

# Splice Connection SLS+

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## Basic documentation - overview

In addition to the individual program manuals, you will find basic explanations on how to use the programs on our homepage [www.friilo.eu/en/](http://www.friilo.eu/en/) in the download area (manuals).

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

## Application possibilities

The SLS+ program is used for the design of uniaxially loaded, bolted girder joints with splices.

### Standards

- DIN EN 1993
- ÖNORM EN 1993

### Assistant

After starting the program, the Assistant is the first thing that is displayed. With the help of the Assistant, the entries required for the verification can be made quickly and easily. The basic entries defined in this way can then be easily modified and supplemented using the graphical-interactive input.

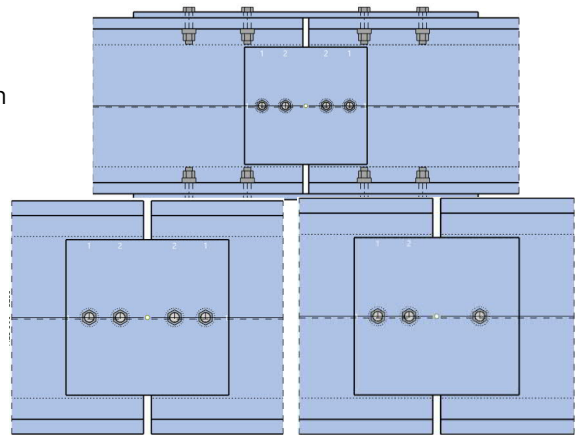
### System

The program can be used to dimension the following connection types:

- rigid splice connection
- flexible splice connection
- hinged splice connection

The connection consists of two double symmetrical I-beams that are connected by a bolt connection using a web splice plate on both sides. Different cross-sections can be selected for the beams. Depending on the type of connection selected, external chord straps are arranged, which can optionally be supplemented by internal chord straps. The beams can also be modeled with an offset of the system lines. If an offset of the system lines is defined, the program automatically arranges lining plates. The thickness of the lining plates is automatically determined by the program based on the offset.

*Note: The lining plates are not dimensioned.*



### Cross-sections

#### Rigid connection

Beam sections:	Splices:
<ul style="list-style-type: none"> <li>▪ I-sections as standard section (HEA, HEB, IPE etc.)</li> <li>▪ I-sections user-defined</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rectangular section as user-defined cross-section</li> </ul>

#### Flexible connection

Beam sections:	Splices:
<ul style="list-style-type: none"> <li>▪ I-sections as standard sections</li> <li>▪ I-sections as user-defined sections</li> <li>▪ Flat steel as standard section</li> <li>▪ Flat steel as user-defined section</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rectangular section as user-defined cross-section</li> </ul>

### Hinged connection

Beam sections:	Splices:
<ul style="list-style-type: none"> <li>▪ I-sections as standard sections</li> <li>▪ I-sections as user-defined sections</li> <li>▪ Flat steel as standard section</li> <li>▪ Flat steel as user-defined section</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rectangular section as user-defined cross-section</li> </ul>

### Loading

Design internal forces from

- $N_d$ ,  $V_{zd}$  and  $M_{yd}$  (Rigid / flexible connection)
- $N_d$  and  $V_{zd}$  (hinged connection)
- Input of several design internal force combinations possible

### Fasteners

Different bolts can be selected in the web splice plates on the right and left members as well as in the chord straps above and below.

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

### Material

The material can be selected differently in the member on the right and left as well as in the splices. The following materials are available:

The following materials are available:

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

### Verifications

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

- Verification of the shearing off capacity of the bolts
- Verification of bearing capacity (beams, splices)
- Verification of cross-sectional resistance
- Verification of local stability under compressive stress

### Output

Depending on the selection made, the results can be output in the output document in a clear, short form, detailed or user-defined.

## Calculation bases

### DIN EN 1993

The basis for the calculation of the connection are the procedures of DIN EN 1993-1-8

## Input

### The Assistant

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

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

Input options in the Assistant:

- Connection type (rigid, flexible and hinged)
- Selection of whether the cross-section for both connected members should be defined identically or differently from each other
- Selection of cross-section/section of the members
- Definition of height offset of the member axes
- Input of the internal force  $N_d$ ,  $V_{zd}$  and  $M_{yd}$  depending on the selected connection type

Assistant
✕

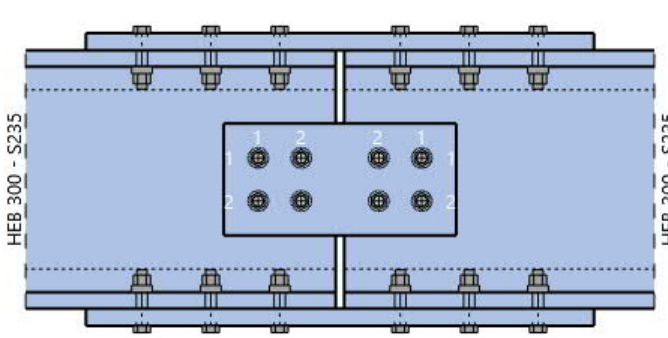
### Create new structural item

Assistant

Templates

Open

System		
Connection type	rigid	▼
Cross-section of the components	rigid	
Cross-section	flexible	
in all components	hinged	
Member position		
Height offset member axes	[mm]	0
Internal forces		
$N_d$	[kN]	0.0
$V_{zd}$	[kN]	0.0
$M_{yd}$	[kNm]	0.00



Selection of the joint type as a rigid, flexible or hinged system.

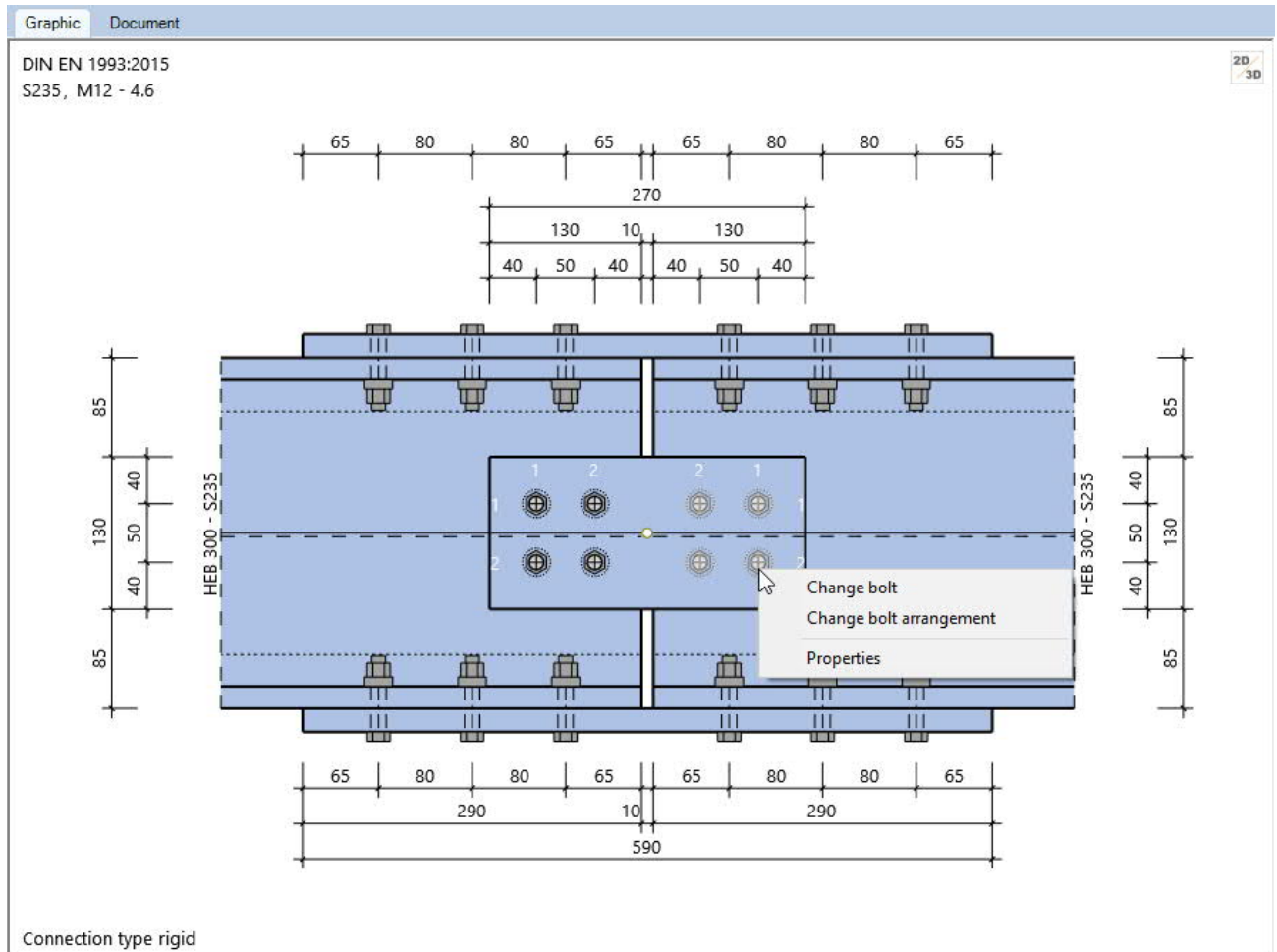
Always use the Assistant to create a new item
 

OK

Cancel

## Interactive graphic

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



For more information, read the chapter ["Interactive graphic"](#) in the operating principles.

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

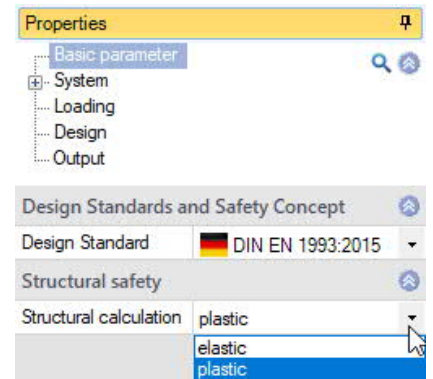
## Basic parameters

Here you select the design standard:


- DIN EN 1993
- ÖNORM EN 1993

*Note: In the case of Eurocodes, the national version of the European standards is indicated together with a reference to the respective National Annex.*

The structural analysis is carried out plastically (MaRd,pl - classification according to load-bearing capacity and stiffness) or elastically (MaRd,el - classification according to stiffness).



## System


Under the SYSTEM item, you can enter the connection type, cross-section, member position, material, splices and bolts. You can use the icons  here 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, splices, etc.).

### System

**Connection type** Selection of the connection type as a rigid, flexible or hinged system.

**Cross-section of the members** The cross-section can be defined identically or differently for both connected members.

### Cross-section

Depending on the selection of whether the cross-sections of the members are identical or different, the section selection for the members is called ().

See the document [Cross-section selection-PLUS](#).

### Member position

**Gap width members** Specifies the gap width between the two members within the connection.

**Height offset of member axes** Specifies the offset of the member axes in the z-direction (i.e. in the web direction) - starting from the member on the left positively downwards.

### Material

The material can be entered identically for all members or differently for each member.

In the material dialog, you define the type and grade of steel. The characteristics of the selected material can be displayed.

### Splices

Dimensions of the splices on the web and on the chords.

### Bolts

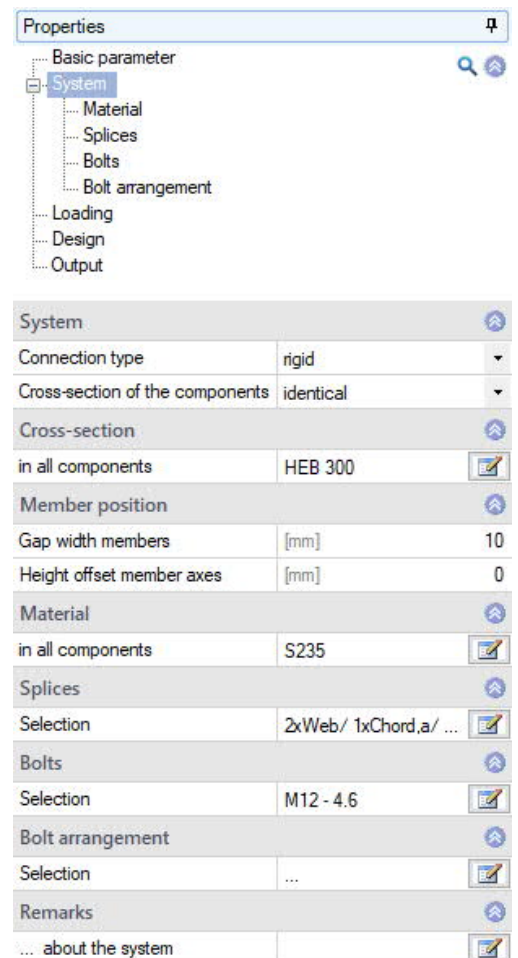
Selection of bolts for the connections of web splice plate / chord strap above / chord strap below.

### Bolt arrangement

Selection of the bolt arrangement in the connections of web splice plate / chord strap above / chord strap below.

### Remarks

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



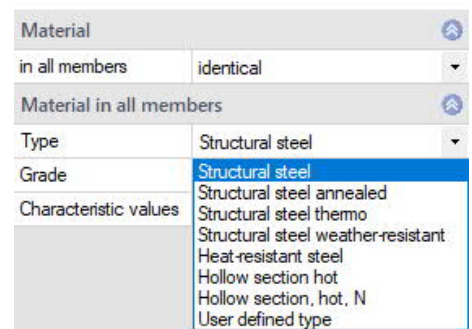
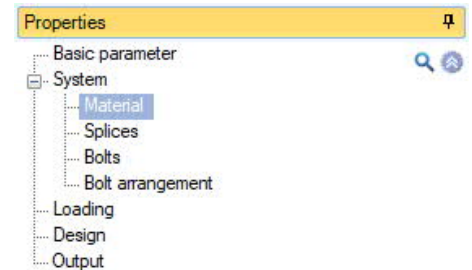
Properties	
Basic parameter	
System	
Material	
Splices	
Bolts	
Bolt arrangement	
Loading	
Design	
Output	
System	
Connection type	rigid
Cross-section of the components	identical
Cross-section	
in all components	HEB 300
Member position	
Gap width members	[mm] 10
Height offset member axes	[mm] 0
Material	
in all components	S235
Splices	
Selection	2xWeb/ 1xChord,a/ ...
Bolts	
Selection	M12 - 4.6
Bolt arrangement	
Selection	...
Remarks	
... about the system	



## Material

In the members The material can be entered identically for all members or differently for each member.

You have the option of specifying the type of steel and, depending on this, the steel grade can be defined. You can also display the material's characteristics. There is also the option of user-defined input of the steel grade. You can define the characteristics yourself.



## Splices

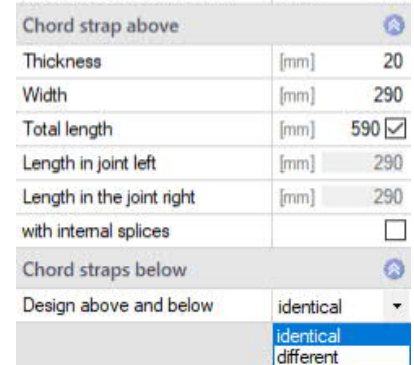
### Web splice plates

Thickness	Sets the thickness of the web splice plate (one-sided).
Height	Sets the height of the web splice plate.
Total Length	Sets the total length of the web splice plate.
Length in connection left	Specifies the length of the web splice plate in the connection area on the member on the left.
Length in connection right	Specifies the length of the web splice plate in the connection area on the member on the right.
Height offset member axis	Specifies the offset of the splice center to the member axis on the left in z (i.e. in the web direction) – positive downwards.



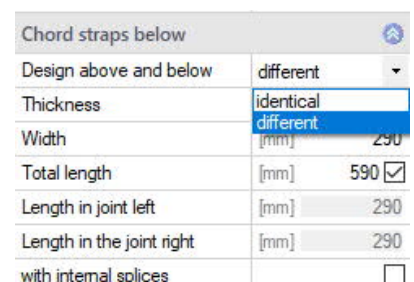
### Chord strap above

Thickness	Sets the thickness of the chord strap (external).
Height	Sets the width of the chord strap (external).
Total length	Sets the total length of the chord strap.
Length in connection left	Specifies the length of the chord strap in the connection area on the member on the left.
Length in connection right	Specifies the length of the chord strap in the connection area on the member on the right.
With internal splices	Determines whether the chord strap above and below are identical or different.




### Chord strap below


Design above and below	Specifies whether the chord strap above and below are identical or different. If the design is different, the input is the same as for the strap chord above.
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## Bolts

Selection of bolts for the connections. Use the icon  to open the input dialog.




...in the connections

The selection of bolts can be the same for all splices or different for each splice. The selection of bolts can also be different for each splice side on the left and right. If you select "assign": The input dialog (Fig. below) can be called up for each bolt using the icon .

Web splice plate		
<b>Screw</b>		
Name		M12
Strength class		4.6
Screw type		Black bolt
Shear joint		Thread in shear joint
Hole diameter	d0 [mm]	13.0
<b>Screw characteristics</b>		
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	d [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
Selection of the metric screw		
<input type="button" value="OK"/> <input type="button" value="Cancel"/>		

Properties	
Basic parameter	
System	
Material	
Splices	
<b>Bolts</b>	
Bolt arrangement	
Loading	
Design	
Output	

Bolts	
Bolts in the connections	assign
in the web splice plate	identical assign
Screws left and right	identical
Bolts	M12 - 4.6 (Black bolt) 
in the chord straps above	
Screws left and right	identical
Bolts	M12 - 4.6 (Black bolt) 
in the chord straps below	
Screws left and right	identical
Bolts	M12 - 4.6 (Black bolt) 

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

For example, the nominal hole diameter for M16 is 18 mm for black bolts (hole clearance 1.0 mm), 17 mm for fitted bolts (hole clearance 0.0 mm).

## Bolt arrangement

**Arrangement** The arrangement of the bolts within the splice can be identical for the connections on the left and right or different for each connection (assign).

**Transverse x longitudinal** Enter the bolt arrangement transversely in the sense of transverse to the main stress and longitudinally in the direction of the main stress. Use the icon to call up the input dialog. The number of bolts can then be entered separately for the transverse and longitudinal directions. The pitches can also be specified.

Bolt arrangement input dialog:

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

**Properties**

- Basic parameter
- System
  - Material
  - Splices
  - Bolts
  - Bolt arrangement**
- Loading
- Design
- Output

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Screw arrangement web splice plates	
Arrangement left and right	identical
cross x long	2 x 2
Screw arrangement chord strap above	
Arrangement left and right	identical
cross x long	2 x 3
Screw arrangement chord straps below	
Design above and below	different
Arrangement left and right	assign
cross x long - left side	2 x 3
cross x long - right side	2 x 3

Web splice plates - M12 - 4.6 (Black bolt)

**Bolt arrangement - transverse**

Rows	2
e2,1 [mm]	40
p2 [mm]	50
e2,2 [mm]	40
Total [mm]	130
Status	Ok

**Bolt arrangement - along**

Bolts per row	2
e1,1 [mm]	40
p1 [mm]	50
e1,2 [mm]	40
Total [mm]	130
Status	Ok

Number of rows - across

OK Cancel

## Loading

The input is made using design values. It is possible to define several load case combinations for the design.

You can make the entries directly in the left menu – see [Operating principles – Table input](#) or via the Load case combinations tab (below the graphic window).

	Description	Situation	Active	Nd	Vzd	Myd
			<input type="checkbox"/>	[kN]	[kN]	[kNm]
1	Lcc<1>	P/T	<input checked="" type="checkbox"/>	40.0	10.0	7.00
2	Lcc<2>	P/T A AE	<input checked="" type="checkbox"/>	0.0	0.0	0.00

The screenshot shows the 'Properties' panel on the left with a tree view containing 'Basic parameter', 'System', 'Loading', 'Design', and 'Output'. The 'Loading' panel is active, showing 'Load case combination 1/2'. It contains a table with the following data:

Description	Lcc<1>	
Situation	P/T	
Active	<input checked="" type="checkbox"/>	
Nd	[kN]	40.0
Vzd	[kN]	10.0
Myd	[kNm]	7.00
Remarks	... to the effects	

You can assign a user-defined name.

The following design situations of the load case combination are available for selection:

- P/T permanent/temporary design situation
- A accidental design situation
- AE design situation earthquake

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

- Nd Design value of the normal force at the cut face of the bar, positive as tensile force away from the node.
- Vzd Design value of the shear force at the cut face of the bar.
- Myd Design value of the moment at the cut face of the bar.

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

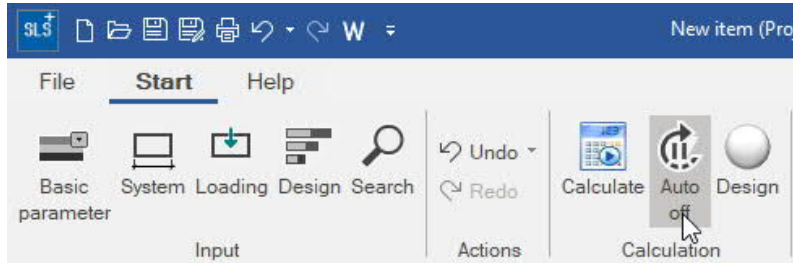
### Remarks

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

The screenshot shows the top menu bar with icons for 'Load case combination', 'Document', 'Save', 'Load', and 'Manage'. The 'Load case combination' icon is highlighted, and its dropdown menu is open, showing options: 'Create', 'Delete', 'Show utilization only for selected LCC', and two entries: '[ Lcc 1 - active ] Lcc<1>' and '[ Lcc 2 - active ] Lcc<2>'.

## 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 every time a change is made.



### Remarks

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

# Output

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

See also:

[Output and printing](#)

The output scope can be selected using the options offered.

**Properties**

- ... Basic parameter
- System
- ... Loading
- ... Design
- Output**

**Global**

Output scope	Standard
System graphics 3D	<input type="checkbox"/>
System graphics 2D	Views in common
Scale	[1:]
Sheet metal excerpt	<input type="checkbox"/>

**Loading**

Only relevant LCc	<input checked="" type="checkbox"/>
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Graphic Document

100% Page 1 of 5 Start page: 1 Page layout

Pages Bookmarks

- Basic parameters
- System
  - System graphics 2D
  - System characteristics
- Loading
- Results Lcc 1
  - Advice
  - Internal forces
  - Web splice plates
  - Chord strap above
  - Chord straps below
  - Cross-section
- Summary

**Position: (New item)**

Splice Connection (x64) SLS+ 01/25 (FRILO R-2025-1/P03)

**Basic parameters**

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

Structural calculation : plastic

**System**

System graphics 2D

Model : rigid splice connection Steel grade S235

**Number of screws**

Connection	Number	Size	Resistance	Screw type
Web splice plate	8	M12	4,6	Black bolt
Chord strap above	12	M12	4,6	Black bolt
Chord strap below	12	M12	4,6	Black bolt