ST8 – Standardized Connections DSTV

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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 ▸ Support ▸ Articles/Information ▸ Basic operating instructions.

Application options

The ST8 application allows the design of moment-resisting and pinned I-beam connections of the types IH as well as IS in combination with IK beam notches in accordance with the DSTV guidelines " Typisierte Anschlüsse im Stahlhochbau" (typified connections in steel building construction), edition 2013 as well 2nd edition 2002.

All connections permissible for the defined system are listed as specified in the catalogue of the German Steel Construction Association DSTV. You can further refine the list by defining additional criteria such as the type of connection, the material or the screw strength or size. The software calculates the utilizations for each listed type of connection and generates a well-structured presentation of the connection details including a 3-d model and a 2-d workshop drawing.

Available standards

DSTV Guidelines edition 2013   DIN EN 1993-1-8
DSTV Guidelines edition 2002   DIN 18800 and DIN V ENV 1993-1-1

IH connection
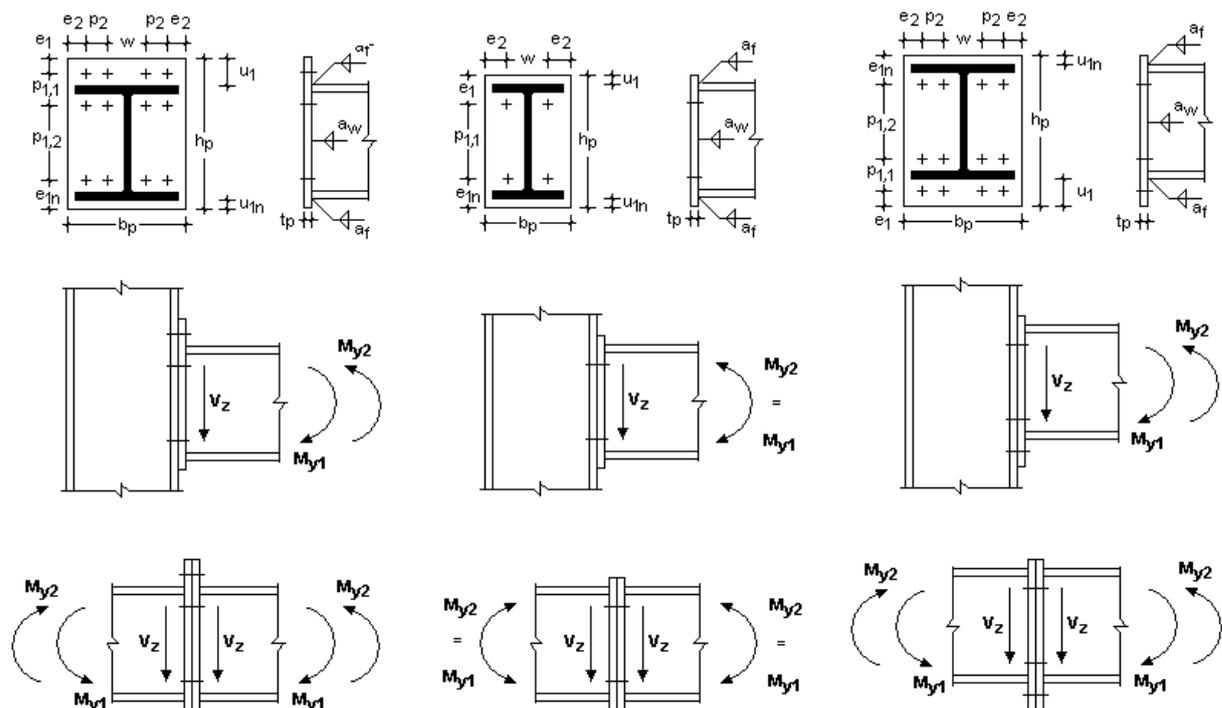
Structural system

- Moment-resisting I-beam connections
- Beam or column connection with dimensioning of the cross section of a continuous column
- Material S235 or S355
- Beams and columns of standard steel shapes such as IPE, HEA, HEB and HEM as well as IPEa, IPEo, IPEv and HEAA
- Same beam heights and positions for systems with beam-column connections on both sides
- Connection with end plate either flush to the surface or projecting on top or bottom and two or four vertical rows of bolts

- Bolts of the strength classes 8.8 or 10.9 with shear joints in the screw shank and a nominal hole clearance of 2 or 3 mm with M27 and M30.
- Either pre-tensioned bolts or bolts that have not been pre-tensioned can be defined.
- Washers shall be provided underneath the bolt head and the nut.
- The weld seam shall be circumferential if the lateral projection exceeds 1.41 a_f.
- Columns marked with "St" shall be braced over their entire width at the level of the beam flanges, with $t_{stiffener} = t_{beam\ flange}$, $b_{stiffener} \geq b_{beam\ flange}$ as well as $a_w = a_f$.

Loading (actions)

- Design values of the internal forces M_y and V_z
- Reverse moment of M_y
- Mainly static loading
- Transfer parameter $\beta = 1$

DIN EN 1993-1-8:

- Low axial force N (normal force) in the beam in compliance with the condition $N/N_{pl} < 0.05$
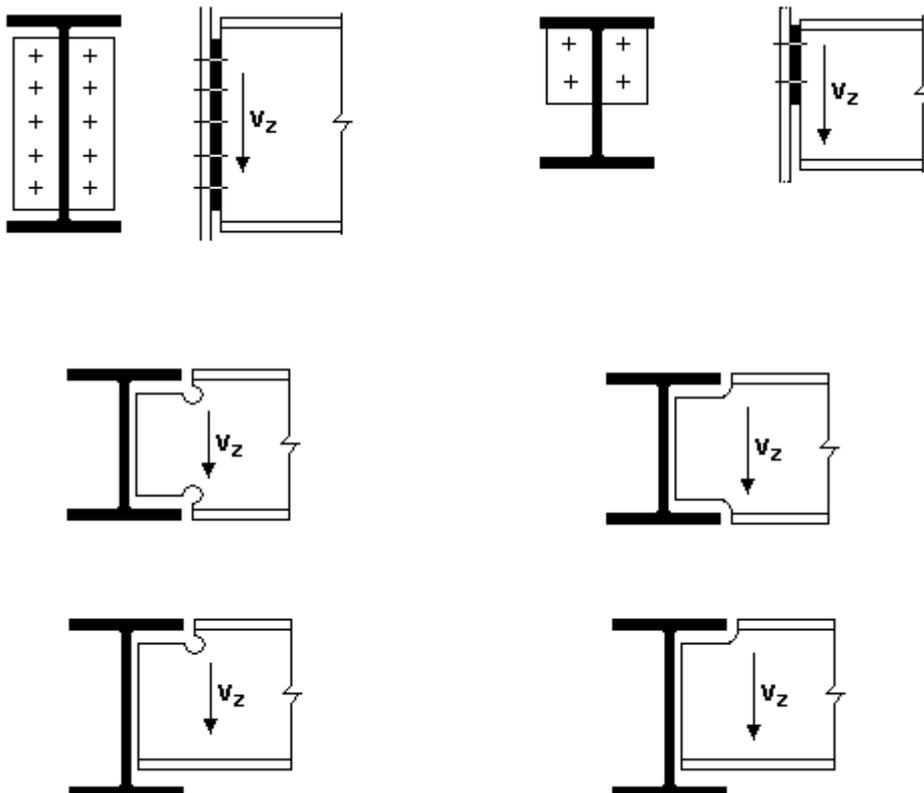- Compressive stress in the column web $\leq 075\,f_{y,wc}$

DIN 18800 and DIN V ENV 1993-1-1:

- Low axial force N (normal force) in the beam in compliance with the condition $N/N_{pl} < 0.1$
- Compressive stress in the column web $\leq 0.5\,f_{y,wc}$
- Compressive stress in the column flange ≤ 180 N/mm^2

IS connection

Structural system

- Pinned I-beam connections with welded end plate

- Beam connection to sheet metal (connection to any component) or to a column web, an unnotched beam web (i. e. connection in the middle of the web) or a notched beam web (flush to the ceiling structure   and, optionally, notched on both sides)

- Material S235 or S355

- Beams of the standard shape series IPE, HEA, HEB and HEM as well as IPEo and IPEv

- The end plate can be welded on centrally or, with unnotched beams, to the flange and the web at the top of the beam

- The weld seam of connections with an end plate can also be in the curvature

- Thickness of the load-bearing component $t_u = t_{u, left} + t_{u, right}$ in systems with connections on both sides

- Bolts of the strength classes 4.6 or 10.9 with shear joints in the screw shank and without pre-tensioning

<u>DIN EN 1993-1-8:</u>

- Nominal hole clearance up to 2 mm

<u>DIN 18800 and DIN V ENV 1993-1-1:</u>

- Nominal hole clearance up to 1 mm

Basis of calculation

The design process in the software is based on the implemented catalogue of the DSTV (German Steel Construction Association) which corresponds to the Guideline "Typisierte Anschlüsse im Stahlhochbau" (Typified connections in steel construction), edition 2013 or 2nd edition 2002, depending on the selected standard.

The calculation of the connections is based on the component method, which decomposes the connection into its individual basic components. For each of the basic components, such as the column web in tension or the bolts in tension, the design resistance is calculated. The global resistance is the sum of the resistances of the individual components.

The guideline cited above gives more information about the verification method used.

Signification of the specified limit states

IH connection

EPB	**E**nd **P**late in **B**ending
BT	**B**olts in **T**ension
BFC	**B**eam Flange/web in **C**ompression
BWT	Beam **W**eb in **T**ension
WELD	WELD seam
*	Elastic distribution of bolt forces
St	Horizontal **St**iffeners in the column web

IS connection

B	**B**eam
BT	**B**ol**t**s
EP	**E**nd **P**late
b	hole **b**earing
s	**s**hear or **s**hear failure
bd	**b**en**d**ing
st	**s**hear frac**t**ure

Explanation of the designation (code) of the connection

IH V.V PP HH MM

The capital letters refer to:

IH	the group of moment-resisting I-end-plate connections
V.V	to be replaced by the code of the end plate type:
	1.1 end plate flush to the surface, two vertical bolt rows
	2.1 end plate flush to the surface, four vertical bolt rows
	3.1 end plate projecting, two vertical bolt rows
	4.1 end plate projecting, four vertical bolt rows
	The digit after the point (1) refers to the revision number

PP to be replaced by the standard shape type

    E for IPE

   Ea for IPEa

   Eo for IPEo

   Ev for IPEv

   A for HEA

  AA for HEAA

   B for HEB

   M for HEM

HH to be replaced by the beam height in cm

MM to be replaced by the bolt size in mm (outer thread diameter)

IS(H) MM N WW

The capital letters refer to:

IS group of moment-resisting I-end plate connections

H with bolt strength of 10.9

MM to be replaced by the bolt size in mm (outer thread diameter)

N to be replaced by the number of bolts

WW to be replaced by the horizontal screw spacing in cm

IK T E.AA

The capital letters refer to:

IK group of notches

T to be replaced by the notch type

   1 notch on one side with bore

   2 notch on both sides with bore

   3 notch on one side, flame cut

   4 notch on both sides, flame cut

E to be replaced by the notch height e in cm

WW to be replaced by the notch length a in cm

Definition of the structural system of a IH connection

Beam

Selection of cross section from the list

System	
Beam	IPE 300 ...
Npld (S235)= 1291	Npld (S355)= 1937 kN

In order to define or select a cross section, click on the steel shape code (in blue). The steel shape selection window is displayed.

All cross sections of the DSTV catalogue are available such as double-T standard shapes, also IPE, IPEa, IPEo, IPEv, HEA, HEAA (under ARBED), HEB as well as HEM.

▸ See the chapter Steel shape selection for further information.

N_{pld}

When you select a profile, the associated N_{pld} value of the materials S235 and S355 is displayed. The maximum neglectable axial force in the connection is calculated with the help of this value.

Loading

Definition of internal forces as design values.

The internal forces shall be specified as design values, i. e. already multiplied with γ_F.

Action			
negligible	Nd=	-20,00	kN
[N / Npl < 0,05]			
	My1d=	-40,00	kNm
Reversal moment	My2d=	10,00	kNm
	Vzd=	25,00	kN

N_d   axial force, compression is negative

In accordance with DSTV, axial force can be neglected up to a relation of $N/N_{pl} < 0.1$. If the division produces a higher value, the connection needs to be changed.

The actual relation is checked by the software.

M_{y1d}   bending moment around the y-axis.

It must always have a negative sign, i. e. produce tension in the top of the beam.

M_{y2d}   reverse moment of M_{y1d}

It must always have a positive sign, i. e. produce tension in the bottom of the beam.

V_{zd}   shear force (in direction of the web)

Connections

Selection of the connection parameters and of a permissible connection as per DSTV catalogue from a list.

Typed sustainable end plate for moments

Selected connection: **IH3.1 E 30 16** — Details — Beam connection

Type	Material	Bolts			t, plate mm	My1,Rd kNm	My2,Rd kNm	Vz,Rd kN	Eta	Column
*	S 235	10.9	*	Number						not
IH1.1	S 235	10.9	M 20	4	30	87,6	87,6	174,2	**0,46**	not
IH3.1	S 235	10.9	M 16	6	20	121,9	58,6	174,2	**0,33**	IPE
IH1.1	S 235	10.9	M 24	4	35	104,9	104,9	174,2	**0,38**	HEA
IH1.1	S 235	10.9	M 27	4	45	113,0	113,0	174,2	**0,35**	HEB
										HEM

You can further reduce the displayed number of types by defining additional criteria such as the type of connection, the material or the screw strength or size.

To do this, select the corresponding items in the selection lists ( ) in the column head.

The asterisk * is used to allow all permitted values of the corresponding parameter.

|		
flush	flush end plate
proj. top	end plate projecting on top
proj. bottom	end plate projecting on bottom
*	any type of end plate
S 235	connection to beam of S235
S 355	connection to beam of S355
*	material S235 or S355

bolts

8.8	bolt strength class 8.8
10.9	bolt strength class 10.9
*	bolt strength class 8.8 or 10.9
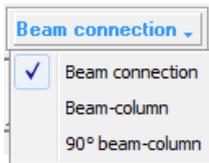
beam connection

Beam column
  - none (= beam-to-beam)
  - IPE
  - HEA
  - HEB
  - HEM

type of the column profile
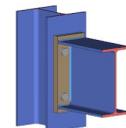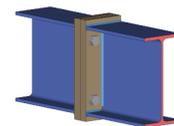
90° beam-to-column

Double-clicking in a row or simple-clicking on the "Details" button accesses the "Connection details" dialog with detailed specifications of the geometry and the resistances of the corresponding connection.

Changes in the geometry or the loading trigger the recalculation of possible connections. Only the permissible connections specified by the DSTV catalogue with a max. utilization ≤ 1 are displayed. The list is sorted according to the utilization.

Sorting order:

You can sort the table rows according to a particular parameter in ascending or descending order by clicking on the corresponding column title.

The highlighted connection is considered decisive for the output and the saving of the item. You can mark several connections.

# Definition of the structural system of a IS connection

Structural system

Beam

Select a cross section as described in the chapter "Definition of the structural system of a IH connection."

Connection

Select the connection configuration in the "Connection" menu.

- Connection to sheet metal (for a connection to a freely definable component)
- Connection to the column web (the connection is applied centrally, the software checks automatically whether the connection width is permissible)
- Connection to the beam web without notch (the connection is applied centrally too, the software checks automatically whether the height of the beam is permissible)
- Connection to the beam web with notch (the beams are designed flush to the ceiling structure, the permissible and required notch and beam heights are checked automatically by the software)
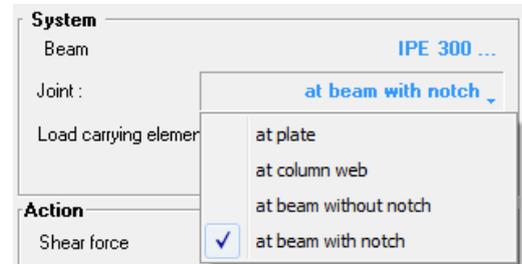
Load-transferring component

If a connection to sheet metal was selected, specify the sheet metal thickness. In the list of the connections, only the versions with lower sheet metal thicknesses are displayed then. To display all variants, enter 0.0 for the sheet metal thickness. In this case, the *req. tu* of the selected connection will become decisive.

For all other connection configurations, you can select the cross section of the column and the beam from the profile selection file.

▸ See the chapter Steel shape selection for further information.

DIN EN 1993-1-8:

In connections where the end plate cannot provide for the required ductility, it must be ensured by the load-transferring component. This applies to all connection variants that are marked as "only suitable for one side".

For the required verification of the ductility, the characteristic yield strength f_{yk} of the load-transferring component must be entered. To facilitate the definition of this parameter, the typical structural steels are summarized in a selection list.
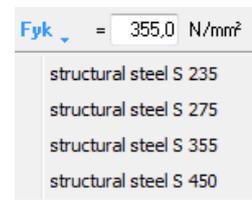
Note: *In the settings for the IS connection, you can adjust the behaviour of the software application, e. g. disable the examination of ductility. In this case, no input field is displayed for f_{yk}.*

Loading

Shear force

Enter the shear force V_{zd} (in the direction of the web) as a design value, i.e. already multiplied with γ_F.

Typified notches

When defining a connection to the beam web with a notch, a selection of permissible notches as specified by the DSTV catalogue is displayed.

You can reduce the listed items to the required parameters by specifying additional criteria such as the material and the notch length.

To do this, select the corresponding items in the selection lists (▼) in the column heads.

The asterisk ***** allows all permitted values for the associated parameter.

Details: detailed information about the geometry and the resistance of the selected (highlighted) notch is displayed.

Type

On one side: notch at the top of the beam.

On both sides: notch at the top and the bottom of the beam

* notch on one or on both sides

Notch length a

40 notch length of 40 mm

…

150 notch length of 150 mm

* any notch length

Note: The selected notch determines the available options for permissible IS-connections. The material that you specify here is automatically transferred to the IS-connection.

Connections

Selection of the connection parameters and a permissible connection as per DSTV catalogue. The available options depend on the previously selected notch.

Options and settings are described in the chapter "Definition of the structural system of a IH connection ▸ Connections.

Bolts 4.6 bolt strength class 4.6

10.9 bolt strength class 10.9

* bolt strength class 4.6 or 10.9

Details: detailed information about the geometry and the resistance of the selected (highlighted) connection is displayed.

DIN EN 1993-1-8:

The end plates of connections of the type "on one side" are characterized by insufficient ductility. The load-transferring component must provide for the required ductility. Therefore, this connection cannot be performed on both sides.

If the thickness and the characteristic yield strength of the load-transferring component are known, the software verifies the ductility of the load transferring side in addition:

The following condition must be satisfied:

$$\frac{d}{t_u} \geq 2{,}8\sqrt{\frac{f_{yu}}{f_{ub}}}$$

with

d	nominal value of the bolt diameter
t_u	sheet thickness of the load-transferring component
f_{yu}	characteristic yield strength of the load-transferring component
f_{ub}	characteristic tensile strength of the bolt

▷ See also the corresponding options in the Settings dialog.

Settings (options)

You can adjust the behaviour of the software in the Settings menu.

IH connection

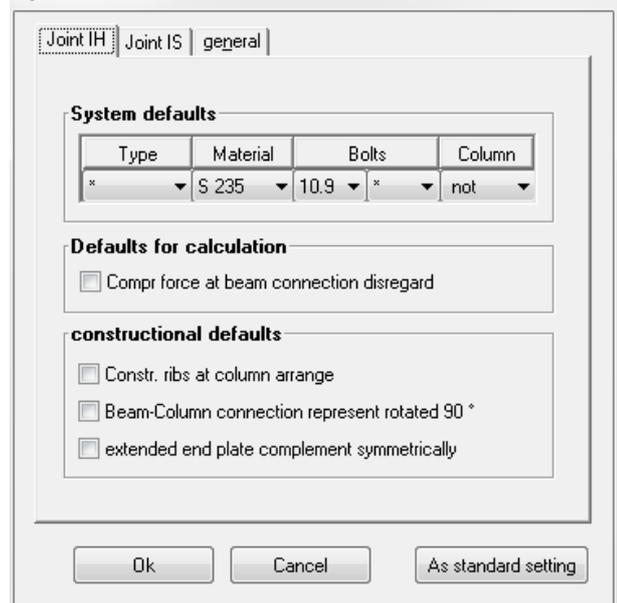|	
System defaults	default assignment of the of the column heads in the result list. You can set preferred values for the standard items.
Design	you can set whether a defined axial compressive force shall be neglected for the availability of connection variants.
Constructive settings	the specifications in this section have no influence on the availability of connection variants. They supplement the configuration by the desired option.

The following defaults can be set:

- Arrangement of constructive stiffeners in the beam-to-column connection

- Representation of the beam-to-column connection rotated by 90°

- Constructive symmetrical supplement of the projecting end plate
(the following conditions apply in this case: $M_{y2d} = M_{y1d}$ and $M_{y2,Rd} = M_{y1,Rd}$)

IS connection

System defaults   default assignment of the column heads in the result list. You can set preferred values for the standard items.

Design   you can select whether the verification of sufficient ductility in combination with DIN EN 1993 shall be neglected.

If the verification of sufficient ductility shall be performed, you can optionally select whether configurations with insufficient ductility shall be excluded in the result list. Otherwise, not permissible variants are marked in red in the output.

General

Design   the result list includes all configurations compatible with the defined system, also connections with a utilization of up to 100 %. You can optionally include configurations with a utilization higher than 100 %. Not permissible configurations are marked in red.
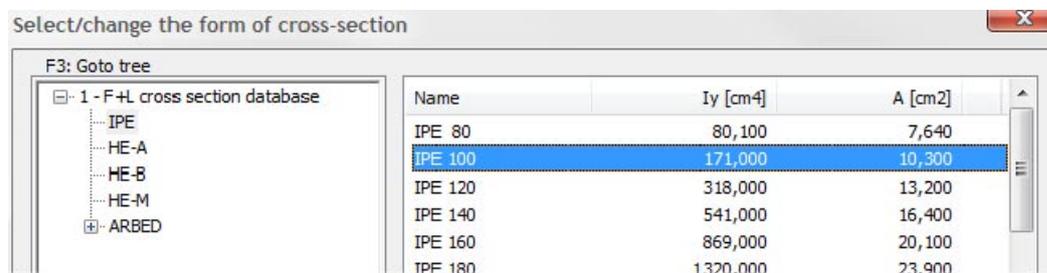
Steel shape selection

You can select among all I-type standard steel shapes specified in the DSTV catalogue.

The following steel shapes are available for IH connections:

IPE, IPEa, IPEo, IPEv, HEA, HEAA (ARBED folder), HEB as well as HEM;

The following steel shapes are available for IS connections:
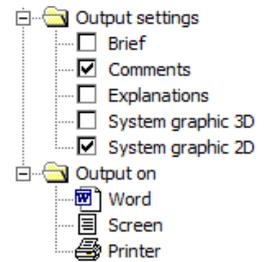
IPE, IPEo, IPEv, HEA, HEB as well as HEM.

The selection of standard shapes is described in the document "Select - edit cross section_eng.pdf"

Output

Output of the system data, results and graphics on the screen or printer.

The Output item in the Main menu allows you to start the output on a printer or the screen.

Output profile		you can define the scope of data to be put out (output profile) by checking or unchecking the corresponding options.
	Summary print	output of the essentially required data.
	Comments	output of user-defined comments to the system.
	3-d system graph	three-dimensional representation of the structural system, i. e. the connection
	2-d system graph	two-dimensional representation of the structural system as a workshop drawing
Word		if installed on your computer, the text editor MS Word is launched and the output data are transferred. You can edit the data in Word as required.
Screen		displays the values in a text window on the screen
Print		starts the output on the printer

Application-specific icons

The buttons allow you to select the output on the screen

- 3-d system graph

- 2-d system graph

If the "2-d graph" is displayed the following options are enabled.

- Dimensioning

- Designation

- Representation of the internal forces