

Continuous Beam Steel STM+

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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 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".

Possible applications

The STM+ program calculates single and multiple span steel beams.

A cantilever can also be selected as a special case.

Overlay and dimensioning are carried out automatically.

The output is compact and can be configured in small parts.

The program is designed for a graphically interactive way of working.

Norms

- DIN EN 1993
- ÖNORM EN 1993
- BS EN 1993
- EN 1993

Wizard

The entries required for a simple system can be made with an Wizard.

This basic system can then be modified and supplemented very easily with the graphical-interactive input.

Supports/holders

You can enter bearings in the Z direction (and in the case of two-axis loading in the Y direction) as well as for the rotation around the y axis. There is always the option of rigid mounting or entering a spring value. A support depression can be specified for the individual bearings. Alternatively, the spring values can also be calculated by the program from a column that can be defined below and/or above the beam and then adopted for the beam calculation.

For the proof of stability, the brackets can be defined on the cross-section. A distinction is made between the position of the retainer in the longitudinal direction of the carrier and the position on the cross section.

Loads

Load types: constant, trapezoidal, triangular, single load and single moment.

Interfaces to further programs

- The 2nd Theory of Torsion-Bending BTII
- Spatial Framework RSX+
- Continuous Beam Timber HTM+
- Forwarding of the bearing loads to the programs Reinforced Concrete Column B5+, Single-Span Steel Column STS+ and Timber Column HO1+

Additional options

STM-2 2-axis
STM-S Stability

Quick start and graphical input

The Wizard

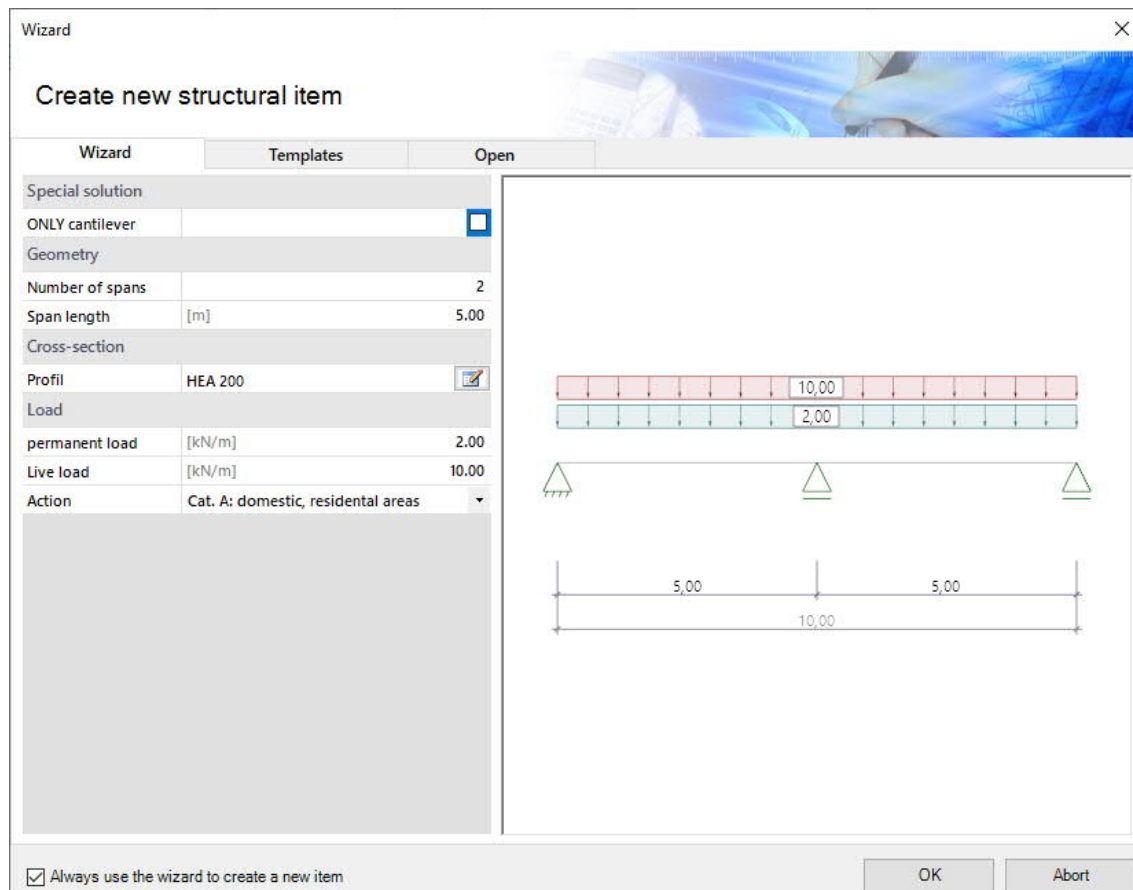
The Wizard is displayed by default when a new position is created - it can also be switched off if necessary (option in the lower window area).

In the [Wizard](#), the entries required for a simple system can be made in an interface.

These are:

- number of spans (or optionally only cantilever)
- span length
- cross-section
- permanent line load
- variable line load and type of action

This basic system can then be modified and supplemented very easily with the graphical-interactive input.



Program interface

The screenshot shows the FRILO software interface with several callout boxes highlighting key features:

- Output document**: Points to the 'Document' button in the top toolbar.
- Calculation / Results**: Points to the 'Calculate' and 'Results' buttons in the top toolbar.
- Visibility**: Points to the 'Visibility' button in the top toolbar.
- Interactive text links**: Points to the text 'Steel girder, DIN EN 1993:2015, Steel S235, CS constant HEA 200, with dead load side fixing: continuously supported' in the main workspace.
- Loads**: Points to the red arrows representing point loads on the beam diagram.
- Objects: Loads, fields, supports usw. – Context per right mouse click**: A general callout for the main workspace.
- New field / Cantilever**: Points to the left support of the beam.
- Bearing**: Points to the central support of the beam.
- Editable dimensional chains**: Points to the dimension lines below the beam.
- Tables**: Points to the 'Loads' table at the bottom of the interface.

| Reference | Load type | Action | A [m] | L1 [m] | L2 [m] | W1 [kN] | W2 [kN] | Unit | Factor | per B | Span wise | Acting | Acting | Designation |
|-----------|-----------|----------------------------|-------------------------------------|--------|--------|---------|---------|------|--------|-------------------------------------|-----------|----------------|---------------|-------------|
| 1 | System | Uniformly distributed load | Permanent loads | — | — | — | 2.00 | kN/m | 1.00 | <input checked="" type="checkbox"/> | No | simultaneously | alternatively | |
| 2 | System | Uniformly distributed load | Cat. A: domestic, residential areas | — | — | — | 10.00 | kN/m | 1.00 | <input checked="" type="checkbox"/> | Yes | none | none | |
| 3 | System | Point load | Cat. E: storage areas | 2.00 | — | — | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 1 | none | |
| 4 | System | Point load | Cat. E: storage areas | 4.00 | — | — | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 1 | none | |
| 5 | System | Point load | Cat. E: storage areas | 8.00 | — | — | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 2 | none | |
| 6 | System | Point load | Cat. E: storage areas | — | — | — | 0.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 2 | none | |

Graphic input

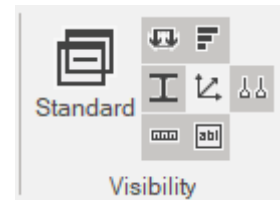
The graphic input is structured in such a way that all inputs can be accessed directly in the graphic window. For example, dimensions or load values can be clicked on and changed directly. Other entries are made through the context menus of the individual objects (field, bearing, load...) or through the interactive texts at the top left. Fields and cantilevers can be added using the symbols on the right and left.

It is also possible to move supports or loads that do not extend over the full length of the beam with the mouse or by entering a coordinate value.

See also "[Interactive Graphics](#)" in the operating principles.

Visibility

Individual objects can be shown and hidden in the graphics window as required. The individual switches can be found in the menu ribbon under "Visibilities". You can show or hide the load, cross section, dimensional chains, load, coordinate system, interactive text links and sections.

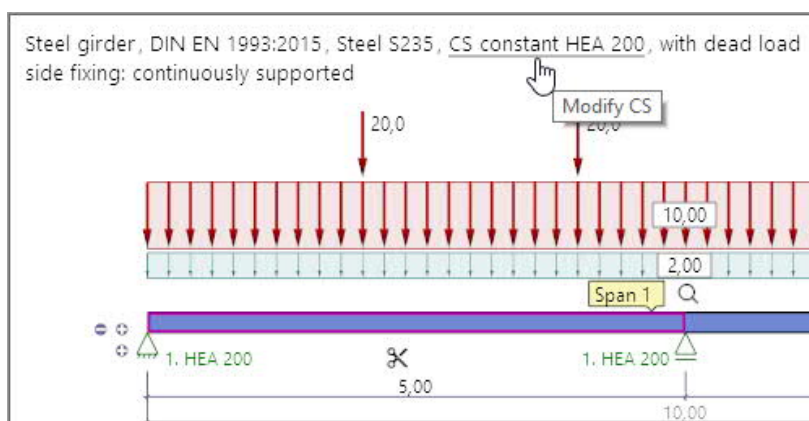


After the calculation, the workload is displayed in the lower right corner of the graphic window and offers a good overview of the economic efficiency of the system entered.

Interactive texts

The texts displayed at the top left are interactive and can be clicked on. These "text links" are used to call up dialogues that have no graphic representation.

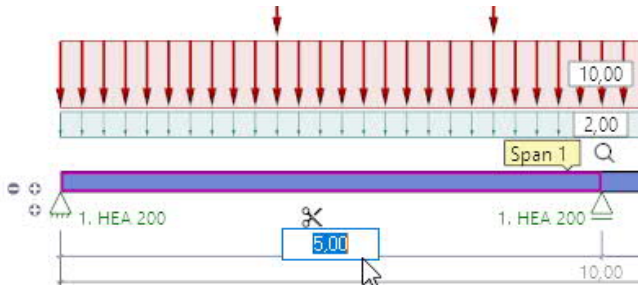
Clicking on the text section with the standard starts the basic settings dialog, clicking on the material leads to the material properties. If you want to modify the cross-section, click on the cross-section to open the cross-section selection. By clicking on "with dead weight", the consideration of the dead weight can be controlled.



Interactive dimensional chains

As in all Plus Programs, the dimensions can also be edited in STM+ and can be changed directly in the graphic.

Tip: the span lengths can also be changed by moving a bearing. To do this, click the bearing with the left mouse button, hold the mouse button and move the bearing.

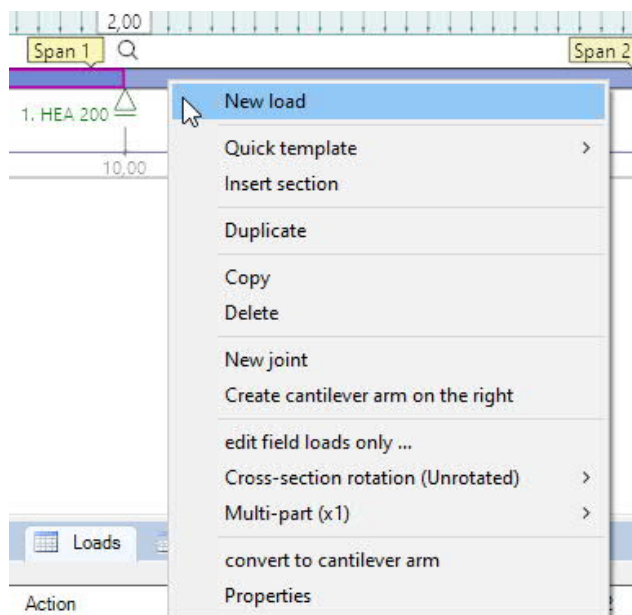


Context menu

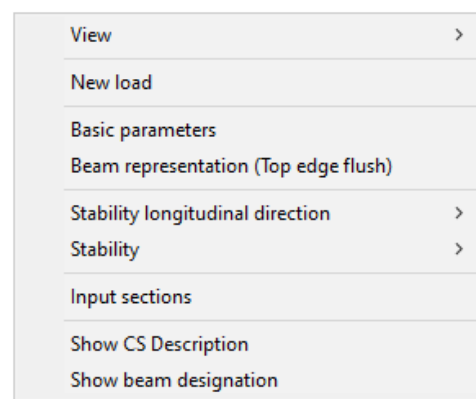
There are appropriate context functions for each object (field, bearing, load, etc.). These functions are displayed with the right mouse button and, as the name suggests, they match the selected object.

A general context menu appears when no object is selected. Here you can find functions that do not represent a graphic object, such as load cases, settings, visibilities.

Details on the functions of the context menu are described for fields, loads, bearings and general functions.



Context menu „Span“



Context menu „General“

Bearing

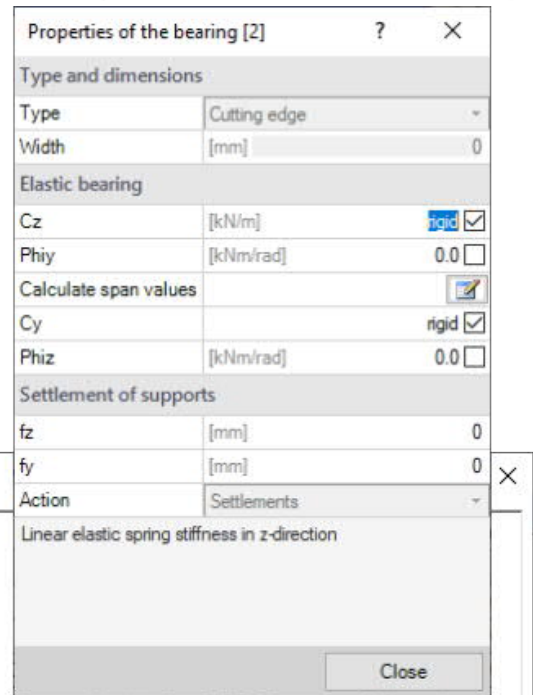
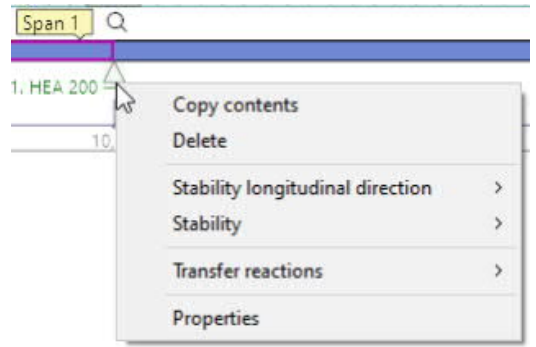
The support properties are called up by double-clicking on the bearing or by right-clicking and making the appropriate selection in the [context menu](#). Here it is also possible to delete supports or to transfer the properties of the support to another support using the "Copy contents" function. In addition, the [fixtures for the stability verification](#) can be defined here.

You can enter bearings in the Z direction (and in the case of biaxial loading in the Y direction) as well as for the rotation around the y axis. There is always the option of rigid mounting or entering a spring value.

A lowering of the supports can also be specified for the individual bearings.

Calculate spring values

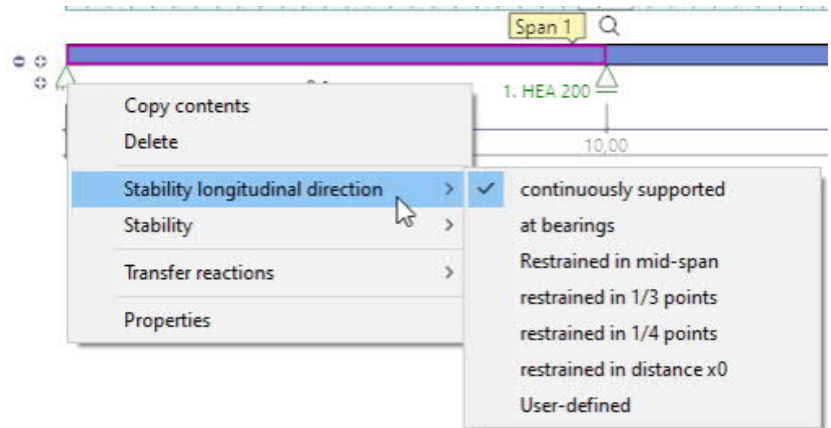
Alternatively, the spring values can also be calculated by the program from a column that can be defined below and/or above the beam and then adopted for the beam calculation.



| Spring values on Support | | | |
|--------------------------|-----------|-----------------|-------------------------------------|
| Lower support | | | |
| Coil spring | | | <input checked="" type="checkbox"/> |
| Torsion spring | | | <input checked="" type="checkbox"/> |
| Bearing of the support | | jointed bearing | |
| h | [m] | 2.50 | |
| Cross-section | | 1. HEA 200 | |
| C below | [kN/m] | 451920.00 | |
| Phi lower | [kNm/rad] | 9303.8 | |
| Upper support | | | |
| calculated values | | | |
| C (Sum) | [kN/m] | 451920.00 | |
| Phi (Sum) | [kNm/rad] | 9303.8 | |
| values to be accepted! | | | |
| Coil spring | C | [kN/m] | 451920.00 |
| Torsion spring | Phi | [kNm/rad] | 9303.8 |

Holders / Stability

You can also use the context menu to define the holders on the cross-section for the stability analysis. A distinction is made between the position of the fixation in the longitudinal direction of the girder (stability in the longitudinal direction) and the position on the cross section (stability of load application).



Stability in the longitudinal direction of the girder

A distinction can be made here between continuous mounting, mounting only on the bearings, additionally in the center of the field or in the third or quarter points of the fields.

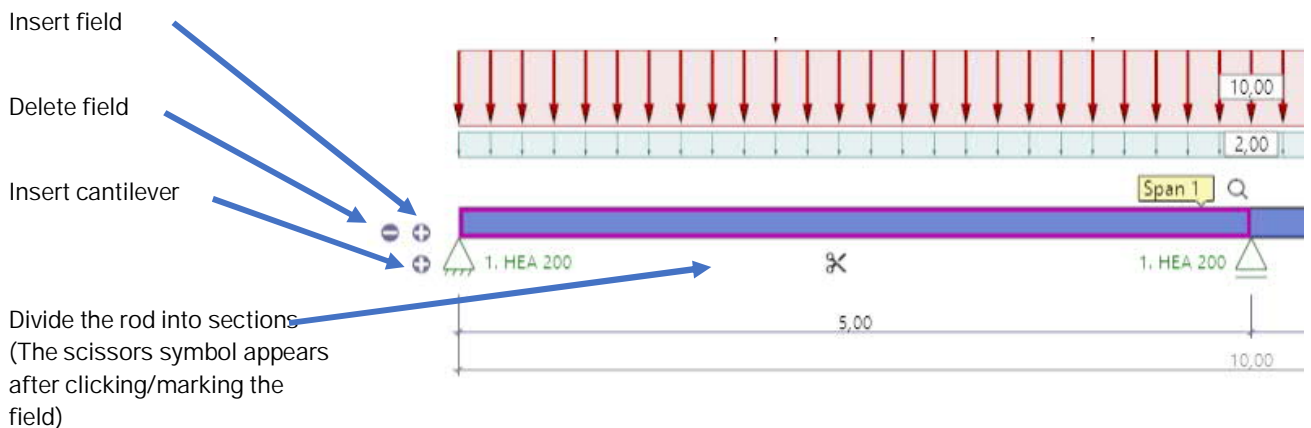
In addition, an even distance can be specified using the "At distance X0" option. With "User-defined" the holders can be completely freely defined.

Stability of load application / position on the cross-section

In addition to the shear center, the lower and upper chords can be selected.

Insert field / cantilever, split bars

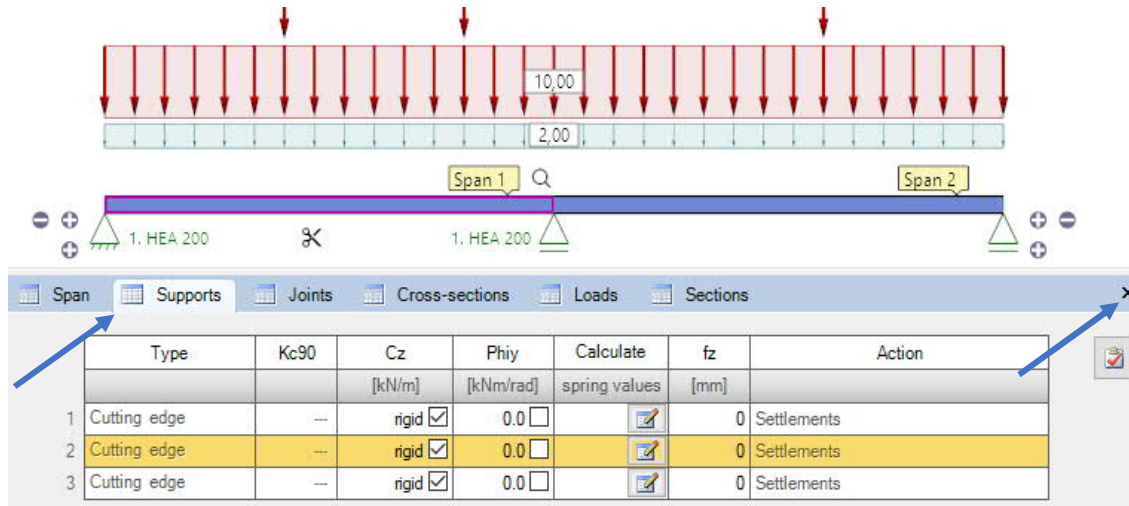
You can also insert new fields, cantilevers or split bars into bar sections directly via the graphic. The symbols on the carrier are intended for this.



Tables

Several tabs are visible on the left in the lower area of the graphics window. A click on one of these tabs opens the respective table - the support table is open in the picture.

Clicking on the cross on the right side closes the table again.

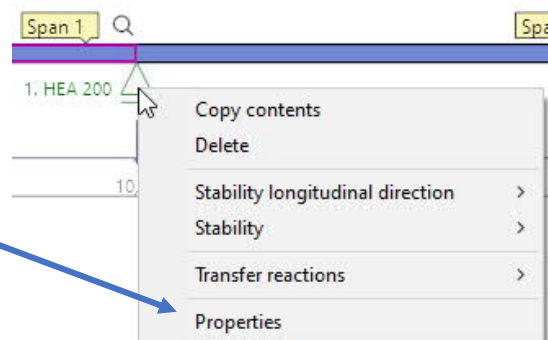


The screenshot shows a beam model with a distributed load of 10.00 kN/m over a span of 2.00 m. The beam is supported by two HEA 200 sections. The 'Supports' table is open, showing the following data:

| Type | Kc90 | Cz [kN/m] | Phiy [kNm/rad] | Calculate spring values | fz [mm] | Action |
|----------------|------|---|------------------------------|----------------------------|------------|-------------|
| 1 Cutting edge | --- | rigid <input checked="" type="checkbox"/> | 0.0 <input type="checkbox"/> | <input type="checkbox"/> | 0 | Settlements |
| 2 Cutting edge | --- | rigid <input checked="" type="checkbox"/> | 0.0 <input type="checkbox"/> | <input type="checkbox"/> | 0 | Settlements |
| 3 Cutting edge | --- | rigid <input checked="" type="checkbox"/> | 0.0 <input type="checkbox"/> | <input type="checkbox"/> | 0 | Settlements |

All input values of the table can also be found in the context menu of the respective object under "Properties".

Please also read the [table entry](#) in the operating principles.



The context menu for the support object shows the following options:

- Copy contents
- Delete
- Stability longitudinal direction >
- Stability >
- Transfer reactions >
- Properties

Loads

| Reference | Load type | Action | A | L1 | L2 | W1 | W2 | Unit | Factor | per B | Span wise | Acting | Acting | Designation |
|-----------|-----------|----------------------------|-------------------------------------|------|-----|-----|-------|------|--------|-------------------------------------|-----------|----------------|---------------|-------------|
| | | | [m] | [m] | [m] | | | | | <input type="checkbox"/> | | simultaneously | alternatively | |
| 1 | System | Uniformly distributed load | Permanent loads | --- | --- | --- | 2.00 | kN/m | 1.00 | <input checked="" type="checkbox"/> | No | none | none | |
| 2 | System | Uniformly distributed load | Cat. A: domestic, residential areas | --- | --- | --- | 10.00 | kN/m | 1.00 | <input checked="" type="checkbox"/> | Yes | none | none | |
| 3 | System | Point load | Cat. E: storage areas | 2.00 | --- | --- | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 1 | none | |
| 4 | System | Point load | Cat. E: storage areas | 4.00 | --- | --- | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 1 | none | |
| 5 | System | Point load | Cat. E: storage areas | 8.00 | --- | --- | 20.0 | kN | 1.00 | <input checked="" type="checkbox"/> | No | Sim 2 | none | |

Reference Choose whether the load entry relates to the entire system or just to a single field. In general, when referring to the system, the distance (column A) refers to the left edge of the system and when referring to the field to the beginning of the field on the left.

Load type Selection: uniform load, trapezoidal load, triangular load, single load, single moment.

Action Selection of the type of action from a list.

Columns A, L1 / L2 and W1 / W2 are used depending on the type of load.

To check your entries, check the load representation in the graphic and pay attention to the selected reference point (see "Reference" above).

A Distance between the start of the load and the reference point.

L1 / L2 Length of the load (L1) or, in the case of a triangular load, the left (L1) and right (L2) load section.

W1 / W2 Load value W1 or with trapezoidal load start (W1) and end value (W2).

Unit Display of the unit. Note: the units can be changed via File - Settings.

Factor Optional input of a load factor.

per B Line load per beam (is not influenced by the beam spacing).

Span wise Here it is defined whether loads that are entered over several spans are to be applied span wise by the program or are only taken into account in combination.

Acting Here you can define (several) groups (Sem 1, Sem 2, etc.) and assign them to the loads. Loads of a group are always applied together.

Acting alternatively Here you can define (several) groups (Alt 1, Alt 2, etc.) and assign them to the loads. Only one of the loads of an alternative group is ever applied. A load over several spans is considered to be one load and is not used as an alternative span wise.

Designation Optional input of a designation text.

Cross-sections

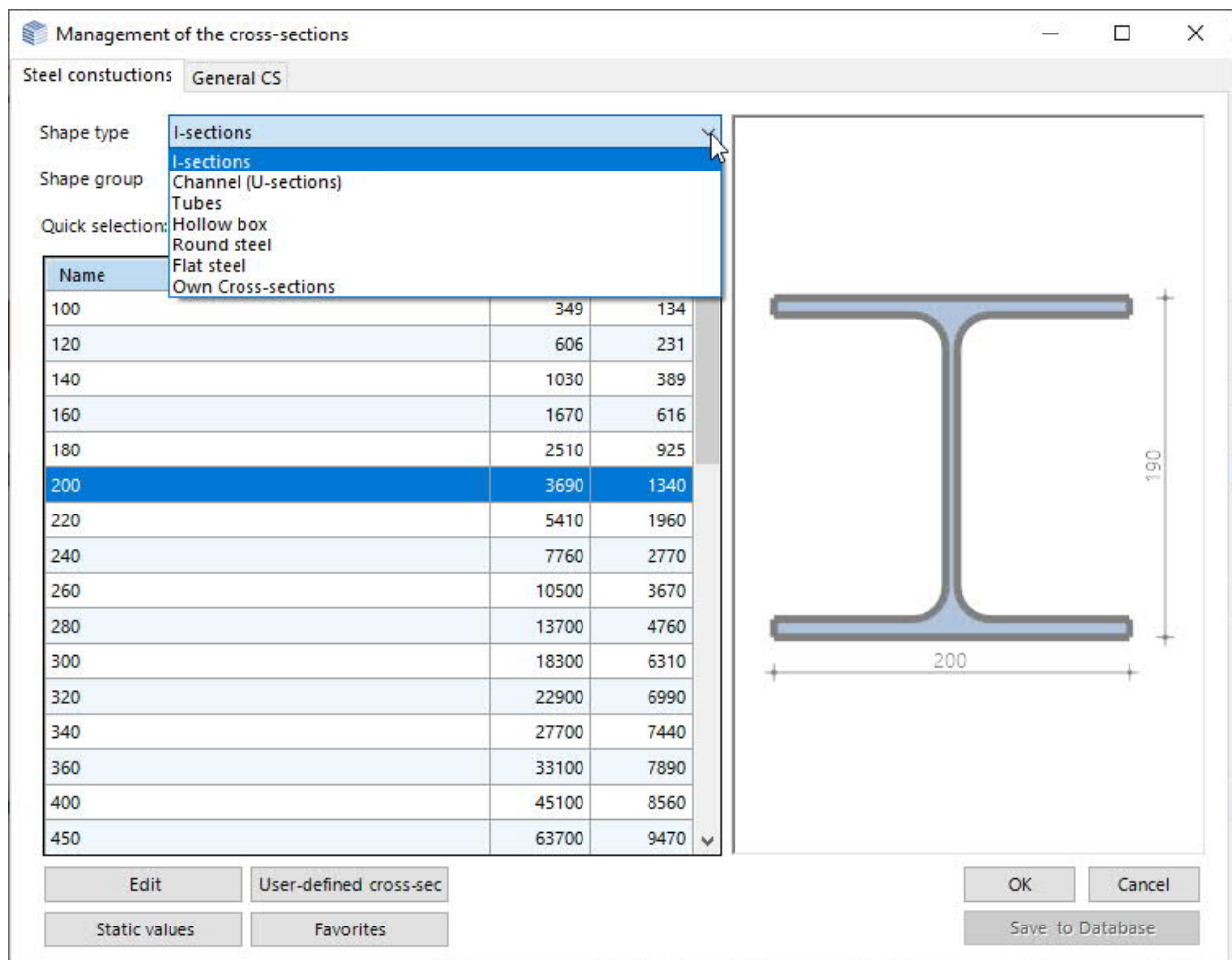
An extensive selection of profiles is available in the program.

Each profile can be used as the basis for processing. The "Edit" function opens a dialog for adapting the geometric values of a profile. Custom profiles can also be created. If this self-defined profile is also to be used outside for other programs or systems, the profile can be saved in a USER database.

For quick access to preferred profiles, the favorites are stored. Each profile can be added to the list of favorites using the context menu. This list is saved in the personal settings on this workstation.

All static values of a profile can be displayed.

See also document [Cross-Section Selection-PLUS](#).



„Properties“ menu

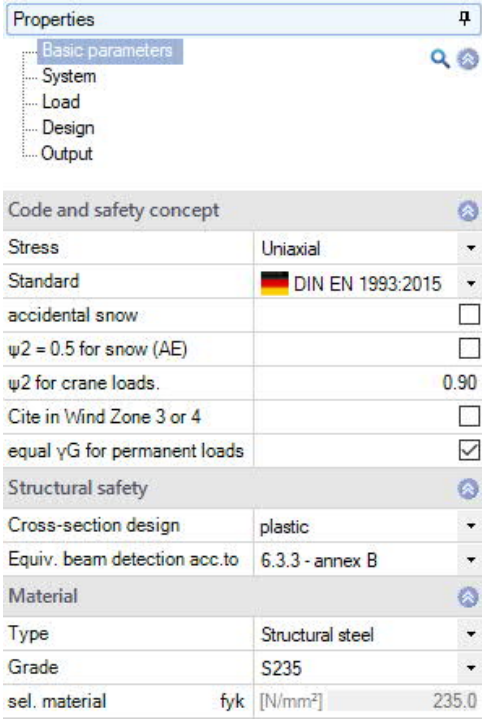
As an alternative to the pure interactive input in the graphics window, all input parameters can be reached in the left menu.

This properties menu bar can be expanded and collapsed as required - see [operating instructions](#).

Tip: individual parameters can be found quickly using the [search magnifier](#).

Basic parameters

Code and safety concept

| | |
|--|---|
| <p>Stress Uni- or biaxial</p> <p>Standard Selection of the norm. See also possible applications.</p> <p>Accidental snow Here you define whether, in addition to the usual design situations, the snow loads should also be automatically applied as an accidental action. The load factor for the accidental snow loads can be freely specified or automatically determined by the program.</p> <p>$\psi_2=0,5$ for snow Specifies whether the combination coefficient ψ_2 for the action of snow should be increased to a value of 0.5 in the earthquake (AE) design situation. See introductory decrees of the federal states, e.g. Baden-Württemberg.</p> <p>ψ_2 for crane loads Combination coefficient ψ_2 for crane loads (= ratio of permanent share to total crane load).</p> <p>Cite in Windzone Indicates whether the building is located in wind zone 3 or 4. In this case, the “snow” action does not need to be included as an accompanying action to the “wind” lead action.</p> <p>equal γ_G ... If the option is selected, all permanent loads or load cases are applied together with the same partial safety factor ($\gamma_{G,sup}$ oder $\gamma_{G,inf}$). Otherwise all permanent loads or load cases are combined with $\gamma_{G,sup}$ and $\gamma_{G,inf}$.</p> |  |
|--|---|

Structural safety

Cross-sections design This takes place elastically according to equation 6.1 or plastically according to equation 6.2.

Equiv. Beam detection acc. to This is done according to 6.3.3 (annex A or B) or 6.3.4

Material

| | |
|---------------|---|
| Type | Choice of standardized steel type or user-defined input. |
| Grade | Choice of standardized steel quality or user-defined input (characteristic values). |
| sel. material | Display for information. |

System

Spans, supports, joints and cross-sections are entered via the tables (tabs under the graphics window) - see also [tables](#).

Beam spacing Beam spacing to distributed load

Side fixing

Continuously supported

Deactivate this option to show the selection options for the position of the lateral bracket in the longitudinal direction or the load application - see the following figure.

| | |
|----------------------------------|---|
| Stability longitudinal direction | restrained in 1/3 points |
| Stability | at bearings Restrained in mid-span |
| Beam representation | restrained in 1/3 points |
| Bottom edge flush | restrained in 1/4 points restrained in distance x0 |
| Remarks | User-defined |

| | |
|---------------------|---------------------------------|
| Stability | on top chord |
| Beam representation | on top chord in shear center |
| Bottom edge flush | on bottom chord |

Remarks

Input of comment text on the system via the [comment editor](#).

The screenshot shows the 'Properties' window with a tree view containing 'Basic parameters', 'System', 'Load', 'Design', and 'Output'. The 'System' table is expanded, showing various parameters and their values. The 'continuously supported' checkbox is checked.

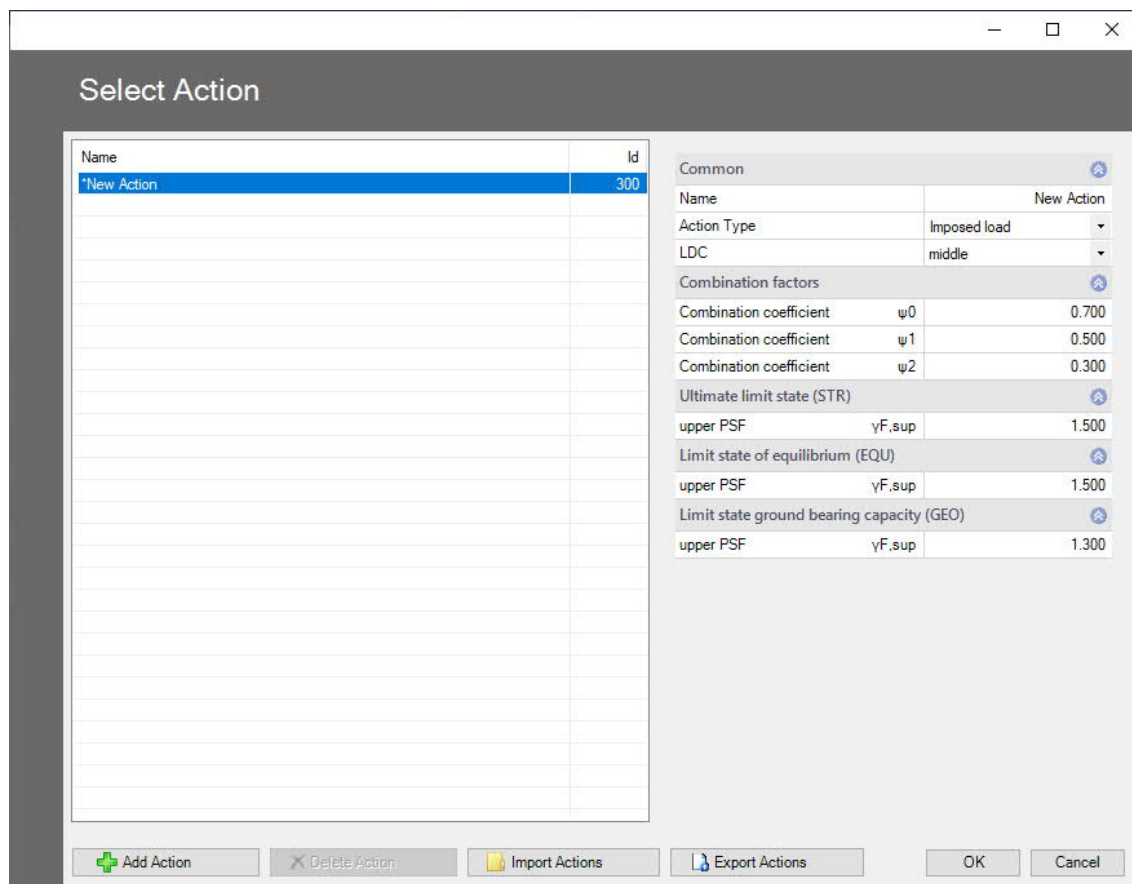
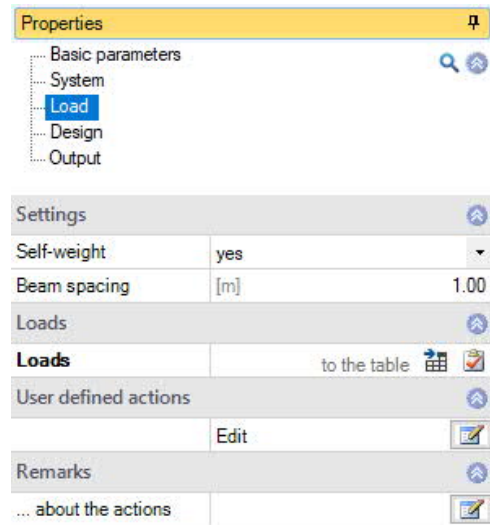
| System | |
|----------------------------------|-------------------------------------|
| Span | to the table |
| Multipart total. beam | 1 |
| Rotation total beam | Unrotated |
| Supports | to the table |
| Joints | to the table |
| Beam spacing | [m] 1.00 |
| Cross-sections | to the table |
| side fixing | |
| continuously supported | <input checked="" type="checkbox"/> |
| Stability longitudinal direction | restrained in 1/3 points |
| Stability | on top chord |
| Beam representation | |
| Bottom edge flush | <input type="checkbox"/> |
| Remarks | |
| ... about the system | |

Loads

The load parameters are entered via the [load table](#) (tab below the graphics window) - see also [tables](#).

Self-weight Selection of whether to calculate with or without self-weight.

In addition to the selectable actions in the [load table](#), user-defined actions can also be defined and named here, which are then available for selection in the load table.



Design

Structural safety as described under [basic parameters](#).

Serviceability

With shear deformation When calculating the deformations, the shear deformation is taken into account.

Design situation Design situation on which the verifications in the serviceability limit state are to be based: characteristic, frequent, quasi-permanent.

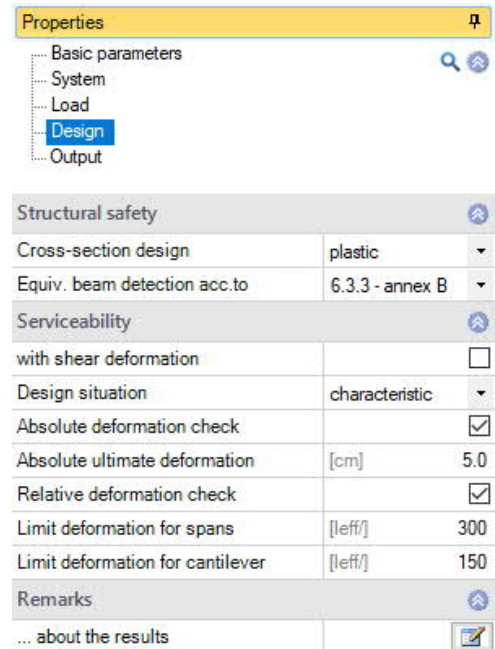
Absolute deformation check Provides proof of serviceability for use with the deformation difference to the undeformed system.

Absolute ultimate deformation Shows the maximum permitted absolute deformation of the system.

Relative deformation check Performs the proof of serviceability based on lengths that are determined by the support points.

Remarks

Calling up the [remarks editor](#).

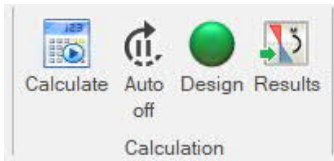


Output and results

Use the "Document" tab to switch to the display of the output. Output sections can be defined using a table.

Calculation

You start the calculation via the "Calculate" symbol in the top menu bar. Result graphics can also be displayed here and the evidence can be displayed.



See also: [Output and printing](#)

The output scope / output profile can be selected.

Properties ⌵

- Basic parameters 🔍
- System
- Load
- Design
- Output**

Output settings ⌵

| | | |
|------------------------|-------------------------------------|---|
| Output scope | Brief | ▼ |
| Notes | <input checked="" type="checkbox"/> | |
| Load value compilation | <input checked="" type="checkbox"/> | |

Output sections ⌵

Sections ▶ the table 📄 🖨️

Graphical ⌵

| | | |
|-------|------------|---|
| Scale | Face width | ▼ |
|-------|------------|---|

Results ⌵

| | |
|-------------------------------------|-------------------------------------|
| Structural safety per cross section | <input checked="" type="checkbox"/> |
| Internal forces Graphics | <input checked="" type="checkbox"/> |
| Structural safety | <input type="checkbox"/> |
| All sections | <input type="checkbox"/> |
| Deformation Graphics | <input type="checkbox"/> |
| Serviceability | <input type="checkbox"/> |
| Support reaction- char. per action | <input checked="" type="checkbox"/> |
| Design values | <input type="checkbox"/> |
| Output per [m] | <input type="checkbox"/> |
| Decisive Combination | <input type="checkbox"/> |

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 70469 Stuttgart Position: (New it
 7/8/2021

Position: (New item)
 Continuous Beam Steel STM+ 02/21 (FRILO R-2021-2/POE)

System
 System Graphic
 Steel girder by 2 span, DIN EN 1993-1-1/NA:2015-08
 Steel grade: S235

Geometry
 Cross-sections

| Name | I_x [cm ⁴] | I_y [cm ⁴] | W_x [cm ³] | W_y [cm ³] | Δ [cm ²] |
|---------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------------|
| HEA 200 | 3692.0 | 1336.0 | 389.0 | 134.0 | 53.8 |

Cross-section is constant over the entire length of the beam.

Support (Bearing conditions)

| No | x [m] | Fy | | Fz | | Rotations ¹⁾ | | |
|----|----------|--------|--------|-----------|-----------------------|-------------------------|-----------------------|-----|
| | | [kN/m] | [kN/m] | [kNm/rad] | ϕ_x [kNm/rad] | ϕ_y [kNm/rad] | ϕ_z [kNm/rad] | |
| 1 | 0.00 | -1 | -1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 5.00 | -1 | -1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 10.00 | -1 | -1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

¹⁾ -1 = fixed, 0 = free, > 0 = elastically restraint