Design of roofs Dach+

This manual describes the DGK+, DKD+, DPD+, DSP+ programs together.

Table of contents

Basic Documentation – Overview

In addition to the individual program manuals, you will find basic explanations on the operation of the programs on our homepage www.frilo.com in the Campus-download-section.

Further documents:

Roof-Loads-Design

Fire protection analysis timber

Wind and snowloads PLUS

Application options

The following roof types can be calculated with the programs of the Roof+ series:

DGK+ Hip-/Valley Rafter

Verification of single-span and multi-span hip rafters or valley rafters with freely selectable angles for the floor plan and the roof pitches of the main and secondary roofs. Roof projections are possible.

DKD+ Collar Beam Roof

Calculation of collar beam roofs with sway or non-sway collar beams. The collar beam can consist of one or two parts. Asymmetrical structural systems are possible.

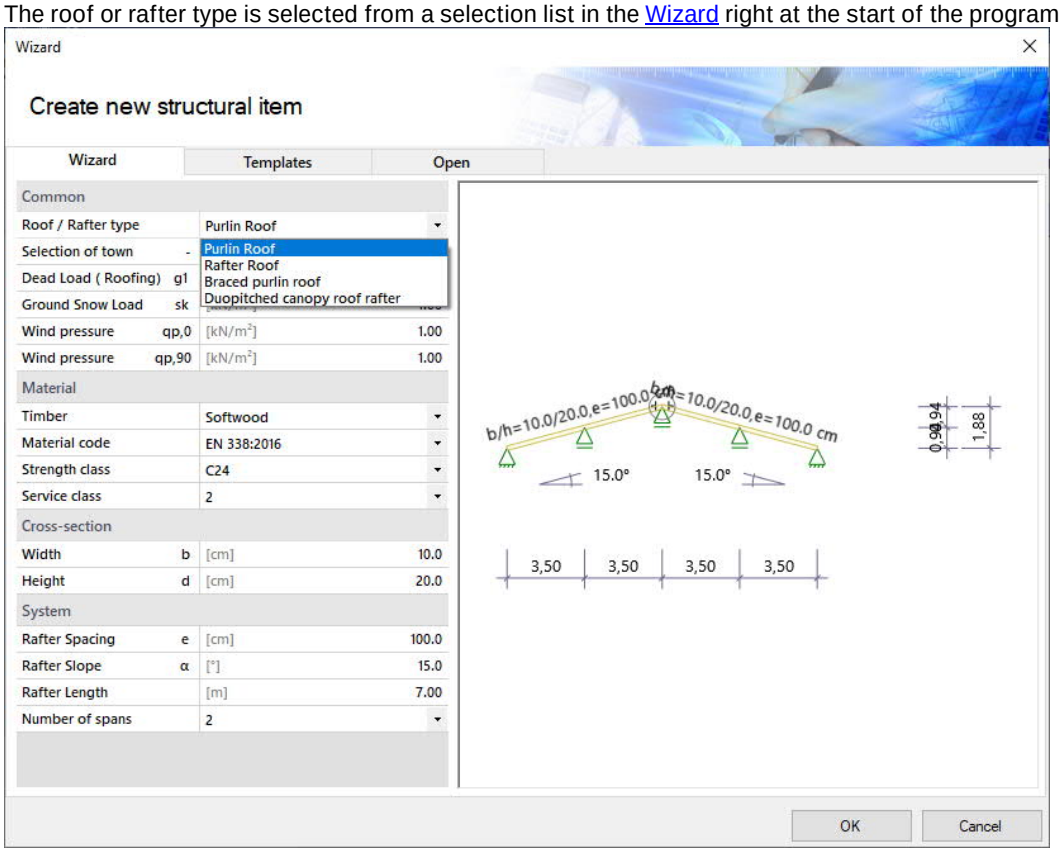
DPD+ Purlin-/Rafter Roof

The program DPD+ can be used to calculate purlin roofs and rafter roofs as well as mixed roofs of both types such as purlin roofs with ridge joints, braced purlin roof, duopitched canopy roof rafter.
The purlins on the left and right roof sides are designed as continuous beams under bending stress.
Asymmetrical structural systems are possible.

DSP+ Continuous Rafter

The DSP+ program can be used to calculate and design single-span and multi-span rafters as individual components. For the continuous rafter, the wind load assumptions are based on a closed, symmetrical building and for the single-pitch roof rafter/monopitched canopy roof rafter, they are based on a closed building with a single-pitch roof. Cantilevers can be defined at the ridge and the eaves.

The roof or rafter type is selected from a selection list in the Wizard right at the start of the program.



Standards

- EN 1995:2008/2014
- DIN EN 1995:2010/2013
- ÖNORM EN 1995:2010/2015/2019
- NTC EN 1995:2008/2018
- BS EN 1995:2012/2019
- PN EN 1995:2010

Loads

- Area loads, weight, snow and wind loads
- Additional loads as uniform, single or trapezoidal loads
- Man loads and wind currents in overhangs

Calculation

The system is treated statically as a framework system, taking into account the normal force deformations and the effect of the real, specified support conditions.

All load combinations are calculated and designed according to the applicable combination regulations.

Design settings

Optionally selectable:

- proof against wind suction (see also document Roof: Loads-Design)
- earthquake combinations
- fire design

For the permissible span/cantilever deflections of the respective verifications (based on the length L), the recommended values of the respective standard are preset as standard. These can be customized.

Since the negative deflection there usually determines the design result in the case of short cantilevers, this often undesirable influence can be optionally eliminated with the option "only positive deflection on cantilevers".

Proofs of stability

For the proof of stability, a continuous tilt bracket and continuous lateral support are used as standard and the buckling length in the rafter level is limited to 0.9 · component length.

These boundary conditions can be adapted individually.

There are various options available for determining the stability lengths.

For each superposition, the associated effective lengths for the individual bars are determined from the eigenvalue solution. Due to numerical problems, however, the effective lengths of bars with a low normal force can be too great.

For precisely such cases, there is the option of limiting the buckling length to a maximum value.

Optionally, the buckling and tilting lengths can be specified individually for each bar.

Alternatively, the buckling/tilting length can always be set to the bar length, component length or a specified value.

Serviceability

The serviceability verification is carried out according to the rules of EN 1995-1-1 with initial and final deformation and consideration of creep deformation.

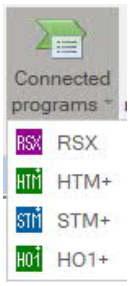
Support forces

Support forces are output as characteristic maximum values and sum per action.

Characteristic support forces are transferred to the subsequent components for each load case, for which the decisive combinations are then created in the program called up.

In addition, the load cases per individual load case and the superpositions can optionally be output.

Load Forwarding / Associated Programs



The bearing loads can (with DSP+, DPD+, DKD+) be passed on to Continuous Beam Timber HTM+, Continuous Beam Steel STM+ and Timber Column HO1+.

See also document Roof: Loads-Design.

The interface to the RSX Framework enables an alternative calculation.

Entered connection details (rafter base point) can optionally be passed on to the corresponding toolbox module for calculation (the corresponding item "TB Toolbox" is then displayed here).

SEMA import/export

"*.sema" files can be imported/exported via File ▸ Import or Export.

Find out more about this in the SEMA manual.

Input

General information on the input fields

This program can be used to calculate according to various standards or national annexes. These standards differ considerably in terms of load approaches, combination rules, determination of the decisive internal forces and verification.

The input fields and selection options described below can therefore differ from one another depending on the selected standard.

Wizard

After starting the program, the wizard opens automatically, with which you can quickly and easily create a calculable basic system.

Here you select the type of roof or rafter.

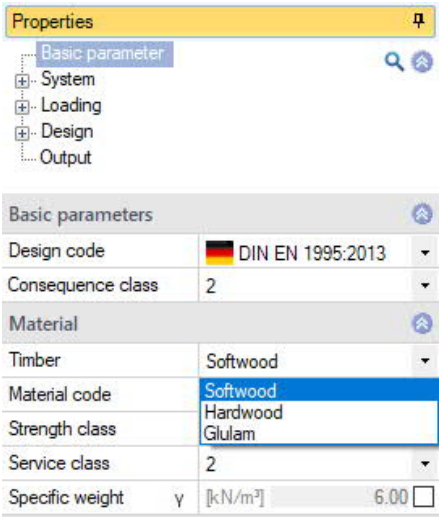
Furthermore, the necessary/most important parameters are queried here.

An item can then be further developed on this basis.

Note: the other roof types can also be called up using the "Other roof types" button in the upper menu ribbon.

Basic parameters

Selection of the standard and the material. You can also enter the strength and service class as well as the specific weight here.



Strength class – user defined material

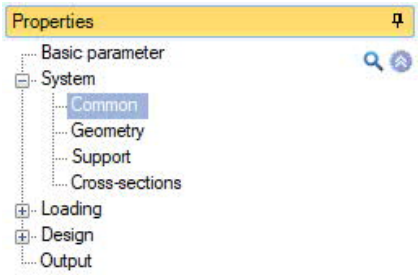
The strengths and stiffnesses can be adjusted. To do this, click in the input field and press the F5 key. You can enter/edit/save/load new material in the "User-defined material" pop-up menu.

System

Note: the following entries differ depending on the selected roof or rafter type.

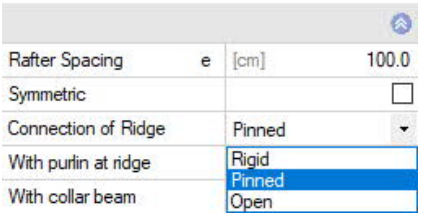
Remarks

You can enter remarks about the system that optionally appear in the output.



General

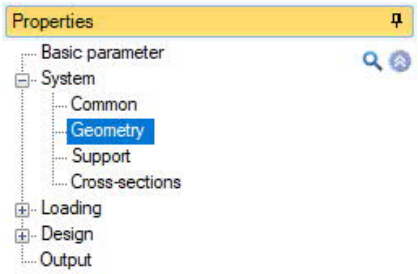
Here you define the other properties depending on the selected roof type.



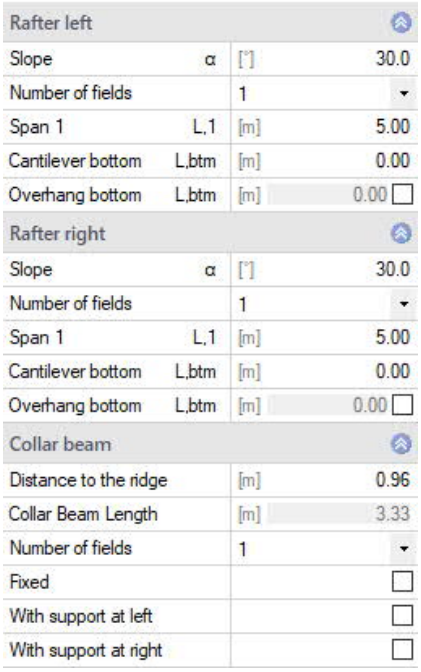
Rafter spacing	Center distance of the rafters
Rafter type	Choice of continuous or pent roof rafters
Symmetrical	Symmetrical or asymmetrical roof
Ridge connection	Rigid, pinned or open
With ridge purlin	Yes/no
With collar beam	Yes/no

Geometry

Depending on the selected roof type and symmetry, the appropriate input fields are displayed.



Rafters (left / right)



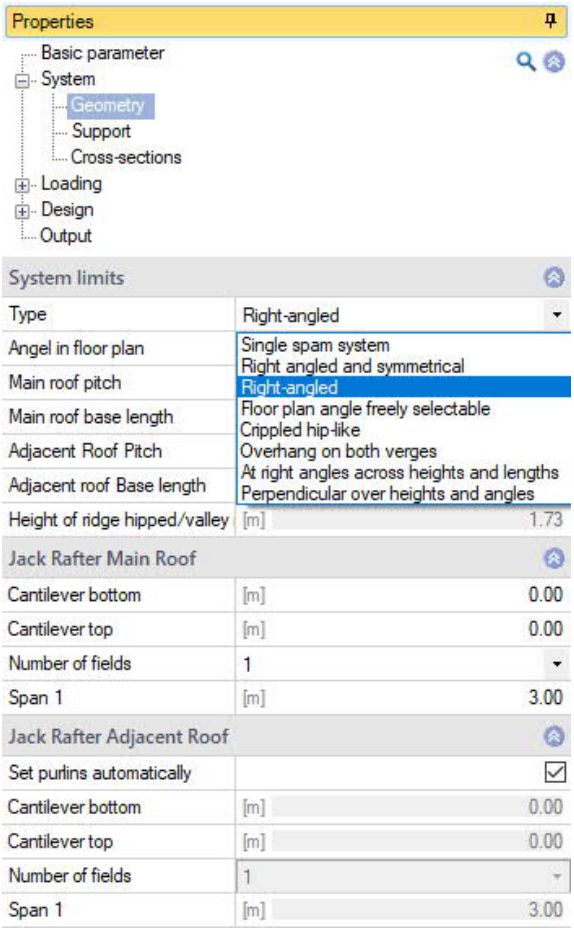
- Slope α	The angle of slope of the rafters - can also be changed directly in the graphic.
- Number of fields	Up to 5 fields/sections are possible.
- Span 1, 2 ...	Lengths of the individual spans. Span 1, Span 2, etc.
- Cantilever	Length of the cantilever.
- Overhangs	Definition of a free roof overhang. The overhang plays a role above all for the approach of wind underneath currents, but also for the consideration of the extension loads. Overhang = start of the rafter to the edge of the house.

Collar beams

- Distance to the ridge	Distance of the collar beam to the ridge.
- Collar Beam Length	Display of the calculated collar beam length.
- Number of fields	Up to 4 fields with different lengths (field 1, field 2 ...) are possible.
- Fixed	If the option is marked, the collar beam roof cannot be moved, otherwise it can be moved.
- With support	Optional supports at the collar beam ends.

Hip or valley rafters

Various input options are available for defining the roof envelope. The dimensions/values are displayed in the graphic for checking and can also be changed there directly.



System limits

Type

Single span system:

the simplest entry with a 90-degree angle, without span subdivisions, cantilever arms, floor plan angles, etc.

Right-angled and symmetrical:
As with the single-span system, however, the top can be subdivided into spans as a result of purlins. Both sides are symmetrical. The input fields for the shift rafters can be expanded.

Right-angled:
an asymmetrical span division is possible here.

Floor plan angle freely selectable:
as right-angled, in addition, the input field for the plan angle can be edited.

Crippled hip-like:

A one-sided overhang is also offered here
(→ greater length of the shift rafters for the load introduction area).

At right angles over heights and lengths:

Input about the height and projection length of the marginal planes.

Perpendicular over heights and angles:

Input about the height and angle of the marginal shift planes.

Angle in the floor plan — The angle between the eaves is illustrated in the graphic and can also be changed there directly.

Main roof pitch — Angle of slope on the main or secondary roof.

Main roof base length — Basic length in the direction of the main roof or the secondary roof.

Main roof projection length edge shifters — With the type “right-angled over heights and lengths/angles, the projection lengths for the main and secondary roofs are entered here.

Ridge height — Informative display or changeable value for the height of the ridge.

Main roof overhang — Overhang on the hipped roof.

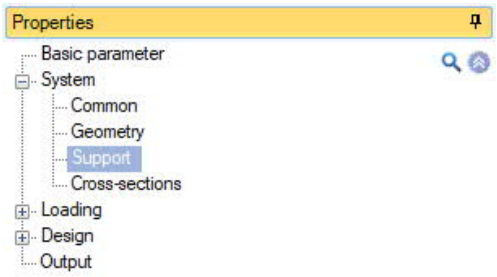
Jack rafters (main or secondary roof)

Cantilever — Length of the cantilever arms above or below.

Number of fields — Die Eingabe von bis zu 3 Feldern ist möglich.

Span 1..3 — Length of the individual spans.

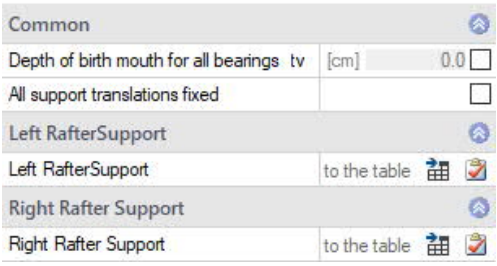
Support



In the Common section, to simplify the entry, you can specify whether the same (standard) mouth depth should apply to all supports or whether you want to enter this value yourself (then check the box) and whether the horizontal and vertical supports should all be rigid.

Depending on the selected roof type, you can call up the corresponding support tables.

Call up the support table(s) via the table symbol or via the tab below the graphic.



The horizontal and vertical supports are entered. If the option is marked, the support is rigid. To enter a custom value, remove the check mark.

An (optional) mouth or incision depth [cm] weakens the rafter cross-section in the support areas.

Active — With hip/valley rafters, the supports are created automatically as a result of the purlins of the shift rafters - if you do not want this, you can set the supports inactive using this option (you can find the option in the table entry under the tab "Supports due to purlins").

Additional supports — In the case of hip/valley rafters, additional supports (e.g. as a result of supports) can be created in the table using the "+-" symbol.

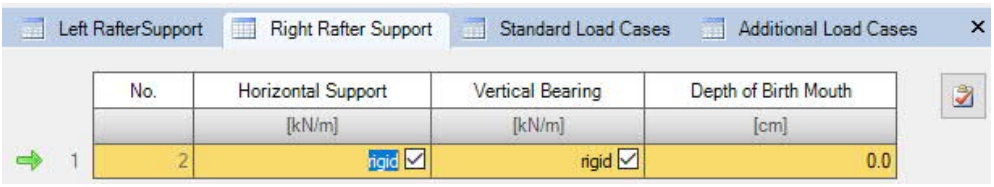
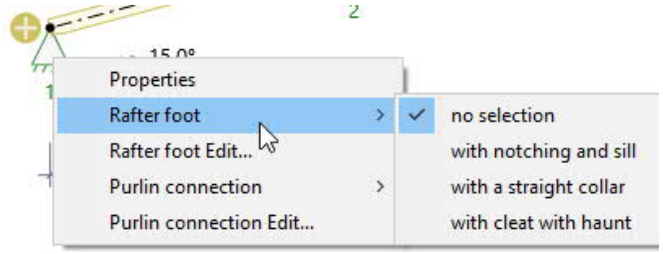


Fig .: Tab under the graphic.

Connection details of the rafter base points

The functions/dialogs for the rafter bases can be called up via the context menu of the supports.

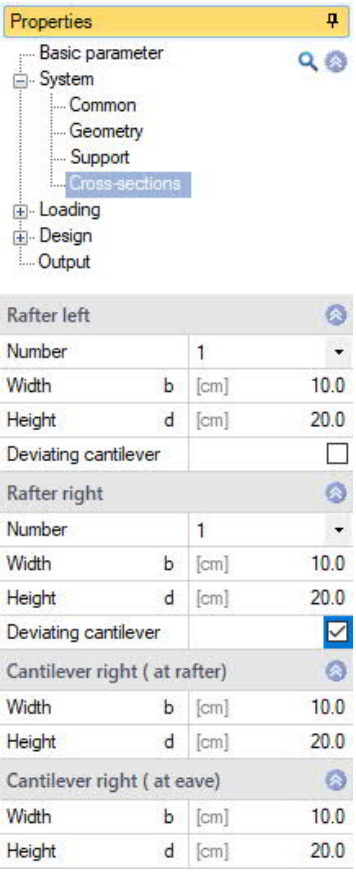


Via "Connected programs" (in the menu above), the connection details can optionally be forwarded to the corresponding toolbox module (rafter base) for calculation.

See also Design ▸ Connection Details.

Cross-sections

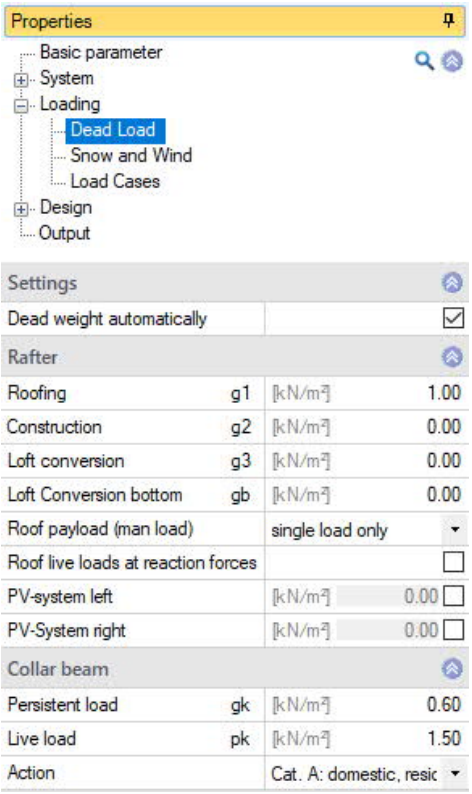
Number	Number of cross-sections (1 or 2).
Width/Height	Display of the selected or input of the cross-section dimensions.
Deviating cantilever	If necessary, other cross-sections than for the rafters can be selected for the cantilever arms. Check this option to display the corresponding input fields.



Loading

See also document Roof: Loads-Design.

You can also define user-defined actions here.



Dead Load

Dead weight autom. — Here you choose whether you want to calculate with or without dead weight.

Rafter

g1/g2/g3 — The loads "g1" and "g2" act over the entire length of the rafter. Your load coordinates are related to the roof area. The loft conversion load "g3" acts from the edges of the house ground to the ridge or between the edges of the house ground.

Loft conversion botttom gb — The program applies the lower load on the collar beam roof between the bottom support and the collar beam.

Roof payload (man load) — No or only single load.

Roof live load at support forces — If the option is marked, live loads of category H are taken into account at support forces and load transfer, otherwise not.

PV-system — Photovoltaic system: select this option to show the corresponding parameters.

Collar beam

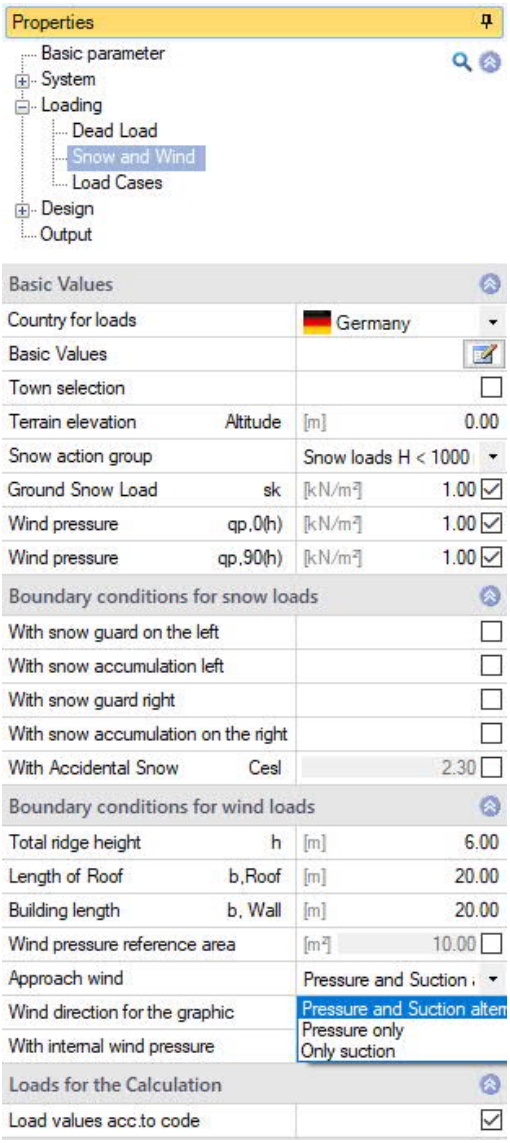
Both permanent loads gk and live loads pk can be specified for collar beams. The live loads are assumed to be one-sided for the asymmetrical load cases.

Snow and wind

Basic values

Basic values — This button opens the snow and wind load dialog.

Town selection — Display of the municipality selected under "Basic values". If you would like to enter your own values instead, uncheck this option and enter the values below.



Boundary conditions for snow loads

Snow skirt and snow accumulation can be selected left and right. Since the factors for exceptional snow loads can differ between the National Annexes, the *Cesl* value can be modified if necessary.

Boundary conditions for wind loads

Ridge height — Height of the ridge above the terrain.

Roof length — Roof length as the width of the wind attack b.

Building length — Building length as the length of the wind attack for walls.

Wind pressure reference area — If this option is checked, the reference area to which the aerodynamic coefficients for the component verifications are referred can be adjusted.

Approach wind — Pressure and suction alternatively, only pressure, only suction.

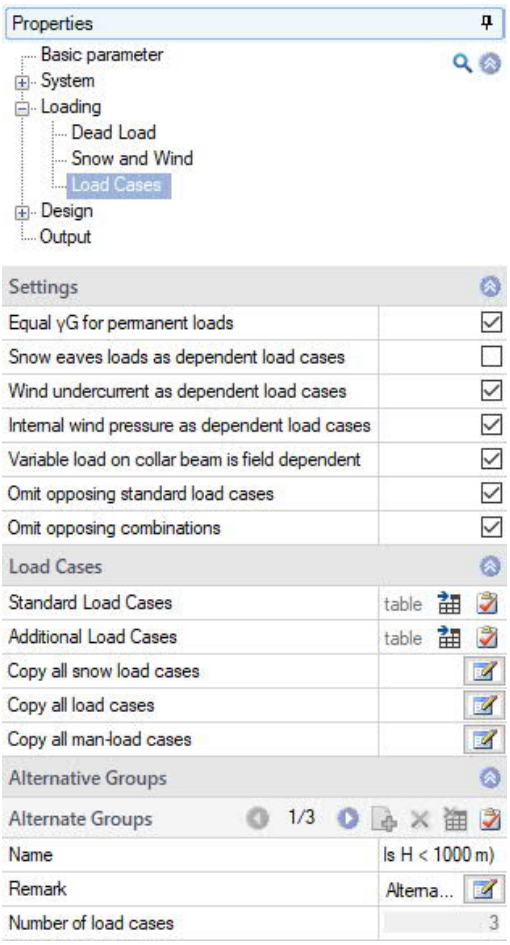
Wind range — With the ridge/valley rafter, you can optionally choose which wind range is to be used as the basis for the averaged wind load on the main/secondary roof. Otherwise the program automatically takes the area with the greatest wind pressure.

Loads for Calculation

Load values acc. to code — Deactivate this option to be able to enter your own values.

Load cases

You can use the “to the table” symbol or the tabs under the graphic to access the tables for the standard load cases or the additional load cases.



Settings

Equal γG for permanent loads	If the option is selected, permanent loads are also combined, otherwise they are all applied the same.
...as dependent load cases	If the option is selected, the loads are assumed to be "dependent" and combined. Note that when you choose a dependency, you must ensure that the loads always occur together at the same time!
Variable load on Collar Beam ...	If the option is selected, the live load on the collar beam is considered independently span by span.
Omit opposing ...	If the option is selected, standard load cases/combinations with loads whose expected deformations are in opposite directions are omitted.

Standard Load Cases

Wind and snow loads are automatically generated as "Standard Load Cases" in accordance with the applicable standards. These load cases can be switched on and off in the table individually or as a whole in the "Active" column, but they cannot be edited.

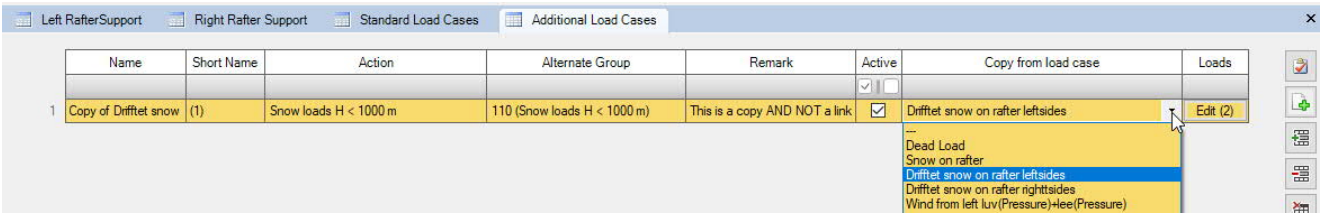
"Standard load cases" can be copied to "Additional load cases" and edited there ("Copy all snow, wind, man load cases").

To display the table, click on the "Standard Load Cases" tab below the graphic.

Additional Load Cases

Here you can create your own load cases or copy “Standard Load Cases” in order to add or change them.

Note: for a new table row click on the right  *symbol.*



Name — Enter a (own) load case name.

Short Name — Enter a short name, eg for display in tables.

Action — Selection of the action from a list.

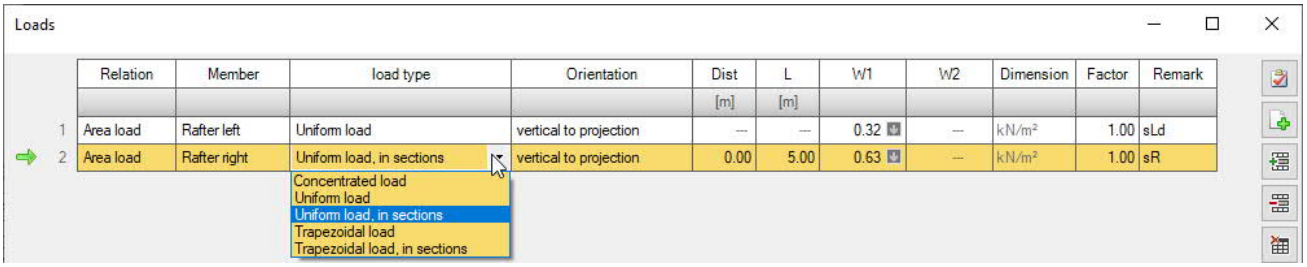
Alt. group — Load cases to which you assign the same alternative group number (>0) do not act simultaneously (but rather "alternative"). Example: Wind loads from different directions.

Remark — Free comment text.

Active — Load cases can be set temporarily inactive here (remove tick).
During the calculation, all load cases marked as "active" are automatically superimposed according to the applicable combination rules, taking into account the alternative groups.

Copy from load case — Here you can select previously entered load cases. The selected load case is then copied and can then be edited/adjusted.

Loads — With this button you call up the input table of the loads for the load case.



Relation — Reference for the load: line load (component-related) or area load (area-related).

Member — Component: Rafters left, right, collar beam.

Load type — Single load
Uniform load (continuous or in sections)
Trapezoidal load (continuous or in sections)

Orientation — Load alignment depending on load type:
Point load:
- vertical (global down)
- horizontal (global)
- transverse (to the member axis)
- longitudinal (in the direction of the member axis)

Line load:
- vertical to beam (global down on member)
- vertical to projection (global down on projection)
- transverse to the beam (perpendicular to the member axis)

Dist. — Specifies the distance of the load in x-direction from the start of the component.

L — Specifies the length of the line load in x-direction.

W1, W2 — Load value at the beginning or at the end of the line load.

A load value compilation can be called up using the "arrow symbol" 

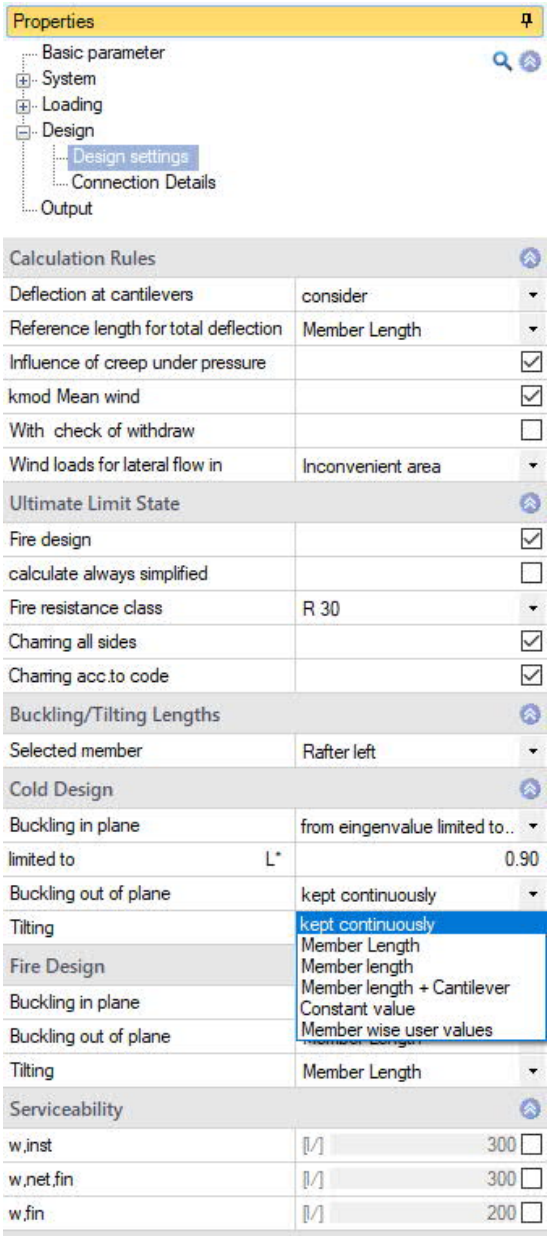
Factor	The load value is multiplied by this freely definable factor.
Remark	Optional entry of free text.

See also document Roof: Loads-Design.

Design

Design settings

Calculation rules



- Deflection at cantilevers:
  If required, the verification of deflection at the cantilever can be switched off completely here.

  Only positive deflection on cantilever arms

  For short cantilever arms the negative deflection there usually determines the design result, this often undesired influence can be eliminated by selecting the option "Only positive deflections on cantilever arms".

- The reference length for the total deflection

  For the serviceability verifications, you can specify whether the member or the component length should be taken into account as the reference length for the total deflection design.
  For the local (member-by-member) deflection verification, the member length is always automatically used as the reference length.

- Creep influence in compression:
  If this option is selected, the stiffnesses due to creep from permanent and quasi-permanent load components are reduced.

- kmod Wind averaged

  If the option is selected, the kmod coefficient for wind is used as the mean value for the classes of load durations short and very short.

- With check of withdraw

  If the option is checked, proof against withdrawal is provided. The cpe1 values are used as a basis for determining the wind loads. The verifications are carried out in the design situation "Equ".

  The case that the load application area of the rafter is underflowed by the wind like a cantilever when the wind flows on the gable side can be taken into account with the option “With gable-side overhang”.

Ultimate Limit State

- Fire protection design:

  Check this option to display the input fields for the fire design. If this option is selected, the stress verifications are also carried out in the event of a fire.

- calculate always simplified:

  If the option is selected, the simplified method with reduced cross-sections is always used in the analysis for fire design. Otherwise the program chooses between the simplified and the exact method (with reduced properties).

- Fire resistance class:

  Selection of the desired fire resistance class or user-defined input of the burn time.

- Charring all sides:

  Uncheck to select individual sides for fire exposure.

- Charring according to code:

  Remove the tick if you want to specify the charring rates βn for the individual sides yourself, otherwise the standard values will be used.

- no reduction in stiffness:

  Depending on the selected standard (NA), the modulus of elasticity of compressively loaded components is reduced by means of kdef in stability checks if the proportion of permanent loads in the total load is large. This leads to smaller (less favorable) buckling coefficients kc.

See also document Fire protection analysis timber.

Buckling and tilting lengths

- Selected member Selection of the component (rafter, collar beam).

Cold Design

The boundary conditions for the buckling lengths in and out of the rafter plane as well as the tilting length or the lengths themselves can be specified separately for each component.

The following conditions are available:

- continuously fixed
- Buckling/tilting length = bar length
- Buckling/tilting length = component length
- from the determination of the eigenvalue for each load combination, optionally with an upper limit
- Specification of a constant value for each bar
- Specification of the values for each individual bar

In the event of a fire, the option of determining the eigenvalues is not applicable, since the cross-section values would vary depending on the design method for the individual verifications!

Fire Design

Analogously as under Cold Design.

Serviceability

w,inst	Limit of elastic deflection
w,net,fin	Limit value of the sum of elastic deflection and creep deformation
w,fin	Limit of the final deformation

Connection Details

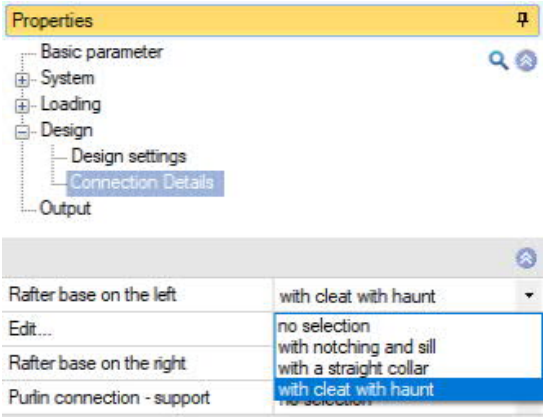
Connection details of rafter base points

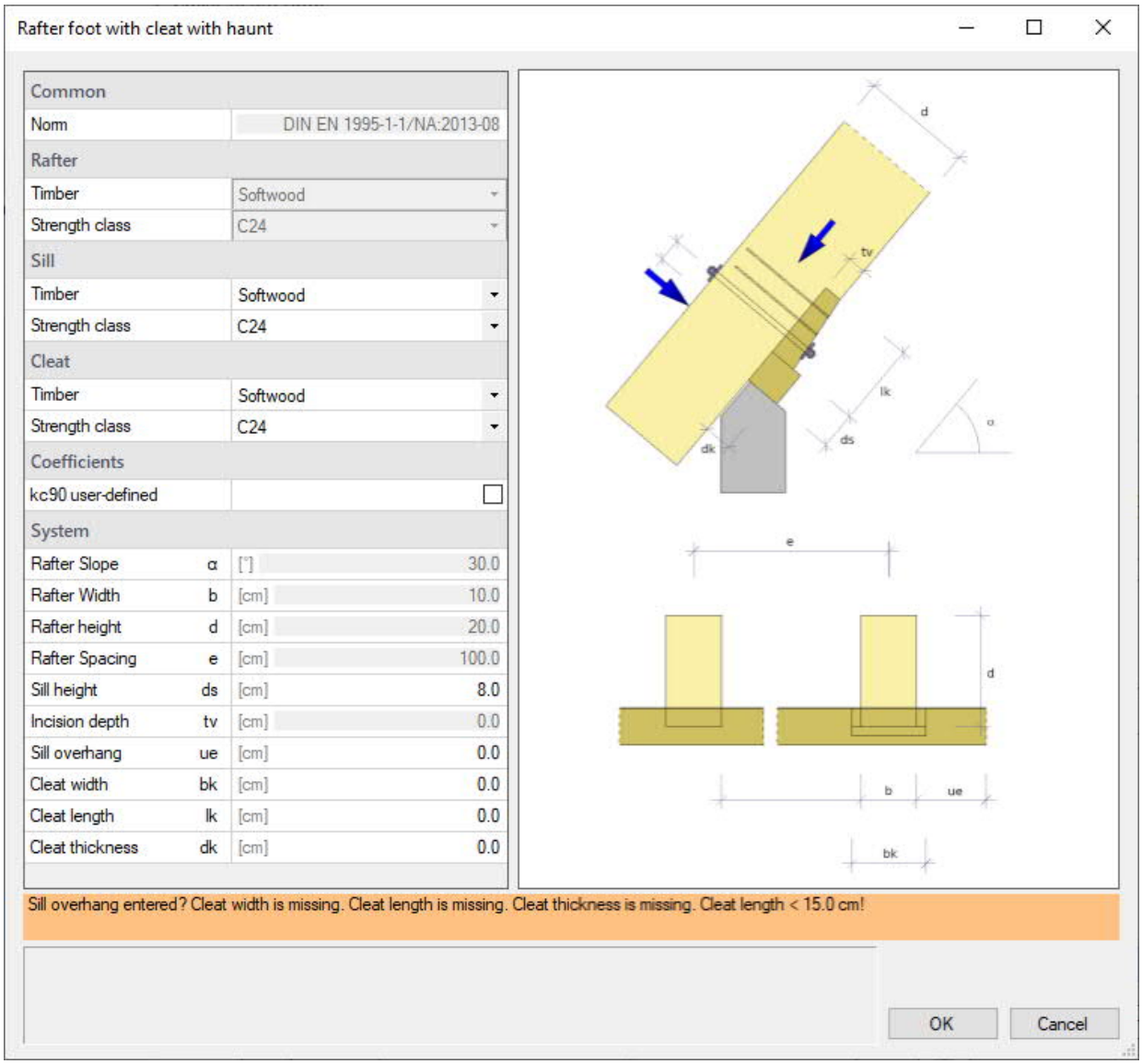
- nothing selected,
- with notch and threshold,
- with straight collar,
- with haunched collar.

With the Edit button you can open the corresponding dialog. The respective parameters are self-explanatory (graphic).

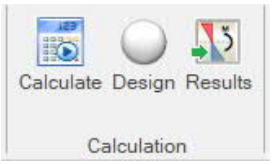
Optional forwarding of connection details to the toolbox (connected programs in the ribbon).

For graphical input, see also the "Support" chapter.





Calculation



To calculate, click on the "Calculate" button in the upper menu bar.

Auto calculation option

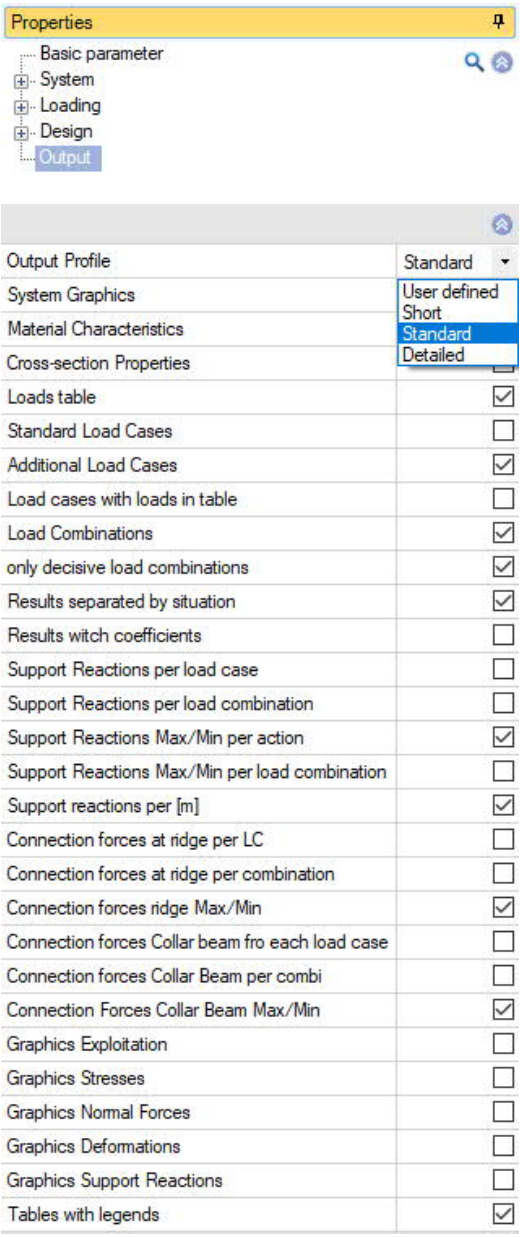
The option for automatic calculation after each input can be switched on under File - Settings if the runtime behavior of your computer is satisfactory, so that a new calculation can be carried out immediately with each input change.

For more information see the document Roof: Loads-Design: Calculation

Output

Before the output click on the symbol "Calculate" in the upper menu ribbon.

After the calculation, the utilization is displayed at the bottom right in the graphics window and offers a good overview of the economic efficiency of the system entered.



Output profile

By clicking on the various output options, you determine the scope of the output.

Results

You can view the result graphics via the “Results” tab in the upper menu ribbon.

Here you can also the options of scaling graphics and taking snapshots for the output.

Output as a PDF document

The output document is displayed in PDF format via the „Document“ tab and can be printed.

See also document Output and printing.