

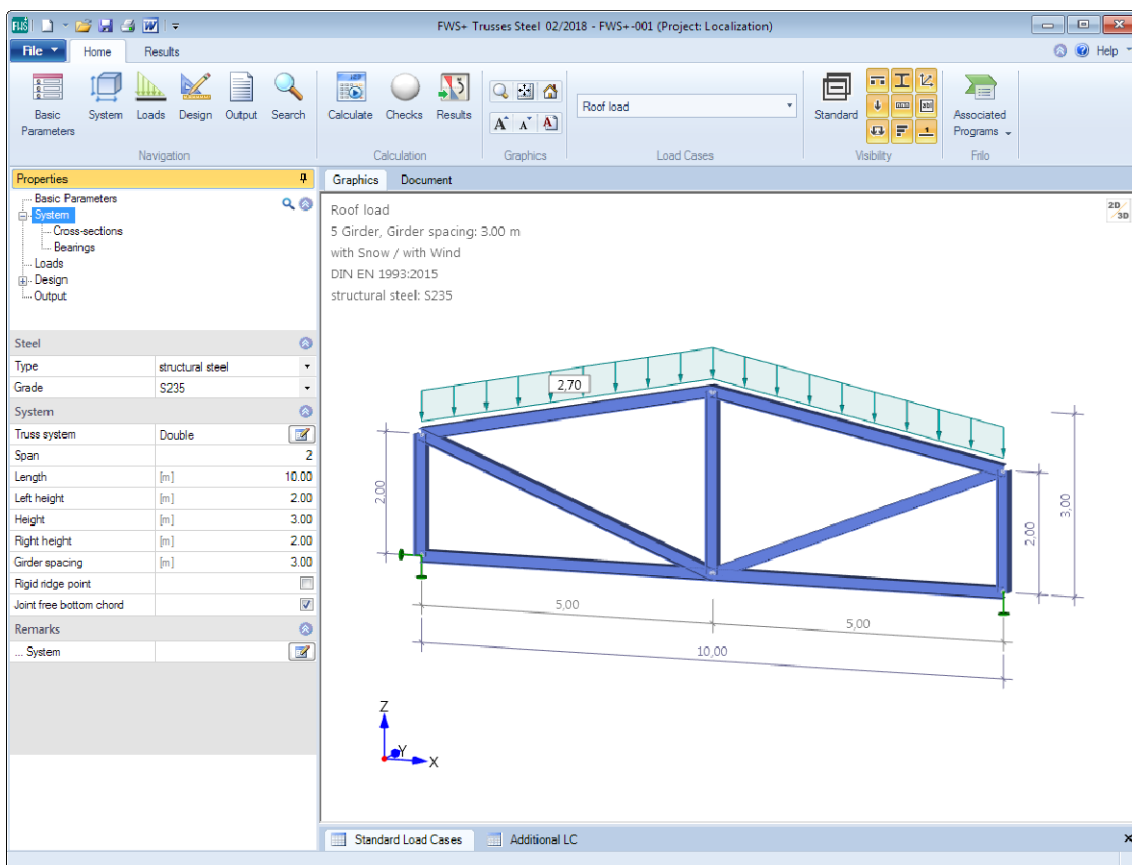
Steel Truss FWS+

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Steel Truss FWS+

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Further information and descriptions are available in the relevant documentations:

Wind & Snow Loads-PLUS	Separate description of the wind and snow loads dialog that is part of various applications.
Basic Operating Instructions - PLUS	General instructions for the manipulation of the user interface of PLUS applications
FCC	Frilo.Control.Center - the easy-to-use administration module for projects and items
FDD	Frilo.Document.Designer - document management based on PDF
FSO	FRILO.Software.Organization: Installation, configuration, network, database
Output and Printing FDC	
Import and Export	

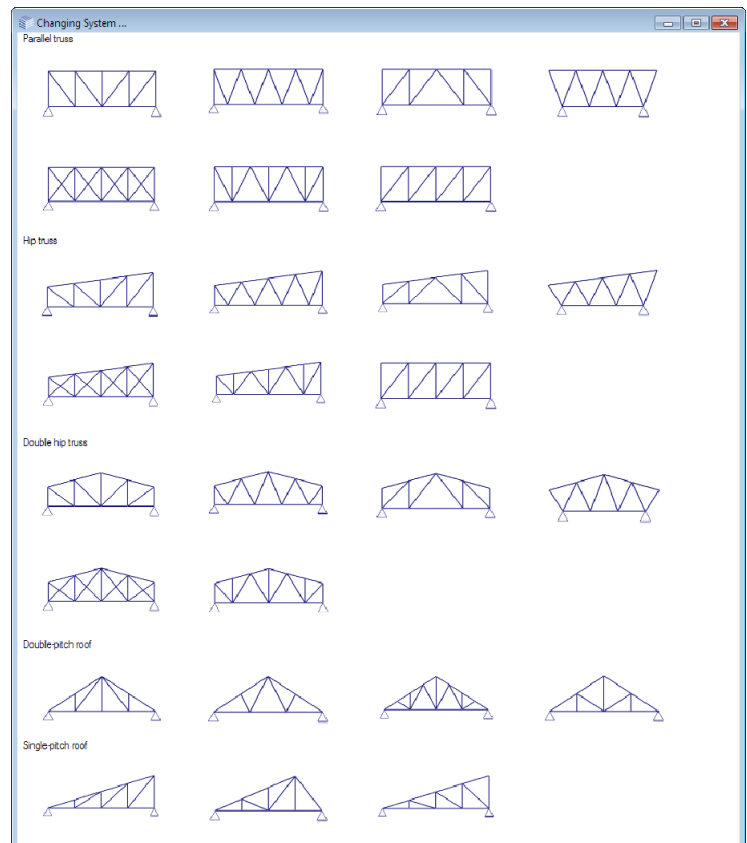
Application options

The software is suitable for the structural calculation and design of steel trusses typical in the construction of portal frames:

- Parallel trusses
- Hip trusses
- Double-hip trusses
- Double-pitch roof trusses
- Single-pitch roof trusses

Continuous chords can be considered as flexurally rigid members.

Member loads due to wind and snow are generated by the software.



Available standards

The FWS+ application performs structural safety analyses in accordance with EN 1993-1-1 and takes the corresponding National Annexes into account.

- DIN EN 1993-1-1/NA
- ÖNORM B 1993-1-1
- BS EN 1993

Snow and wind loads are based on the standards EN 1991-1-3 and EN 1991-1-4 and their National Annexes.

- DIN EN 1991-1-3/NA; DIN EN 1991-1-4/NA
- ÖNORM B 1991-1-3; ÖNORM B 1991-1-4

Calculation / Verifications

The internal forces are determined with the help of the elastic frame method. The load combinations decisive for the design are calculated in a first-order analysis.

All necessary combinations of actions are automatically considered in accordance with the safety concept set forth in DIN EN 1990.

The verification of the cross-sectional resistance is based on the internal plastic limit forces. You can optionally select the theory of elasticity as verification method.

The component verifications (stability verifications) of the truss members are performed by the software. You can define lateral supports at the top and bottom chord perpendicular to the truss plane as well as at the vertical edge members, if any.

The software calculates the deformation of the structural system as well as the relative deformation of the individual components in the serviceability limit state in accordance with the selected design situation.

The support reactions are put out with the characteristic loads for each load case.

Load transfer

You can transfer loads to the following software applications

STS+	Steel Column
HO1+	Timber Column
B5	Reinforced Concrete Column
ST4	Steel Girder Support
B9	Reinforced Concrete Corbel

Interface to BTII+ for advanced stability verifications

If you hold a licence for BTII+ (Lateral Torsional Buckling Analysis), you can transfer the top chord, the bottom chord and the vertical edge members, if any, to BTII+. This software application provides for the calculation of more complex systems.

Basic parameters

Standard and safety concept

Select the desired standard.

Available standards - see [Application options](#).

Snow accidental/load factor snow:

Check this option if the snow loads shall be included automatically not only in the typical design situations but also as an accidental action. You can either specify a load factor for the accidental snow loads or have it determined automatically by the software (select the corresponding checkbox).

ψ_2 :

Check this option to increase the value of the combination coefficient ψ_2 to 0.5 for snow action in the seismic design situation.

(See introductory decree of the federal states, e.g. Baden-Württemberg)

Wind zone 3 or 4:

Check this option if the building is situated in wind zone 3 or 4. In this case, you need not consider snow as an accompanying action with wind being the leading action.

Same γ_G for permanent loads:

Check this option if all permanent loads or load cases shall be included with the same partial safety factor ($\gamma_{G,sup}$ or $\gamma_{G,inf}$). Otherwise, all permanent loads or load cases are combined with each other with $\gamma_{G,sup}$ and $\gamma_{G,inf}$.

Structural safety

Cross-section design optional selection whether the elastic model as per equation 6.1 or on the plastic model as per equation 6.2. should be used.

Equivalent member verification in accordance with 6.3.3 (annex A or B) or with 6.3.4.

Serviceability

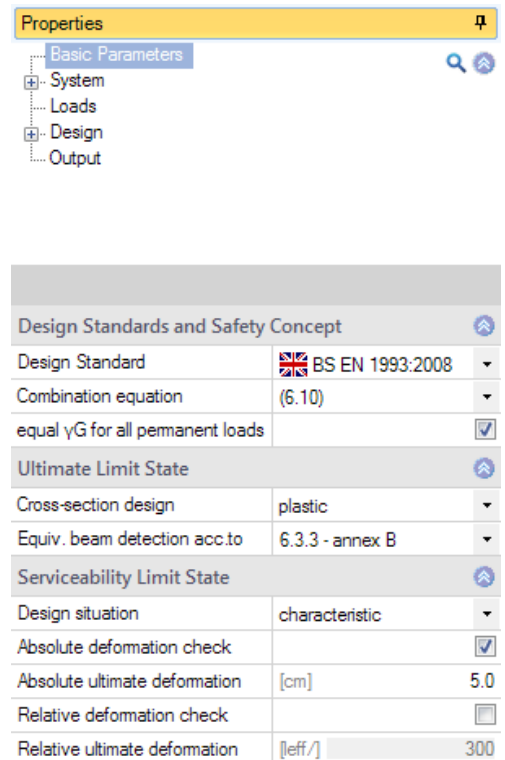
Design situation select the design situation the verifications in the serviceability limit state should be based on (characteristic, frequent and quasi-permanent).


Verification absolute deformation select this option to perform the serviceability verification with consideration of the deformation difference in relation to the undeformed system.

Absolute limit deformation defines the permitted maximum absolute deformation of the structural system.

Verification relative deformation select this option to perform the serviceability verification based on the effective lengths, which are determined by the turning points (moment passage) of the bending line.

Relative limit deformation defines the permitted maximum relative deformation of the structural system.




Design Standards and Safety Concept		
Design Standard	 BS EN 1993:2008	▼
Combination equation	(6.10)	▼
equal γ_G for all permanent loads		<input checked="" type="checkbox"/>
Ultimate Limit State		
Cross-section design	plastic	▼
Equiv. beam deflection acc.to	6.3.3 - annex B	▼
Serviceability Limit State		
Design situation	characteristic	▼
Absolute deformation check		<input checked="" type="checkbox"/>
Absolute ultimate deformation	[cm]	5.0
Relative deformation check		<input type="checkbox"/>
Relative ultimate deformation	[$l_{eff}/$]	300

Structural system

Steel material

Selection of the steel type and steel grade.

Type of truss

Click on the button  to select the truss shape and type.

See also: graphical representation of the types of trusses in the chapter [Application options](#).

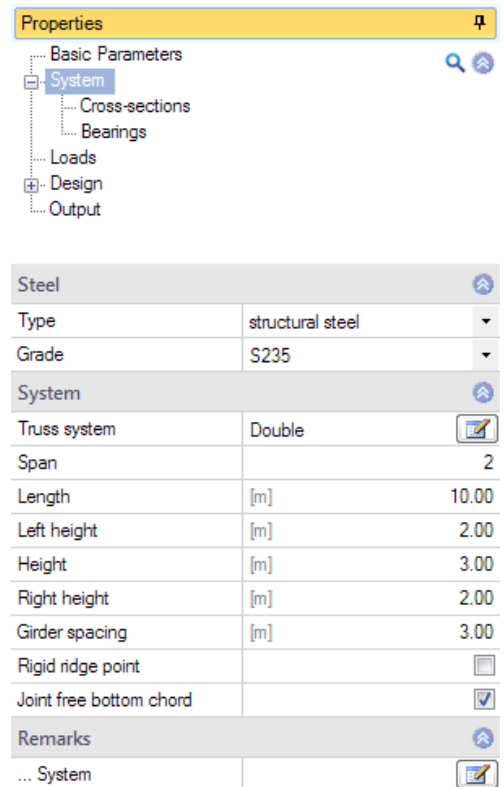
Depending on the selected type of truss, the associated system dimensions are displayed for selection (number of spans, height, length etc.) - additional information is available via the respective tooltips.

Flexurally rigid ridge point



Check this option to define a ridge point that is resistant to deflection.

Bottom chord free from hinges


Specifies whether the hinge definitions also apply to the bottom chord.



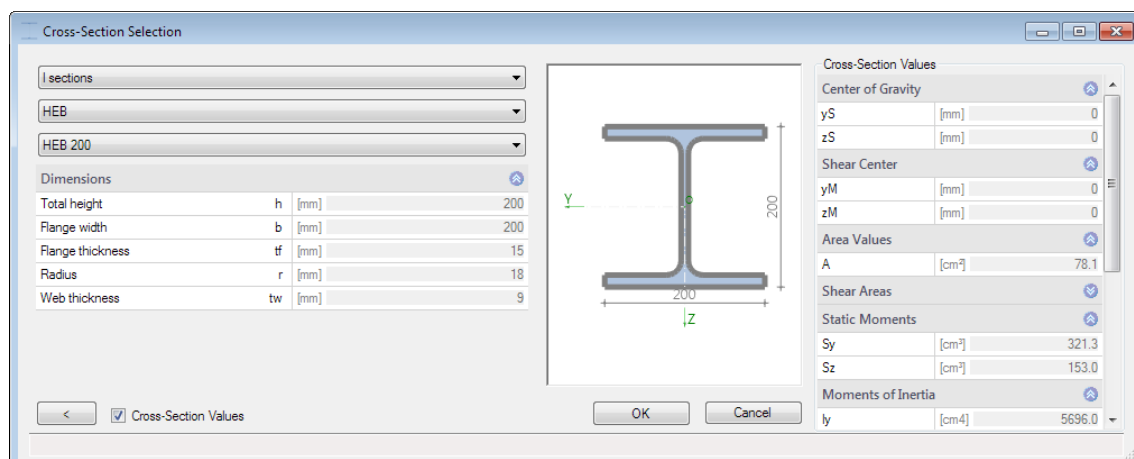
The Properties dialog box shows a tree view on the left with 'System' selected. The main area displays the following settings:

Steel	
Type	structural steel
Grade	S235
System	
Truss system	Double 
Span	2
Length	[m] 10.00
Left height	[m] 2.00
Height	[m] 3.00
Right height	[m] 2.00
Girder spacing	[m] 3.00
Rigid ridge point	<input type="checkbox"/>
Joint free bottom chord	<input checked="" type="checkbox"/>
Remarks	
... System	

Cross-sections

Click on the  buttons to select the cross-sections of the chords, posts and diagonal struts in a separate dialog.

The '>' and '<' buttons allow you to expand and reduce the dialog. You can optionally display the cross-sectional properties.



The Cross-Section Selection dialog box shows the following settings:

- Sections: HEB, HEB 200
- Dimensions:

Total height	h	[mm]	200
Flange width	b	[mm]	200
Flange thickness	tf	[mm]	15
Radius	r	[mm]	18
Web thickness	tw	[mm]	9
- Cross-Section Values:

Center of Gravity	
yS	[mm] 0
zS	[mm] 0
Shear Center	
yM	[mm] 0
zM	[mm] 0
Area Values	
A	[cm²] 78.1
Shear Areas	
Static Moments	
Sy	[cm³] 321.3
Sz	[cm³] 153.0
Moments of Inertia	
Iy	[cm⁴] 5696.0

Select the cross-section either from the FRILO profile selection file or define it by specifying the dimensions.

You can also edit defined cross-sections in this dialog.

See also the [Selecting /Defining Cross-Sections-PLUS](#) documentation:

Supports

Supports out of plane

Specify the supporting conditions of the different components (top chord, bottom chord, left edge, right edge).

Distance distance to the left or to the bottom, related to the projection plane

Spring value c_y discrete supporting conditions for translation in the y-direction (rigid, 0 = free, >0 = elastically supported)

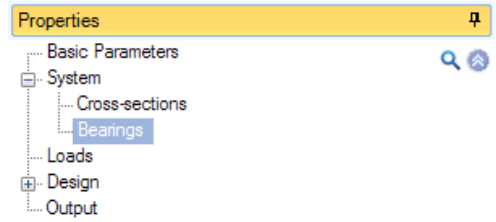
Application point available options are 'top edge', 'bottom edge' and 'component axis'

Spring value $c_{\phi x}$ discrete supporting conditions for rotation around the component x-axis

Continuous support (foundation) of the top chord

Translational foundation top edge
translational foundation at the top edge of the top chord in the y-direction


Torsional foundation
torsional foundation of the top chord about the x-axis



Supports from the plane		
Bearing 2/2		
Member	Top chord	
Distance	[m]	0.50
Spring value	C_y	rigid <input checked="" type="checkbox"/>
Point of attack	C_y	Center line of member
Spring value	$C_{\phi x}$	[kNm/rad] 0.0
Bedding of the top chord		
Elastic restraint of top chord	[kN/m ²]	0.00
Rotational bedding	[kNm/rad/m]	0.0

Loads

Building and load parameters

Click on the  button to access the dialog of the building and load parameters.

Height above ground level

Specify the height of the bottom chord (system axis) above the top edge of the ground to consider different wind pressure values at different height levels. The wind pressure is calculated for the specified height.

Trusses

Number of trusses in the building.

Truss spacing

Specify the spacing of the trusses being the width of the load area.

Length of the building

The building length calculated from the number of trusses and their spacing is indicated.

Gable truss

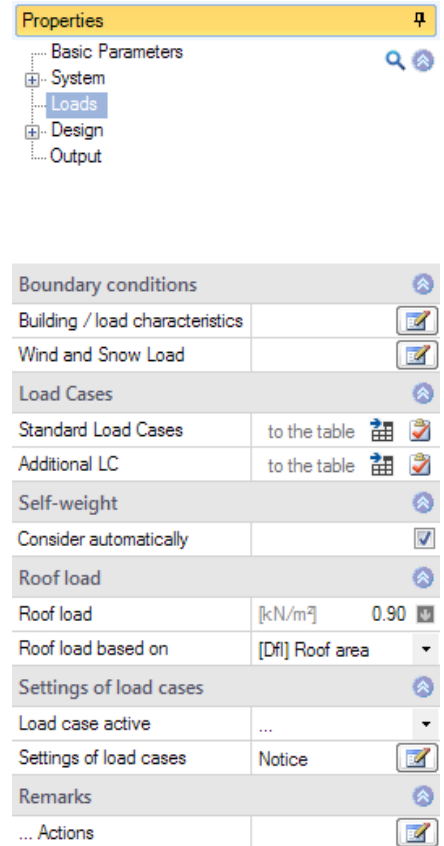
This option allows you to define a gable truss. If you leave the option unchecked (default), the truss is treated as an inner truss. The option influences the selection of the wind area.

Affected width factor


Factor for the load application area on the truss.
Width of load area = factor · truss spacing.

Area with increased wind load

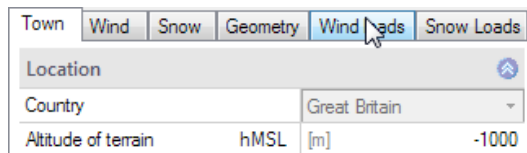
The load application area of the truss is exposed to increased wind load at the gable.



Wind and snow

Click on the  button to display the dialog of the border conditions for the calculation of the wind and snow loads. This dialog is described in the documentation Wind and Snow Loads-PLUS.

The different tabs (municipality, wind, snow...) provide access the respective dialogs and data-entry fields.



Standard/additional load cases

The load case 'permanent', generated by the software, as well as the wind and snow load cases are standard load cases. The wind and snow load cases are generated automatically based on the truss dimensions, the position and installation height and the snow and wind zones.

You cannot edit them, and they are newly generated each time you modify the structural system. You can disable these load cases (by clearing the checkbox).

	Description	Action	Alt	Active	Loads
→ 1	Roof load	Permanent loads	0	<input checked="" type="checkbox"/>	Details (1)
2	Wind from left case 1	Wind loads	111	<input checked="" type="checkbox"/>	Details (6)
3	Wind load from left side case	Wind loads	111	<input checked="" type="checkbox"/>	Details (6)
4	Wind load from left side witho	Wind loads	111	<input checked="" type="checkbox"/>	Details (4)
5	Wind from right case 1	Wind loads	111	<input checked="" type="checkbox"/>	Details (6)

Additional load cases

To edit standard load cases, copy them in the table 'Additional load cases' and edit them as required ('Copy loads from load case' column).

If you need additional load cases, you can define them in this table.

	Description	Action	Alt	Active	Copy loads from load case	Loads
→ 1	Add. load case	Wind loads	0	<input checked="" type="checkbox"/>	---	Edit (0)

Dropdown menu options for 'Copy loads from load case':

- Roof load
- Wind from left case 1
- Wind load from left side case 3



click on this button to add a new additional load case (a new table row).


Self-weight

Check this option to include the self-weight automatically as a permanent load in the calculation.

Roof load

Enter the permanent load of the roof superstructure.

Roof load from load value summary:

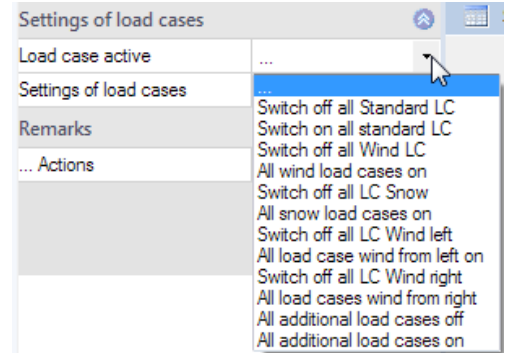
By clicking on the arrow icon  you can access a load value summary - see the description of the LOAD+ application.

Select subsequently whether the roof load should be referenced to the roof area or the base area.

Load case control

You can enable and disable load cases in this section.

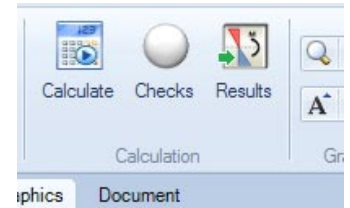
Please read the tooltip below the information button.



Design

Calculate

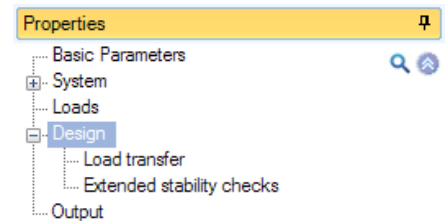
Click on the 'Calculate' button. After completion of the calculation, the utilizations are displayed.



Load transfer

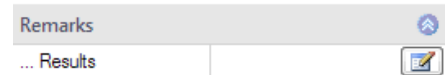
You can transfer the characteristic support reactions to the applications:

STS+	Steel Column
HO1+	Timber Column
B5	Reinforced Concrete Column
ST4	Steel Girder Support
B9	Reinforced Concrete Corbel



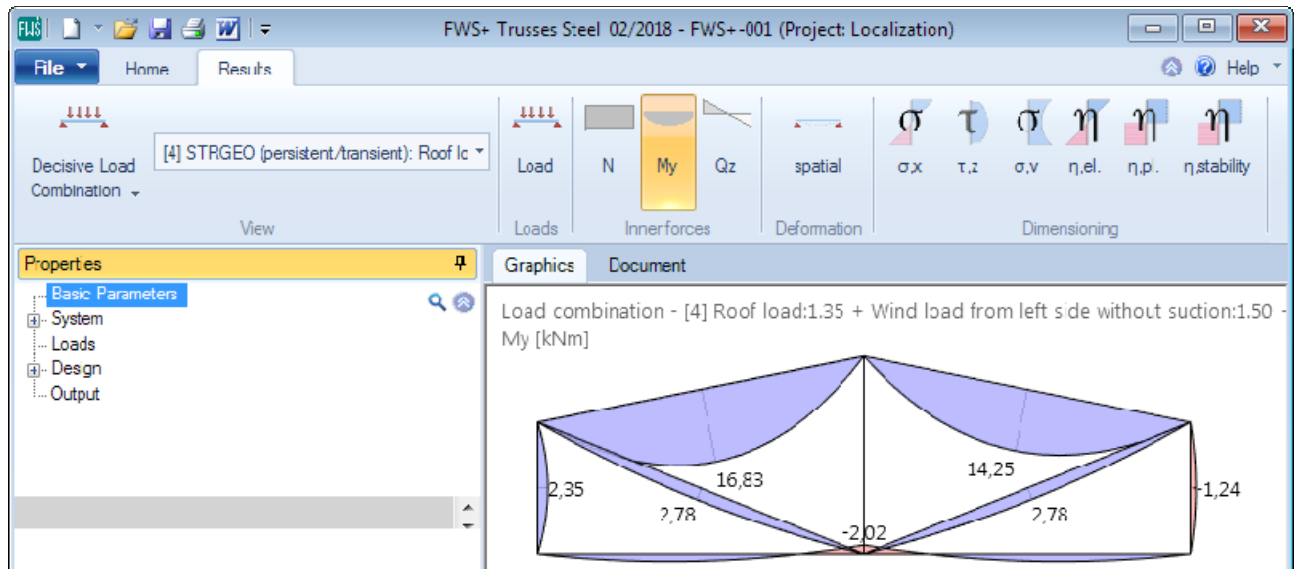
Enhanced stability verifications BTII+

If you hold a licence for BTII+ (Lateral Torsional Buckling Analysis), you can transfer the top chord, the bottom chord and the vertical edge members, if any, to BTII+. This software application provides for the calculation of more complex systems.



Results and output

Via the 'Results' tab (on top) you can display the different result graphs.



The 'Output' menu item allows you to define the desired scope of data to be put out by checking the corresponding options.

Properties	
Basic Parameters	
System	
Loads	
Design	
Output	
General	
Brief output	<input checked="" type="checkbox"/>
Notes	<input type="checkbox"/>
System	
System graphics 2D	<input checked="" type="checkbox"/>
System graphics 3D	<input type="checkbox"/>
Force the scale	<input type="checkbox"/>
Loads	
Actions	<input checked="" type="checkbox"/>
Load Case Graphics	Details (7)
Results	
Support reaction- characteristic per load case	<input checked="" type="checkbox"/>
Result Graphics	Details (6)
Resulting item forces in table	Details (6)

The output document can be accessed by clicking on the 'Document' tab (above the graphic screen).

Frilo Software

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Position: FWS-001

Trusses Steel FWS-00/2018 (Frilo N-2018-2/P08)

Basic Parameters

Design code : NA to EN EN 1995-1-1:2005-12
 Safety concept / load combinations : NA to EN EN 1992/A1:2005-06
 Combination equation : (6.10)
 Permanent loads : all equally (yes/no or yes/x)
 Check of cross-section : plastic
 Stability : S.S.S - annex 6
 Designation serviceability : characteristic
 Check of absolute deflection δ_{lim} : 5.0 cm

System Double hip truss

Circle length L = 10.00 m 2 beam with L_1 = 5.00 m
 Height of beam centre = 3.00 m left/right = 2.00 m
 Slope = 11.5 °
 Top and bottom chord without joint

Ground height above sea level : -10.00 m
 Support position : 3.00 m about ground level
 Length of the building : 12.00 m beam spacing = 3.00 m
 Factor influence width : 1.00 m inner beam

Terrain Country II
 Height of a h = 6.00 m Basic wind velocity v_{bs} = 50.00 m/s
 Velocity pressure $q(z)$ = 1.40 kN/m² Basic velocity pressure q_{bs} = 0.55 kN/m²

Ground snow load s_k = -1.80 kN/m² Snow region 1

Section properties

Component	Name	Material	I_y [cm ⁴]	I_z [cm ⁴]	W_y [cm ³]	W_z [cm ³]	A [cm ²]
all	H 88 200	S235	5896.0	2003.0	589.6	200.3	76.1

Reference literature

- /1/
- /2/ DIN 1052, 1996, Part 1 A1, Timber structures, Design and construction, Modifications
- /3/ DIN 1055: 1978, Part 1 to 5, Design loads for buildings
- /4/ DIN 1052:2004-08, Part 1, Draft, Design of timber structures - General rules and rules for buildings
- /5/ DIN 1055:2001-03, Part 100, Actions on structures
- /6/ DIN 1055:2005-03, Part 4, Wind loads
- /7/ DIN 1055:2006-03, Part 4 Amendment 1, Wind loads, Amendments to DIN 1055-4:2005-03
- /8/ DIN 1055:2005-07, Part 5, Snow and ice loads
- /9/ DIN 18800: 1990, Part 1, Structural steelwork; design and construction
- /10/ DIN 18800: 1990, Part 2, Steel structures; Stability - Buckling of bars and skeletal structures
- /11/ Krüger Ulrich, Stahlbau Teil 1+ 2, Ernst & Sohn Verlag 1998
- /12/ DIN EN 1993-1-1:2010, Design of timber structures – Part 1-1: General
- /13/ EN 1990:2010, Basis of structural design
- /14/ EN 1991-1-1:2010, Actions on structures – Part 1-1: General Actions on Structures:
- /15/ EN 1991-1-3:2010, Actions on structures – Part 1-3: General actions - Snow loads
- /16/ EN 1991-1-4:2010, Actions on structures – Part 1-4: General actions - Wind loads
- /17/ EN 1991-1-7:2010, Actions on structures – Part 1-7: General actions - Accidental actions
- /18/ DIN EN 1995-1-1/NA:2010, National Annex to EN 1995-1-1
- /19/ DIN EN 1990/NA:2010, National Annex to EN 1990
- /20/ DIN EN 1991-1-1/NA:2010, National Annex to EN 1991-1-1
- /21/ DIN EN 1991-1-3/NA:2010, National Annex to EN 1991-1-3
- /22/ DIN EN 1991-1-4/NA:2010, National Annex to EN 1991-1-4
- /23/ DIN EN 1991-1-7/NA:2010, National Annex to EN 1991-1-7