

# Steel Section Design ST7

*Note:* ST7 was replaced by the successor program "[SQN+ Verification of Steel Cross-Sections](#)" with release 2023-2.

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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.frilo.com](http://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

ST7 is suitable for the verification of the structural safety of a steel cross section.

### Available standards

- DIN EN 1993
- ÖNORM EN 1993
- DIN 18800

### Verifications

#### EN 1993:

The steel cross section is categorized in one of the cross section classes 1 to 4 in accordance with the applying load and the  $c/t$  ratio of its compression-loaded parts. The verification is determined by the classification.

The verification of cross sections of the classes 1 to 3 is based on the equations 6.1 (stress resistance verification) and 6.2 (utilization of plastic load-bearing capacities in accordance with the cross section class).

The verification of class 4 cross sections with effective stiffness is currently only implemented for I shapes in accordance with eq. (6.1).

The structural safety verification of open, thin-walled cross sections in accordance with Kindmann/Frickel - Stahlbau, magazine 10/1999 is also available.

The user can calculate cross sections with three limbs, such as U-channel sections or single- or double-symmetrical I-shapes under biaxial loading including Saint-Venant's torsional moment and warping torsion.

#### DIN 18800:

The description of the calculation in accordance with this standard is available on demand.

### Interfaces and batch processing

In addition to the verification of a single cross section, ST7 allows you to handle a batch with any number of cross sections in the form of a table.

You can import profile sections from the applications

- S7 - Portal Frame
- BTII - Lateral Torsional Buckling Analysis
- DLT - Continuous Beam

into the batch of ST7 together with the pertaining internal forces. ST7 provides for the closer examination of the cross section's load-bearing capacity.

## Basis of calculation

You can find the description of a calculation in accordance with DIN 18800 and the partial internal forces method in accordance with Kindmann/Frickel in our prior documentation (on demand).

## Definition of the structural system

The cross section is defined by specifying or selecting

- the material
- the shape
- the internal forces

The structural safety of this cross section is verified in accordance with the selected method.

### Batch processing of several cross sections

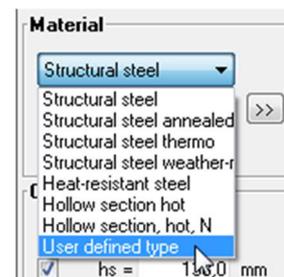
To calculate several cross sections simultaneously in order to compare them, you can add them to an output batch and have them processed by the software.

## Material

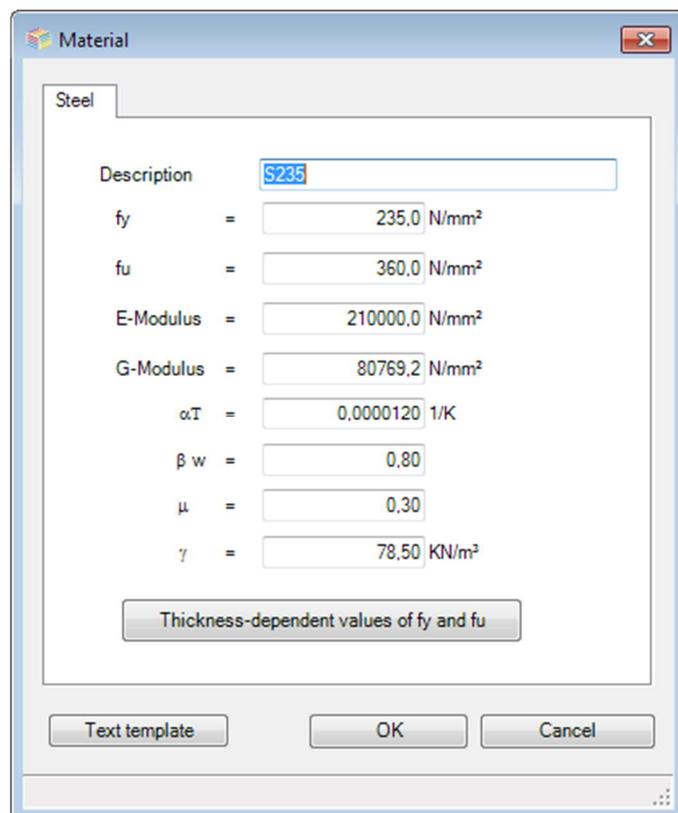
The material can be defined via selection lists that depend on the selected code.

### Free material definition

To specify the required values manually select user-defined material and click on the  button.



Enter a name for the material and the desired properties.



## Cross section

### Selection of the cross section

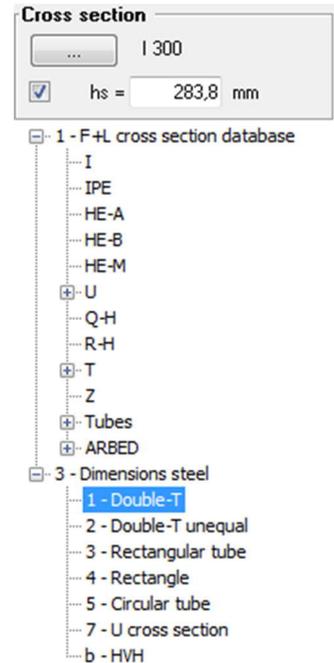
Click on the  button to select/define a new cross section or edit a previously defined section → the steel shape selection window is displayed.

See also the document [Select - edit cross section](#)

I, U, T, Q-H, R-H, Z and ARBED steel shapes as well as pipes are available for selection. Not every available verification method is suitable for each cross section.

The option "Steel dimensions" allows you to freely define a cross section.

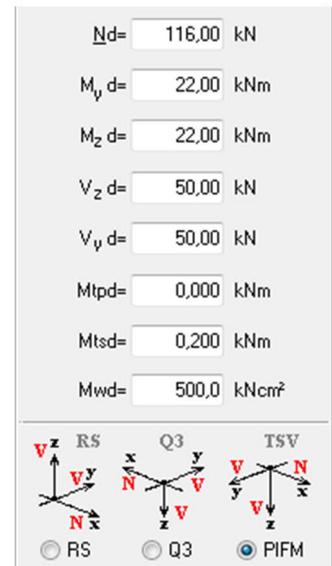
hs check this option to define the equivalent web height for the verification in accordance with the [partial internal forces method](#). Otherwise,  $h_s$  is internally calculated from the distance of the centres of gravity of the flanges.



## Loading - internal forces

Specify the internal forces as design values.

$N_d$	axial force, compression is negative
$M_{y_d}$	bending moment around the y-axis
$M_{z_d}$	bending moment around the z-axis
$V_{z_d}$	shear force in the direction of the z-axis
$V_{y_d}$	shear force in the direction of the y-axis
$M_{t_{pd}}$	primary torsional moment (St. Venant's torsion)
$M_{t_{sd}}$	secondary torsional moment (warping torsion)
$M_{w_d}$	warping moment (from warping torsion)



### Sign definition

Define the internal forces in relation to one of the three systems of coordinates shown. Changing the system of coordinates results in a change of the signs of the internal forces and the system is recalculated in the new system of coordinates.

The following condition applies to all of the three systems of coordinates: the y- and x-axes lie in the section plane of the shape, the x-axis relates to the longitudinal axis of the intersected member.

## Verification method

This option allows you to define whether the verification of the cross-sectional bearing capacity should be based on the elastic-elastic or elastic-plastic method. Select the associated type of verification subsequently.

Each time you edit a defined value, the structural system is recalculated and the utilization ratio of the cross section and the cross section class (QKL) are displayed.

<b>Resistance</b>	$\eta$ , plastic = 0,76	<b>CSC</b>	1
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**Design procedure**

elastic - elastic     
  elastic - plastic

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**Elastic - plastic**

Design acc. to paragraph 6.2 c.f

Partial Internal Forces Method according to Kindmann/ Frickel

Please note that the utilization ratio is determined by the limit load factor and the combination of internal forces when using the elastic-plastic method whereas it is calculated from the ratio  $\frac{\text{vorh.}\sigma}{\text{zul.}\sigma}$  when using the elastic-elastic method.

### Output batch

To add the verified cross section to the output batch, click on the Add button.

See the chapter [Output batch](#).

## Settings - verification options

This menu option is only enabled in combination with DIN 18800.

## Output

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

Screen displays the values in a text window on the screen

[Printer](#) starts the output on the printer

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.

File ▶ page view displays a print preview of the PDF file.

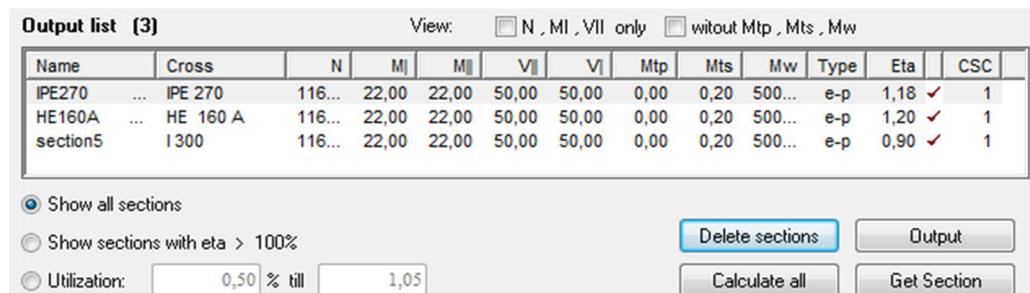
## Output batch

The output batch allows you to handle any number of cross sections in a table.

To add a verified cross section to the output batch, click on the add button. In the subsequent dialog, you can enter a name for the cross section.



Click on the "Cross section manager" button to switch from the system definition to the output batch.



Name	Cross	N	M	MII	VI	V	Mtp	Mts	Mw	Type	Eta	CSC
IPE270 ...	IPE 270	116...	22,00	22,00	50,00	50,00	0,00	0,20	500...	e-p	1,18	✓ 1
HE160A ...	HE 160 A	116...	22,00	22,00	50,00	50,00	0,00	0,20	500...	e-p	1,20	✓ 1
section5	I 300	116...	22,00	22,00	50,00	50,00	0,00	0,20	500...	e-p	0,90	✓ 1

You can optionally display or hide individual columns (view).

### Sort

By clicking on the column title, you can sort each column in ascending or descending order.

### Filters for the listing of cross sections

The options below the table allow setting filters for the rows to be displayed.

The following options are available to filter the sections shown in the list:

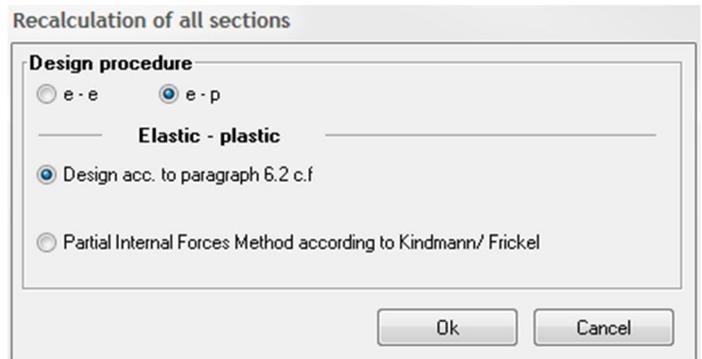
- all sections
- all sections with a utilization ratio of more than 100 %
- all sections with a maximum utilization between user-defined limits (in per cent). Maximum utilization in this context means the maximum loading rates in the specified range. To display all sections with a utilization rate greater than the specified lower limit, enter 0.0 for the upper limit.

### Display definition dialog for a section

Double-click on a section in the table or activate the "Add to the system" button to display the definition dialog for this section. You can edit the corresponding properties as desired.

### Recalculate

Click on the button "Calculate all" to recalculate all sections with the verification method defined in the subsequently displayed dialog.



### Delete sections

Clicking on the "Delete sections" button deletes the currently selected sections.

To select several sections at a time:

Press the Shift key and click on the first and the last row of a block of successive rows to select them.

Press the Ctrl key and click on the individual rows you want to select.

### Output

Click on the Output button to display the results of the selected sections on the screen. You can select several sections by using the functions described above.

## Output profile

By checking or unchecking the corresponding options you can determine the scope and contents of the data to be put out.

#### Output batch

This option is not available in the system definition section because only the currently defined section is shown when you change to the output window.

In all other cases, select via this option whether the selected sections in the output batch or just the previously defined section should be put out.

#### Summary print

Output with or without intermediate values

#### CSC classification

Classification of the cross section

#### Additional stress resistance verification

This option is not available in combination with the summary print.

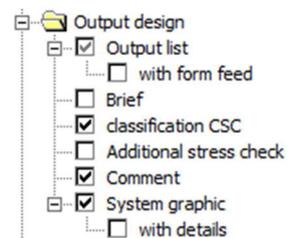
Additional output of the stress resistance verification in accordance with eq. 6.1 (el.-el.) if the calculation was based on the elastic-plastic method.

#### Item text

Output of the texts entered as "Comments".

#### System graphs

Graphic of the cross section. Check the "With details" option to display stress points and buckling fields in the cross section.



## Application-specific icons



The buttons allow you to select the output on the screen

- of the shape
- of the shape with details
- of the shape with MaxSigma values

## Import/export ASCII interface of ST7

The data of an item can be exported to a file or imported from a file with a format defined by Frilo.

Access: File ▶ Import/Export ▶ F+L ASCII

## Reference literature

- EN 1993 [2010-12]
- DIN 18800, November 1990, Part 1
- PETERSEN, CHR.: Stahlbau. 3rd Edition. Braunschweig, Wiesbaden (Vieweg & Sohn) 1993.
- RUBIN, H.: "Interaktionsbeziehungen zwischen Biegemoment, Querkraft und Normalkraft für einfachsymmetrische I- und Kasten-Querschnitte bei Biegung um die starke und für doppelsymmetrische I-Querschnitte bei Biegung um die schwache Achse", in: Der Stahlbau 47.1978, Booklet 3, page 76 - 85.
- RUBIN, H.: "Interaktionsbeziehungen für doppelsymmetrische I- und Kasten-Querschnitte bei zweiachsiger Biegung und Normalkraft", in: Der Stahlbau 47.1978, Booklet 5, page 145 - 151 and 174 - 181 (second part and conclusion).
- KINDMANN, R. ; FRICKEL, J.: „Grenztragfähigkeit von I-Querschnitten für beliebige Schnittgrößen“, in Der Stahlbau 68.1999, Booklet 4, page 290 – 301
- KINDMANN, R. ; FRICKEL, J.: Elastische und plastische Querschnittstragfähigkeit, 1st Edition. Berlin, Ernst & Sohn 2002