

# D9 – Continuous Rafter

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The screenshot displays the FRILO software interface for a 'D9 Continuous Rafter' project. The window title is 'D9 Continuous Rafter 01/2016/B - Item: D1a (Project: Localization) - [input]'. The interface is divided into several sections:

- Code:** A tree view on the left lists various standards such as DIN 1052-A1, EN 1995:2004, and BS EN 1995:2012.
- Material:** Set to 'Softwood' and 'C16'.
- System:** Inclination is 34.0 degrees, spans are 2, and cantilever is set to 'excess of roof'.
- Standard Rafter Table:**

span	length
cant. bt	1,65
span 1	3,82
span 2	1,68
cant. tp	0,00
excess top	0,00
- Support Table:**

no.	t	hor. fixed	vert. fixed
1	3,00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	3,00	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	3,00	<input type="checkbox"/>	<input checked="" type="checkbox"/>
- 3D Model:** A 3D perspective view of the rafter system on a roof slope. It shows a distributed load  $s=0,57$  and a wind load  $w=0,34$  from the left. The total span is 7,15. The vertical height is 4,82.
- Buttons:** 'Loads', 'Additional load', 'design-defaults', 'always calculate', and 'calcul.'.
- Bottom Panel:** Cross section parameters:  $e = 70,0$  cm RAFTER: 1 x b/d = 8,0 / 20,0 cm. Calculation results:  $\eta c = 0,99$  and  $\eta f = 0,39$ . An 'output' button is also present.
- Status Bar:** Shows 'type of timber' and the date/time '21.04.2016 | 13:45'.



# D9 – Continuous Rafter

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

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Further information and descriptions are available in the relevant documentations:

<a href="#">FDC – Basic Operating Instructions</a>	General instructions for the manipulation of the user interface
<a href="#">FDC – Menu items</a>	General description of the typical menu items of Frilo software applications
<a href="#">FDC – Output and printing</a>	Output and printing
<a href="#">FDC - Import and export</a>	Interfaces to other applications (ASCII, RTF, DXF ...)
<a href="#">FCC</a>	Frilo.Control.Center - the easy-to-use administration module for projects and items
<a href="#">FDD</a>	Frilo.Document.Designer - document management based on PDF
<a href="#">Frilo.System.Next</a>	Installation, configuration, network, database

## Application options

The D9 application calculates and designs continuous single- and multi-span rafters as beams under bending stress. Structural problems of this kind normally occur on typical purlin roof systems that do not impose high axial forces on the rafters. Cantilevers can be defined on both sides.

The D9 application is not suitable for the design of rafters with ridge joints (e.g. rafter roofs) because the interaction between the two roof halves as well as the axial loading on the rafter must be taken into account in this case (rafters without purlin supports).

### Available standards

- EN 1995-1-1:2004/2008/2014
- DIN EN 1995-1-1:2010/2013
- ÖNORM EN 1995-1-1:2009/2010/2015
- BS EN 1995-1-1:2012
- UNI EN 1995-1/NTC

*still optionally available:*

- *DIN 1052:2004/2008*

In addition to typical roof loads such as uniformly distributed, weight, snow and wind loads, additional loads can be defined as uniform linear loads, concentrated or trapezoidal loads and assigned to groups of action. The software also allows you taking wind uplift at overhangs into account.

The load assumptions can optionally be based on EN 1991-1-x in combination with the relevant National Annexes - *still available: DIN 1055*.

If EN 1995 or EN 1991 was selected, combinatorics is based on EN 1990.

*DIN 1052: combinatorics IAW DIN 1055-100*

The standard applicable to the assumption of wind and snow loads is freely selectable.

The supporting forces are no longer put out as the result of the superposition but separately for each group of actions. The ridge joint forces are specified in addition.

The support reactions and connection forces are optionally put out either as characteristic values of the individual actions or as design values of the maximum and minimum combinations.

The verification of the resistance against wind suction is optionally available.

## Basis of calculation

The calculation is based on the strut-and-tie model. Axial force deformations and the effect of the real, specified support reactions are taken into account.

The axial force effects are not considered in the stress resistance verifications.

The bearing forces are exactly determined in the framework calculation. Due to constraints caused by axial force effects, horizontal bearing components might occur even if only vertical external loading applies.

### EN 1995-1

EN 1995-1-1 is the basic framework for the European timber standard. In combination with EN 1995, always a National Annex must be used, which specifies the nationally determined parameters. This applies also to EN 1990 and EN 1991. Moreover, National Annexes may have an influence on verification methods prescribed by the Eurocode. You can always select the National Annex in the software.

For the verifications as per EN 1995-1-1, the superpositions are always created in accordance with the rules of EN 1990-1. The support reactions are optionally represented as characteristic values of the groups of actions or as design values for the maximum and minimum combinations. The splitting into characteristic values is helpful to generate additional combinations for the connected components.

The stress and stability verifications are based on EN 1995-1-1, 6.2 and 6.3. The shear resistance verification takes always the entire shear force into account.

Determination of the effective length – see the document "[Roof load design](#)".

The serviceability verifications are based on EN 1995-1-1, 7.2. The vibration resistance verification as per 7.3 is currently not available for roofs.

### EN 1990, EN 1991

The software can determine the values for wind and snow loads on the basis of the National Annexes to EN 1991.

The combination rules are specified by EN 1990.

Since all standards and National Annexes are based on the semi-probabilistic safety concept, the software allows combinations of different standards. We strongly recommend using the associated National Annexes, however.

## Definition of the structural system

In the "Material" section, you can define the timber species, and the grading and usage classes.

For fasteners, steel St37 is assumed.

Activating the  button displays a dialog for the definition of additional material-specific details (specific weight).

You can display the available definition options via the menu item ▶ Options ▶ [Settings](#):

- Spanwise definition (D9)
- Definition via coordinates (D11/D12)
- Projection-related definition (D11/D12)

This dialog also allows you to define which standard should be set by default when starting the software.

### Spanwise definition

When selecting this option, you can define the structural system to be calculated span by span. First, you must define the inclination of the rafters on both sides and the number of spans. Subsequently, you can define the projections lengths of the individual spans and cantilevers in the x-direction.

#### Roof inclination

**$\alpha$**  Specification of the inclination angle of the rafter.

**n** number of rafter spans.

#### Cantilever=roof overhang

Option for the definition of a roof overhang. If you uncheck this option, you can make a user-defined specification that differs from the cantilever length. The overhang is particularly important for the definition of [wind uplift](#) and the consideration of finishing loads.

**Single-pitch roof** select this option to define an overhang at the upper cantilever. The wind loads are assumed for a single-pitch roof then.

**Cantil. bottom** projection length of the cantilever at the eaves in the x-direction

**Cantil. top** projection length of the cantilever at the ridge in the x-direction

**Span i** projection length of the span number "i" in the x-direction.

Unlike a cantilever, a span always has a support at its front end and its rear end!

**Overh.** Projection lengths in the x-direction of the roof overhang.

## Supports/purlins

- No.** consecutive support number.
- t** birdsmouth or cutting depth [cm], → it weakens the rafter cross section in the supporting area.
- Hor. fixed** check this option to define the corresponding support as horizontally non-sway.
- Vert. fixed** check this option to define the corresponding support as vertically non-sway.

## Cross section

- e** rafter spacing [cm]
- $\eta\sigma$**  Eta Sigma: max. utilization ratio of the cross section by stresses.
- $\eta f$**  Eta f: max. utilization ratio of the cross section by deflection.

### Interactive cross section design

The check values Eta Sigma and Eta f indicate the maximum utilization ratios for stress and deflection and are displayed to allow the user evaluating the cross section.

The stress resistance verifications are performed for the maximum span loading and the maximum column loading.

The option "Always recalculate" must be active for an interactive cross section design. To change the cross section (b/d) of the rafter or ledger, proceed as follows:

- Position the cursor in the respective input field (b or d).
- Edit and adjust the indicated values with the help of the arrow keys ( $\uparrow\downarrow$ ) of your keyboard.

Check Eta Sigma and/or Eta f.

## Loads

### Selection of the standard

The selected [standard](#) is only relevant for the determination of the load values. Combinatorics is based on the safety concept specified by the selected timber standard.

The following permanent loads can be applied:

- g1** loads by the roof covering
- g2** loads by the structure
- g3** loads by the roof finishing

The loads "g1" and "g2" act over the entire rafter length. Their load ordinates are referenced to the roof area.

The finishing load "g3" applies from the edges of the building floor plan to the ridge and/or between the edges of the building floor plan.

The self-weight and snow loads apply vertically, the wind loads apply as wind pressure or wind suction orthogonally to the roof area.

### Loading and design documentation

Further information on the topics

- load assumptions
- wind and snow loads
- superpositions
- additional loads
- design settings
- effective length for buckling and lateral buckling
- load transfer
- verification of the wind suction resistance

are summarized for the D9, D11 and D12 applications in the document: [Roof: Loads - Design](#)

## Output

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

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

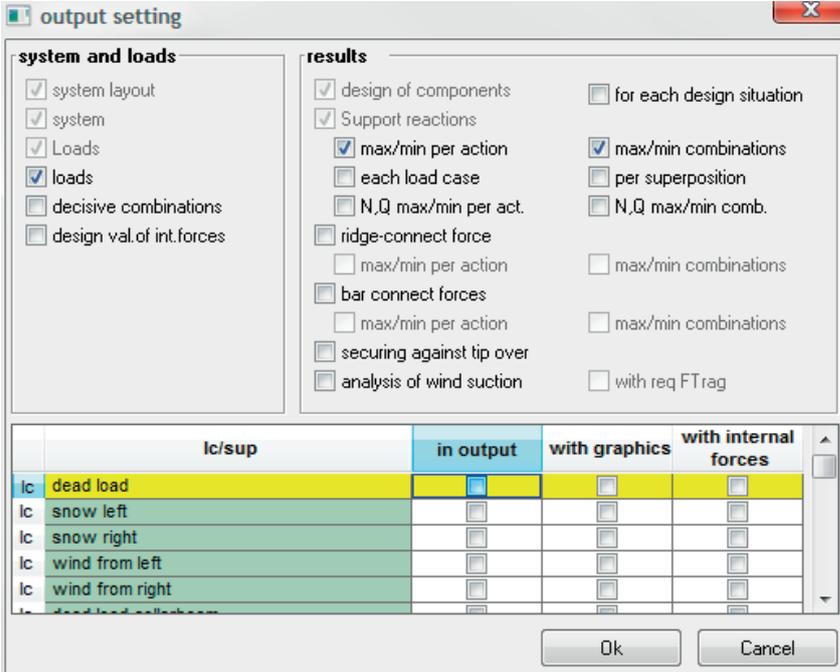
Screen	displays the values in a text window on the screen
Print	starts the output on the printer
Word	if installed on your computer, the text editor MS Word is launched and the output data are transferred. You can edit the data in Word as required.

See also the document "[Output and Printing](#)".

*Note:* The "Comments" menu item allows you to integrate explanatory notes into the documents to be put out.

## Output profile

You can select supplementing information related to the load cases and the superpositions, which should be integrated in the graphical or textual output, in order to allow a more detailed evaluation of the results.



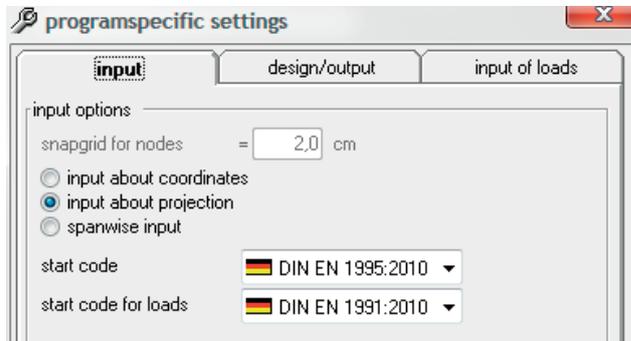
	lc/sup	in output	with graphics	with internal forces
lc	dead load	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
lc	snow left	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
lc	snow right	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
lc	wind from left	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
lc	wind from right	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>System graph</b>	graphical representation of the structural system including the loads.
<b>System</b>	output of the system values in the form of tables.
<b>Loads</b>	output of standard and additional loads in the form of tables.
<b>Actions</b>	optional; the groups of actions are put out with their combination coefficients in the form of tables.
<b>Decisive combinations</b>	optional; the decisive combinations are put out in the form of tables.

<b>Internal design forces</b>	optional; the decisive internal forces in the decisive combinations are put out separately for each component in the form of tables.
<b>Design of components</b>	the design results for the individual components are put out in the form of tables.
<b>Support reactions</b>	the support reactions are put out in one of the following optionally selectable variants:
<b>Max./min. per AG</b>	optional; the characteristic (simple) values of the support reactions are put out separately for each applying action. The results can be used for further combinations in the subsequent components.
<b>Max./min. combinations</b>	optional; the maximum and minimum design values of the support reactions are put out for the combinations. A combination with other loads in the subsequent components is difficult and can only be done by approximation.
<b>Per load case</b>	optional; all simple support reactions are put out for each load case in the form of tables.
<b>Per superposition</b>	optional; all support reactions are put out for each listed superposition as design values in the form of tables.
<b>N,Q max./min. per AG</b>	optional; the characteristic values of the support reactions in the direction of the rafter axis and perpendicular to it are put out (analogously to the internal forces).
<b>N,Q max./min. comb</b>	optional; the maximum and minimum design values of the support reactions in the rafter axis are put out for the combinations. A combination with other loads in the subsequent components is difficult and can only be done by approximation.
<b>Ridge joint forces</b>	optional; the ridge joint forces can be put out in the following, optionally selectable variants:
<b>Max./min. per AG</b>	optional; the ridge joint forces are put out as characteristic (simple) values separately for each action in the form of tables.
<b>Max./min. combinations</b>	optional; the maximum and minimum design values of the combinations are put out in the form of tables.
<b>Ledger connection forces</b>	optional; the ledger connection forces can be put out in the following, optionally selectable variants:
<b>Max./min. per AG</b>	optional; the ledger connection forces are put out as characteristic (simple) values separately for each action in the form of tables.
<b>Max./min. combinations</b>	optional; the maximum and minimum design values of the combinations are put out in the form of tables.
<b>Lateral buckling stability</b>	optional; the results of the lateral buckling stability verification are put out.
<b>Suction resistance verification</b>	optional; the results of the verification of the resistance to wind suction forces are put out in the form of tables. Currently only available in combination with the old DIN 1055 standard.
<b>With req. F<sub>Trag</sub></b>	optional; the force $F_{Trag}$ that must be borne by the fasteners in the suction resistance verification is put out in the form of tables. Currently only available if the old DIN 1055 was selected.

## Options - settings

The menu item ▶ Options ▶ Settings allows you to make software-specific settings.



### Definition options

Capturing range	this value specifies the range in which the system combines several nodes to a single one automatically. This option helps to avoid the generation of small members in the total structural system. You should not set this value to 0 because it is important to consider a tolerance range particularly for the supports at the collar beam connections due to numerical differences.
.... input	allows selecting the definition method in the D11 and D12 applications: Via coordinates, Projection-related, or Spanwise are the available options. You can change the method any time during the session.
Default standard	allows you to define the standard that should be set by default when starting the software.

### Design and output

Design IAW DIN	this option is only available in combination with the old DIN 1052:1988 standard - see documentation in our archive at <a href="http://www.friilo.com">www.friilo.com</a> .
Self-weight	if you check this option, the software determines the self-weight of the components automatically from their geometry and the specific weight of their materials.
Creep in stability	check this option to consider the influence of creep in the stability verifications of components mainly under pressure in accordance with the requirements of the selected standard.
Consequence classes	CC1 to CC3 - see EN 1999, Annex B.

### Definition of the loads

Pre-set $w_0$ , $s_0$	you can optionally pre-set user-defined values for the regular snow load and the impounding wind pressure.
Snow-load-on-eaves factor	some regional building codes allow the reduction of the snow load on eaves using a particular factor.
Pre-set snow AG	this option allows you to define the snow action group to which the standard snow load should be assigned.