snow		
O Wind		$1 \vee 1 \vee 1 \vee 1 \vee 1$
		── ₽ [×] ── ⋎ ₽── <u>∨</u> ₽─
O Combinations		▶
Bracing		
Bracing O Bracing properties		
Bracing O Bracing properties		
Combinations Bracing Bracing properties Sizes of braces sections		
Bracing O Bracing properties		
Bracing O Bracing properties		
Bracing O Bracing properties		1 1
Bracing O Bracing properties		



Project settings	:
O Standard	Consider only selected ones
Truss properties	Use complete assortment of timber depths
O Material	Manimum count of a towardia during iterations
O Thickness	Maximum count of automatic design iterations: 10
O Mounting	Ineffective timber edge: [mm]
O Suppliers	
Design options	- Timber depth limits:
O Splices	Top chords 120 260 ✓ ▲ Limit depths for top chords:
Members	Bottom chords 120 260 🗸 minimum depth: 120 [mm
O Nail plates	Edge verticals 100 260 D
Out of plane buckling	Vertical webs 80 260 – maximum depth: 260 [mn
O In plane buckling	Webs 80 260 - 🗸 keep the maximum cross-section depth
O Details	
O Structure	Assume minimum and maximum depths from timber assortment for automatic design?
roject settings	
Standard	Webs cutting mode
Truss properties	Bottom chord end
• O Material	Left bottom detail
O Thickness	Left upper detail
•••• O Mounting	Right upper detail
O Suppliers	Right bottom detail
Design options	Webs cutting mode for small angles
O Splices	
O Members	
•••• O Nail plates	
Out of plane buckling	
O In plane buckling	
• O Details	
O Structure	
O Limit values	
O Deflections	
Gable ladders	
O Advanced	
O Truss division	
O Supports	
Load generator	
O General	
O Imposed loads	
O Snow	
-	
Wind	
O Combinations	
∃ Bracing	Description : Intersection
O Bracing properties	
O Sizes of braces sections	
	Add Modify Remove
	Renove



Standard		ail plates in truss cuttings			
Truss properties	Cut non-structural men				
O Material	Hide nail plates located	-			
• O Thickness • O Mounting	Splices on top chords and an	-			
O Suppliers	Splices on bottom chor	-			
Design options	Always keep vertical dir Characteristic values in				
O Splices		metalwork database			
O Members	Modelling of web joints:				
O Nail plates	structural model acc. to DI	N EN 1995-1-1			
O Out of plane buckling	Modelling of support joints				
O In plane buckling					
O Details	Diagonal ends cutting mod				
 Structure 					
O Limit values	Editable position of webs in	joints			
O Deflections	Members end conditions:				
O Gable ladders	all joints in the structure ar	e analysed as semi-rigid joint	s		
O Advanced O Truss division	Offect of order warticals / off	ot in the invested direction.			
O Supports	Offset of edge verticals (off	sec in the inward direction)			0,0 [m
Load generator	Update topology during) automatic design			
O General	Attic height				2500,0 [m
ect settings					
-					_
Standard	 Check deflections 				
Truss properties	Limiting values of deflection	n between supports			
O Material	instantaneous, w _{inst.lim} :	span-dependent 💌	1/	300 [-]	
O Thickness		-F			
O Mounting O Suppliers	Final, w _{fin,lim} :	span-dependent 🔻	1/	200 [-]	
Design options	Limiting values of cantileve	deflection			
O Splices	Limiting values of cantileve				
O Members	instantaneous, w _{inst,lim} :	span-dependent 🔻	1/	150 [-]	
O Nail plates	Final, w _{fin,lim} :	span-dependent 💌	1/	100 [-]	
Out of plane buckling	, inclusion				
O In plane buckling	Limiting values of collar def	lection			
O Details	instantaneous, w _{inst lim} :	span-dependent 🔻	1/	300 [-]	
O Structure					
O Limit values	Final, w _{fin,lim} :	span-dependent 🔻	1/	200 [-]	
 Deflections 	Slip factor:			1,15 [-]	
O Gable ladders	Silp factor.				
O Advanced	Check local deflections				
O Truss division O Supports	Limiting values of local defl	ection in hav			
Load generator	Limiting values of local den	ection in Day			
O General	instantaneous, w _{inst,lim} :	span-dependent 🔹	1/	300 [-]	
O Imposed loads	Final, w _{fin,lim} :	span-dependent 💌	1/	200 [-]	
O Snow	f final, wfin,lim	span acpendent	"	200 [1]	
O Wind	Limiting values of local defl	ection on cantilever/overhan	g		
O Combinations	instantaneous, w _{inst.lim} :	span-dependent 💌	1/	150 [-]	
Bracing	inst, im	-bbenarit			
O Bracing properties	Final, w _{fin,lim} :	span-dependent 🔹	1/	100 [-]	
O Sizes of braces sections					
	Check deformations in	upward direction for overhan	gs		
	Check deflection of bra	cing trusses			
	Limiting values of deflection	-			
	cirining values of deflection				
	limiting deflection, w _{lim} :	span-dependent 🔻	1/	500 [-]	



Project settings	×
O Standard Truss properties O Material O Thickness O Mounting Suppliers Design options	 Use the old model of support in joint with one web Do not create static model (static model is identical to mounting scheme) Do not consider transport forces in the analysis Extend chords to wall plate at bottom detail. Analysis of superchords according to DIN Use the old method of embedment analysis Change compressive strength of timber for embedment analysis
O Splices	Compressive strength of timber for embedment analysis: [MPa]
Wail plates Out of plane buckling Out of plane buckling O In plane buckling O Details	Slenderness limits: Maximum slenderness ratio for members in compression: 400,0 Maximum slenderness ratio for members in tension: 400,0
O Details O Structure O Limit values O Deflections Gable ladders Advanced Truss division	

As the other settings are of minor importance or will be dealt with later, we can close the project settings dialog with "OK".

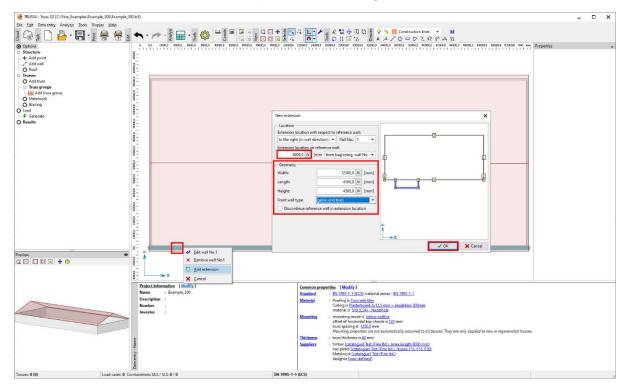


Project input

In a first step we will add an extension to the existing building in its lower left part – that's where the bakery shop is located. Then we will place the main trusses, the trusses in the building extension and the valley and finally we will add bracing frames at the appropriate locations.

Finalizing the building model

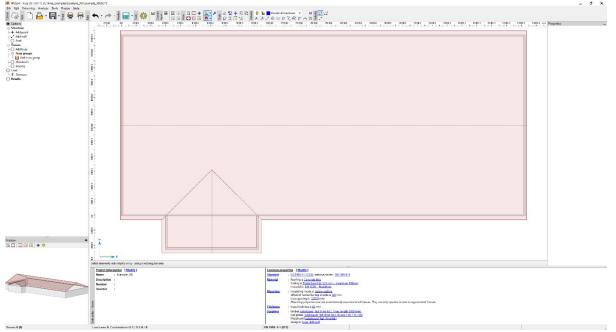
We add an extension to the lower left part of the building.



In the main window right mouse click on the lower horizontal wall and select "Add extension" from the context menu. Fill in the shown values (Extension location: 6000mm, Width: 12500mm, 4500mm and 4500mm) and select gable-end truss as Front wall type in the dialog.



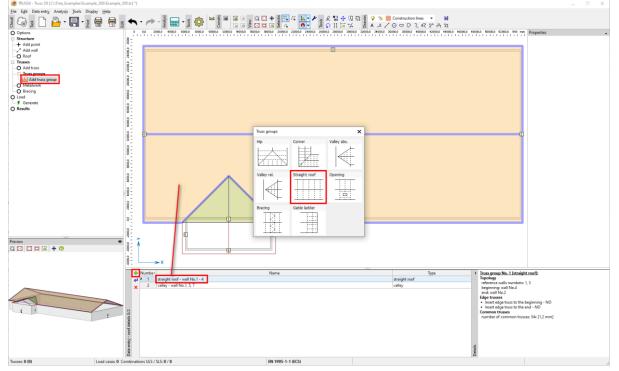
Adjust your view vie the icon 🖾 so the entire plan view of the building is well visible in the main window.



Adding the roof trusses

We will be using the truss group "straight roof" to create all trusses.

Click on "Add truss group" in the section "Trusses" of the options windows, then double click on "straight roof" (or on the purple bent arrow) in the selection window "Truss groups".

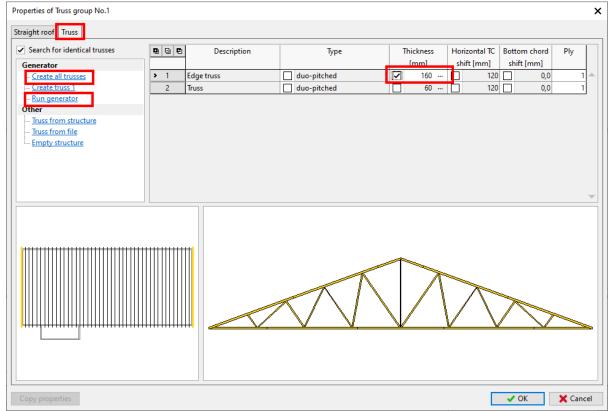


On the tab "Straight roof" of the appearing dialog make the shown selections and enter the shown values. Insert the edge trusses with a value of -70mm, which will place them with their edges aligned with the roof edges of the gable walls.



Properties of Truss group No.1	×
Straight roof Truss	
Edge trusses Insert edge truss to the beginning Truss offset from beginning: -70,0 [mm] The first truss and common trusses are identical. Insert edge truss to the end Truss offset from end: -70,0 [mm] The last truss and common trusses are identical. Edge trusses are identical	
Common trusses Location mode: spacing, edge dist. symmetrically Spacing: 1250,0 [mm] Number of trusses: 45; Edge distance: 1190,0 mm	©¢
Copy properties	V OK X Cancel

Switch to the tab "Truss" and create the trusses as shown and described.



For the edge truss change the timber thickness to 160mm as we will use the timber flatwise. Then "Create all trusses" and "Run generator" in order to adjust the webbing of the gable trusses. We want to have verticals only.

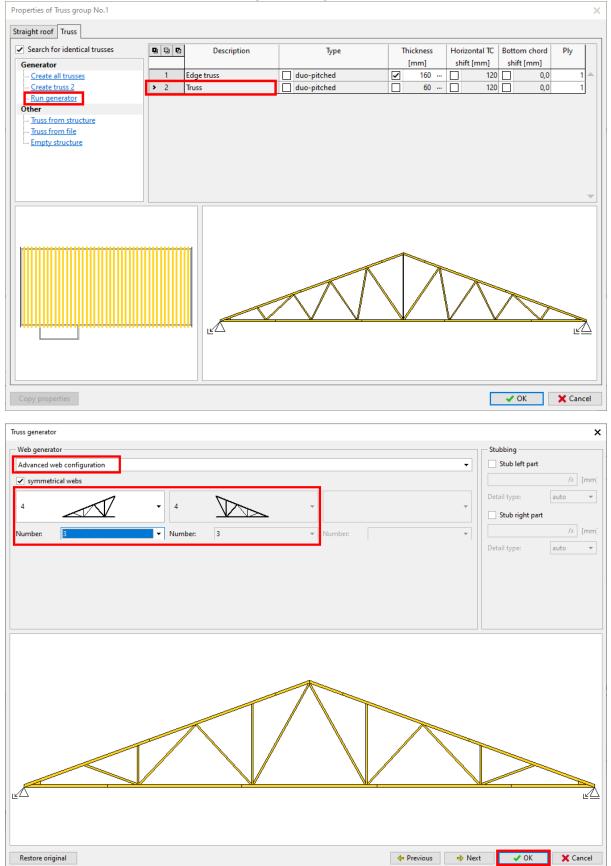


In the Web generator select "Average distance" and further use the settings and values shown in the picture.

Web generator Stubbing Average distance Stub left part Verticals	
Verticals	
Marinel assis	
Maximal spacing 1250,0 fx [mm] Detail type: auto	2 [mm]
Insert verticals:	
Stub nght part	_
— Diagonals —	: [mm]
Configuration: do not generate Detail type: auto	~
Beginning: top chord	
•	





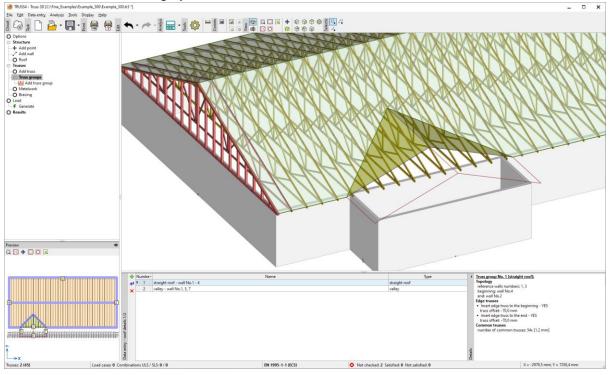


Select the "Advanced web configuration", type 4 webbing and 3 repetitions.

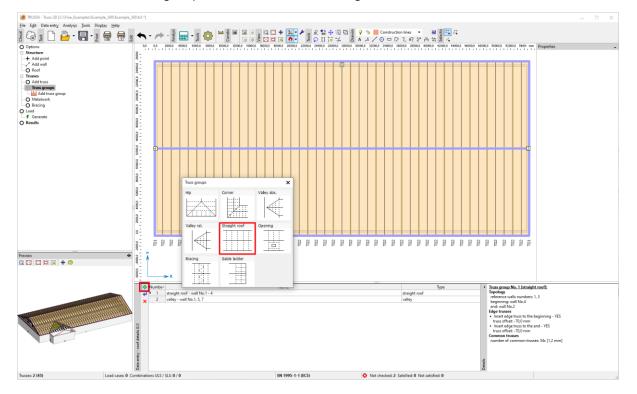


Close the dialog "Properties of Truss group No.1" with "OK".

Check the model thoroughly in 2D and 3D view.

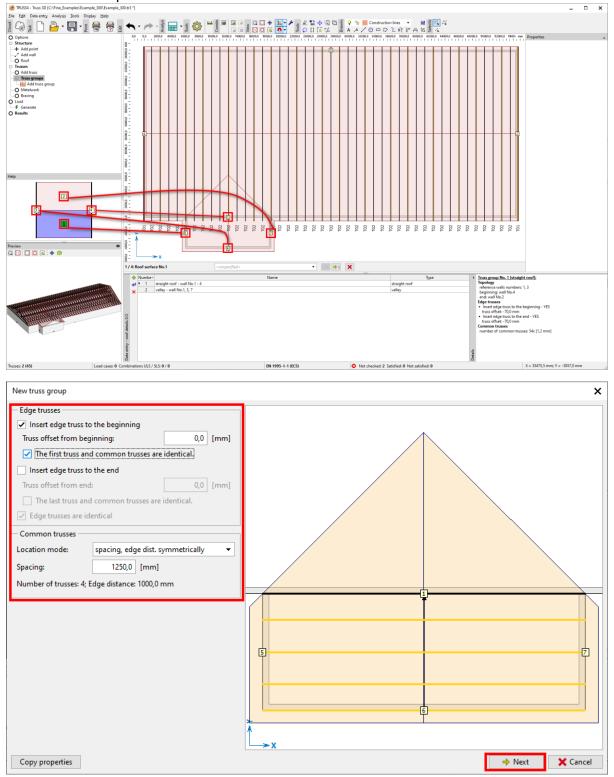


In the next step we will add the trusses at the extension. Click on the "+"-sign in the upper left corner of the truss groups table and select "Straight roof".



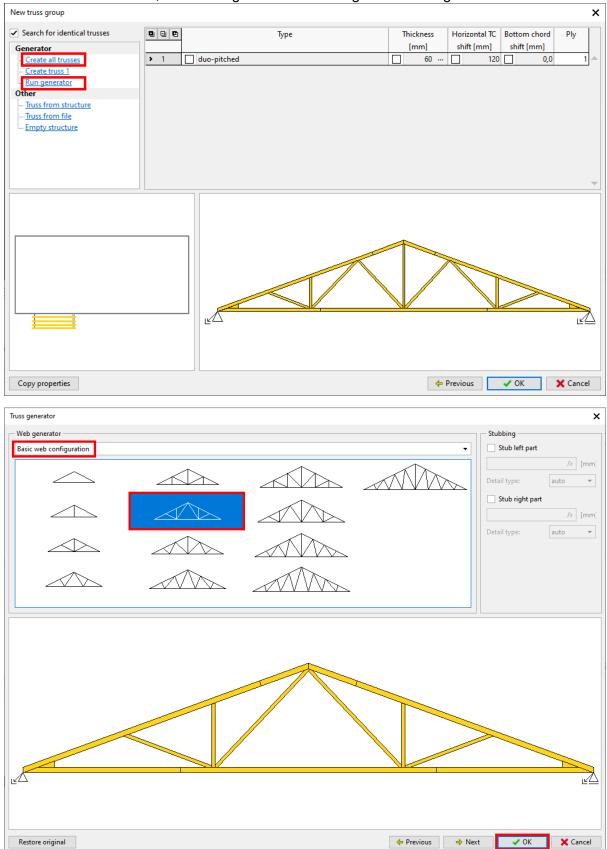


Click on the roof planes and walls in the shown order.



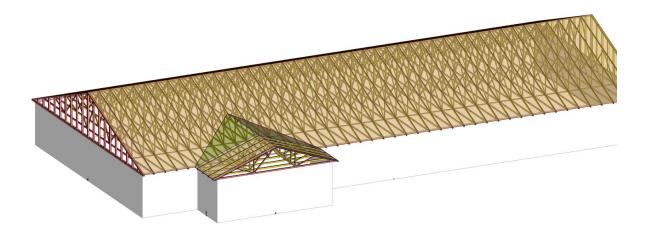


"Create all trusses" first, then "Run generator" to change the webbing.



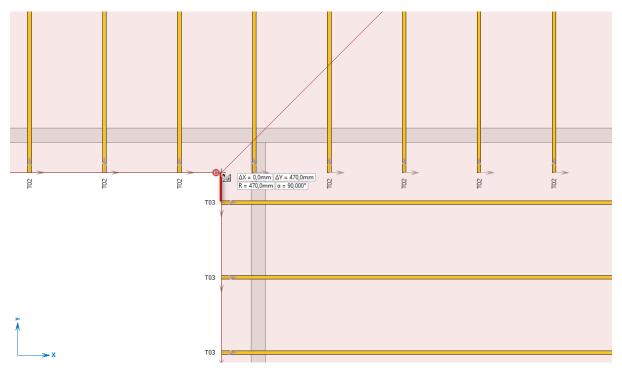
Close also the truss group dialog with "OK".





Trusses on the roof after the second truss group has been added.

We measure the distance between last truss of the extension and the main roof edge in order to get an equal spacing of the trusses on the extension and the valley trusses.



The measured distance between the roof edge and the upper side of the closest truss T03 is 470mm. This will lead to the position of the first valley truss at 1250 - 470 = 780 mm.



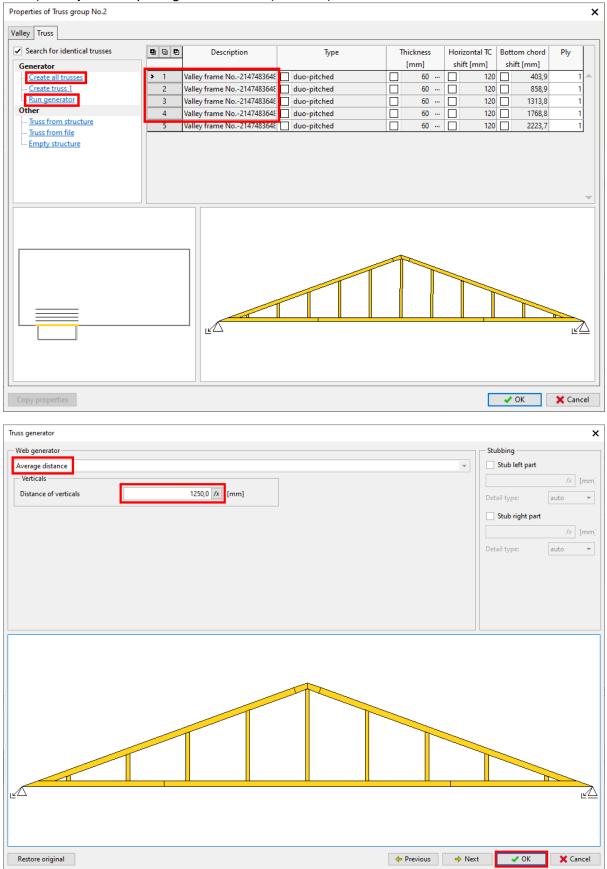
We finalize the roof trusses by filling the valley with a corresponding truss group. Select "valley" in line 2 from the table and click on the purple bent "Edit"-arrow

		Name	Туре
	1 straight roof - wall No.1 - 4		straight roof
	× 2 valley - wall No.1, 5, 7		valley
	3 straight roof - wall No.1, 5 - 7		straight roof
Data entry - roof details 0/3	Data entry - roof details 0/3		
	Properties of Truss group No.2		×
1	Valley Truss		
	Main valley truss Truss offset: 0,0 [mm] Number of plies: Bottom detail: Main valley truss is load-bearing. Common valley trusses Measuring mode: from main truss Layout mode: user-defined input ◆ 1 2 1250,0 ✓ Non-structural valley frames Do not reduce the depth of bottom chord		
	Copy properties		VOK X Cancel

Set values and tick boxes as shown above. "Non-structural valley frames" will provide us with trusses that have vertical webs only, though their spacing still must be adjusted in the generator. In order to change spacing within the truss group, click on the "+"-symbol and enter the spacing and count values (number of trusses) as given.

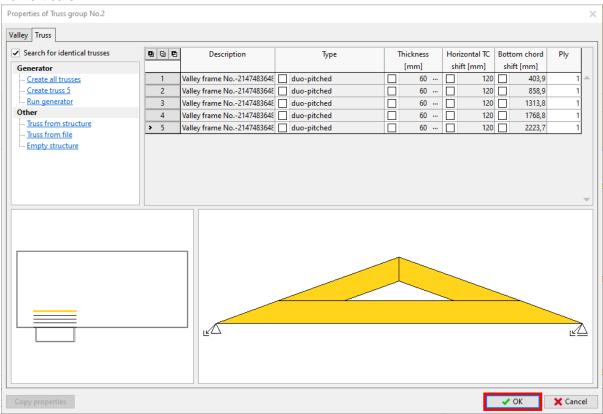


We create all trusses and then run the generator for the first four valley frames (one after the other) to adjust the spacing for the studs (verticals) at 1250mm.

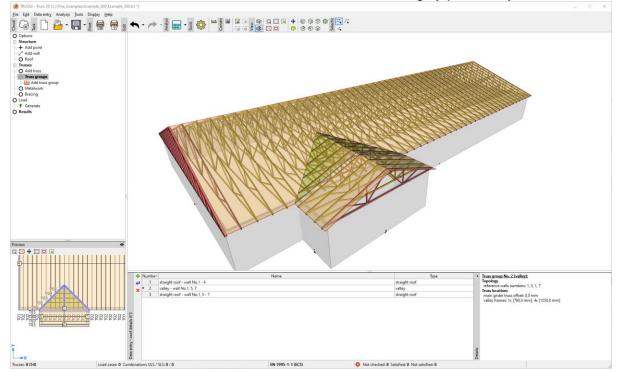




There is no need to perform any changes for the smallest of the valley trusses as it contains no verticals.



All roof trusses have been created, we check the model thoroughly plausibility and collisions.



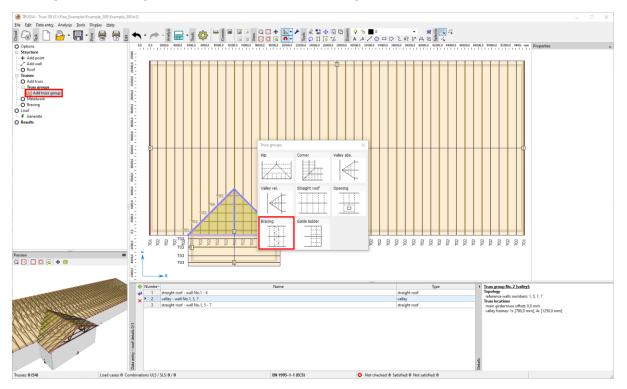


Adding the bracing frames

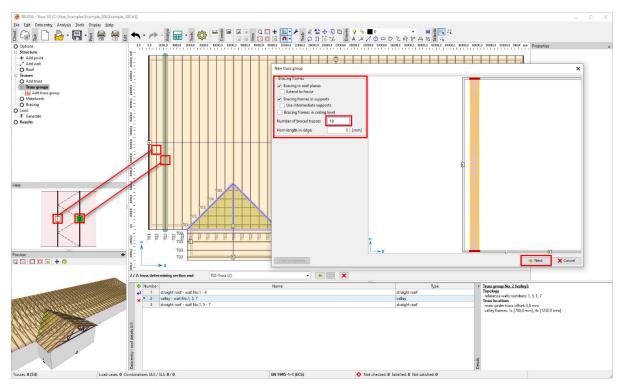
Generally, one can assume that one bracing frame is capable of supporting 10-12 main trusses, depending on the size of the compressive force in the top chord and the type of lateral bracing.

In our case we have 43 main roof trusses (truss T02), which leads to an estimated requirement of 5 bracing elements in the top chord planes on each side of the roof. (The outer bracing frames need to be placed close to the end walls, so we actually need one more than 43/10 = 4). Vertical frames at the eaves ensure that the resulting horizontal forces are transferred into the walls.

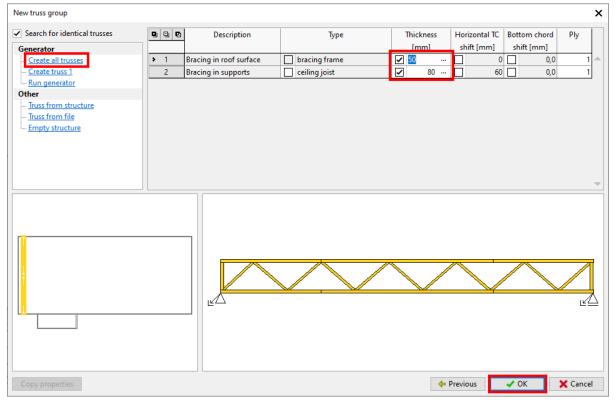
Go to "truss groups" in the options window, click on bracing in the Truss groups selection dialog, then click on the two trusses between which the top chord bracing and the vertical frames shall be placed. Enter "10" for the number of braced main trusses. We want to make all the bracing frames identical and the inner bracing frames have to carry the lateral load from 10 connected trusses. The entered value is directly connects with the load acting on the bracing frames (a higher number means a safer design).





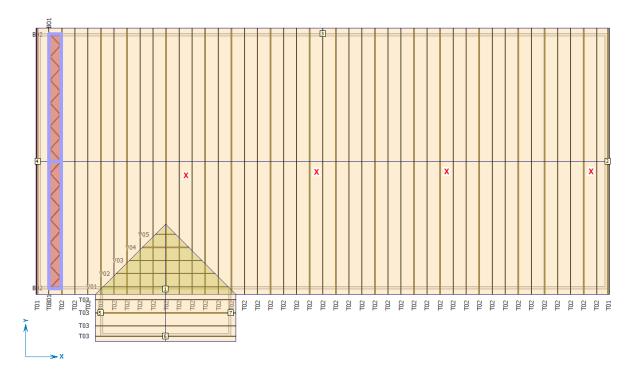


Change the timber thickness to 50mm and 80mm, respectively, create all trusses, confirm with "OK".

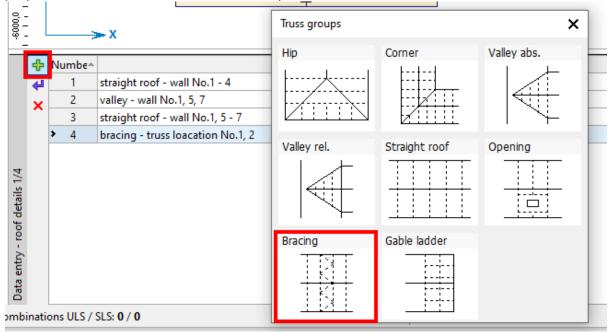


In the same manner we will place the other top chord bracing frames in the positions marked with "X".





We can save ourselves some work by copying the properties of the previously entered and created bracing truss group. Add a new bracing truss group, then click on the "Copy properties" button in the lower left corner of the dialog and select the group whose properties you want to copy. This not only uses the settings from this dialog page, but also all truss properties, such as timber thickness, web patterns etc.

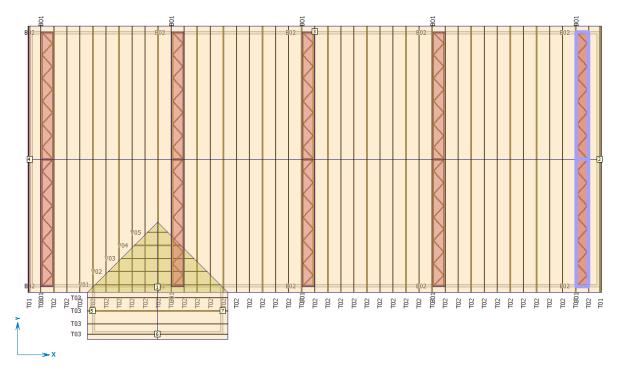




New truss group		×
Bracing frames		3
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Use intermediate supports		
Bracing frames in ceiling level		
Number of braced trusses 0		
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	>	
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Copy properties	⇒ Next	🗙 Cancel
bracing - truss loacation No.1, 2		

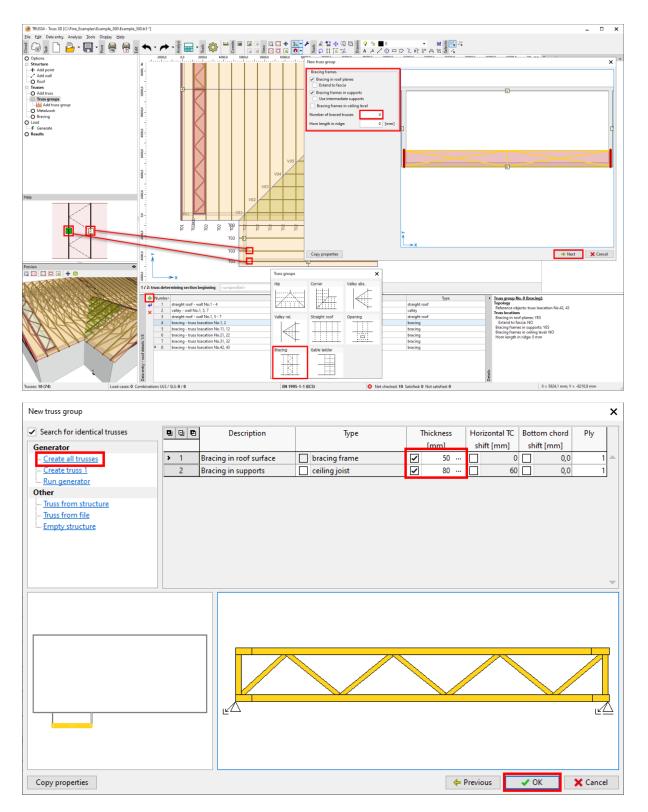
Close the second part of the dialog with "OK".

Repeat these steps three more times.

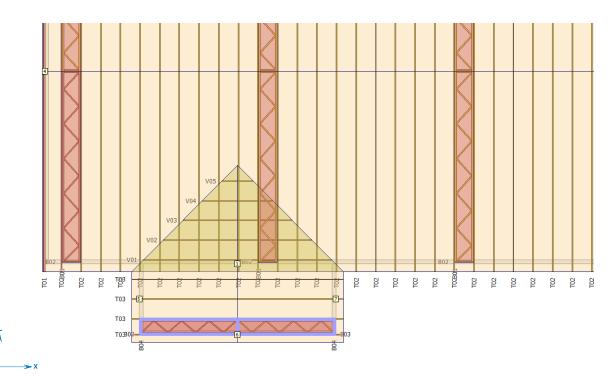


Also, the trusses above the building extension need to be braced in the same way, the number of trusses to be braced is equal to four.





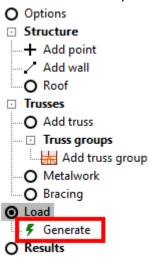




And with that we have placed all trusses and bracing fames on the roof. An actual threedimensional bracing requires additional elements, e.g. steel straps running diagonally between adjacent top chord bracing frames and the apex and the heels.

Loading

We add loads to the main trusses by using the load generator. Click on "Load" and "Generate" in the options window.





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MARTIN	5 bracing - truss loacation No.11, 1	2	bracing	Bracing frames in supports: YES
	و 6 bracing - truss loacation No.21, 2		bracing	Bracing frames in ceiling level: NO Horn length in ridge: 0 mm
	7 bracing - truss loacation No.31, 3		bracing	
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The loads for the main roof trusses have been created, the loads for the bracing frames and beams will be calculated on the basis of the internal forces of the corresponding roof trusses. Check all load cases thoroughly.

Results - Analysis

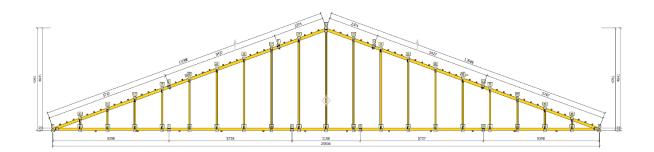
First have a look at the valley trusses shown in table window. Unlike the other trusses they don't have a tick in the "Check" column. This is due to our previous selection of non-structural valley frames, which means that they will not be analysed.

Number	Description		Che	ck			Thickness		Ply	K _{sys}	Transfer of load from		
					ULS	SLS		[mm]			[-]	Width [mm]	Tran
3	B03	~	not verified				~	50		1	1,00	1000,0	do not transfer
4	B04	~	not verified				~	80		1	1,00	1000,0	do not transfer
5	T01	~	not verified	⚠			~	160		1	1,00	1250,0	full load transfe
6	T02	~	not verified	⚠				60		1	1,00	1250,0	full load transfe
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9	V02		-					60		1			
10	V03		-					60		1			
11	V04		-					60		1			
12	V05		-					60		1			
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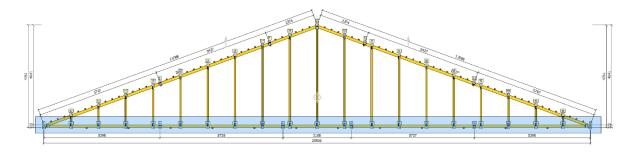
First have a look at the trusses that we want to have analysed and designed.

Truss T01 (gable truss on main roof): you may realize that no supports have been created because the generator is not able to determine those for a truss placed totally on a wall.

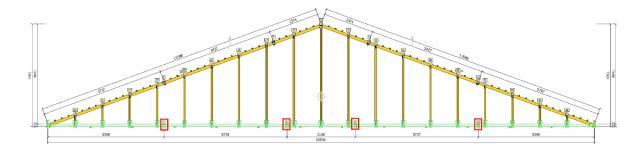




The supports can be added manually via the function "Support for selected joints". Move your mouse to the left end of the truss, hold down the left mouse key and drag your mouse as shown to create a rectangle which encloses all joints along the bottom chord.



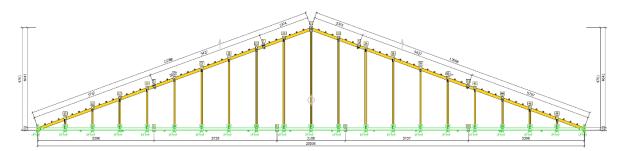
Now hold down the <CTRL>key and click on the four splice joints ([4], [6], [8] and [10]) to deselect them. Eventually repeat this for any selected (highlighted) joints on the top chord. Right mouse click on any of the highlighted bottom chord joints and select "Support for the selected joints (21)" from the context menu and use the shown settings in the appearing dialog.





	Support for selected joints (21)
	- Support
	Free Displacement along axis V: fixed Displ. Y Z: X: fixed Hinge Rotation round axis: X: fixed Fixed Support rotation: Displ. Z X: 0,000 °
	Special V out of plane buckling prevented
X <u>R</u> emove joint	Wall plate
% <u>C</u> onvert to absolute	Support type:
✓ Move joint	theoretical support 🔹
🕂 Merge joint	- Properties
Support for selected joints (21)	Support width: [mm]
🖲 E <u>d</u> it nail plate	Centre distance from joint: [mm] Additional member position [-]
✓ <u>A</u> utomatic design	Respect in structural layout
* Rem <u>o</u> ve nail plate	Don't check compression parallel to the grain
🗙 Ca <u>n</u> cel	V OK

Close the dialog with "OK".



The gable truss now has a theoretical support under each vertical stud. We still need to cater for any horizontal forces by right mouse clicking on the left most joint [1], selecting "Edit joint" from the context menu and check the Y:-box in the "Support" dialog.

Edit detail Number 1		×
Topology Code Support	Wall plate Bottom detail Joint edit	
Free Displace Y: V Displ. Y Z: V		
Fixed Support	t rotation:	
Linear st	or displacement of plane buckling prevented	
 Apply to symmetrical ob 	ject 3	✓ OK X Cancel



Now we can let the program design the trusses by hitting <CTRL+F8> or clicking the icon

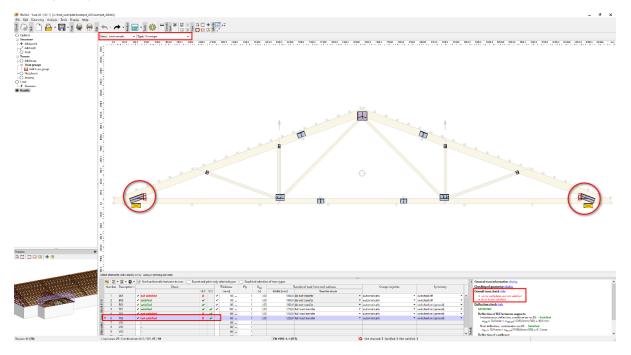
Number	Description	Check				Thickness			Ply	K _{sys}	Transfer of load from roof surface		
				ULS	SLS		[mm]			[-]	Width [mm]	Transfer mode	
1	B01	1	not satisfied	X		~	50		1	1,00	1000,0	do not transfer	
2	B03	1	satisfied	~		~	50		1	1,00	1000,0	do not transfer	
3	R01	1	satisfied	-		~	80		1	1,00	1000,0	do not transfer	
≻ 4	T01	~	satisfied	-	1	~	160		1	1,00	1250,0	full load transfer	
5	T02	~	not satisfied	X	-		60		1	1,00	1250,0	full load transfer	
6	T03	1	not satisfied	X	-		60		1	1,00	1250,0	full load transfer	
7	V01		-				60		1				
8	V02		-				60		1				
9	V03		-				60		1				
10	1/04						CO		4				

We will need to look closer at the results for trusses B01, T02 and T03, as they don't match all design criteria, exclusively in ULS (ultimate limit state) checks.

We start with truss T03 and for that we look right of the results table at the "Overall truss check". In case it should not show any information, click on the hyperlink "display.



Here we immediately see that some nail plates are not satisfied and therefore can directly display the joints results:



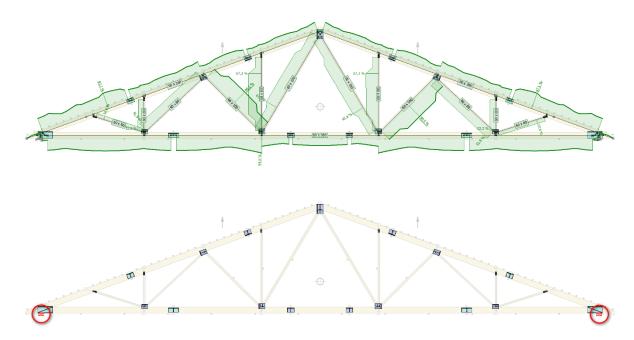
Apparently, the auxiliary plates at the heel joints don't' have a sufficient bite into the chords. Due to the fact that the timber cross sections of the chords are big enough to place the wedge and the main plate above the support, we can omit the usage of an auxiliary plate.



Edit detail Number 1					×
Topology Code S	Support Wall plate B	ottom detail	edit		
O Default	Vertically	○ Horizontally			
O Perpendicularly	\sim O Intersection	O Parallelly			
Bottom chord end:			extend to top chord		▼
Heel height measu	ring direction:		vertically (parallel to axis Z)		•
Heel height:	120,0 [mm]	Overhang type:	without overhang 🔹	✓ Automatic wedge design	
✓ Edge cut:	0,0 [mm]	In direction of:	~	only main nail plate 🔻	
		Overhang length	[mm]	✓ Wedge Length: 250,0 [mm]	
Apply to symme	trical object 3				VOK X Cancel

Right mouse click on the left heel joint, select "Edit joint" from the context menu, switch to tab "Bottom detail" and select "only main plate" from the drop down list below "Automatic wedge design". Close the dialog with "OK" and re-analyse the truss by hitting <F8>. The truss is successfully designed.

Then we look at truss T02, we check the members result where everything is ok, then we check the joint results and see the truss is overstressed at the two supports.

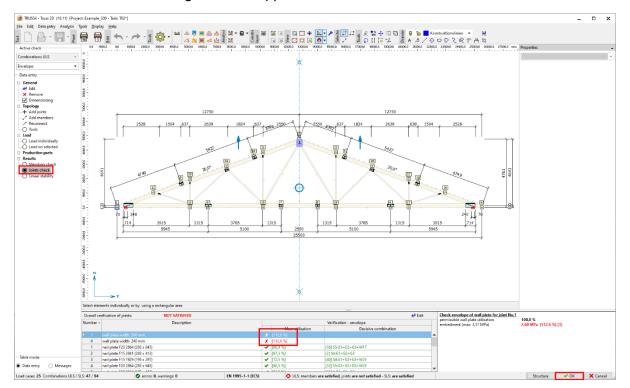


Double click on truss T02 in the results table, so Truss2D gets launched with this truss opened. Alternatively select T02 in the results table and then click on the Truss2D icon in the upper left corner above the table.



ſ	🕙 🔊 -	- 🔛 - 🗐 -	-	Use load transfer between trusses 📃 Expor	t and p	orint o	nly s	elected type	es
	Number	Description		Check			Thickness		
					ULS	SLS	[mm]		
	1	B01	~	not satisfied	X		~	50	
9	2	B03	~	satisfied	-		~	50	
truss check 11/0	3	R01	~	satisfied	-		~	80	
hec	4	T01	~	satisfied	-	-	~	160	
ss cl	> 5	T02	~	not satisfied	X	-		60	
tru:	6	тоз	~	satisfied	-	-		60	
-Y	7	V01		-				60	
Data entry -	8	V02						60	
ata	9	V03		-				60	
	10	104						CO	

In the options window on the left select "Joints check" and look at the results in the table below the truss window. Joints 1 and 3 (heel joints) show an overstress of 112,6%, which means that the current length of the support at 240mm is not sufficient.



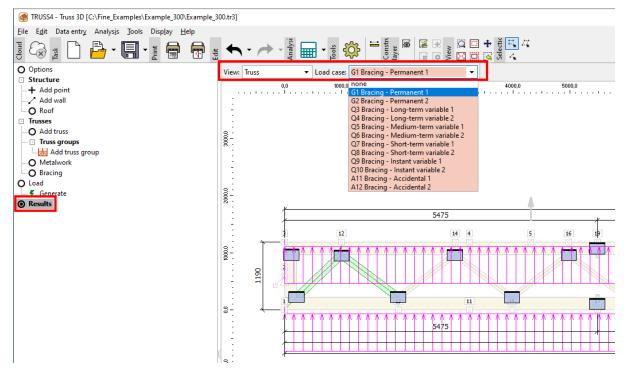
Close the Truss2D by clicking on "OK" in the lower right corner of the program. Back in Truss3D right mouse click on joint 1 (left heel), select "Edit joint" from the context menu and on the "Wall plate" tab change the "Support width" to 280mm.



Edit detail Number 1		×
Topology Code Support Wall plate Bottom	etail Joint edit	
Support type:		
wall	•	
- Properties		
Support width:	280 [mm]	
Distance from joint: 5	0,0 [mm]	
Additional member position	,00 [-]	
 Respect in structural layout 		
Don't check compression parallel to the grain		
 Apply to symmetrical object 3 		V OK X Cancel

If "Apply to symmetrical object 3" in the lower left corner was ticked, the change should have been applied to the right heel joint, too. Hit <F8> and observe that the truss is now successfully designed. The increase of the support is usually done by using a steel plate of the required length.

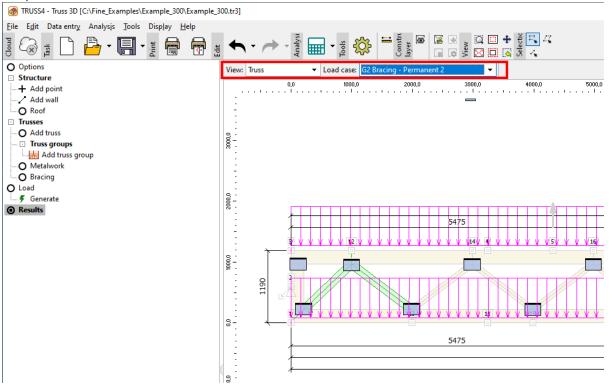
We move on to design the bracing frame B01. Before we look at the existing design results we have an eye on the loads and the design criteria of bracing frames.



A bracing frame has significantly different load cases from standard trusses. The loads and in alternating directions on the chords, being a result from axial forces in the trusses that are braced and are related to the load duration classes (permanent, long-term, medium-term)







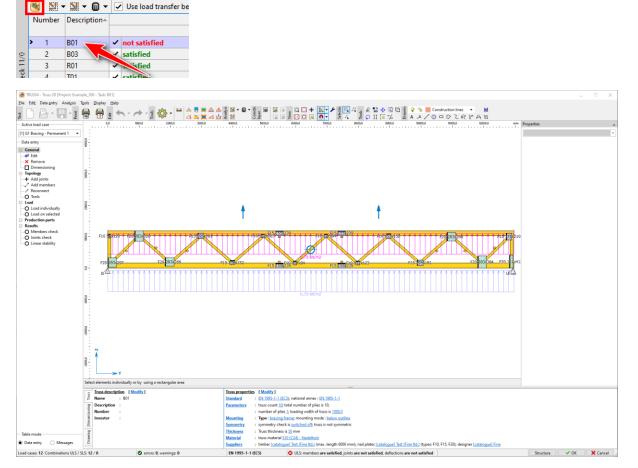
The load values are calculated on the basis of equation (9.37) EN 1995-1-1:2010-12, considering the number of trusses to be braced, the average compressive force in the braced truss member and the length of the bracing itself. These calculated loads only consider the imperfections (bows) of the truss chords, not loads deriving from inclination of the trusses or from external wind loads, e.g. wind on gable.

From the look at the results overview we see that some nail plates are not satisfied and also the deflection check is not fulfilled. As we are using the entire scope of all nail plates in the database, the design becomes a lengthy process. For this reason, it is recommended to use only one type of nail plate, here the F15 (15mm gauge).

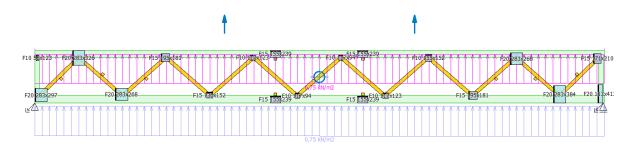
3	2	🎽 🗕 🗕 🗕	-	Use load transfer b	etwee	n trus	ses	Export and	Export and print only selected types Graphical selection of truss types						<u>General truss information display</u>		
Nu	mber	Description *		Check			1	Thickness	Ply	K _{sys}	Tran	sfer of load from roof surfaces		Compr. in joints	Symmetry		Checking of geometry display
					ULS	SLS		[mm]		-i	Width [mm]	Transfer mode					Overall truss check hide
>	1	B01	~	not satisfied	×		~	50	1	1,00	1000,0	do not transfer	•	automatically 🔻	switched off		 some nail plates are not satisfied
	2	B02	~	not satisfied	×		1	80	1	1,00	1000,0	do not transfer	•	automatically 🔻	switched off		 deflection check is not satisfied
	3	B03	1	satisfied			~	50	1	1,00	1000,0	do not transfer	•	automatically 🔻	switched off		 truss is not satisfied
	4	B04	~	satisfied			1	80	1	1,00	1000,0	do not transfer	•	automatically 🔻	switched off	•	Deflection check hide
	5	T01	~	satisfied		1	1	160	1	1,00	1250,0	full load transfer	•	automatically 🔻	switched on (gene		NOT SATISFIED
	6	T02	1	satisfied		1		60	1	1,00	1250,0	full load transfer	•	automatically 🔻	switched on (gene		Deflection of B/C between supports:
	7	T03	~	satisfied		1		60	1	1,00	1250,0	full load transfer	•	automatically 🔻	switched on (gene		ULS, combination no.8: - Not satisfied w = 34,9 mm ≥ w _{Em} (12940,4mm/500) = 25,9 mm
	8	V01		-				60	1								w = 34,9 mm 2 w _{im} (12940,4mm) 500) = 23,9 mm
	9	V02		-				60	1								
	10	V03		-				60	1							▲ sile	
		4													•	10	

The end verticals of the bracing beam will have to provide enough width for connection with the vertical frame B02, so we increase their width to 220mm. The chords contribute to reducing the deflection of the frame, so we also increase them to 220mm. These changes can be done in an easy way in Truss2D. Double click on truss B01 in the results table or click on the icon Truss2D in order to launch that program.





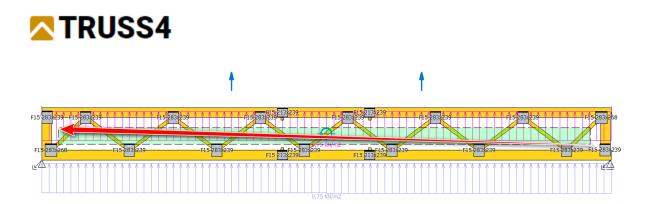
Click left on both end verticals and chords to select them.



On the right-hand side in the Properties window untick the check box "Depth from data" and enter a value of 220 for "Member depth".

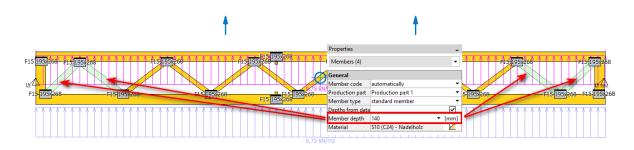
Properties _							
Members (4) 💌							
General							
Member code							
Production part	Production part 1	-					
Member type	standard member	-					
Depths from data	1						
Member depth	220	[mm]					
Material	S10 (C24) - Nadelholz	4					

All selected members now have a depth of 220mm. Unselect those members by hitting <ESC>, then open a rectangle from right to left which touches the webs only.



Change the depth of all webs to 100mm. Then select the two left and right most diagonals only and set their depth to 140mm.

Properties _						
Members (13) 🔻						
General						
Member code	automatically	-				
Production part	Production part 1	-				
Member type	standard member	-				
Depths from data						
Member depth	100	[mm]				
Material	S10 (C24) - Nadelholz	<u>k</u>				

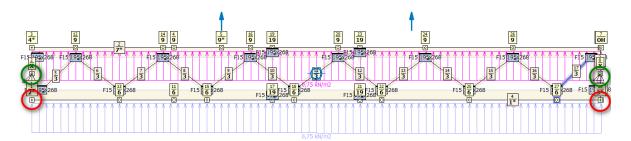


Select the entire truss by hitting the key combination <Ctrl+A>. Below properties select "Connections" from the drop-down list. Untick "Automatic design" and select "F1,50" under "Type". Set all nail plates to size 195x268 and the orientation (rotation of all plates) to 0°.

	Properties	-	Properties				
	Connections (20)	-	Connections (20)				
	General		General				
Properties _	Production part	Production part 1	Production part	Production part 1 🔹			
Members (17)	Connection parame	eters	Connection parame	eters			
Members (17)	Connection type:	nail plate 🔹	Connection type:	nail plate 🔻			
Joints (27)	Automatic design		Automatic design				
Connections (20)	Material	common material (zinc coated 🔻	Material	common material (zinc coated) 🔻			
Production part Production part 1	Туре	F15 1.50 -	Туре	F15 1.50 👻			
Member type standard member	Dimensions	E10 1 00	Dimensions	F15 1926 (195 x 268) 🗸			
Depths from data	Rotation	F15 1,50	Rotation	0,000 [°]			
Member depth [mm]	Position Y	F20 2,00	Position Y	[mm]			
Material S10 (C24) - Nadelholz 🖌	Position Z	[mm]	Position Z	[mm]			

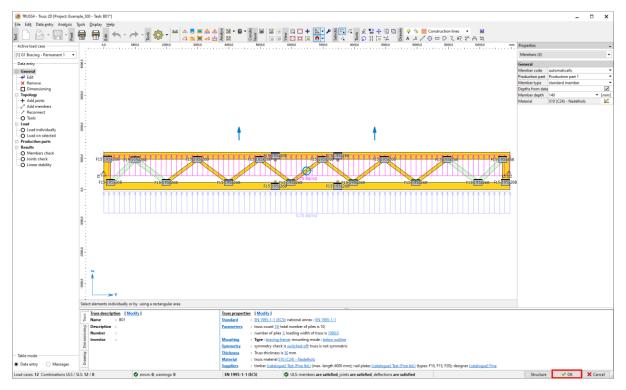
Finally change the current supports location from the heel joints in the lower edges to the existing mid-joints at the end verticals. This is a more realistic modelling of the truss, as in fact it will be connected to B02 all along these members.





Right mouse click on joints 1 and 10 and change the "Support" from "hinge" and "Displ.Y" to free and set joints 2 and 8 to "hinge" and "Displ.Y".

Click on "OK" in the lower right part of the program window to close Truss2D and return to Truss3D.



Analyse the truss by hitting <F8>, it should satisfy all requirements now.

General truss information display Checking of geometry display Overall truss check hide • truss is satisfied Deflection check hide SATISFIED Deflection of B/C between supports: ULS, combination no.8: - Satisfied w = 22,9 mm ≤ w_{lim}(12724,0mm/500) = 25,4 mm

Divergent from roof trusses the deflection check for bracing frames is carried out by using ULS load cases. The deflection here is limited to 1/500 of the distance between supports and must strictly be fulfilled, otherwise the bow of the top chord of the main trusses would



exceed the limits for which formula (9.37) is still valid, resulting in higher loads acting on the bracing frame.

Further steps to finalize this project would be creating documentation and files for driving saws, presses etc. As this is not part of this example, we are done with it and can save the project.

For more engineering manuals visit https://www.finesoftware.eu/.