

# Steel Angle Connection SWA+

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## Basic documentation - overview

In addition to the individual program manuals, you will find basic explanations on the operation of the programs on our homepage [www.friilo.com](http://www.friilo.com) in the Campus-download-section.

*Tip: To go back - e.g. after a link to another chapter/document - in the PDF use the key combination "ALT" + "Left direction key".*

## Application options

The SWA+ program is used to design hinged beam angle connections in steel construction. The angle connection can be entered with or without a notch. The notch can be arranged either on one or both sides.

### Standards

- DIN EN 1993
- ÖNORM EN 1993

### Wizard

After starting the program, the first thing that appears is the Wizard. With the help of the Wizard, the entries necessary for the verification can be made quickly and easily. The basic inputs defined in this way can then be easily modified and supplemented using the graphic-interactive input.

### System

With the program, the connection of a secondary beam to a main beam can be designed using angles with and without beam notch. The secondary beam can be connected to the main beam in the middle, flush with the top edge or bottom edge, or in a user-defined manner by the user. Depending on the connection configuration, the notch on the secondary support can be arranged at the top, bottom or on both sides.

### Cross-sections

#### Carrier-sections

- I-section as standard section (HEA, HEB, IPE etc.)
- I-sections custom
- Flat steel as a standard section
- Flat steel custom

#### Angle

- Equal-leg and unequal-leg angle as standard cross-section or as custom cross-section

### Loading

- Design internal force from shear force  $V_{zd}$
- Input of several design internal force combinations possible

### Fasteners

Different bolts can be selected for the main beam and the secondary beam.

- Bolts (black bolts and fitted bolts Schrauben)
- Sizes: M12, M16, M20, M22, M24, M27, M30, M36
- Strength classes: 4.6, 5.6, 8.8, 10.9

## Material

The material can be chosen differently for the main beam, secondary beam and angle.

The following materials are available to choose from:

- structural steel (S235, S275, S355, S450)
- annealed structural steel (S275N – S460N)
- thermo structural steel (S275M – S460M)
- weatherproof structural steel (S235W – S355W)
- creep resistant steel (S460Q – S460QL1)
- hollow section warm (S235H – S355H)
- hollow section warm N (S275NH – S460NH)
- custom steel type

## Verifications

The program provides all the necessary verifications according to the selected design standard:

- Verification of bolts in shear
- Verification of bearing (main beam, secondary beam, angle)
- Verification against block tearing
- Verification of contact pressure
- Verification of notch of the secondary beam
- Cross-sectional verification angle

## Output

The results can be output in the output document in a clear short form, in detail or custom, depending on the selection made.

# Calculation bases

## DIN EN 1993

The basis for calculating the connection is the procedures of DIN EN 1993-1-8.

## Input

### The Wizard

The Wizard is displayed by default when creating a new item - it can also be switched off if necessary (option in the lower part of the window).

The necessary entries for a simple system can be made in the [Wizard](#). The basic system created in this way can then be easily modified and supplemented using the graphic-interactive input.

Input options in the Wizard:

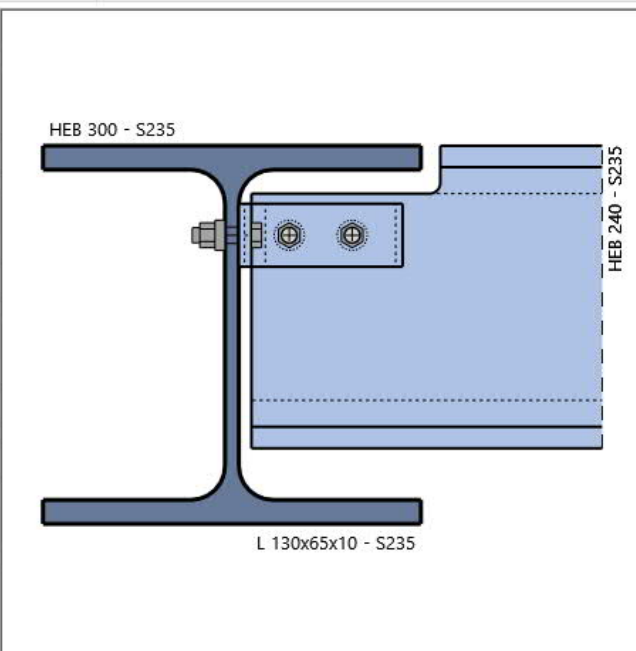
- Cross-section/section of the main beam
- Cross-section/section and vertical distance of the secondary beam. u1 = custom distance.
- Geometry of the notch of the secondary beam
- Cross section/section of the angle as well as length of the angle section in the connection area, leg length and arrangement (uw = user-defined position).
- Internal force Vz<sub>d</sub> (design value of the shear force at the cut face of the bar).

Wizard
×

### Create new structural item

Wizard
Templates
Open

<b>Cross-section</b>	
Main beam	HEB 300
<b>Secondary carrier</b>	
Cross-section	HEB 240
Distance vertically	same top edge
u1 [mm]	0 <input type="checkbox"/>
<b>Notch in the secondary beam</b>	
Arrangement	top
Height above eT1 [mm]	38
Length a [mm]	150
<b>Angle</b>	
Cross-section	L 130x65x10
Length l [mm]	50
Leg position	long leg on secondary beam
Arrangement	top
uw [mm]	8 <input type="checkbox"/>
<b>Internal forces</b>	
Vzd [kN]	0.0



Selection of the cross section of the main beam (usually the load-bearing member)

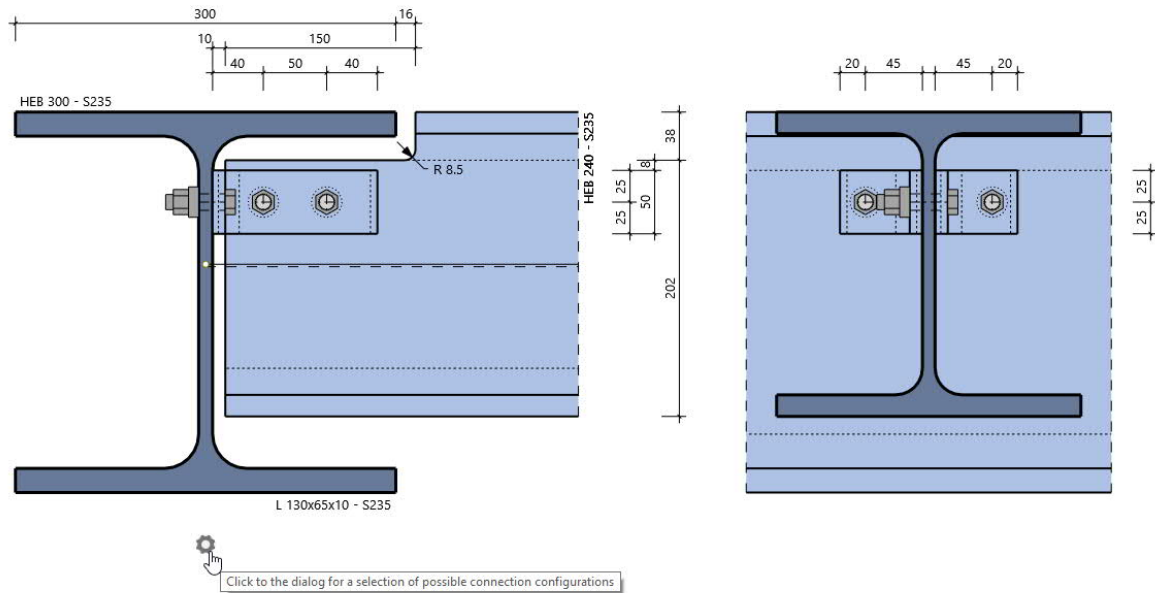
Always use the wizard to create a new item
 

OK
Cancel

## Interactive graphics

DIN EN 1993:2015  
S235, 2 x 1 x M12 / 2 x M12

20  
30



You can make the entries either in the left menu or directly in the graphic (click on objects or use the right mouse button).

Please read the “[Interactive graphics](#)” chapter in the operating principles.

- Click on the individual members (beams, bolts, load arrow, etc.) to display the appropriate parameter dialog.
- You can make changes to the dimensions directly in the dimension chains.
- The text links (top left) are also interactive.

### Gear symbol: suggestion function for the system

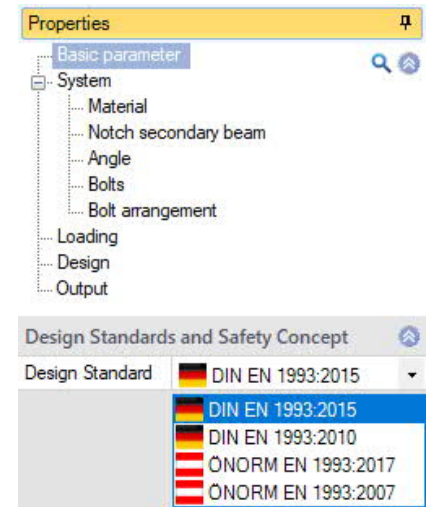
Click the gear icon to display the suggestion dialog. You can then choose between various predefined connection variants, which are based on the connections according to the DSTV ring binder type IW “Hinged angle connections”. In the SELECTION menu item, you are offered possible connection variants to choose from via the drop-down menu. The angle geometry, the length of the angle and the number of bolts including bolt size are displayed.

## Basic parameters


Here you select the design standard:

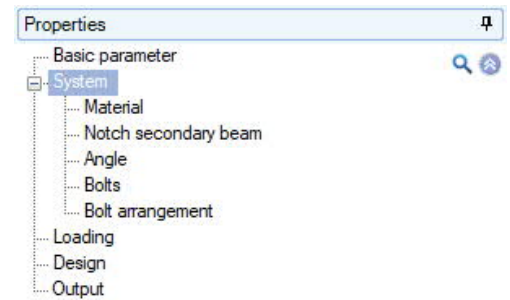
- DIN EN 1993
- ÖNORM EN 1993

*Note:* In the case of Eurocodes, reference is also made to the respective national appendix when the national version of the European standards is stated.




## System


Under SYSTEM the entries for the main and secondary beams, notches, angles, bolts and material are made. You can use the icons  to call up the respective input dialog as a separate dialog. Alternatively, the input fields are displayed directly in the left column using the submenu items (Material, Notch, etc.).



### System

**Main beam** Call up the section selection for the beam () - see document [Cross-Section Selection-PLUS](#) and [Application options – Cross-Sections](#).

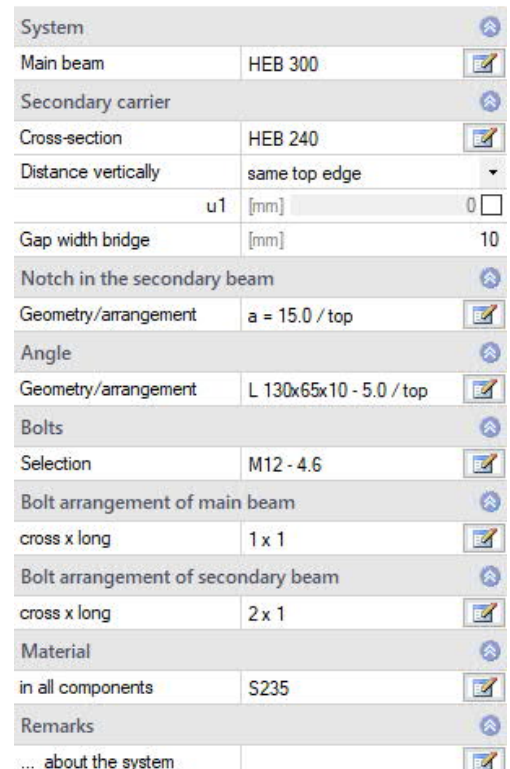
### Secondary beam

**Cross-section** Call up the section selection for the secondary beam () - see document [Cross-Section Selection-PLUS](#).

**Distance vertically** Quick selection to set the distance from the top edge of the main beam to the top edge of the secondary beam:

- same top edge
- in the middle
- same bottom edge or
- user-defined distance (tick u1)

**Gap width bridge** Gap between the web main beam and the web secondary beam



### Remarks

Calling up the [Remarks editor](#). The remarks are listed in the output in the system data.

## Material

In the members The material can be entered identically for all members or differently for each member. You have the option to specify the type of steel and depending on this the steel quality can be defined. You can also display the characteristics of the material. There is also the option of user-defined entry of the steel grade. In this case, the characteristic values can be defined yourself.

Material	
in all members	different
Main carrier material	
Type	Structural steel
Grade	Structural steel
Characteristic values	Structural steel annealed Structural steel thermo Structural steel weather-resistant
Secondary carrier material	
Type	Heat-resistant steel Hollow section hot Hollow section, hot, N
Grade	User defined type

## Notch in the secondary beam

Arrangement Definition of a notch in the secondary beam and its arrangement. Depending on the configuration, the notch can only be arranged at the top or bottom or on both sides.

Execution The notch can be carried out with drilling (diameter entry) or flame cut (radius entry).

Radius flame cut Sets the radius of the flame cut in the notch. The usual value is 8.5 mm.


Clearance The minimum value for the gap between the chord of the main beam and the chord of the secondary beam must be specified.

Height top/bottom Defines the height of the notch on the top or bottom chord of the secondary beam

Length Specifies the length  $a$  of the notch

Notch in the secondary beam	
Arrangement	top
Execution	Flame cut
Radius flame cut	rT with hole Flame cut
Clearance	[mm] 10
Height above	eT1 [mm] 38
Length	a [mm] 150


## Angle

Cross-section Selection of the angle section and definition of the arrangement. Use the icon  to call up the input dialog. See [Cross-Section Selection-PLUS](#).


Leg position Specifies whether the long or short leg is connected to the secondary beam.


Arrangement Arrangement at the lowest possible distance from the top edge of the secondary beam or in the middle of the bar axis of the secondary beam or user-defined distance (tick uw).

Length Length of the angle section in the connection area.




Angle	
Cross-section	L 130x65x10 
Leg position	long leg on secondary beam
Arrangement	top
uw	[mm] 8 <input type="checkbox"/>
Length	l [mm] 50

## Bolts

Selection of bolts for the connections to the main and secondary beams. Use the icon  to call up the input dialog.

In the connections      The bolts can either be identical in all connections or different in the main and secondary beams. When selecting "Different": The input dialog can be called up for each bolt using the icon .

You can choose from bolt sizes M12 to M36 with strength classes 4.6 to 10.9. The bolt can be chosen as a black bolt or as a fitted bolt. You can choose whether the thread or the shaft of the screw is in the shear gap. After entering the screw type, the hole diameter used is set to the nominal hole diameter of the respective screw size. This can be customized.

Bolts		
in the connections	identical	▼
Screw		
Name	M12	▼
Strength class	4.6	▼
Screw type	Black bolt	▼
Shear joint	Thread in shear joint	▼
Hole diameter	d0 [mm]	13.0 <input type="text"/>
Screw characteristics		
Tensile strength	fub [N/mm <sup>2</sup> ]	400.0
Yield strength	fyb [N/mm <sup>2</sup> ]	240.0
Thread diameter of the screw	[mm]	12.0
Shaft diameter	ds [mm]	12.0
Shaft cross section	A [cm <sup>2</sup> ]	1.1
Stress cross section	Asp [cm <sup>2</sup> ]	0.8
Washer diameter	dsa [mm]	24.0



## Bolt arrangement

The bolt arrangement can be selected differently on the main and secondary beams.

### Screw arrangement main / secondary beam

Cross x long Enter the bolt arrangement transversely in the sense transverse to the main stress and longitudinal in the direction of the main stress. Use the icon to call up the input dialog. The number of bolts can then be entered, separated into the transverse and longitudinal directions. Furthermore, the bolt spacing can be specified.

Bolt arrangement of main beam	
cross x long	1 x 1
Bolt arrangement of secondary beam	
cross x long	2 x 1

Bolt arrangement input dialog:

- Rows Number of bolts within a row
- e1,i Edge distance in longitudinal direction
- e2,i Edge distance in transverse direction
- p1 Hole spacing in longitudinal direction
- p2 Hole spacing in transverse direction
- Bolts per row Number of bolts within a row

**Bolt arrangement of main beam - M16 - 4.6 (Black bolt)**

Bolt arrangement - transverse		
Rows	2	
e2,1	[mm]	50
p2	[mm]	60
e2,2	[mm]	50
Total	[mm]	160
Status		Ok

Bolt arrangement - along		
Bolts per row	2	
e1,1	[mm]	30
p1	[mm]	70
e1,2	[mm]	30
Total	[mm]	130
Status		Ok

Number of bolts within a row - one behind the other in the longitudinal direction

OK Cancel

## Loading

The input is made via the design value of the shear force Vz<sub>d</sub>. It is possible to define several load case combinations for the design.

You can make the entries directly in the left menu - see basic operating instructions-plus - [Table Entry](#) or via the Load Case Combinations tab (under the graphics window).

Load case combinations						
	Description	Situation	Active	End of member	Reference point	Vzd
			<input checked="" type="checkbox"/> <input type="checkbox"/>			[kN]
1	Combination 1	P/T	<input checked="" type="checkbox"/>	Secondary carrier	A	active 65.0
2	Combination 1<1>	P/T	<input checked="" type="checkbox"/>	Secondary carrier	A	active 65.0

You can assign the description in a user-defined manner.

The following design situations for the load combination are available:

P/T: persistent/transient design situation

A: accidental design situation

AE: seismic design situation

Active Sets the status of the load case combination active/inactive.

Vzd Design value of the shear force at the cut face of the bar.

You can also restrict the display of the load case combinations using the load case combinations symbol in the top menu bar.

### Remarks

Calling up the [Remarks editor](#). The remarks are listed in the output in the chapter Loading.

The screenshot shows the software interface with two panels. The 'Properties' panel on the left lists various parameters under 'System', including Material, Notch secondary beam, Angle, Bolts, and Bolt arrangement. The 'Loading' panel on the right shows the configuration for 'Load case combinations' 1/2. It includes a table with the following data:

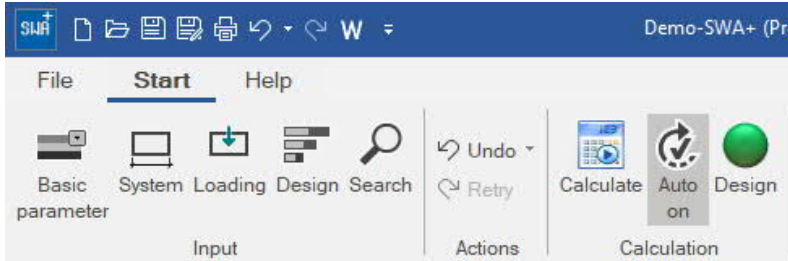
Load case combinations		1/2
Description	Combination 1	
Situation	P/T	
Active	P/T	
End of member	A	
Reference point	AE	
Input	active	
Vzd	[kN]	65.0
Remarks	...	
... to the effects		

The screenshot shows a context menu for 'Load case combination'. The menu items are:

- Create
- Delete
- Show utilization only for selected LCc
- [ Lcc 1 - active ] Combination 1
- [ Lcc 2 - active ] Combination 1<1>

## Design

If "Auto" is set to off (click on the icon to switch), you must start the calculation using the "Calculate" icon in the top menu bar. If "Auto" is set to on, the calculation is carried out automatically with every change.



### Remarks

Calling up the [Remarks editor](#). The remarks are listed in the output with the results.

# Output

Use the "Document" tab to switch to the display of the output.

See also:

[Output and printing](#)

The scope of output can be selected using the options offered.

## Interfaces/connected programs

You can transfer the system to the [Fin Plate SFB+](#) program using the Connected Programs icon in the top menu bar.

**Properties**

- Basic parameter
- System
  - Material
  - Notch secondary beam
  - Angle
  - Bolts
  - Bolt arrangement
- Loading
- Design
- Output

**Global**

Output scope	Standard
System graphics 3D	Brief
System graphics 2D	Standard
Scale	User defined
<b>Loading</b>	
Only relevant LCc	<input checked="" type="checkbox"/>

Graphics Document

75%

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Start page: 1

Pages Bookmarks

- Basic parameters
- System
  - System graphics 2D
  - System characteristics
- Loading
- Results Loc 1
- Connection to main beam
- Connection to secondary b

**Basic parameters**  
Design code : DIN EN 1993-1-1/NA:2015-08

**System**  
System graphics 2D

**Model Angle connection Girder on Girder with notch**  
pinned Steel grade S235 / S355 Screws in the connections 2 x 2 x M16 + 2 x M16

Member	Name	Material	h cm	h <sub>web</sub> cm	b <sub>fl</sub> cm	t <sub>fl</sub> cm	t <sub>w</sub> cm	r cm	b <sub>fl</sub> cm	t <sub>fl</sub> cm
Main beam	HEB 300	S235	30.0	20.8	30.0	1.9	1.1	2.7	30.0	1.9
Secondary carrier	IPE 200	S355	20.0	15.9	10.0	0.9	0.6	1.2	10.0	0.9
Secondary carrier	Notch		15.3				0.6	1.2	10.0	0.9

**Location of secondary supports**

vertical distance TE to TE main beam	horizontal distance from web to web main beam	
Arrangement	u1 mm	Gap size mm
according to instructions	0	5

**Secondary beam notch**

Execution	Height top eT1 mm	Length a mm	Member height h <sub>m</sub> mm	Radius flame cut r mm
top, with flame cut	47	145	153	8.5