

Flight of stairs

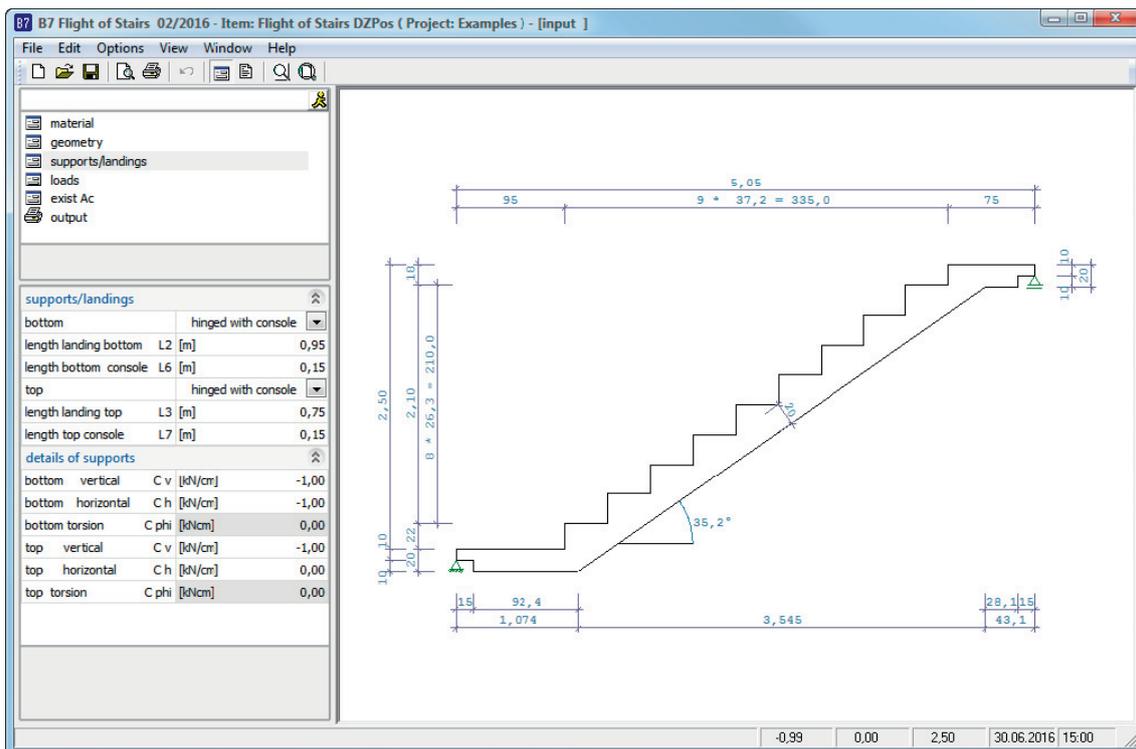
FRILO Software GmbH

www.friilo.com

info@friilo.com

Version 1/2016

As of 28/07/2016



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Further information and descriptions are available in the relevant documentations:

FDC – Basic Operating Instructions	General instructions for the manipulation of the user interface
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
FDC – Menu items	General description of the typical menu items of Frilo software applications
FDC – Output and printing	Output and printing

Application options

B7 allows you to perform the static calculation of a single flight of stairs.

The geometry, composed of treads / landings / consoles is taken into account.

For a given height, the program is able to propose the dimensions of the steps. Guidelines for steps, safety and usability are taken into consideration.

Standards

- DIN 1045 07-88
- DIN 1045-1
- ÖNorm B4700
- DIN EN 1992 1-1: 2012 + 2013 + 2015
- ÖNORM EN 1992 1-1: 2011
- BS EN 1992 1-1: 2015

See also:

list of the implemented euro-standards for each program: www.friilo.com

Support / landing

For the support of the flight of stairs you can choose between the following types:

- rigid support of the landing
- hinged support with console
- hinged support without console

Loads

A permanent load g and live load q can be applied independantly on flight and landing.

The live load can be assigned to an action group (important for the ψ values).

Output

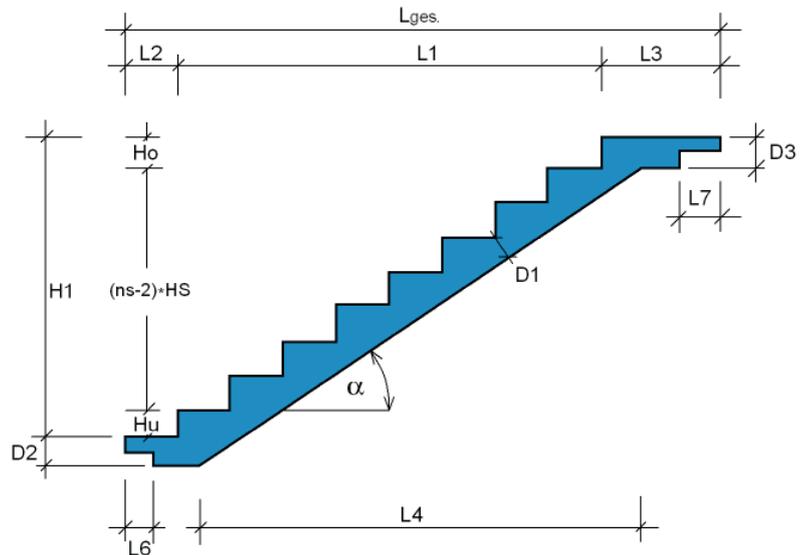
The output includes the system graph, the complete system values, the structural system, the loads and optionally, the durability requirements and the design of the stair flight (bending design, shear design and crack width verification). The result of the bending design proposes a bending reinforcement (number of bars, diameter and spacing). The user can edit and customize the proposed reinforcement.

The crack width verification is based on the quasi-permanent load combination.

If the flight of stairs is restrained on one or both sides, a reinforcement proposal is submitted for the point(s) of restraint and the crack width verification is performed in addition to the bending design and the shear design.

The reactions, the characteristic as well as the design values, are listed separately, according to permanent and live loads. Also the combined reactions are represented.

The results are always displayed in m width.



Input

Material

Selection of the standard

The user selects the desired standard in the main menu.
 (You need a valid licence to do this).

Material

Selection lists allow the user to select the desired concrete strength and the reinforcing steel grade, depending on the selected standard.

In order to expand a list, click to the corresponding entry or the button .

material		
norm		BS EN 1992:2015
concrete		C25/30
concrete steel		Grade460YH
durability		XC1
Reinforcement location		
bottom	d1 [cm]	3,00
top	d2 [cm]	3,00

Durability

Activating the button  displays the [Durability](#) dialog.

If the durability requirements concerning the concrete class and/or the reinforcement spacing (d1 and d2) are higher than the adjusted values, a message is displayed after closing the durability dialog informing the user and asking him/her whether the values should be adjusted to the requirements. If the user confirms the prompt with “Yes”, the concrete class and/or the reinforcement bar spacing is adjusted automatically.

The reinforcement bar diameters determined automatically in the calculation or defined by the user are displayed as default values in the durability dialog. Therefore, we recommend accessing the durability dialog after completion of the data entry in order to determine the durability requirements with the decisive reinforcement bar diameters.

Reinforcement layers

For the distance of the centres of gravity of the longitudinal reinforcement to the top and the bottom edges, the values d1 and d2 are set to 3 cm by default;

d1 = reinforcement layer on bottom,

d2 = reinforcement layer on top

Geometry

Stairs geometry

Automatic:

The application optionally proposes the stair dimensions for a given stair height, while considering the step height, comfort and safety rules.

Manual input:

Manual input of all dimensions.

Stair height H1

The vertical value **H1** indicates the distance from the upper to the lower unfinished finished floor level.

Stair length L1

Input of the projected stair length **L1** from the first to the last tread.

Number of risers ns

The number of risers **ns** corresponds to the number of steps.

Stair rise HS / stair run LS

Displays the corresponding information.

Height of step Hu/Ho

Height of the first and last step

Hu (height of top step), Ho (height of bottom step).

The ratio HS/LS is determined and displayed automatically.

Flight width / covering width B1/B2

The values **B1** and **B2** allow you to distinguish between the width of the stair flight and the tread covering. The tread covering only affects the approach of the additional permanent load *g*.

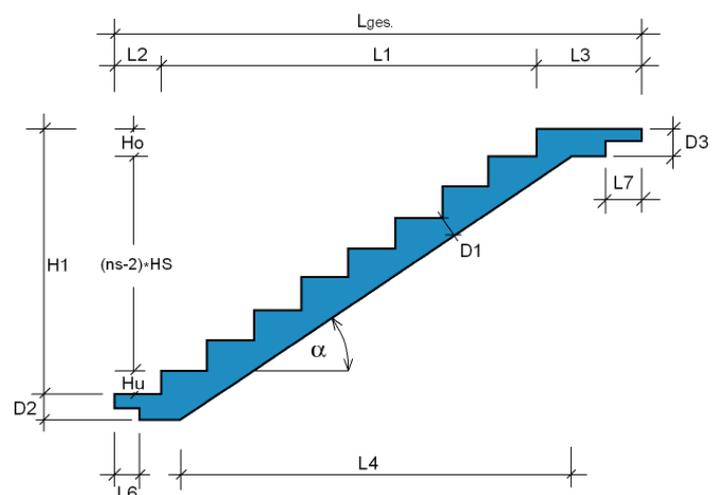
Stairs flight thickness D1

Thickness of the flight of stairs.

Landing thickness bottom/top D2, D3

See sketch.

geometry			
geometry of staircase		automatically	▼
height of staircase	H1 [m]		2,20
length of staircase	L1 [m]		3,47
ns	ns		13
inclination of staircase	HS [m]		0,17
step surface	LS [m]		0,29
height of step bottom	Hu [m]		0,17
height of step top	Ho [m]		0,17
width of flight	B1 [m]		2,00
width of cover	B2 [m]		2,00
thickness of staircase	D1 [m]		0,30
thickness of landing bottom	D2 [m]		0,30
thickness of landing top	D3 [m]		0,35
remarks			
remarks			0 ...



Support/landings

For the two stairs supports,

- the type of support,
- the lengths from the front edge of the step to the front edge of the support L2, L3 as well as the console lengths L6, L7
- depending on the support type

Types of supports: - hinged with consoles
 - hinged w/o consoles
 - restrained in landing

Support details

Input of the supports

- 1 = rigid,
- 0 = free,
- >0 = spring stiffness in kN/cm

Loading

The loading on the flight of stairs, the landings and consoles is divided in a permanent load g and a live load q . Characteristic loads (service loads) are always defined. Here, the permanent load g describes only the weight of the tread covering. The self-weight of the staircase is considered by the program automatically.

supports/landings			
bottom		hinged with console	
length landing bottom	L2 [m]		0,40
length bottom console	L6 [m]		0,15
top		hinged with console	
length landing top	L3 [m]		0,95
length top console	L7 [m]		0,20
details of supports			
bottom vertical	C v [kN/cm]		-1,00
bottom horizontal	C h [kN/cm]		-1,00
bottom torsion	C phi [kNcm]		0,00
top vertical	C v [kN/cm]		-1,00
top horizontal	C h [kN/cm]		0,00
top torsion	C phi [kNcm]		0,00

at staircase			
permanent load	g1 [kN/m ²]		1,00
live load	q1 [kN/m ²]		3,00
at landing/console bottom			
permanent load	g2 [kN/m ²]		1,00
live load	q2 [kN/m ²]		3,00
at landing/console top			
permanent load	g3 [kN/m ²]		1,00
live load	q3 [kN/m ²]		3,00
settings			
actions	ACG		Cat A - domestic

Exist. As / pre-set reinforcement of flight of stairs

This main menu item is always available independently of the selected standard.

The required reinforcement (req. As) and the existing reinforcement (exist. As) are displayed.

diameter diameter of the stairs flight reinforcement

count ϕ width number number of selected diameters for the entire stair flight width

For stairs restrained on one or both sides, the required reinforcement and the existing reinforcement as well as the number and the diameter of the fixed-end reinforcement are displayed in addition.

per meter			
reinf. stair	req. as	[cm ² /m]	4,91
	exist. as	[cm ² /m]	4,96
absolute			
reinf. stair	req. As	[cm ²]	9,82
	exist. As	[cm ²]	10,21
input reinforcement staircase			
diameter			10
count ϕ width number			13

Note: The existing relative reinforcement "exist. As" (cm²/m) is determined under the condition that the axes of the two outermost lateral reinforcement bars have a distance of 5.0 cm to the lateral surfaces of the stairs. The remaining reinforcement bars are distributed evenly between the two outer bars. The geometric axes spacing between two reinforcement bars is determined as follows:

$$\text{Distance} = (\text{stairs width} - 2 * 5 \text{ cm}) / (\text{number of reinforcement bars} - 1)$$

The existing relative reinforcement "exist. As" is determined as follows:

$$\text{Exist. As} = \text{surface of reinforcement steel} / \text{distance}$$

Calculation

Superposition of the internal forces

The superposition of the internal forces for EN standards is based on EN 1990-1-1 including the relevant National Annex.

For the design

$Q_d = 1.35 * G_k + 1.5 * Q_k$ as per eq. (6.10) for NA Germany (NA-D), for NA Austria (NA-A)

$Q_{d1} = 1.35 * G_k + 1.5 * \psi_0 * Q_k$ or

$Q_{d2} = \chi * 1.35 * G_k + 1.5 * Q_k$ as per eq. (6.10a) or eq. (6.10b) for NA Great Britain (NA-GB) or the original Eurocode

The higher value of Q_{d1} and Q_{d2} is decisive.

ψ_0 in accordance with the action group and the respective NA,

χ in accordance with the respective NA

For the crack-width verification (quasi-permanent combination of actions)

$Q_d = G_k + \psi_2 * Q_k$ as per eq.(6.16b)

ψ_0 in accordance with the action group and the respective NA

Design

Bending design

The bending design is performed for the landings and the stair flight; for restrained stairs, a bending design is also performed at the stair foot and at the stair head as well as at the points of restraint.

The bending design is performed in accordance with the kh-method. The minimum reinforcement for bending specified in para. 9.2.1.1 is taken into consideration. For stairs restrained on one or both sides, the limitation of the pressure zone height x_d/d as per DIN EN 1992-1-1 Para. 5.4 (NA.5) is taken into account in order to ensure sufficient ductility.

The B7 application generates a reinforcement proposal (number of reinforcement bars, diameter and spacing of the reinforcement bars) based on the required reinforcement. The user can edit the proposed values.

The proposed reinforcement is calculated in such a way as to ensure that the crack width verification is successful, if possible.

Shear design

The shear design is performed at the front end and rear end of the landings and the stairs flight. To facilitate comprehension and ensure traceability, intermediate values are also put out.

Crack width verification

The crack width verification is performed for the span area and, if applicable, at the points of restraint. The limit diameter and the calculated crack width are put out and compared to the diameter of the existing reinforcement and the permissible crack width.

Output

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

The following results are put out:

- System graph with dimensions
- Geometric data, optionally either in a summarised or a detailed version
- Supporting conditions
- Load (flooring and live loads)
- Optionally, durability requirements
- Results of the bending design
- Optionally, results of the shear design
- Optionally, results of the crack width verification
- Support reactions
- Self-weight of the pre-fabricated part (without flooring)

The user can customize the output scope by ticking the desired options in the output profile.

output layout	
output geometry	<input checked="" type="checkbox"/>
Output requirements durability	<input checked="" type="checkbox"/>
output always shear force proof	<input checked="" type="checkbox"/>
Output crack widths	<input checked="" type="checkbox"/>

Output of the bearing forces:

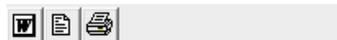
The put out bearing forces refer to the global x/z-system of coordinates (x-axis, positive to the right, z-axis: positive to the top).

Vertical bearing forces are positive when they act from the bottom to the top.

Horizontal bearing forces are positive when they act in the negative direction of the x-axis.

Torques on the support are positive when the act anti-clockwise.

The output on a printer or the screen is launched via the corresponding output buttons.



W	output to MSWord. If MS Word is installed on your computer, it is launched automatically
Screen	displays the values in a text window on the screen
Printer	starts the output on the printer

You can find further information concerning the output in the document [FDC - output and printing](#)