Butt Plate Joint SPS+

Contents

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.frilo.com in the Campus-download-section.

Tip: Go back - e.g. after a link to another chapter / document - in the PDF with the key combination "ALT" + "left arrow key".

Application options

The SPS+ program is suitable for the design of end plate joints in steel construction.

In an end plate joint, two beams are connected with a welded-on end plate either flush to the surface or projecting. Two or four vertical bolt rows are used to create a moment-resistant connection. The permissible profile types are I-shaped steel profiles.

Standards

- DIN EN 1993
- ÖNORM EN 1993

Calculation bases

The calculation of the connections is based on the methods described in DIN EN 1993-1-8.

In the verification of end plate joints with four vertical bolt rows, the model described in the following publications is used:

- Research Report 3/2009: Entwicklung eines Bemessungsmodells für geschraubte momententragfähige Kopfplattenverbindungen mit 4 Schrauben in einer Schraubenreihe auf der Grundlage der prEN 1993-1-1:2003; Deutscher Ausschuss für Stahlbau DASt, Düsseldorf.
- WAGENKNECHT: Stahlbau-Praxis nach Eurocode 3, Band 3 Komponentenmethode, 2nd edition; Beuth Verlag GmbH, Berlin, Wien, Zürich 2017.

Data entry

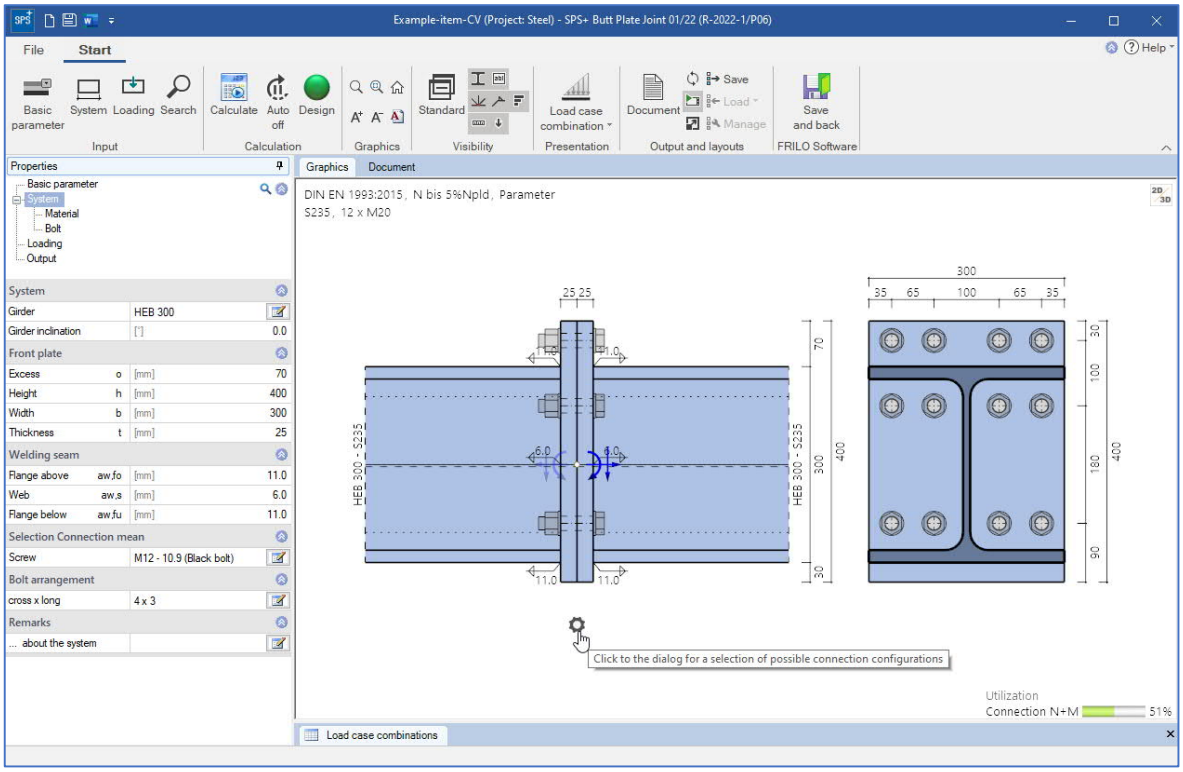
Wizard

After starting the program, the wizard is displayed first. You can define the most important and required parameters to have a first calculable basic system at hand that you can further customise subsequently.

Interactive graphical user interface (GUI)

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

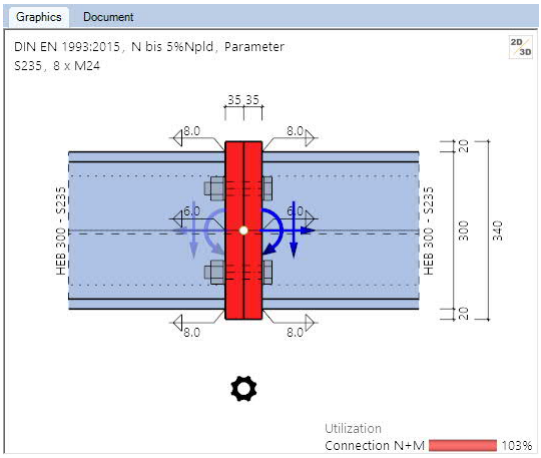
For more information, read the chapter "Interactive Graphical User Interface" in the Basic Operating Instructions.



- Click on the individual components (beam, butt plate, screw, load arrows) 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.

Suggestion function for suitable typical designs of the butt plate

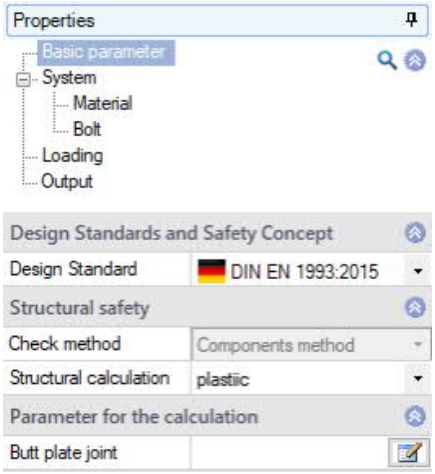
Click on the gear symbol to display the suggestion dialog. You can then choose from a list of typical designs of the butt plate.



Colored marking of critical components

If the utilization is greater than 1.0, the critical component is highlighted in the 2D graphic.

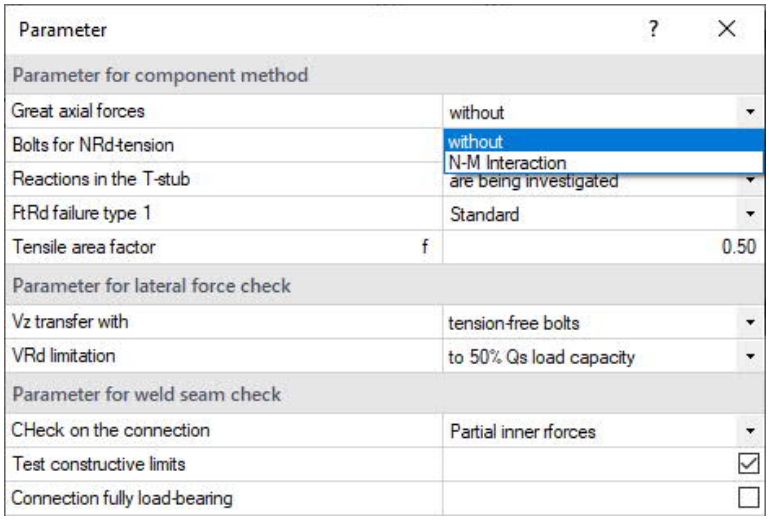
Basic parameters



Design standard	DIN EN 1993 ÖNORM EN 1993
Verification method	Component method (in German)
Structural calculation	the structural calculation is based either on the plastic method (decisive MaRd,pl - classification according to load-bearing capacity and stiffness) or on the elastic method (decisive MaRd,el - classification according to stiffness).

Parameters for the calculation / end plate joint

Parameters for the component method



Great axial forces	without or with N-M interaction. Consideration of the axial forces through a verification against NRd and interaction N-M according to equation 6.24 of EN 1993-1-8.
Bolts for N_{RD} tension	include without restriction, neglect in the projection: Allows you to define whether the bolts in the projection or in the haunch should be neglected for the determination of the NRd tension.
Supporting forces in the T-stub	you can either examine them or assume their generation in general. You define whether it is generally assumed that supporting forces can build up in the joint (Tab. 6.2, Lb < Lb* NOTE 1) or whether the generation of these supporting forces is examined by the program.
FtRd failure type 1	select whether the standard or the alternative verification of the bending resistance is used for determining failure type 1 in the equivalent T-stub of the component flange/plate.
Factor tension area	this factor allows you to define which bolts absorb tensile stress for MRd: with f = 1.0 all bolts in the connection area up to the pressure point act in tension, with f = 0.5 only those bolts in the half of the joint that is away from the pressure point act in tension.

Parameters for the shear force verification

Vz transfer via	the shear force is either transferred by all bolts in the valid connection area or exclusively by bolts that do not absorb tensile forces. See also factor f for the tension area in the component method. If bolts are subjected to tensile and shear forces, the shear capacity is reduced by the N-V interaction.
VRd limitation	you can limit the design shear force resistance to 50 % of the design shear resistance of the crossbeam. This limitation is used in the calculation of the utilization by VRd. This dispenses with the examination of the interaction with VRd, which would otherwise have been required as a separate calculation.

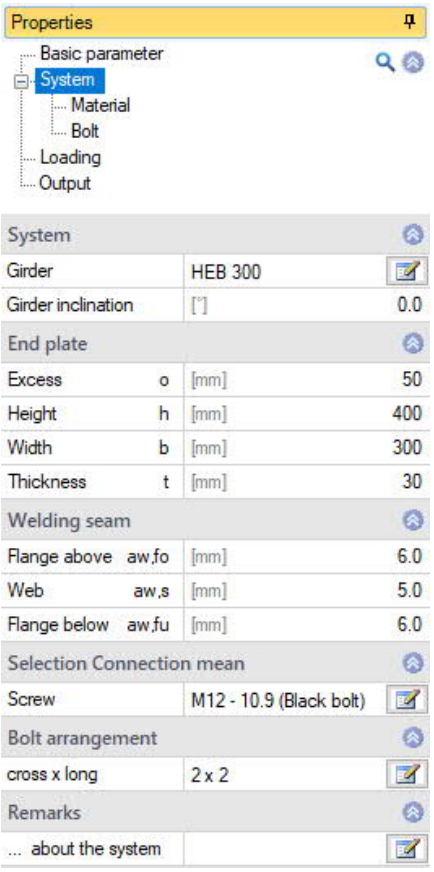
Parameters for the welding seam verification

Verification type in the joint	the verification of the weld seams in the connection is performed optionally - with the respective partial internal forces - via the structural analysis of the overall weld seam pattern (IAW*)
Test constructive limits	If the option is selected, the design limit values of the weld seam thickness are checked by the program.
Fully resistant joint	the weld seams at the connection are verified in such manner that they are able to transmit the limit moment and limit shear force of the joint. The ductility of weld seams is limited. Therefore, they should be dimensioned is such a way that they are not relevant for the design, i. e. that another component fails first. NOT with activated interaction of N and M according to equation 6.24 of EN 1993-1-8

*IAW = Institut für Arbeitswissenschaft (German Institute for Labour Science)

Structural system

Girder	accesses the profile selection for the beam - see the document Cross-section selection-PLUS
Girder inclination	inclination of the beam in degrees, mathematically positive (-45° ... 45°)



End plate

Enter the end plate dimensions.

o	distance of the top edge of the plate to the top edge of the adjoining component.
h	height of the plate.
b	width of the plate.
t	thickness of the plate.

Weld seam

aw,fo	thickness of weld seam plate to flange on top
aw,s	thickness of weld seam plate to web
aw,fu	thickness of weld seam plate to flange bottom

Fasteners

Accesses the data-entry fields for the bolts. See the chapter Bolts.

Bolt arrangement

Klick the edit button to enter the values for the bolt pattern .

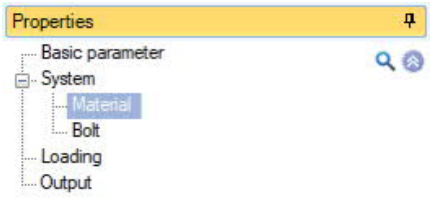
Transverse means transverse to the direction of the main loading (i. e. in the flange direction, seen from the joint) and longitudinal means in the direction of the main loading (i. e. in the web direction, seen from the joint).

Rows	number of rows of bolts in the transverse direction - these are arranged symmetrically on each side of the web, i. e. always 2 or 4.
w	distance of the bolt axes in the transverse direction (in the web area).
w1	hole spacing of the bolts in the transverse direction.
w2	distance of the bolts to the edge in the transverse direction.
	w, w1, w2 are shown in the GUI.
Per row	number of bolts within a row - in longitudinal direction, one behind the other.
e	a data-entry table for the distances of the bolts in longitudinal direction, measured from the upper edge of the end plate is displayed. e1, e2 etc. are shown in the GUI.
Conflict	the program tries to solve the conflict by arranging the bolts with valid distances.

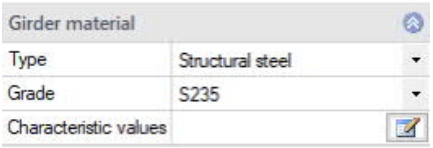
Remarks

Call up the Remarks Editor. The comments are included in the output with the system data.

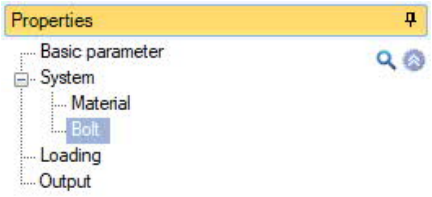
Material



Steel type/grade — structural steel, fine-grained structural steel or user-defined (entry of the characteristic values). The corresponding steel grades are offered for selection.



Bolts

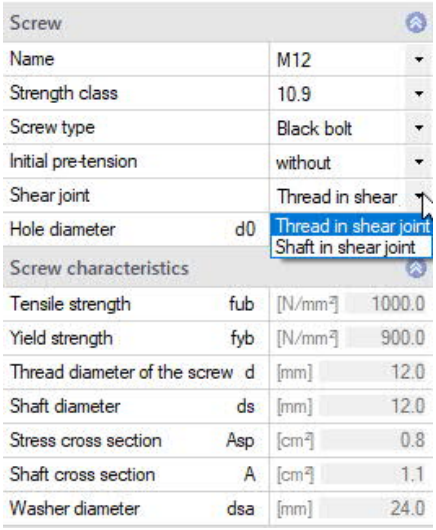


The bolt sizes M12 to M36 are available for selection in the strength classes 4.6 to 10.9.

You can select among black bolts and fit bolts.

Black bolts with an internal hole clearance between 0.3 and 2.0 mm

and fit bolts with an internal hole clearing between 0.0 and 0.3 mm can be used.



Controlled pre-tensioning of the bolt:

Category A or D only for qualitative improvement of the serviceability by applying the controlled pre-tensioning force Fpc*.

Category B, C or E to increase the structural safety by applying the full pre-tensioning force Fpc.

Category A - shear/bearing stress joint

Category B - non-slip connection in the SLS

Category C - non-slip connection in the ULS

Category D - tensile connection, not pre-tensioned

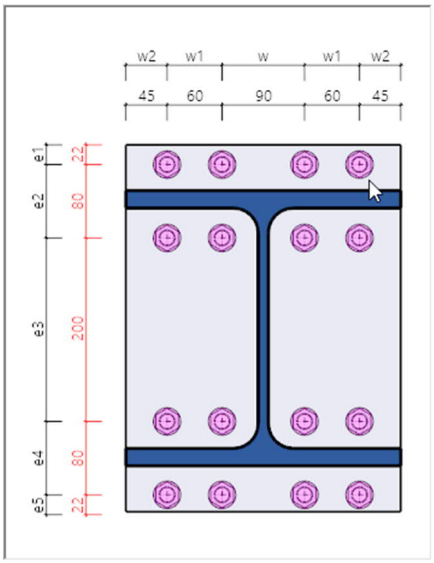
Category E - pre-tensioned tensile connection

You can select whether the thread or shank of the bolt should be in the shear joint.

After having defined the bolt type, the hole diameter is set to the nominal hole diameter of the corresponding bolt size.

It can be adjusted within the permissible range.

The nominal hole diameter of M16 is 18 mm for black bolts (internal hole clearance of 1.0 mm) and 17 mm for fit bolts (internal hole clearance of 0.0 mm), for example.



Note: *The characteristic values of the yield strength f_{ybk} and the tensile strength f_{ubk} are indicated by the strength class:*

*f_{ybk} = (digit preceding the dot) * (digit following the dot) * 10 N/mm²*

*f_{ubk} = (digit preceding the dot) * 100 N/mm²*

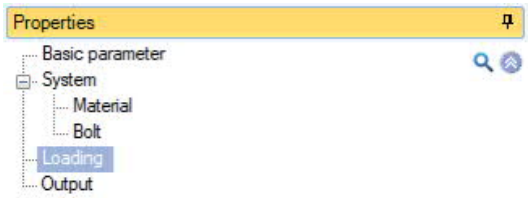
e. g. *F-5.6* *f_{ybk} = 300 N/mm²*

f_{ubk} = 500 N/mm²

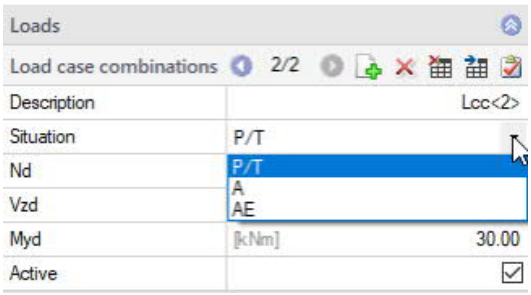
Bolt arrangement: see System

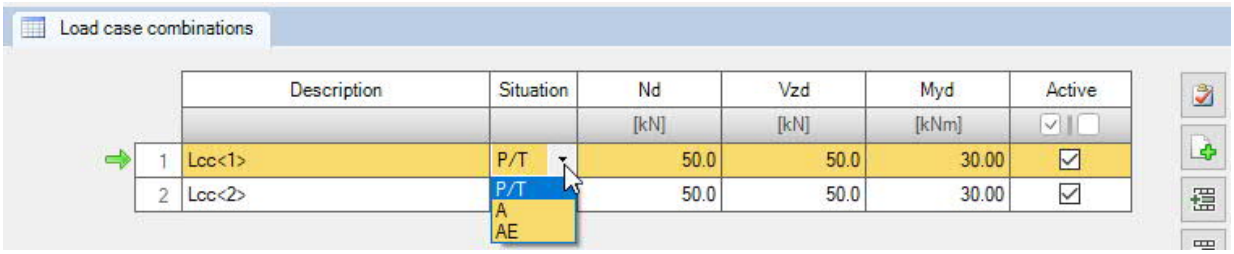
Loading

To access the table of the load case combinations, click on "to the table" or on the tab "Load combinations" below the GUI.



You can add or delete table rows via the icons on the right - as well as via the "Load case combination" icon in the menu ribbon.





You can assign a name to each load case combination.

Situation — Design situation of the load combination
P/T : persistent/transient design situation
A : accidental design situation
AE : seismic design situation

Nd — design value of the axial force at the cut face of the member positive as tension force away from the node.

Vzd — design value of the shear force at the cut face of the member.

Myd — design value of the moment at the cut face of the member (see also dashed fibre in the system diagram).

Active — enables/disables the corresponding load case combination.

Output

The "Document" tab displays the data to be put out.

See also

Output and printing

The output scope is selectable.