# Timber Joints HO3 / HO13 / HO14

Standard

| Stress | η = 0,96 | Diagonal left | State: | Calculated. |
| Connection | η = 0,99 | Chord | | |
| Steel plate | η = 0,37 | Diagonal left | | ΣH = 0,0    ΣV = 0,0    kN |

# Timber Joints HO3 / HO13 / HO14

*Note:* *This document describes the* **Eurocode-specific application**. *Documents containing old standards are available in our documentation archive at* *www.frilo.de* *>> Dokumentation >>Manuals>Archive.*

## Contents

Further information and descriptions are available in the relevant documentations:

FDC – Basic Operating Instructions  General instructions for the manipulation of the user interface

FDC – Menu items  General description of the typical menu items of Frilo software applications

FDC – Output and printing  Output and printing

FDC - Import and export  Interfaces to other applications (ASCII, RTF, DXF …)

FCC  Frilo.Control.Center - the easy-to-use administration module for projects and items

FDD  Frilo.Document.Designer - document management based on PDF

Frilo.System.Next  Installation, configuration, network, database

# Differences of HO3 / HO13 / HO14

### HO3 / HO13

HO3 and HO13 are suitable for the calculation of <u>tensile splices</u> in timber construction. The available fasteners are dowel pins, fit bolts/bolt, nails and special dowels. The tensile splice can be applied to multipart cross sections with butt straps of solid timber or steel.

### HO13

In addition to tensile splices, the HO13 application is also suitable for the calculation of typical <u>truss nodes</u> in timber construction:

In such a joint, up to five outgoing members are connected in one centre point. If the members are all single-part, they are connected by means of steel plates that are either mounted to the surface or driven into slots to establish a steel-to-timber connection. Alternatively, a multi-part diagonal strut or multi-part chord can be connected in a timber-to-timber connection. The currently available fasteners are dowel pins/fit bolts/bolts as well as nails. For timber-to-timber connections and steel-to-timber connections with exterior metal plates, special dowels are additionally available. In timber-to-timber connections, combined arrangements of dowel pins and fit bolts are definable.

### HO14

The HO14 application allows the calculation of the <u>load -bearing capacity of a single fastener</u>, typical in timber construction, while taking the given angle between the applying force and the grain into account.

# Available standards

DIN EN 1995:2010/2013

ÖNORM EN 1995:2010/2015

BS EN 1995:2012

NTC EN 1995:2008

DIN 1052:2004/2008 (Description of the bases of calculation in accordance with DIN available in our manual archive at [www.frilo.eu](www.frilo.eu) ▸ Service ▸ Documentation ▸ Manuals ▸ Archive)

# HO3 / HO13: Tension Joint / Timber Joint

## Application options

HO3 and HO13 allow the calculation of tensile splices in timber construction. The available fasteners are dowel pins, fit bolts/bolt, nails and special dowels. The tensile splice can be applied to multipart cross sections with butt straps of solid timber or steel.

The load-bearing capacity verifications of the fasteners are performed in accordance with Johansen's theory. Suspension effects can be taken into account, if applicable. On the basis of the load-bearing capacity, the software calculates the required number of fasteners, checks the minimum spacing to be complied with and performs the necessary verifications on the connected components in the area of the connection.
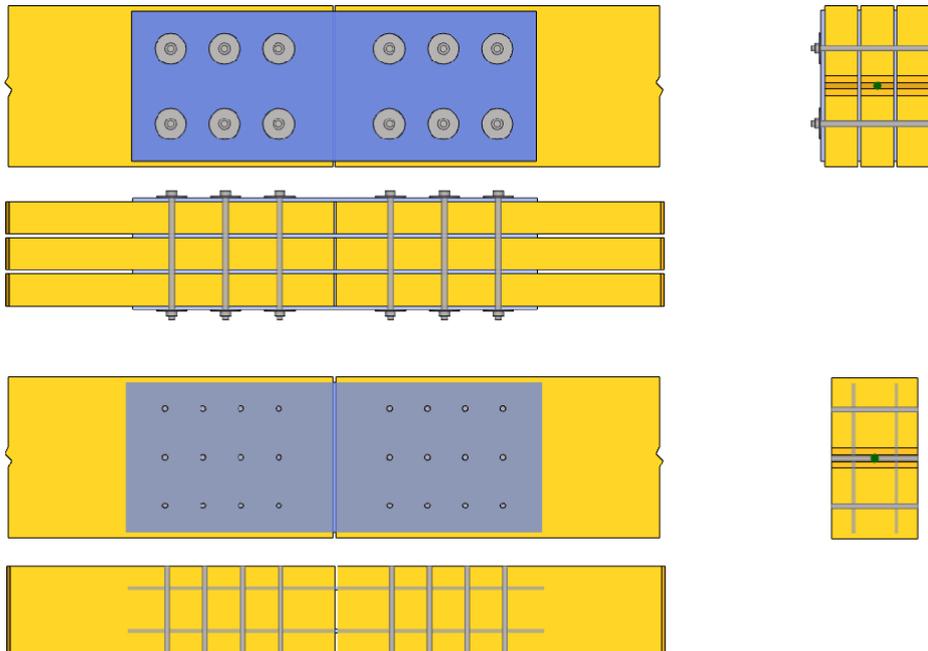
The loads are assumed applying symmetrically to the member axis. The loading should mainly apply in the central area of the member parts. A timber member can consist of three parts maximum.
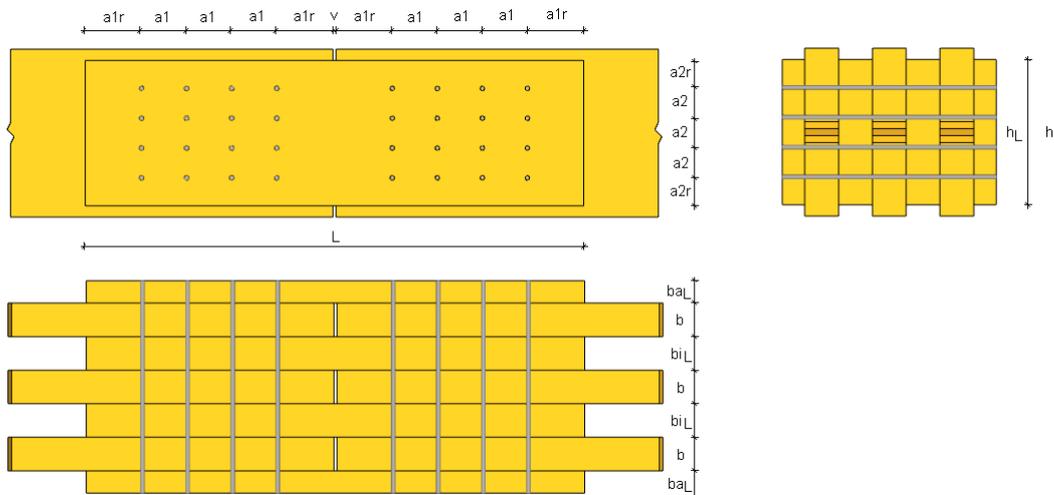
The weakening of the cross section caused by the fasteners is taken into account in the verification of the connection area. The additional moment from distortion of the outer butt straps is considered in a simplified manner via a stress verification with reduced tensile strength.

## Input

### Basic parameters

#### Standard

Selection of the desired design standard.

#### Fasteners

Verification:
The verification is performed for the defined fastener layout and the defined spacing.

Rows + Design:
The required number of fasteners for each row is calculated automatically by the software. The number of fastener rows in parallel to the edge and the associated distance a2 cross to the grain flow are defined by the user. The distance a1 between the fasteners can be set optionally.

#### Verification in accordance with Johansen

This option allows you to include the rope effect of pullout-resistant fasteners in order to increase the load-bearing capacity in the verification in accordance with Johansen.

#### Slot plate joint

For slot plate joints, the additional moment for eccentric load introduction in the outer part of the cross section is taken into account with a factor kte of 0.4 or 2/3. The user can disable this reduction for the modelling process and set kte to 1.0.

#### Erecting state

The user can specify whether all minimum distances of the fasteners to the butt ends of members should be assumed under tension independently of the actually defined internal force for a particular available erecting state.

#### Material

The user can define the material for each member individually or set the "same material for all" members.

If this option is activated in HO13, it applies to all cross sections and fasteners.

#### Definition of fasteners

Standardized fasteners are available for selection in a list. The user can also specify user-defined dimensions or edit the values of standard fasteners – see also Design - fasteners.

#### Tensile splice graph

Graphic representation of the tensile splice (single side or symmetrically completed)
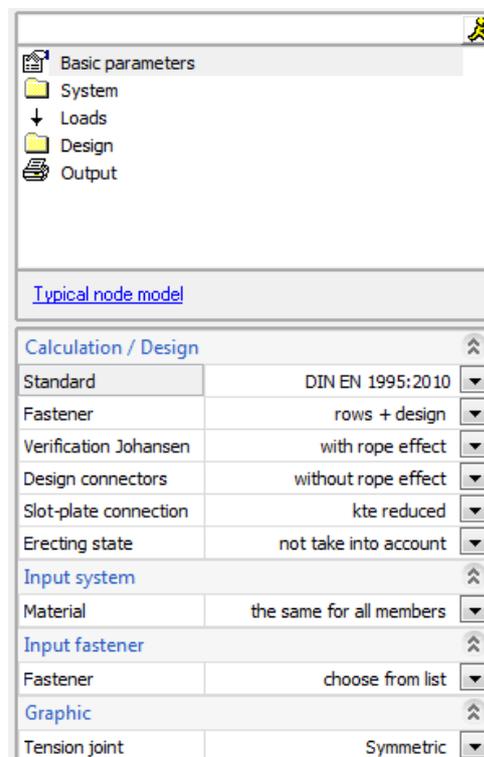
## System

### Material

Selection of the  timber species (C = coniferous timber/softwood, D = deciduous timber/hardwood, Gl = laminated timber/glulam) and definition of the usage class (ambient climate conditions).

*Note:* *Depending on the setting of the basic parameters (same material for all members or individually for each member) the material parameters are set in the system section or during the definition of the individual component.*
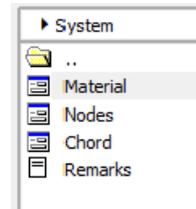
### Nodes

Selection of

a timber-to-timber or

a steel-to-timber connection.

For steel-to-timber connections, further specifications about the location of the metal plates are required.
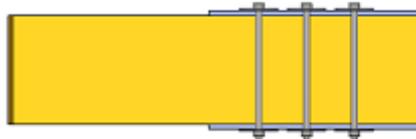
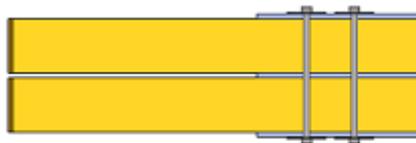| | | |
|---|---|---|
| HO3 / HO13<br>Interior | Slot plates<br>Single-part chord | |
| HO3 / HO13<br>Exterior | plates fitted to the outside<br>Single-part chord | |
| Only HO3:<br>Interior + exterior | Interior and exterior plates<br>Multipart chord | |

### Chord

Allows the definition of the cross section of the chord. In connections with only interior or only exterior plates, the chord is always assumed single-part. In connections with both,  interior and exterior plates, the chord must have two or three parts. In timber-to-timber connections, the chord can optionally be single-, two- or three-part

For multi-part chords, the user is prompted to specify the clearance *a* between the different cross-section parts. This clearance specification determines the width of the connected butt straps.

For symmetric representations of tensile splices, the clearance *v* between the butt ends of the joined chords can be specified. This specification has an effect on the total length of the butt straps.
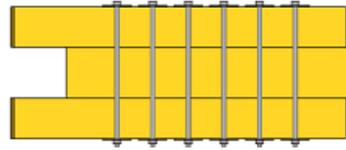
### Butt strap

This option allows you to define the butt straps of a timber-to-timber connection. The width of the butt straps for multi-part chords is determined by the specification of the cross-section spacing in the chord, if any specification was made. The width is editable. Changing the value causes the automatic adjustment of the chord spacing. For multi-part chords, the location of the straps must be defined in detail.

Exterior butt straps can have another width than the interior ones.

Location (with multipart chords):

| | | |
|---|---|---|
| Interior | Butt straps are only fitted inside | |
| Interior + exterior | Butt straps are fitted inside and outside. | |
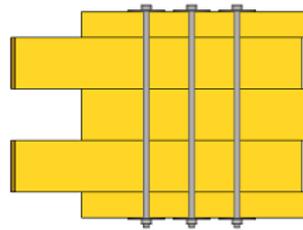
## Loads, actions

### KLED

defines the load action period.

### N,d

design value of the axial force at the cut face of the chord, positive as tension force in grain direction away from the node.

## Design / fasteners

### Type

Allows the definition of the type of fastener. Available for selection are dowel pins, bolts, fit bolts, dowel pins combined with fit bolts, special dowels or nails.

Depending on the selected topology, particular types of fastener may not be available. The combined arrangement of dowel pins and fit bolts is only available for timber-to-timber connections. Special dowels cannot be used to fasten slot plates.

Depending on the selected fastener, further specifications are required for the definition of the fastener geometry.

If the user has activated the selection of fasteners based on preferred values, the software proposes a selection list with standard values. The corresponding geometry values are shown but cannot be edited. To define the geometry directly, change the selection of fasteners to the option "Specification of dimensions".

Diameters are freely selectable in the range of 6 to 30 mm.

Dowel pins and fit bolts are fitted accurately to dimension, bolts are fitted with a gap of 1 mm.

### Dowel pins

| | | |
|---|---|---|
| Preferred values | d | List of standard diameters (DIN 1052) |
| Steel grade | | List of steel grades |
| Dowel pin diameter | d | Selected diameter |
| Projecting/countersunk | uv | *Positive*, if projecting over the chord surface, *negative*, if countersunk |

### Bolts/fit bolts

| | | |
|---|---|---|
| Preferred values | M | List of standard values (DIN 7990) |
| Strength class | | List of strength classes |
| Bolt diameter | d | Selected diameter |
| Washer | | Standard selection for washers |
| Washer diameter | ds | Selected outer washer diameter |
| Inner washer diameter | dsi | Selected inner washer diameter |
| Projecting/countersunk | uv | Countersunk bolt *negative* |

**Special dowels**

| Toothing/spiking | | Single-sided: two plate dowels are fitted back to back, type B1, C2, C4, C11 |
|---|---|---|
| | | Two-sided: two-side spiked or toothed plate dowels A1, C1, C3, C5, C10 |
| | | The selected option has an effect on the further definition of the dowel geometry and depends on the [node topology](). |
| Dowel type: | | A1          joint ring |
| | | C1 - C5     plate dowel |
| | | C1 - C5     toothed plate |
| | | C 10/11    spiked plate |
| Value | dc | dc     diameter       of A1, B1, C1, C2, C10, C11 |
| | a1 | a1     edge length   of C3, C4, C5 |
| Bolt geometry | | All geometry values for bolts, see above. |

**Nails**

| Arrangement | | in parallel rows |
|---|---|---|
| | | or |
| | | offset on both sides |
| Arrangement along the back mark line | | Along the back mark line without offset |
| | | or |
| | | Along the back mark line, offset by 1*d (might increase $n_{eff}$) |
| Shaft | | round and smooth |
| | | or |
| | | square and smooth |
| Hole | | Predrilled |
| | | or |
| | | not pre-drilled (the length of the opposite nail is possibly restricted) |
| Preferred values | | List of standard geometries |
| Nail diameter | d | Selected diameter |
| Head diameter | dk | Selected head diameter |
| Length | l | Selected nail length |

## Design of butt strap or chord

Calculation results and definition of the fastener distribution for the butt strap in a timber-to-timber connection or the chord in a steel-to-timber connection.

### Number of fasteners

| | |
|---|---|
| Required [Johansen]: | specifies the number of required fasteners obtained from the bearing capacity of an individual set of fasteners (for one joint) independently of the arrangement. |
| n eff. [Total]: | specifies the number of required fasteners in relation to the effectiveness in the arrangement (n eff.), which is decisive for the design. |
| Existing: | number of existing fastener sets in the considered connection area. |

### Rows

| | |
|---|---|
| max.: | maximum number of fastener rows in grain direction, that can be arranged on the component in parallel rows (perpendicular to the grain). |
| selected: | selected number of fastener rows in grain direction |
| Number per row: | number of fasteners in one row in grain direction. Depending on the basic parameter settings, the user can specify a user defined number (in the verification) or it is set automatically by the software (rows + design). |

### Distances

Output of the minimum fastener spacing and definition of:

| | |
|---|---|
| a2 edge | distance of the fastener rows to the edge perpendicular to the grain |
| a2 | distance of the fastener rows from each other perpendicular to the grain |
| a1 edge | distance of the fasteners to the face side in grain direction |
| a1 | distance of the fasteners to each other in grain direction |

*Tip: If you ender "0", the software proposes a value.*

The distances are shown in the chapter Application options.

## Design / metal plate

(Only available with steel-to-timber connections)

| Type of connection | |
|---|---|
| Type of connection | steel-timber ▼ |
| Plate location | inside + outside ▼ |

### Location

The definition of the plate location corresponds exactly to the definition given in the chapter "System" , paragraph Nodes.

### Thickness

Definition of the plate thickness

### Number

Only in combination with slot plates: up to four slot plates can be set. Due to the equal distribution of the forces on the left and the right of the plate, the distances between the plates should be selected in such manner that the distance to the outer edge amounts to 35 to 50 % of the inner plate spacing.

### Internal hole clearance

Allows the specification of the internal hole clearance *dl* on the plate.

### Hole type

Drilled and punched holes are available for selection.

### Material

Allows the specification of the steel grade for the plate.

### Edge distance allowance

Allows to define the distance of the plate edge to the component edge. "0" means that the plate is inserted flush to the component surface. A value greater than "0" means that the plate is recessed in relation to the surface.

### Distance of fastener from edge e1

Allows the definition of a minimum distance between the plate edge and the outer fastener *e1*. The value refers to the member axis and applies to all connection areas.

# HO13: Timber Joint

## Application options

HO13 is suitable for the calculation of typical truss nodes in timber construction. Tensile splices can be calculated too.

In such a joint, up to five outgoing bars are connected in a centre point. If the bars are all single-part, they are connected by means of steel plates that are either mounted to the surface or driven into slots to establish a steel-to-timber connection. Alternatively, a multi-part diagonal strut or multi-part chord can be connected in a timber-to-timber connection.

The currently available fasteners are dowel pins/fit bolts/bolts as well as nails. For timber-to-timber connections and steel-to-timber connections with surface-mounted plates, special dowels are additionally available.

In timber-to-timber connections, combined arrangements of dowel pins and fit bolts are definable.

The load-bearing capacity verifications of the fasteners are performed in accordance with Johansen's theory (verification method in accordance with Annex G of DIN 1052: 2004/2008). Suspension effects can be taken into account, if applicable.

On the basis of the load-bearing capacity, the software calculates the required number of fasteners, checks the minimum spacing to be complied with and performs the necessary verifications on the connected components in the area of the joint.

## Node topology

Definition of  tensile splice: Select a chord with pinned support in the menu  ▶ System  ▶ Nodes and deselect the options "Post" and "Diagonal", see also chapter HO3 / HO13: Tensile splice

Definition of  truss node: Selecting the menu item  ▶ System  ▶ Nodes  ▶ "Typical variations" displays a window with schematic representations of node variants.
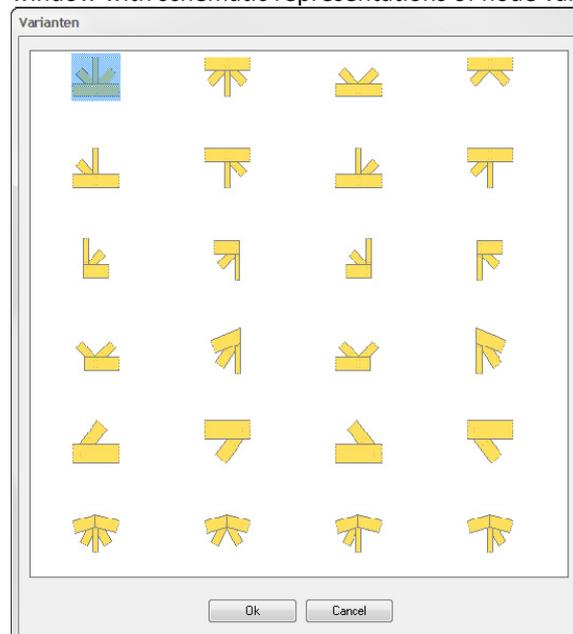


In principle, the definition of the nodes is based on the chord as the reference member. The node reference point M is located on the system axis of this chord The system axes of all connected members intersect in M.

The position of the chord can be horizontal or with an inclination α.
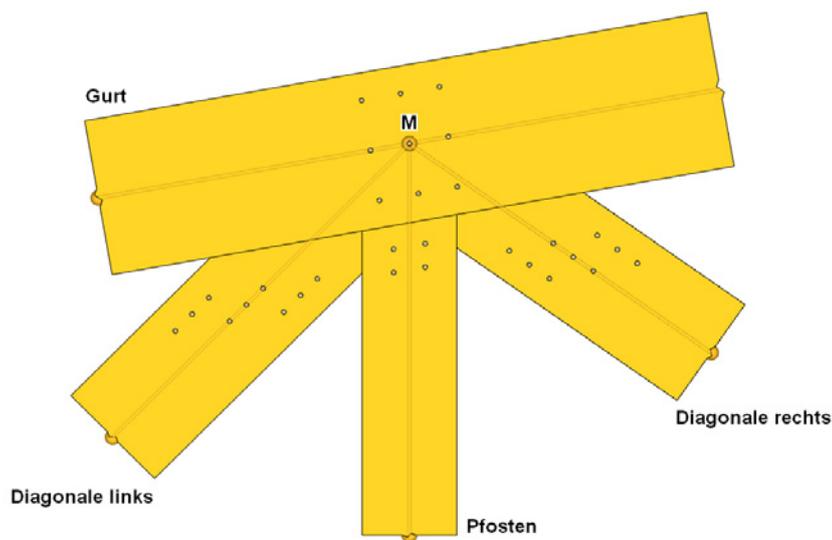
Posts are always connected in the global vertical axis independently of the chord inclination.

The location of the struts to the left and right is determined by a given angle β referenced to the chord.

Struts and posts can be connected together on top or underneath the chord.

The chord can have a pinned support and an inclination above the posts and struts to the left and right as in a ridge joint.

As outer member left/right, the chord can support a post and a strut to the inside. Additional geometries are planned for later software versions.

## Definition

### Basic parameters

For the setting of the basic parameters for HO13 see the chapter
HO3 / HO13 Basic Parameters.

### Detail graph

Displays a two-dimensional graph of the node and its members. The individual connected members are either shown in their actual position in the node or in a standardized position, i. e. the grain flows always in direction of the x-axis and the connected end of the represented member is on the left.

### System

#### Material

As described in HO3 / HO13 Basic Parameters.

#### Cross section

Definition of the width *b* and height *h*.

*Note:* *The input dialog is only displayed if the cross sections were all set identical in the basic parameters. In this case, only single-part cross sections can be defined.*
*If the definition of individual cross sections for each member was set in the basic parameters, the input fields for the cross section are displayed in the definition of each member.*

#### Nodes

Selection of

a timber-to-timber or

a steel-to-timber connection.

For steel-to-timber connections, further specifications about the location of the metal plate (interior or exterior) are required.
See graphs in the HO3 / HO13 Basic Parameters.

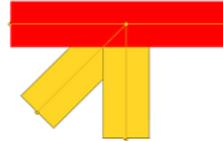The position of the chord and the connected members must be defined in addition.

To facilitate the definition, typical joints (for timber-to-timber or timber-to-steel) can be selected from a list of schematic joint representations. The corresponding values are displayed in the input fields and the user can edit these values to adjust the standard model to the desired joint.
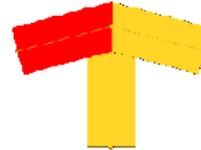
See also Node Topology.

Depending on the selected node variant, the following input fields are available for the modelling of the joint:

Chord: definition of the type of chord.

- Continuous

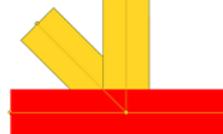- Pinned joint

- Right-angle left

- Right-angle right

Chord position: Definition of the chord position in relation to the connected members.

- On top

- On bottom

With post

Allows you to specify whether a post is connected to the chord. The post is always vertical in relation to the global system of coordinates. In a steel-to-timber joint, the post is connected with a metal plate; in a timber-to-timber joint, it is connected as a compression member via the contact surface. With the latter connection, additional measures are required to ensure position stability.
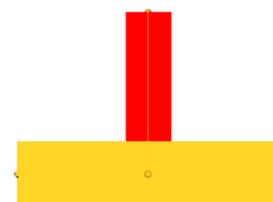
With strut on the left

Allows you to add a strut on the left node side. In a steel-to-timber joint, struts are combinable with all other members. In a timber-to-timber joint, only a single strut can be connected either on the left or right due to the condition of a point-centred node. Struts can also be used as posts in timber-to-timber joints if the connection of a multi-part member should be mapped.
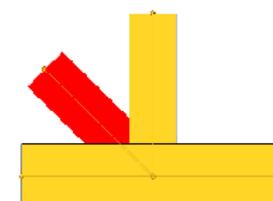
<u>With strut on the right</u>

Allows you to add a strut on the right node side. (See also "With strut on the left").
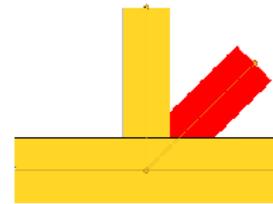
<u>Supported node</u>

The option allows the mapping of models with nodes connected to a support or reinforced with constructive measures, for instance. When defining a supported node, the user can enter horizontal and vertical internal force components in the centre, which map the total equilibrium in the node correctly. This type of node requires additional verifications that are not available in this software application.

In the verifications of the contact joint of a compression post (timber-to-timber joint), the optional distinction between pressure on a single support and on a continuous support is available for supported nodes.

## Chord

Defines the cross section of a chord, either continuous or ending on the left or right of the node.

In connections with slot or exterior plates, the chord is always assumed single-part.

In timber-to-timber connections, the chord can optionally be single-, two- or three-part.

For multi-part chords, the user is prompted to specify the clearance $a$ between the different cross-section parts. This clearance specification determines the width of the connected struts.

The inclination of the chord is referenced to the horizontal axis and defined positive if anti-clockwise. An inclination with an angle of 60° to - 60° is allowed.  The face of chords ending on the left or the right of the node intersects the vertical axis. With inclined chords, this produces a section that is not right-angled.  Therefore, the chord inclination can be used for the indirect modelling of the member section.

Too small face distances in end chords can impede the appropriate arrangement of fasteners in the connection area. In these cases, a projection of the chord should be considered. The projection is defined with the help of the intersecting point with the member axis of the connected outer member.
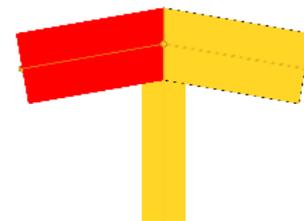
Chord inclination (negative)
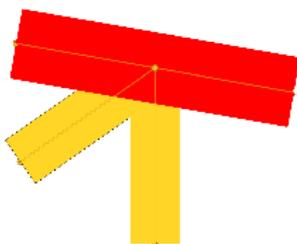
Chord inclination (positive) with vertical section on the face side of the projecting chord
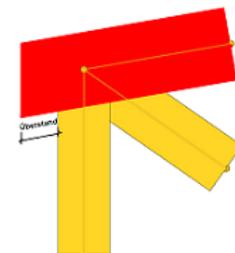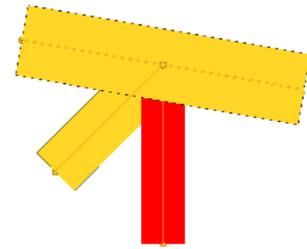
## Chord left / right

This option allows you to define the single-part cross section of the chord in pinned steel-to-timber joints. Bottom chords are always horizontal (chord inclination = 0). Top chords can have an inclination. Inclinations that are positive on the left and negative on the right produce a downward inclination on both sides.

### Post

Allows you to define the cross section of the post, which is always single-part. The post has always a vertical position independently of the chord inclination. In timber-to-timber joints, the post is always connected to a single-part chord as compression member via a contact joint. Constructive safeguarding measures are required in this case.

### Strut left / right

Defines the cross section of a strut. In a timber-to-timber joint with single-part chord, the struts are designed as collar ties. The distance between the outer cross-section parts is determined by the width of the chord. In combination with multi-part chords, the struts are in-between the chord parts and their width corresponds to the spacing of the latters.

Note:    *Member inclinations should be defined positive and anti-clockwise. The angle between two adjacent members must have 15° minimum. Otherwise, the software adjusts the value automatically.*

## Loads, actions

The loading should mainly apply in the central area of the member parts.

### KLED

The option allows you to define the load action period.

### N,d

Axial force at the cut face of the member, positive as tensile force acting in direction of the grain outgoing from the node, used as design value. Should be entered with its $\gamma_F$-fold value.

### Vz,d

Design value of the shear force applying at the cut face of the chord, positive if acting upwards on the left face and downwards on the right face.

This value allows the user to take transversal loads on the chord into account, which produce an angle between the resultant and the grain direction in the joint.



positive internal forces
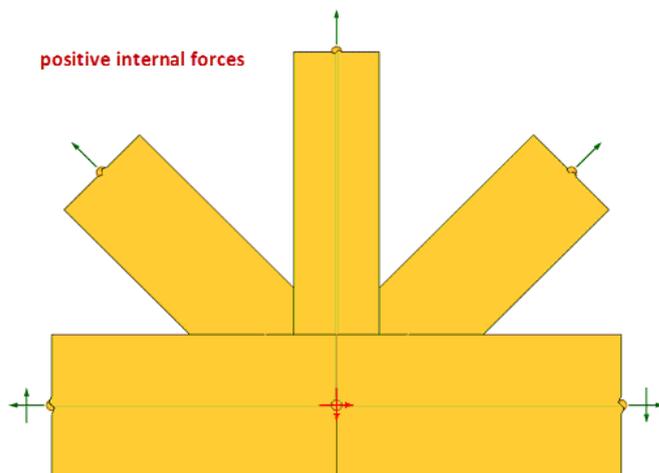
*Note:*     **The equilibrium of the forces applying to the node must be balanced!**
*Otherwise, the software does not put out any results. The sum of the horizontal and vertical forces is displayed for review.*

### Support H,d and V,d

The user should only make a specification if a supported node was defined. The values are used to model the topologies of additionally supported nodes.

The design values *H,d* for a horizontal supporting force and *V,d* for a vertical force apply in the centre point of the node. The horizontal force is positive if it applies from the left to the right. The vertical force is positive if it applies from top to bottom.

A supported node might require verifications that have not been implemented in the software yet.
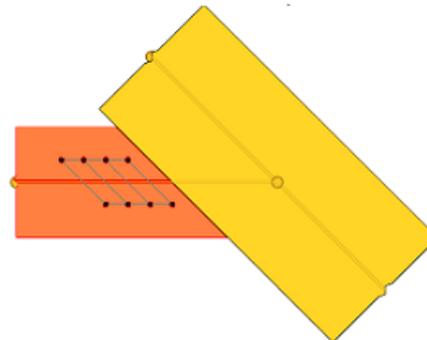
## Design / settings

### Layout of the fasteners

Allows the specification of the arrangement of the fasteners in the member section.
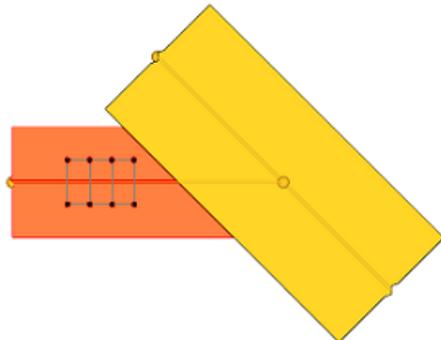
| | |
|---|---|
| linearly orthogonal | linearly parallel |
| (pairs of two parallel rows perpendicular to the grain) | (pairs of two parallel row in parallel to the axis of the connected member) |

The layout is defined separately for the truss members (posts, struts) and the chord with pinned joints and is only available for steel-to-timber joints.

## Design / metal plate

(Only available with steel-to-timber connections)

### Plate location

Specification of the plate location (interior, exterior).
See also graphs in the chapter HO3 / HO13 Basic Parameters

### Thickness

Allows the definition of the plate thickness

### Number

Only in combination with slot plates: up to four slot plates can be set. Due to the equal distribution of the forces on the left and the right of the plate, the distances between the plates should be selected in such manner that the distance to the outer edge amounts to 35 to 50 % of the inner plate spacing.

### Plate shape

A variety of options is available to tailor the outline of the plates to the requirements. The plate can have a rectangular shape or an outline matched to the joint.
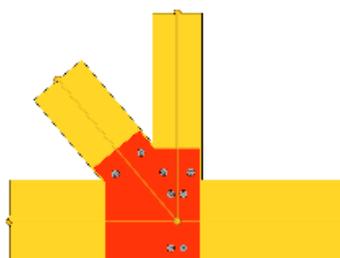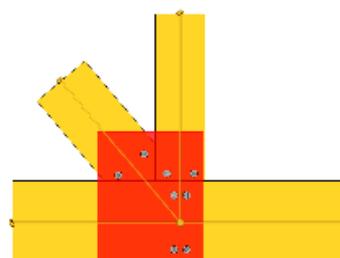
| | |
|---|---|
| matched to the joint | rectangular |

## Shape in the area of the chord

The connection area of a continuous chord constitutes a special case. The plate matched to the node shape is either concave, i. e. cut at a minimum distance to the fasteners or orthogonal, i. e. extends to the outer edge of the connected members.

If only a single strut or post is connected, the plate can have a trapezoidal shape, extending from the connected member into the chord.



| Concave | Orthogonal | Slanted |
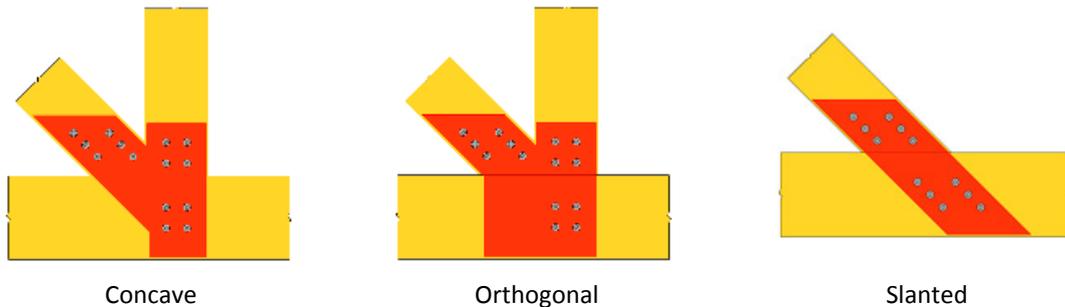
## Section in truss member

With plates matched to the joint, the section in the truss member can be adjusted to the arrangement of the fasteners. By defining the distance to the longitudinal edge e1, the default minimum spacing can be changed.
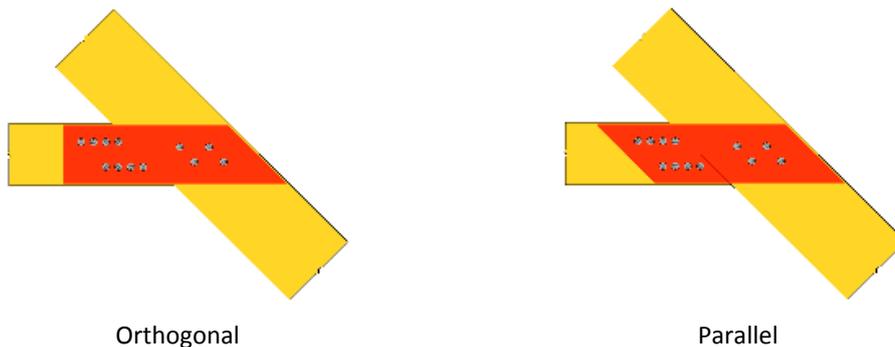


| Orthogonal | Parallel |

## Internal hole clearance dl

Allows the specification of the internal hole clearance dl on the plate.

## Hole type

Drilled and punched holes are available for selection.

## Material

Allows the specification of the steel grade for the plate.

## Edge distance allowance

Allows to define the distance of the plate edge to the component edge. "0" means that the plate is inserted flush to the component surface. A value greater than "0" means that the plate is recessed in relation to the surface.

## Distance of fastener from edge e1

Allows the definition of a minimum distance between the inserted plate edge and the outer fastener. The value refers to the direction of the member axis and applies to all connection areas.

### Design / fasteners

See chapter Design / Fasteners in a tensile splice

### Design / Fastener patterns for the individual bars

#### Metal plate joint

The geometry of the section on the connected member and the permissible distances of the fasteners to the edges determine the area inside which the fasteners can be arranged in rows. The back mark in grain direction is parallel to the component edge and symmetrical to the member axis. The back mark cross to the force direction can optionally be set orthogonal to the component edge or parallel to the section in the member connection.

The continuous chord constitutes a particular case, because the back marks are always orthogonal to the edge: if only a single strut or post is connected with a plate, the back marks may also be parallel to the inclination of the connected member. The metal plate normally adopts the shape of a parallelogram in this case.

#### Timber-to-timber connection

The allowable area for the arrangement of the fasteners is determined by the intersecting connected members and the minimum edge distances of the fasteners.

The back marks in force direction are parallel to the edge of the load-applying component and symmetrical to its member axis. The back marks cross to the force direction are parallel to the edge of the load-bearing component.

#### Number of fasteners

Required [Johansen]: specifies the number of required fasteners obtained from the bearing capacity of an individual fastener set (for one joint) independently of the arrangement.

n eff. [Total]: specifies the number of required fasteners in relation to the effectiveness in the arrangement (n eff.), which is decisive for the design.

Existing: number of existing fastener sets in the considered connection area.

At least two fasteners are assumed in the connection area. In the area of the continuous chord, at least four fasteners are required. By selecting the basic setting option "Verification", only a single fasteners could be provided in the connecting area. At least, four shear areas must be effective in this case. For nails and screws, a minimum quantity of two applies as a rule.

#### Rows

Max.: maximum number of fastener rows in grain direction, that can be arranged on the component in parallel rows (perpendicular to the grain).

Selected: selected number of fastener rows in grain direction

Number per row: number of fasteners in one row in grain direction. Depending on the basic parameter settings, the user can specify a user-defined number (in the verification) or it is set automatically by the software (rows + design).

#### Distances

Output of the minimum fastener spacing to comply with and definition of:

a2 edge     distance of the fastener rows to the edge perpendicular to the grain
a2     distance of the fastener rows from each other perpendicular to the grain
a1 edge     distance of the fasteners to the face side in grain direction
a1     distance of the fasteners to each other in grain direction
*Tip: If you enter "0", the software proposes a value.*

# HO14: Single-fastener Timber Joint

## Application options

The HO14 application allows the calculation of the load -bearing capacity of a single fastener, typical in timber construction while taking the given angle between the applying force and the grain into account.

The available fasteners are dowel pins, fit bolts/bolt, nails and special dowels. The joint can be modelled for multi-part cross sections with butt straps of solid timber or steel. In a single-part cross section, you can calculate joints with up to four slot plates.
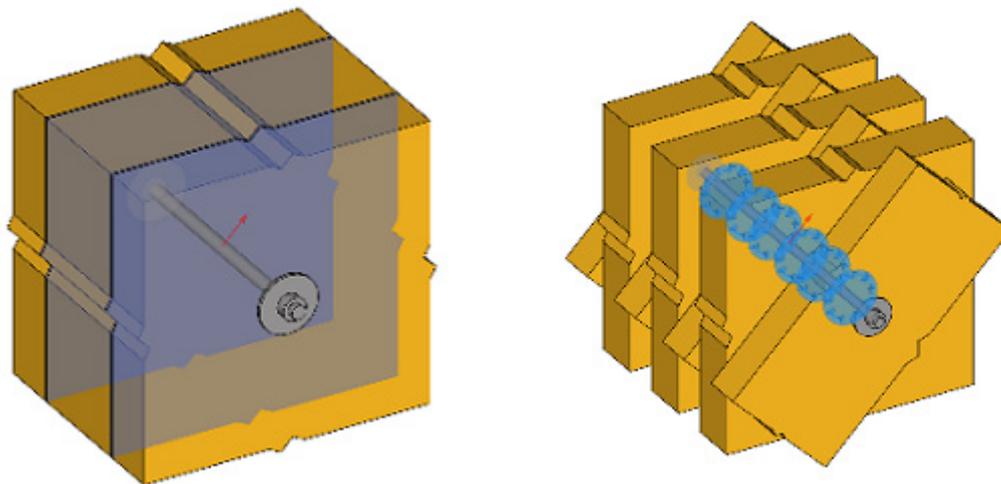


The load-bearing capacity verification of the fastener is performed in accordance with Johansen's theory. Suspension effects can be taken into account, if applicable.

In order to calculate the bearing capacity of an individual fastener, all required minimum distances must be adhered to. The effectiveness of a fastener in a particular fastener arrangement must be examined separately, which cannot be done with this software. A verification of the component in the connecting area is neither available. The HO13 application is suitable for the modelling of a node with consideration to the necessary verifications.

## Definition

### Basic parameters

#### Standard

Selection of the desired design standard.

#### Verification in accordance with Johansen

This option allows you to include the rope effect of pullout-resistant fasteners in order to increase the load-bearing capacity in the verification in accordance with Johansen.

#### Material

Optionally, the materials are defined for each component separately or for all components together.

#### Definition of fasteners

Standardized fasteners are available for selection in a list. The user can also specify user-defined dimensions or edit the values of standard fasteners.

How to define fasteners is described in the chapter HO3 Design - Fasteners. (Without the fastener types "dowel pin" and "dowel pin with fit bolt").

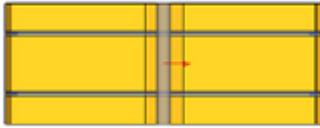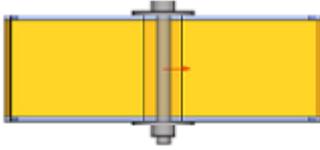### System

#### Type of joint

Selection of

a timber-to-timber or

a steel-to-timber connection.

Specification whether the joint is single-shear or multi-shear.

#### Metal plate

For steel-to-timber connections, further specifications about the location of the metal plate are required.

| Interior | slot plates single-part component |  |
| Exterior | plates fitted to the outside single-part component |  |
| Interior + exterior | interior and exterior plates multi-part component |  |
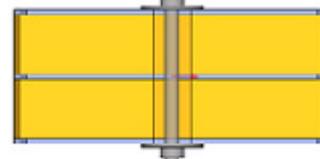
### Component 1

Defines the cross section of the load-bearing component. In connections with only interior or only exterior plates, the component is always assumed single-part. In connections with both, interior and exterior plates, the component must have two or three parts. In timber-to-timber connections, the component can optionally be single-, two- or three-part.

For multi-part components, the user is prompted to specify the clearance $a$ between the different cross-section parts. This clearance specification determines the width of the connected butt straps or the load-applying component.

The grain in component 1 runs always in direction of the global horizontal axis of the defined system.

Material: as described in the chapter System of the HO3 manual.
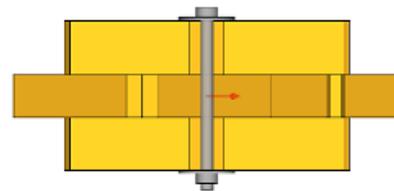
### Component 2 (butt straps)

This option allows you to define the load-applying component in a timber-to-timber connection. The width of the butt straps for multi-part components is determined by the specification of the cross-section spacing in component 1, if any. The width is editable. When the user changes the value, the spacing in component 1 is automatically adjusted.

For multi-part components, the location of the straps must be defined in detail.

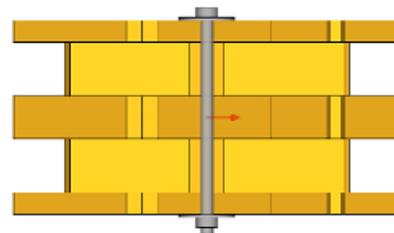Exterior butt straps can have another width than the interior ones.

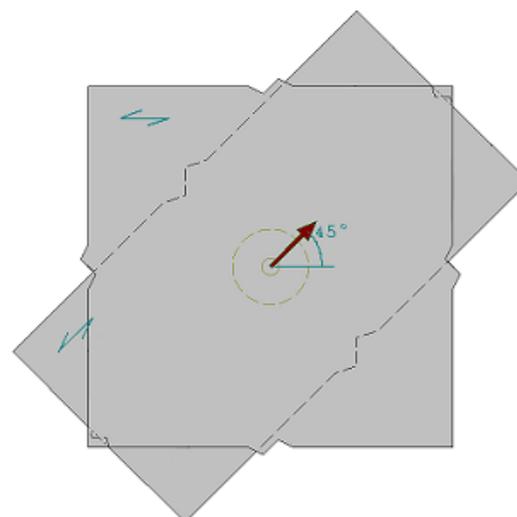| | | |
|---|---|---|
| Inside | Butt straps are only fitted inside |  |
| Interior + exterior | Butt straps are fitted inside and outside. |  |

The grain direction of component 2 is defined in the input field "Inclination". Inclinations in the range of -360° to 360° are definable. If the user specifies "0°", the grains flow in direction of the global horizontal axis.

## Loads, actions

### Internal forces combinations

KLED: The option allows you to define the load action period.

### Load-applying internal force

Angle $\alpha$ between the resultant force F in the fastener and the grain direction, selectable range between -360° and 360°. An angle of "0°" defines a force acting in horizontal direction to the right. The magnitude of the force f is not decisive for the calculation of the fastener's load-bearing capacity in the ULS and, therefore, no specification is required.
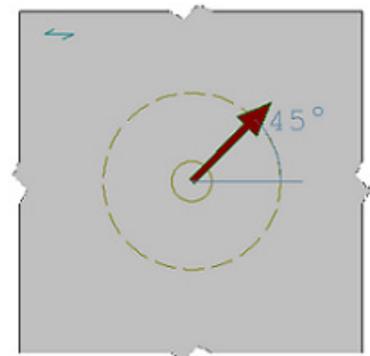
*Ill.: A resultant force F applying at an angle of 45°*

## Design / fasteners

### Fasteners

The definition of the fastener is described in the chapter HO3 Design - Fastener. (Without the fastener types "dowel pin" and "dowel pin with fit bolt").

### Metal plate

(Only available with steel-to-timber connections)

Location

See chapter HO14 - System

Thickness:

Allows the definition of the plate thickness

Quantity:

Plate fitted inside, single-part cross section. Only in combination with slot plates: up to four slot plates can be set. Due to the equal distribution of forces on the left and right of the plate, the distances between the plates should be selected in such a manner that the distance to the outer edge corresponds to a portion of 35 to 50 % of the inner plate spacing.

Internal hole clearance dl:

Allows the specification of the internal hole clearance dl on the plate.

Hole type:

Drilled and punched holes are available for selection.

Steel:

Allows the specification of the steel grade for the plate.

# Output

The user can launch the output of system data, results and graphical representations on the screen or the printer via the Output menu item in the FDC selection area.

→ See also the document Output and Printing - FDC

and output in the Frilo.Document.Designer

| | |
|---|---|
| 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 |
| Printer | starts the output on the printer |
| Page view | (file menu) displays a Print preview. |

### Output profile

The output profile allows the user to define the scope of data to be put out. Tick the options as desired.

## Graphic toolbar

**3D** A node is shown in a three-dimensional model. To improve the overview of the system, an

exploded view can be displayed (by activating 💣.

In the 3-d graphic window, the context menu shown in the right illustration can be displayed by pressing the right mouse button.
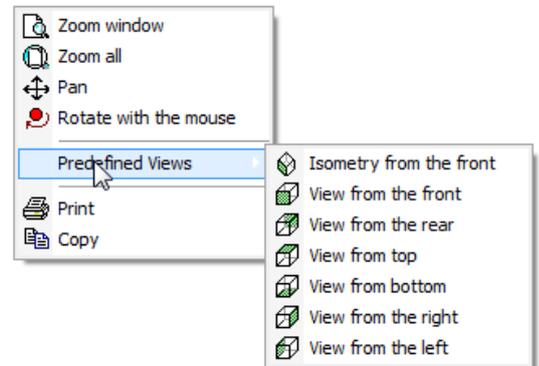


**2D** A detailed two-dimensional drawing shows the individual associated components with full dimensioning of the fastener arrangement.

In the 2-d graphic window, the context menu shown in the right illustration can be displayed by pressing the right mouse button.

The user can toggle between the representation of the entire node and a more detailed view of

an individual member via the context menu or the 🔲 button on the toolbar.

The 3-d and 2-d representations of the total node or member can optionally be added to the output scope. The text size may vary, depending on the geometry of the displayed components. To adjust the text size, use the buttons "Increase/decrease text size" in the toolbar of the 2-d graphic window.

**View options**

The following features can be displayed or hidden in the 3-d- and 2-d representations. The availability of particular functions depends on the node topology.

| | |
|---|---|
| ⬇ | 3D - System lines of the connected members |
| | 3D/2D - Plates |
| | 3D/2D - Allowed area for the arrangement of fasteners |
| | 3D - Fasteners |
| ⬇ | 3D/2D - Internal forces |
| | 2D - Dimension lines and designations |
| | 2D - Member cross section in the view of the entire node |
| | 2D - Member in detail / entire node |

**View options**