

Strip Foundation FDS+

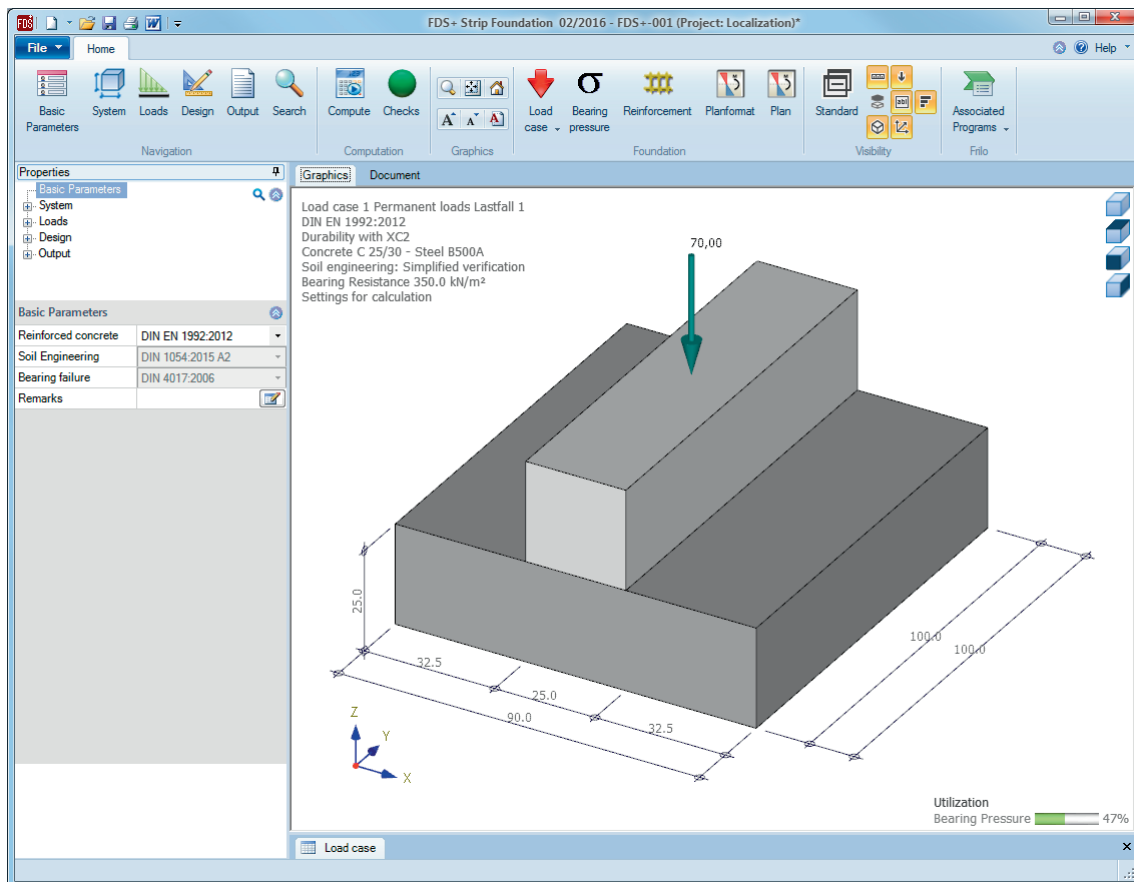
FRILO Software GmbH

www.friilo.com

info@friilo.com

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Strip foundation FDS+

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Further information and descriptions are available in the relevant documentations:

Basic operating instructions-PLUS	General operating instructions for the user interface of Frilo applications
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
Menu items.pdf	
Output and printing	
Import and export.pdf	

Application options

The FDS application allows you to calculate the required dimensions of strip foundations under centric and uniaxial eccentric loading. The required bending and shear reinforcement is calculated for the defined dimensions. The software also checks whether shear and bending reinforcement can be dispensed with in the lower layer. Moreover, the permissible bearing pressure, the gaping joint as well as the safety against sliding, displacement and ground failure are verified.

The following loads are available:

- Wall loads G and Q
- Moments in the x- and y-directions
- Horizontal loads in the x- and y-directions
- Loading on the foundation area left and/or right to the wall
- Any number of load cases with definable actions, possibly in simultaneous and alternative groups.
- Foundation self-weight is automatically taken into account

As a result, utilization of the foundation analyses is displayed on bottom right of the graphical user interface.

Conditions:

- the corresponding verifications have utilizations greater than 0 %
- the verifications have been selected in the output profile

The bending moment and the required bending reinforcement are indicated per linear metre of the foundation, if applicable. For rising masonry walls, the design is performed for the smoothed moment underneath the wall axis and for rising concrete walls for the face moment.

Optionally, you can design the connecting reinforcement for rising concrete walls.

!!Attention: *The FDS+ application is intended for the calculation of strip foundations in the classical sense. If the defined loads and dimension of the structural system produce a deviating load-bearing behaviour like that of an angular retaining wall for instance, another calculation method is required and you should use the appropriate application program.*

Basis of calculation

Available standards

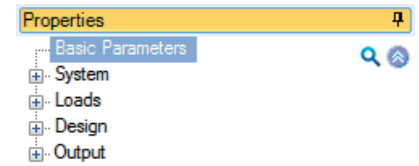
- DIN EN 1992
- ÖNORM EN 1992
- BS EN 1992
- DAfStb¹ Booklet 240
- Foundation standard:
 - DIN EN 1997-1 in combination with DIN 1054:2010
 - ÖNORM EN 1997-1 in combination with DIN 1054:2005.The software selects the foundation standard automatically (DIN 1054:1976/2005/2010) in accordance with the selected reinforced concrete standard.

You can find further information about the basis of calculation in the document [FL.FD_eng.pdf](#).

¹ German Committee for Reinforced Concrete

Data entry

The definition of properties and control parameters is done in the menu on the left side of the screen. You can check the effect of the entered values in the graphical representation on the right side of the screen. Before entering any data, you can change the dimensional units (cm, m ...) via the options File ▶ Program options.

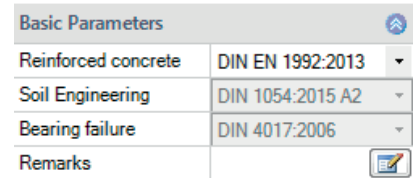



Wizard

The [Wizard](#) appears by default / automatically at startup, but can be switched off.

Input Options in the GUI

The input options in the GUI window are described in the document [Basic operating instructions-PLUS.pdf](#).



Basic Parameters	
Reinforced concrete	DIN EN 1992:2013
Soil Engineering	DIN 1054:2015 A2
Bearing failure	DIN 4017:2006
Remarks	

Basic parameters

Reinforced Concrete


Select the desired reinforced concrete standard:

see also [Basis of calculation](#)

Soil Engineering and Bearing failure

According to the selected reinforced concrete standard, the software selects the corresponding standards for soil engineering and bearing failure automatically.

Remarks

Click on the  button, to enter your own comments to the system.

System

Foundation / Wall material

Selection of the concrete type (standard or lightweight), concrete quality and reinforcement steel grade. Wall: optional masonry or concrete.

Foundation

In the foundation ground plan, the x-axis (positive) runs from the left to the right and the y-axis (positive) from the bottom to the top.

Width x	foundation dimension in the x-direction
Length y	foundation dimension in the y-direction
Height z	foundation height
Anchoring depth d	lowest foundation depth below the ground level or the top edge of the basement floor.
Density γ	gamma concrete

Wall

Wall

Thickness x	thickness of the wall
Length y	length of the wall

Eccentricity

Eccentricity across	eccentricity in the x-direction (transverse)
Eccentricity lengthwise	eccentricity in the y-direction

Properties

- Basic Parameters
- System
- Foundation
- Wall
- Soil
- Loads
- Design
- Output

Foundation material

Type of concrete	Normal-weight concrete
Concrete	C 25/30
Steel	B500A

Material wall

Wall	Concrete
Concrete	Masonry
Concrete	Concrete
Steel	B500A

Foundation

Width	x	[cm]	70.0
Length	y	[cm]	100.0
Height	z	[cm]	50.0
Anchoring depth	d	[cm]	50.0
Density	γ	[kN/m ³]	25.00

Wall

Thickness	x	[cm]	25.0
Length	y	[cm]	100.0

Eccentricity

Eccentricity across	[cm]	0.0
Eccentricity lengthwise	[cm]	0.0

Soil

Soil Values

Bearing pressure	Select whether the design value of the bearing resistance should be entered directly, or to come from a standard table or from a user defined table - see section below.
Bearing resistance	Specification of the permissible bearing pressure $\sigma_{R,d}$
Friction Angle φ'	Angle of the inner friction underneath the foundation base.
Groundwater Exists	This option allows you to define whether groundwater exists (displays the entry "Groundwater Depth").
Groundwater Depth	Absolute depth of the groundwater below the bottom edge of the foundation body.

Soil Values		
Bearing pressure		DIN 1054:2015 A2
Bearing resistance $\sigma_{R,d}$	[kN/m ²]	170.70
Friction angle φ'	[°]	30.00
Groundwater Exists		<input checked="" type="checkbox"/>
Groundwater Depth	[cm]	0.0
Soil bearing resistance by		
First soil layer		
Density γ	[kN/m ³]	18.5
Density by buoyancy γ'	[kN/m ³]	11.0
Friction angle φ'	[°]	30.0
Cohesion c'	[kN/m ²]	0.0
Soil layers		

Soil bearing resistance by table If the bearing pressure is not specified directly, the design value of the bearing resistance is taken from a table (standard or user defined)

Click the Button to open the table dialog.

Parameters by table:

According to Annex	The soil pressure is taken from the corresponding table in the soil engineering standard or its National Annex.
Increase (geometry)	When the option "Bearing pressure: from table" is activated, the permissible bearing pressure is increased by 20 % if the relevant border conditions (b/d) specified by the applicable standard are satisfied.
Increase (strength)	When the option "Bearing pressure from table" is activated, the permissible bearing pressure is increased by 50 %, if the soil is sufficiently solid. <i>Note: The values are added up under particular conditions (70 %).</i>
Anchoring depth d	Lowest foundation depth below the ground level or the top edge of the basement floor.

user defined table:



Generates a new entry

$\sigma_{R,d}$	Design value of the bearing resistance. This value should come from a geotechnical report and contain sufficient guarantees against ground failure and a sufficient limitation of settlements.
b, d	Corresponding foundation width and anchoring depth.

First soil layer

In this section you can enter the values of the first soil layer.

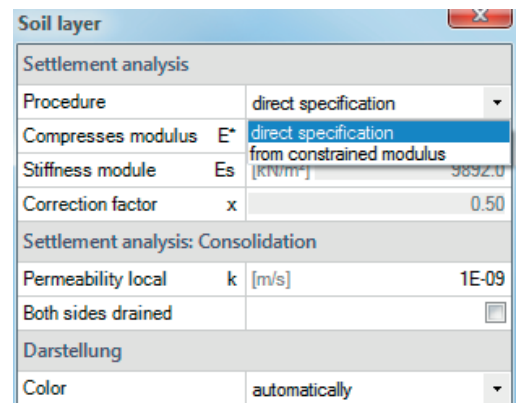
Click the Button to open the dialog for additional soil layers.

	γ	γ'	ϕ'	c'	xU	other
	[kN/m ³]	[kN/m ³]	[°]	[kN/m ²]	[cm]	
→ 1	18.5	11.0	30.0	0.0	150.0	

- γ Specific weight of the soil.
- γ' Specific weight of the soil layer under buoyancy. This value is only used if groundwater was defined (▶ System ▶ Soil)
- ϕ' Friction angle of the soil in this layer.
- c' Soil cohesion.
- xU Thickness of the soil layer. Soil layers below 0.10 m cannot be defined.

Click the (“other”) Button to open the dialog for additional parameters.

- Procedure
 - direct specification:
Define the compressibility of the soil (E_m -module) directly in E^*
 - from the constrained modulus:
 E_m will be calculated from stiffness modulus E_s and correction factor x (from DIN 4019 T1).



Settlement analysis: Consolidation

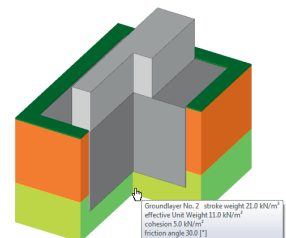
- k Permeability coefficient of the rate of consolidation. The value can be extracted from the soil report.
- Both sides drained For the calculation of the time to approximate decay of consolidation settlement in unilateral drainage the full layer thickness is set, in bilateral drainage only half the layer thickness.

Color

Note: this section only affects the colour representation on the graphical screen.

Select the desired color, Type of Soil (coarse gravel to rock) and the soil admixture (coarse granular to blocky).

Note: The selection of the soil type is only important for the colour representation on the graphical screen.



Loads

Self-weight γ	automatic consideration of the self-weight.
Impact H loads Sole	<input type="checkbox"/> Option not ticked: The horizontal loads apply at the top edge of the base and generate a moment with a particular lever arm <input checked="" type="checkbox"/> Option ticked: The horizontal loads apply directly in the base joint without generating a moment
Delete horizontal loads	delete all horizontal loads with one click! This is useful if a lot of loadcases from other applications (GEO, B5...) has been imported.

Loading		
Self-weight	γ	<input checked="" type="checkbox"/>
Impact H loads	Sole	<input type="checkbox"/>
Delete horizontal loads		

Load Cases

Enter the data of the first load case via the input mask or directly in the load case table, which can be displayed by activating the tab (beneath the graphic).

Load case toolbar: - see [Data entry via tables](#)

To add additional load cases, click on the button once more (a new empty input mask is displayed each time).

Tip: A description is displayed in the status line each time you click into an input field.

Load case

Description	optionally, a comment to the selected action can be entered. This text is included in the output.
Action:	the appropriate actions can be selected from a list: Permanent loads ... seismic loads. (calculation method "characteristic").

Properties	
Basic Parameters	
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Wall single loads

Vertical force in z	vertical force in the centre of the wall
Moment about x/y	positive moments generate pressure on top right or in the positive x/y section of the foundation.
Horizontal force in x/y	horizontal loads act on the top edge of the foundation. They generate moments on their way down to the foundation base, which are taken into account automatically by the software.

Load Cases		
Load case		
Load case		
Description	Load case 1	
Action	Permanent loads	
Einzellasten Wand		
Vertical force in z	[kN]	100.0
Moment about y	across [kNm]	0.00
Horizontal Force in x	across [kN]	0.0
Moment about x	längs [kNm]	0.00
Horizontal Force in y	längs [kN]	0.0
Area Loads		
Area load left	[kN/m ²]	0.00
Area load right	[kN/m ²]	0.00
Group affiliation		
Simultaneous group		0
Alternative group		0

Area Loads

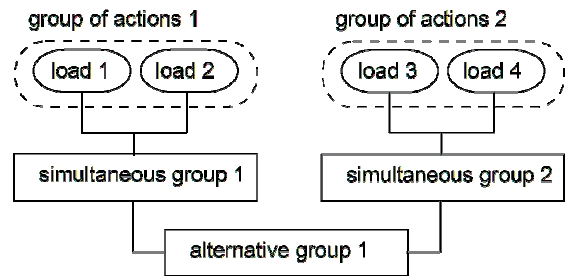
Area load left/right	you can define area loads on the left or the right of the wall.
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Group affiliation

Different variable load cases with similar actions can be assigned to an alternative load case group via the allocation of an alternative group number. Only the decisive load case of this alternative load case group is invoked in the superposition.

Simultaneous (concurrent) group

Loads of a particular action group can be defined as "always acting simultaneously" by assigning them to simultaneous (concurrent) groups.



Ill.: Example for the functioning of alternative and simultaneous groups

Bearing pressure / Actions from the column

Display of the bearing pressure pattern

To ensure traceability, the bearing pressure pattern with stress can be shown for all load cases and superpositions decisive in the verifications. Click the symbol "Bearing pressure" the get the graphic in a popup window..

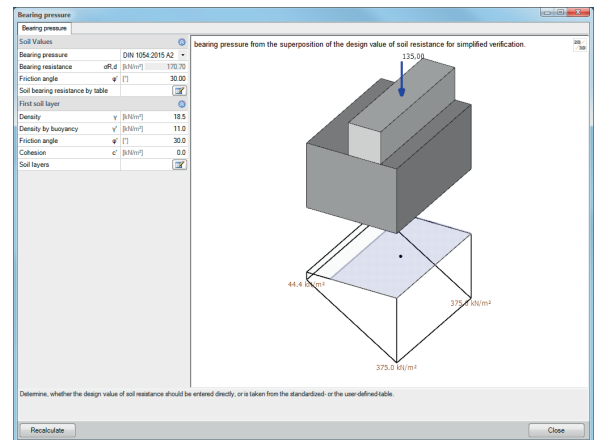


Explanation:

Positive moments M_x and M_y generate compressive strains in the foundation joint in the right top corner and/or the positive x/y section.

The moment M_x rotates around the x-axis and the moment M_y around the y-axis; the horizontal forces H_x and H_y act in direction of the axes. H_x generates a moment M_y and H_y a moment M_x .

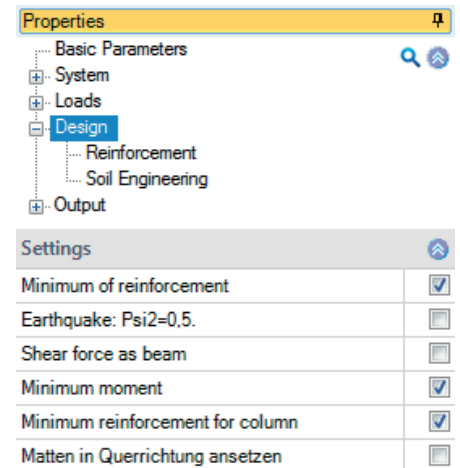
The moments resulting from first and second order calculations are used for all verifications. The scope of data to be put out is defined in the [Output profile](#).



Design / Verifications

Settings - Program settings

Minimum reinforcement	ductility reinforcement in accordance with the selected reinforced concrete standard
Earthquake: $\Psi_2=0.5$	in accordance with the introductory decree of DIN 4149 for Baden-Württemberg, the combination coefficient $\Psi_2 = 0.5$ for snow loads should be used in the superpositions with earthquake loads.
Shear force as beam	specification whether the shear resistance should be verified on a slab or a beam.
Minimum moment	when you tick this option, minimum moments for compression members are taken into account as per Eurocode 6.1 (4).
Minimum reinforcement for column	this option allows you to take a minimum reinforcement for compression members into account.
mat in transverse direction	



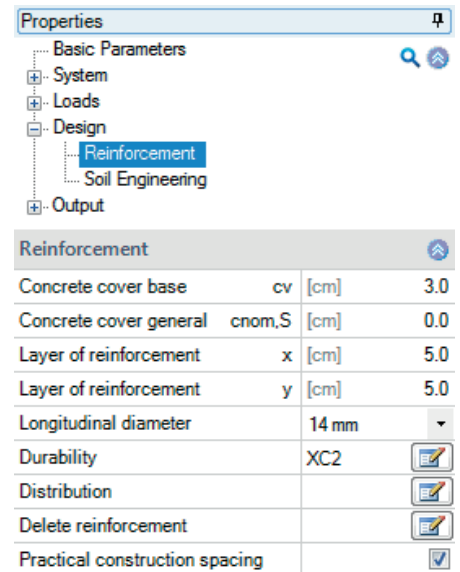
Reinforcement


You can define up to 2 mats and 2 layers of steel rods over the whole upper foundation area.

Lower layer: 2 mats and one layer of steel rods in X- and Y- direction according to the selected distribution of the reinforcement (acc. to booklet 240 or variants of it).

See also „chapter „[Distribution / extended reinforcement](#)” dialog.

C_v	concrete cover at base
$C_{nom,S}$	concrete cover in general
x	reinforcement layer for the moments around the x-axis
y	reinforcement layer for the moments around the y-axis
Longitudinal diameter	Select the longitudinal diameter for the reinforcement. The software starts with this diameter to calculate a reinforcement that covers the requirements. If the minimum and maximum spacing cannot be realised with the initially defined diameters, higher diameters are used.



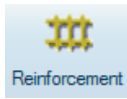
Durability: Activating the  button displays the [Durability](#) dialog. When you confirm your settings in this dialog with OK, the concrete cover, reinforcement layers and their diameter are checked and adjusted accordingly.

Distribution extended reinforcement dialog ().

Delete reinforcement Deletes the defined reinforcement

Practical construction spacing By default, the bar spacing is defined "exactly", that is, the resulting bar distances are determined on 1 mm accuracy. When this option is ticked, the bar spacings are adapted to 5, 6, 7, 7.5, 8, 9, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5 or 30 cm.

Distribution / Extended reinforcement dialog

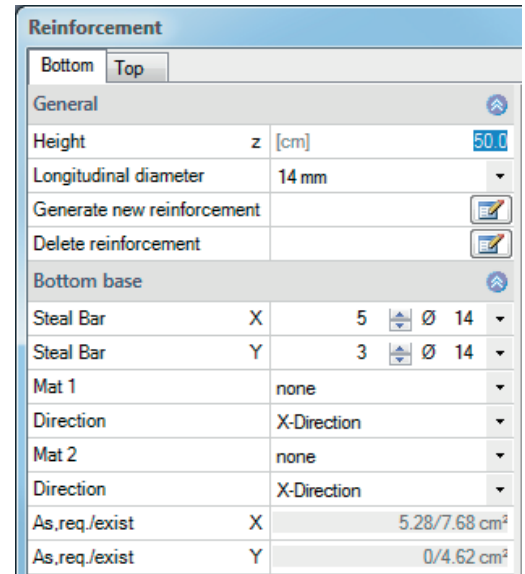


Click this symbol **Reinforcement** for the extended reinforcement dialog.

- Height** Height of the foundation in z-direction
- Longitudinal diameter:** see chapter “[Reinforcement](#)”.
- Generate new reinforcement** A reinforcement is calculated which covers a minimum of the required reinforcement.
- Delete reinforcement** Deletes the defined reinforcement. Only the required reinforcement will be taken into account.

Bottom / Top base

- Steel Bar X/Y** definition of number (1. column) and diameter (2. column) of steel bars
- Mat 1/2** Selection of rebar mats.



Soil Engineering

Check bearing pressure resultant Requirement for the simplified verification: the inclination of the characteristic or representative bearing pressure resultant complies with the condition $HV < 0.2$.

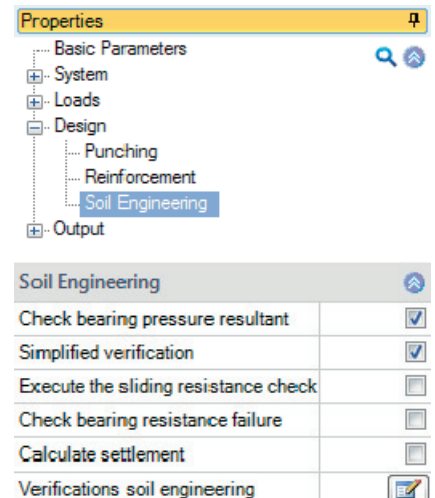
Simplified verification The verifications for the border conditions ground failure, sliding and suitability for use (verification of settlements) are replaced by the use of practical data for the design value of the bearing resistance.

Execute sliding resistance check Verifies the foundations against failure by sliding in the base plane, if the loadfactor isn't vertical on the base plane.

Check bearing resistance failure In the case of ground failure verification the shear resistance of the soil below the foundation level are considered. The soil layers above the foundation level are considered in the case of a horizontally soil plane and a horizontal terrain only as top load.

Calculate settlement For the settlement analysis, the compression of the soil should be taken into account until the depth t_s . T_s may be assumed in the depth at which the vertical additional stress generated by the mean settlement effective load has an amount of 20% of the effective vertical output stress of the soil.

Verifications of soil engineering Click this symbol to open the extended dialog with graphical illustrations to bearing failure, bearing pressure and settlements.



Bearing failure

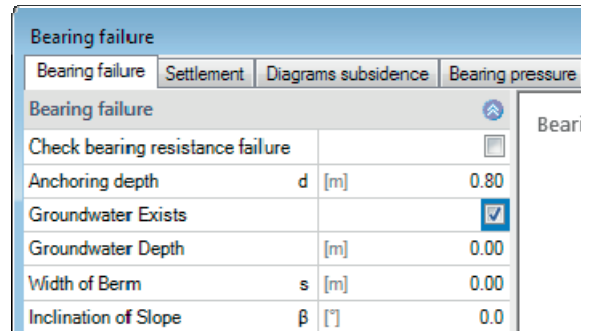
Anchoring depth Lowest anchoring depth below terrain/ top of basement sole.

Groundwater exists Tick this option if groundwater exists at all.

Groundwater Depth Absolute depth of the groundwater from lower edge of the foundation.

Width of Berm *s* The width of berm is the distance between the outer edge of the foundation and the beginning of the slope.

Inclination of Slope β The terrain inclination indicates the angle of inclination of a slope from the defined berm. The inclination affects the ground failure verification and defines exclusively downsloping terrain.



Settlement

Calculate settlement See page before.

Settlement with permanent loads only

Tick this option when settlement should be determined with permanent loads only, or permanent and variable loads together.

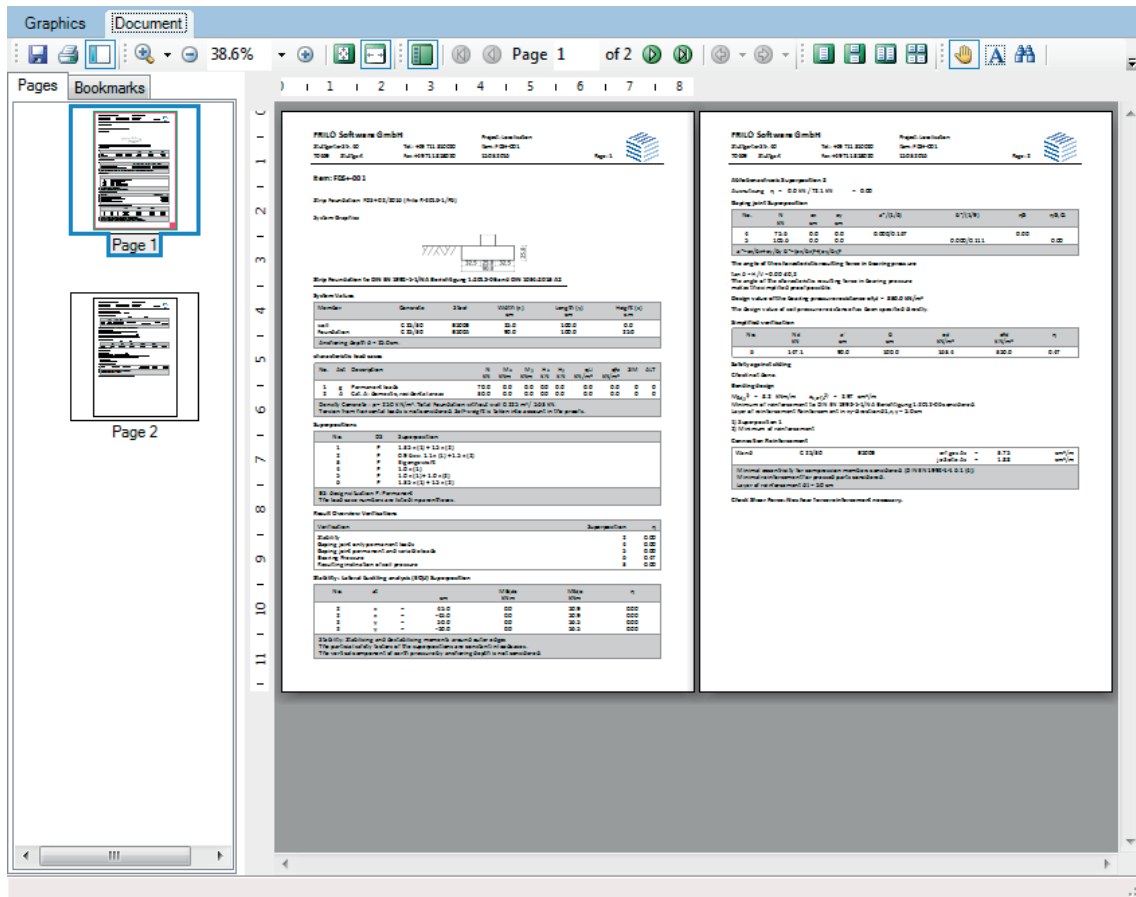
Output

Output scope / Options

By checking the desired options, you can determine the scope of text to be put out.

Output as PDF

The Document tab displays the document in PDF.



See also: [FDC - Output and printing_eng.pdf](#)