Reinforced Raft Foundation FDR+

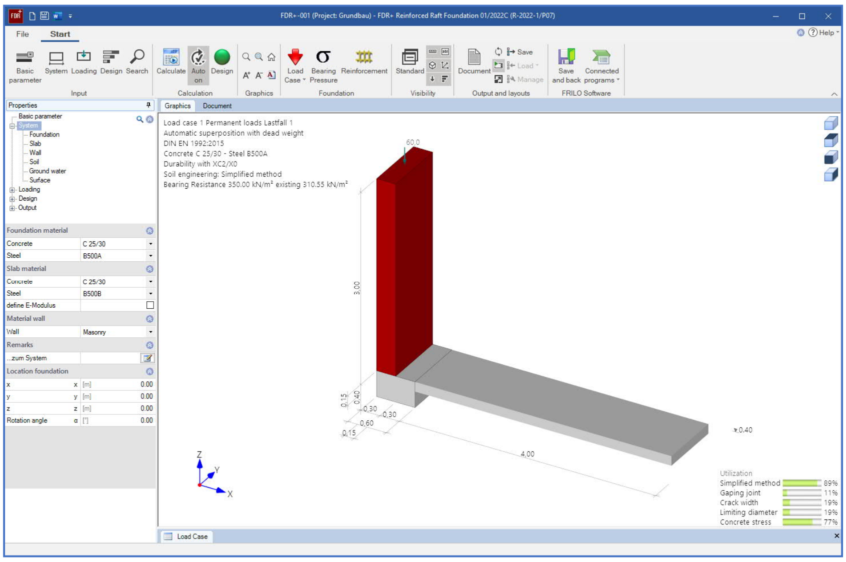
Contents

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.

Application options

The FDR+ application allows the design of eccentrically loaded boundary foundations that are connected to a reinforced concrete slab with a rigid joint. In the design, the centring moment, the centring tensile force and the soil pressure are determined with consideration to deformations.



Properties

- Selection options concerning the durability requirements
- Load definition: moments, axial forces, horizontal loads
- Different load cases, that apply alternatively or simultaneously according to the user's selection, are automatically superimposed
- Determination of the base pressure as well as the design value of the base pressure resistance with the help of tables in the selected soil engineering standards or of user-defined tables taken from a soil expertise, for instance
- Examination and consideration of a gaping joint
- Consideration of the accidental design situations BS-A and BS-E
- Interface to the FRILO Building Model (GEO)
- The self-weights of the wall, the facing masonry and the foundation can be selected independently of each other
- Optional calculation of the connecting reinforcement of the rising wall to the foundation
- Bending design of the foundation and verification whether reinforcement could be dispensed with in the lower layer of the foundation
- Centring in the rigidly connected reinforced concrete slab in accordance with J. Kanya, Bautechnik 05/1969
- Simultaneous restraint in the wall and the slab is optionally selectable
- Bending design at the connection between the foundation and the reinforced concrete slab
- Calculation of settlement effects
- Calculation of the foundation's deformation
- Verification of the concrete compression stress and the steel tensile stress at the connection to the slab
- Crack width verification at the connection to the slab
- Ground failure verification with consideration of berms and the anchoring depth of the foundation
- Simplified verification using the design value of the base pressure resistance as a rule
- Reinforcing steel mesh, steel bar or user-defined As values are the available reinforcement options

Limits of application

The following conditions in accordance with Kanya, Bautechnik 05-1969 are to be complied with when using the software:

- The foundation of the building is designed in such a way as to ensure that all foundations are subject to the same average settlement in the centre of gravity of their surface areas (no settlement variations).
- The eccentrically loaded border foundation can rotate around the fulcrum "D".
- The adjacent central foundation is torsionally stiff.
- A pure structural system is assumed, i.e. there are no disturbing connecting devices parallel to the supporting direction of the centring plate.
- The centring plate is appropriately reinforced and softly supported. No external influence acts additionally on the centring plate.
- The border foundation is infinitely stiff in itself.
- The self-weight of the centring plate is negligibly small compared to the applying load.

Note: *The stiffness modulus should be selected with utmost care.*
Because the cross section in the connection between the floor slab and the foundation can tear off widely, you can reduce the stiffness of the floor slab with a pre-factor. You can also define a factor for the bending stiffness of the wall.

Actions and loads

Loads are always defined with characteristic values. You can define loads as acting alternatively. The alternative group numbers are available for this. When you assign the alternative group 0 to the defined load, this means that it can participate in all load combinations generated with the combination rules. If two or more loads are members of the same alternative group, they never act simultaneously.

For the structural components wall, facing masonry and foundation, you can activate or deactivate the self-weight separately. The activated self-weight portions, which are calculated automatically, are included in the combinatorial analysis.

Verifications in the ultimate limit state

You can select different concrete types and reinforcing steels for the wall, the foundation and the connected reinforced concrete slab. You can also define masonry for the wall. In order to provide for the required reinforcement, you can define woven steel fabric and/or rebar. If the selected reinforcement exceeds the required quantity in the ultimate limit state, it is included in the verification of the serviceability limit state instead of the required reinforcement. Dialogs for the selection of the exposure classes and the determination of the shrinkage coefficient and the creep factor are available in connection with the durability and serviceability requirements. The resulting concrete coverage and reinforcement layers are taken into account. The bending design is based on the kh (kd) method. If the wall is connected to the foundation in a deflection-resistant manner, the foundation is dimensioned in the contact face of the wall. Otherwise, the bending moment centrally underneath the wall is taken into account in the design. The minimum reinforcements of the wall, the foundation and the slab can be selected independently of each other. The software checks whether the foundation can be installed without reinforcement in the lower layer. The shear force analysis is performed at the distance from the wall that is equal to the structurally effective height d. The user can select whether the foundation should be designed as a reinforced concrete slab or a reinforced concrete beam. The shear design as a reinforced concrete beam produces the minimum shear reinforcement in each case.

Verifications in the serviceability limit state

The deformation of the foundation is calculated for the quasi permanent and infrequent load combinations. In this calculation, the displacement of individual points in the foundation is indicated as a fraction of the foundation width (e.g. L/500) and torsion is specified in degrees. In addition to the deformation analysis, verifications are performed in accordance with the selected reinforced concrete standard. They include verifications of the compressive concrete stress, the tensile steel stress as well as the calculation of the existing crack width and the limit diameter of the reinforcement at the connection of the reinforced concrete slab and the foundation. In these calculations, a creep factor that can optionally either be defined by the user or be calculated by the software is taken into account.

Verifications in the ultimate limit state

Simplified verification, normally using the design value of the base pressure resistance

Based on the calculation method by Kanya, the software calculates a trapezoidal or, if a gaping joint occurs, a triangular base pressure distribution, which is compared to the selected design value of the base pressure resistance. Optionally, the permissible base pressure can be taken from a table in the selected foundation engineering standard, a table in a soil expertise or the user can enter a user-defined value. As far as the gaping joint is concerned, the software checks whether a gaping joint occurs when only permanent loads apply and whether the gaping joint produced by permanent and variable loads is greater than half of the foundation width.

Ground failure analysis

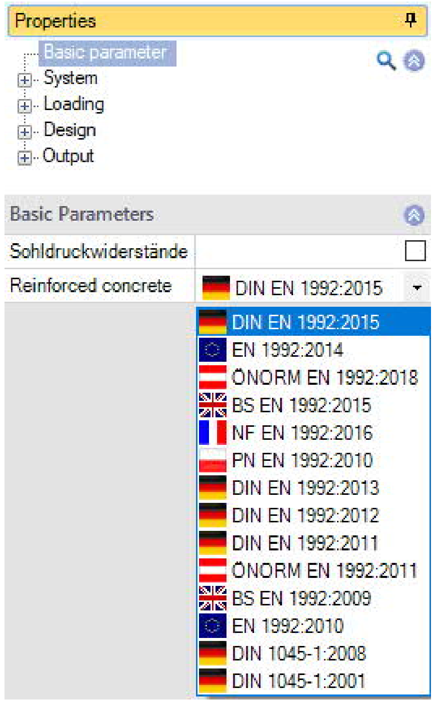
In addition to the verification of the base pressure, the FDR+ software offers the possibility of performing a ground failure analysis as per DIN 4017 [2006-03] or ÖNORM B 4435-2 [1999-10]. In this verification, a homogenous soil layer above the foundation base and a homogenous soil layer underneath the foundation base are assumed. These layers are determined by the ground failure pattern calculated from the individual soil layers. A berm adjacent to the foundation can be taken into consideration. The relation of the foundation thickness *d* to the foundation width *b* should not exceed 2 in this calculation.

Basis of calculation

Available standards

- DIN EN 1992-1-1:2011/2012/2013/2015
- ÖNORM EN 1992-1-1:2011/2018
- BS EN 1992-1-1:2015/2009
- NF EN 1992-1-1:2016
- PN EN 1992-1-1:2010
- EN 1992-1-1:2010/2014

- DIN EN 1997-1:2010
- ÖNORM EN 1997-1:2013
- BS EN 1997-1:2014
- NF EN 1997-1:2018
- PN EN 1997-1:2011
- EN 1997-1:2009



National design standards

- DIN 1054:2005/2010/2021
- DIN 4017:2006
- DIN 4019:2014
- ÖNORM B 4435-2:1999 sowie
- J. Kanya / Bautechnik 05/1969
- NF P 94-261:2013

Basis of calculation in accordance with Kanya, Bautechnik 1969

Initial values

a	= foundation height
b	= foundation width
c	= load distance from outer edge of the foundation
d	= slab thickness
l	= clear distance between two neighbouring strip foundations
E_b	= modulus of elasticity of the concrete
I_b	= moment of inertia of a slab cross section with a width of 1 cm
I_b	= surface area of a slab cross section with a width of 1 cm
E_{Bo}	= stiffness modulus of the subsoil
C_{Bo}	= subgrade reaction modulus of the subsoil
S_{Bo}	= shear modulus of the subsoil
P	= resulting vertical load

Initial values – foundation restrained in the slab

$$\alpha = 3{,}2 \cdot \frac{E_b \cdot I_b}{l \cdot E_{Bo}}$$

$$\beta = \alpha - d/2$$

$$\gamma = P/b$$

$$\delta = \frac{2 \cdot \beta^2}{3 \cdot F_b \cdot E_b + 2{,}5 \cdot l \cdot E_{Bo}} \cdot F_b \cdot E_b$$

Special case – foundation restrained in the wall and the slab, wall hinged on top

$$\zeta = \left(\frac{l_{Wall}}{3 \cdot E_{Wall} \cdot I_{Wall}}\right) / \left(\frac{l_{Slab}}{4 \cdot E_{Slab} \cdot I_{Slab}}\right)$$

$$\alpha = 3{,}2 \cdot \frac{E_b \cdot I_b}{l \cdot E_{Bo}} \cdot \frac{1}{1+\zeta}$$

$$M_{Wall} = \frac{\zeta \cdot M_Z}{1+\zeta}$$

$$M_{Slab} = M_Z - M_{Wall}$$

Special case – foundation restrained in the wall and the slab, wall restrained on top

$$\zeta = \left(\frac{l_{Wall}}{4 \cdot E_{Wall} \cdot I_{Wall}}\right) / \left(\frac{l_{Slab}}{4 \cdot E_{Slab} \cdot I_{Slab}}\right)$$

$$\alpha = 3{,}2 \cdot \frac{E_b \cdot I_b}{l \cdot E_{Bo}} \cdot \frac{1}{1+\zeta}$$

$$M_{Wall} = \frac{\zeta \cdot M_Z}{1+\zeta}$$

$$M_{Slab} = M_Z - M_{Wall}$$

Exterior base pressure

$$\sigma_2 = \frac{\frac{2}{3} \cdot b^2 - c \cdot b + \delta + \alpha}{\frac{b^2}{6} + \delta + \alpha} \cdot \gamma$$

Interior base pressure

$$\sigma_1 = 2 \cdot \gamma - \sigma_2$$

Special case - gaping joint

$$b' = \frac{+c \pm \sqrt{c^2 + 4/3(\delta + \alpha)}}{2} \cdot 3$$

$$\sigma_2 = 2 \cdot \gamma' = 2 \cdot \left(P/b'\right)$$

$$\sigma_1 = 0$$

Distance of the base pressure resultant from the outer edge of the foundation

$$s = \frac{1}{3}\left(\frac{\sigma_1}{\sigma_1 + \sigma_2} + 1\right) \cdot b$$

Base pressure underneath the calculated equivalent area

$$\sigma' = \frac{(\sigma_1 + \sigma_2) \cdot b}{4 \cdot s}$$

Internal forces inside the centring plate

$$M_z = (\sigma_2 - \gamma) \cdot \alpha$$

$$H_z = (\sigma_2 - \gamma) \cdot \delta/\beta$$

Subgrade reaction modulus

$$C_{Bo} = 2{,}5 \cdot E_{Bo}/b$$

Angle rotation due to the centring moment

$$\phi = \frac{1}{4} \cdot \frac{M_z}{E_b \cdot I_b} \cdot l$$

Vertical displacement on the interior side

$$\Delta_1 = \frac{\sigma_1}{C_{Bo}}$$

Vertical displacement in the foundation centre

$$\Delta_v = \frac{\sigma_1 + \sigma_2}{2 \cdot C_{Bo}}$$

Vertical displacement on the exterior side

$$\Delta_2 = \frac{\sigma_2}{C_{Bo}}$$

Horizontal displacement on the bottom

$$\Delta_H = \phi\left(a - \frac{d}{2}\right) - \Delta_Z$$

Horizontal displacement on the top

$$\Delta_Z = \frac{H_Z \cdot l}{F_B \cdot E_b}$$

Other parameters to be included

Self-weights of the foundation, the wall and the facing masonry

You can active or deactivate separately the self-weights of the wall, the foundation and the facing masonry. Permanent loads always act simultaneously. The self-weight portions of the foundation, the wall and the facing masonry result from the defined values for the volume and the specific weight.

The self-weight is taken into account by generating a resulting load P, which is composed of the vertical loads of the respective load combination considering the associated combination rule and of the respective activated self-weight portions.

In this connection, a new resulting load distance C of the load P from the outer edge of the foundation is also calculated.

$$P = N_{Ed} + F_{Wall} + F_{facing} + F_{Foundation}$$

$$c = \frac{(N_{Ed} + F_{Wall}) \cdot l_{distance\ to\ axis,Wall} + F_{facing} \cdot l_{distance\ to\ axis,Facing} + F_{Foundation} \cdot l_{distance\ to\ axis,Foundation}}{N_{Ed} + F_{Wall} + F_{Facing} + F_{Foundation}}$$

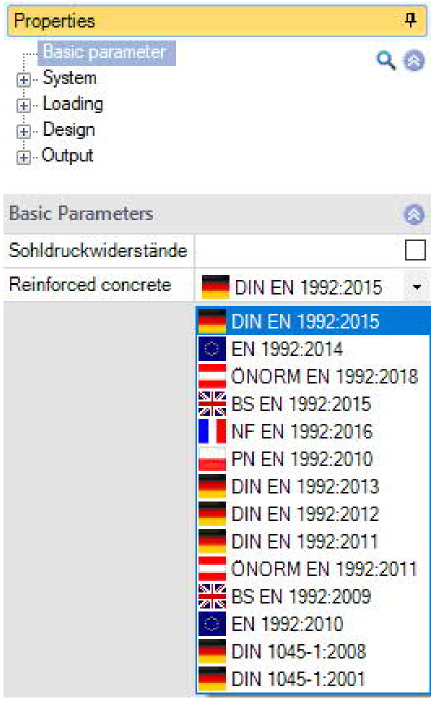
Consideration of horizontal loads

In the calculation, horizontal loads are applied to the top of the foundation in the central axis of the wall. In the calculative approach of the software, they generate a moment with a lever arm that is as great as half the height of the connected reinforced concrete slab. The horizontal load itself is transferred through the foundation and considered in the design of the connection of the foundation to the reinforced concrete slab.

Consideration of moments

If moments are defined in addition to vertical loads or if moments result from the horizontal loads at the base of the wall, they influence the position of the resultant of the vertical loads. Moments defined as positive rotate the foundation clockwise towards the inside of the building. The resultant of the vertical loads is displaced by the length $e = M_{Ed} / P$ towards the inside of the building. Moments defined as negative act inversely because of the negative sign of e.

Data entry – Basic parameters



You can enter values and define control parameters in the menu on the left screen section. The effect of the entered values is immediately shown in the graphical representation on the right screen section. Before entering any data, you can edit the dimensional units (cm, m ...) via the options File ▸ Program settings.

Wizard

The definition wizard is automatically launched when you start the software. You can disable the wizard in the settings menu.

Input options in the three-dimensional GUI

The data entry via the GUI is described in the document "Basic operating instructions-PLUS."

Basic parameters

Soil bearing resistance

If the option is selected, only the bearing capacity of the soil is output in the form of a table with the design values for the bearing pressure resistance.

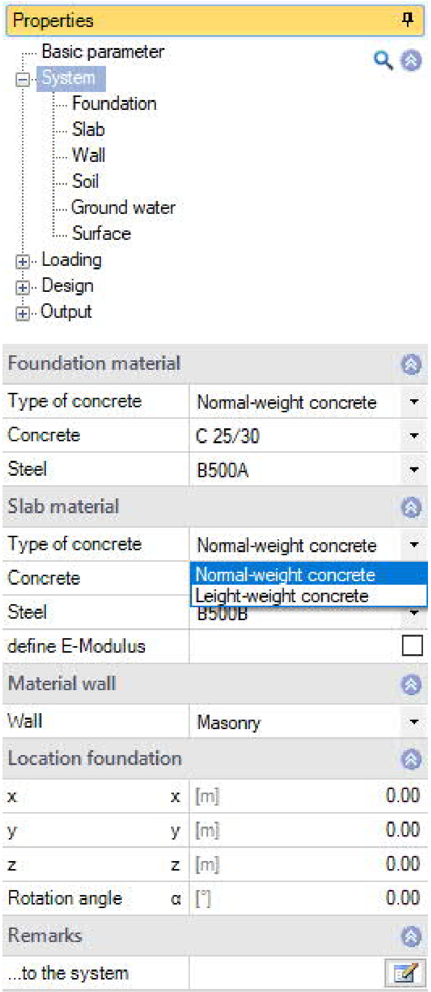
Reinforced Concrete

Select the desired reinforced concrete standard:
See Basis of calculation.

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

System

Material



Select the type (normal/lightweight concrete) and quality of the concrete and the reinforcing steel grade as well as the material of the wall (masonry or concrete).

For the calculation of internal forces, of soil pressure and base pressure as well as of deformations, the modulus of elasticity of the connected reinforced concrete slab is used as a standard. Optionally, you can specify a user-defined modulus.

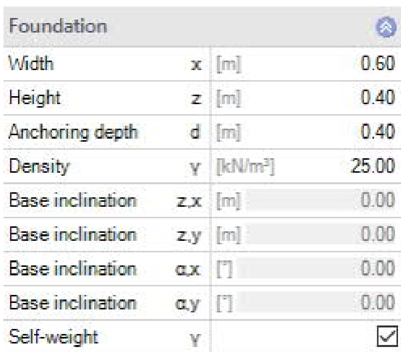
Location foundation

The global position related to the foundation axis is only required for communication with other programs such as GEO and SBR+.

Remarks

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

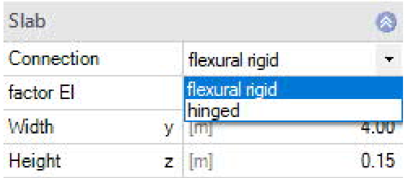
Foundation



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 x-direction
Height	z foundation height
Anchoring depth d	Lowest foundation depth below the ground level or below the top edge of the basement floor.
Specific weight γ	Gamma concrete
Base inclination	Additional anchoring depth from base inclination.
Self-weight	Automatic inclusion of the self-weight of the foundation.

Slab



Connection — The connection of the slab to the foundation can be flexurally rigid or hinged.

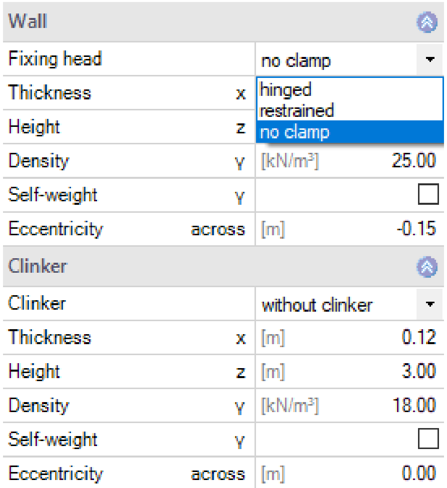
Factor EI — When selecting "flexurally rigid", it is the factor for the bending stiffness of the slab. It refers to the stiffness of the cross section in state I. Values up to 1.2 are possible.

Area load… — When selecting "hinged" it refers to the permanent load portion of the reinforced concrete slab that is supposed to act on the foundation.

Width — Clear distance between the foundations.

Height — Height of the slab. The height affects the flexural rigidity of the slab and thus the torsion of the foundation.

Wall



Fixing on top — Specifies how the wall impedes torsion of the foundation:
hinged, restrained, no fixing/clamp.

Factor EI — Hinged: factor for the flexural rigidity of the slab. It refers to the stiffness of the cross section in state I.

Thickness x — Thickness of the wall.

Height z — Height of the wall.

Density γ — Specific weight of the wall.

Self-weight — Automatic inclusion of the self-weight of the foundation.

Eccentricity, transverse — Eccentricity in the x-direction.
Note: No positive values are intended for the eccentricity, because that would mean that the connected reinforced concrete slab is bedded on the ground. This is not taken into account in the calculation approach. For such cases it is recommended to calculate the system as bedded beams.

Clinker / Wall facing

Clinker — Allows you to select whether facing masonry should be included in the calculation.

Thickness — Thickness of the facing masonry.

Height — Height of the facing masonry.

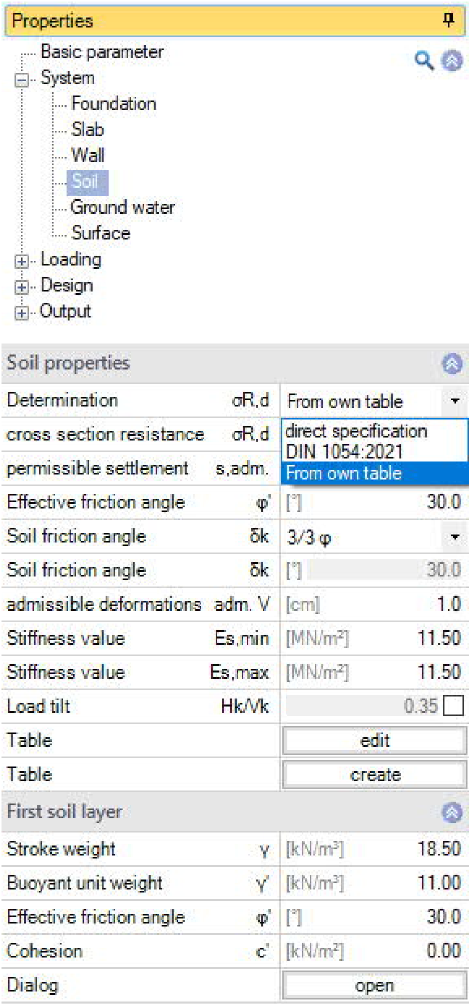
Density — Specific weight of the soil.

Self-weight — Activate this option to include the self-weight of the facing masonry automatically.

Eccentricity — Eccentricity of the facing masonry in the transverse direction.

Soil

Soil properties



Determination $\sigma_{R,d}$ Select whether the design value of the bearing resistance should be entered directly, or to come from a standard table (DIN 1054) or from a user defined (own) table - see section below.

Bearing capacity Specification of the permissible bearing pressure $\sigma_{R,d}$
In the case of “direct specification”, input of the design value of the bearing pressure resistance σR,d for the permanent design situation BS-P. For the design situations BS-A, BS-E and BS-T, the design value is increased according to the ratio of the partial safety factors of the bearing capacity. For example 1.4/1.2 = approx. 116% or 1.4/1.3 = approx. 107%.

Permissible settlement Permissible settlement for comparison with the calculated settlement and presentation of the utilisation of the settlement verification.

Eff. friction angle φ´ Friction angle of the drained soil underneath the foundation base.

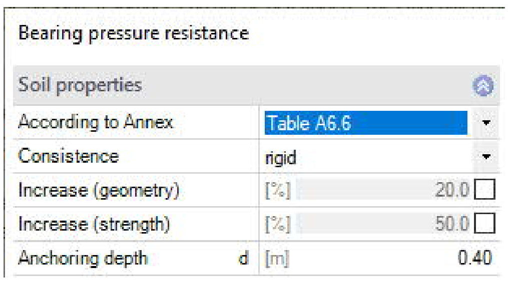
Soil friction angle The soil friction angle is relevant for the sliding safety check. If the angle of friction δ is not determined separately, the characteristic angle of friction ϕ'k may be used instead of the critical angle of friction for in-situ concrete foundations. A value of 35° must not be exceeded. The same applies to prefabricated foundations if the precast elements are laid in the mortar bed. If the prefabricated foundations are smooth and without a mortar bed, the characteristic soil friction angle δk = 2/3 ϕ' k shall be used.

adm. deformations V Permissible displacement. It is compared to the maximum displacement of the foundation in the vertical direction.

Stiffness value Es,min/max.; upper/lower limit of the stiffness modulus. You can define the upper and lower limits for the stiffness modulus. In each superposition, the most unfavourable values are used. If the calculation should be performed without limits, enter the same value for the upper and the lower limit. The stiffness modulus is provided by the soil expert. Betonkalender 1998, part 2, p. 472 specifies guiding values for the stiffness modulus Es in MN/m²: gravel, pure: 100.0 to 200.0 - sand, pure: 10.0 to 100.0 - coarse clay: 3.0 to 15, clay 1.0 to 60.0 - peat 0.1 to 1.0

Load tilt With "direct specification" you can enter (if the option is ticked) the maximum inclination of the characteristic or representative base pressure resultant H/V, which is to be checked in the simplified verification. Otherwise, default values are used.

Dialog/Table If the determination σR,d is not specified directly, the design value of the bearing pressure resistance is taken from a table (standard or user defined)
Click the “open”/”edit” Button to open the tabledialog.



<u>Parameters by standard table DIN 1054:</u>

According to Annex	Selection of the table in the selected soil standard or the currently active NAD. The permissible base pressures are taken from this table.
Consistency	Consistency of the soil: rigid, semi-solid, solid.
Increase (geometry)	The permissible soil pressure can be increased by 20 % if the corresponding border conditions (b/d) specified in the standard are complied with.
Increase (strength)	Optional increase by 50 % if the soil is sufficiently solid. *Note: The values are added up under particular conditions (70 %).*
Anchoring depth d	Lowest foundation depth below the ground level or the top edge of the basement floor.

<u>From own table:</u>

Create:	Generates a table with design values of the bearing pressure resistance from several parameters.
Edit:	Open the dialog to enter the design value of the bearing pressure resistance σRd. The value σRd should come from a geotechnical report and should have sufficient guarantees against ground failure and a sufficient limitation of settlements. Furthermore, the corresponding foundation width and anchoring depth must be specified.

The meaning of the other buttons can be seen from the Tooltips.

First soil layer

In this section you can enter the values of the first soil layer.
For additional soil layers click the Button "Dialog – open".

Erste Bodenschicht			
Stroke weight	γ	[kN/m³]	18.50
Buoyant unit weight	γ'	[kN/m³]	11.00
Effective friction angle	φ'	[°]	30.0
Cohesion	c'	[kN/m²]	0.00
Dialog			open

Stroke weight	γ	Specific weight of the soil.
Buoyant unit weight	γ'	Specific weight of the soil layer under buoyancy. Define ground water to enable this data-entry field.
Eff. friction angle	φ'	Friction angle of the soil in this layer.
Cohesion	c'	Soil cohesion.

Additional soil layers / additional parameters (Dialog "open")

Library	Cat.	Name	Icon	γ	γ'	φ'	c'	xU'	v	Em	Pl	α	qc	E'	Procedure	E*	Es	x	ks	both sides drained	Cα'
				[kN/m³]	[kN/m³]	[°]	[kN/m²]	[m]		[kN/m²]	[kN/m²]		[kN/m²]	[kN/m²]		[kN/m²]	[kN/m²]		[m/s]		
Table	-	-	-	18.50	11.00	30.0	0.00	1.50	0.20	6000.00	700.00	0.50	1000.00	3500.00	direct specification (direct specification / from constrained modulus)	4946.00	2473.00	0.50	1E-09	☐	0.003

Table	Defined layers/values can be selected via a soil layer library.
Category	Soil category according to Annex A of standard NF P94-261. It is important for the bearing capacity calculation from values of the pressiometer test according to Annex D of NF-P94-261.
Name	A name for the soil layer can be assigned here.
Symbol	An abbreviation for the soil layer can be assigned here.
xU	Thickness of the soil layer. Soil layers below 0.10 m cannot be defined.
v	The Poisson's ratio defines the ratio of a change in thickness to a change in length as soon as a stress is applied. The Poisson's ratio or transverse contraction coefficient has the formula υ or μ. It is one of the elastic material constants and bears the name of the physicist Siméon Denis Poisson.
Em	Define the pressiometric modulus according to Ménard here. It is needed for the settlement calculation from data of a pressiometer test.
Pl	The representative value of the limit pressure according to Ménard in the foundation base of the shallow foundation.
α	Rheological factor for settlement calculation from results of a pressiometer test.
qc	The peak pressure resistance comes from the pressure test and derives modulus of elasticity and friction angle for base failure and settlement calculation.

Calculation of the settlement

Procedure	User-defined / based on stiffness modulus Select whether to enter a user-defined value for the modulus of compressibility *E** or have it calculated from the stiffness modulus and the correction factor (DIN 4019 P1).
E*	Modulus of compressibility. The compressibility of the soil can be obtained from a pressure settlement line or be calculated using the stiffness modulus and the correction factor.
Es	Stiffness modulus
x	Correction factor

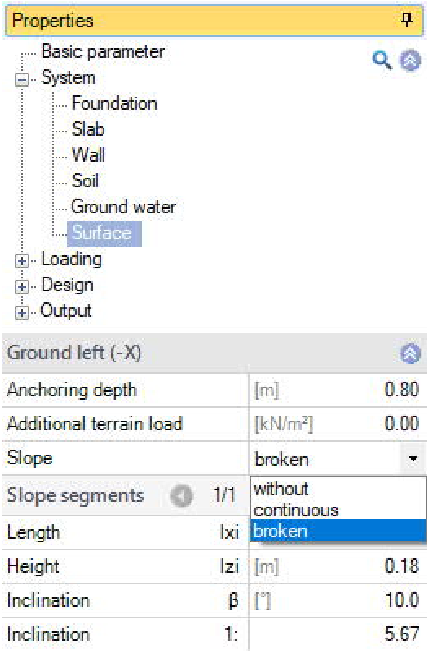
Settlement analysis: Consolidation

ks	Coefficient of permeability for the consolidation speed. You can take the value from a soil expertise.
Both sides drained	For the calculation of the time until the consolidation settlement subsides approximatively, the full layer thickness is taken into account with drainage on one side. With drainage on both sides, only half of the layer thickness is taken into account.
Cα'	The creep coefficient Cα can be determined from a time-settlement test according to DIN 18135. Usual value range 0.001 to 0.00001.

Groundwater

Groundwater existing	Check this option when groundwater exists in the subsoil - the data-entry field for the depth of the ground water is displayed subsequently.
Groundwater	Absolute depth of the groundwater below the bottom edge of the foundation body.

Surface

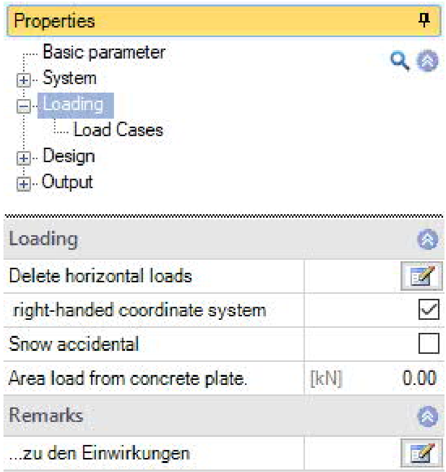


Anchoring depth	Anchoring depth of the foundation body.
Additional Terrain load	Additional characteristic permanent area load on the bearing failure figure, which increases the characteristic punching shear resistance.
Slope	The ground level can be modeled as horizontal, with a continuous slope, or with a broken embankment.

Continuous:
Here you can define a berm and the slope - see advanced foundation dialog.

Broken:
Input of the embankment sections. The "+" symbol creates a new table row for a further section. Parameters are length, height or inclination or rise (the height adjusts automatically to the incline).

Loads



Delete horizontal loads: The button allows you to delete all horizontal loads at once! This function can be helpful when importing load cases from other software applications (GEO, B5+...). You can define horizontal loads in the Load Cases dialogs.

Right-hand coordinate system (new standard)

Coordinate system based on the right-hand rule, also referred to as right-hand coordinate system. The signs comply with the sing definitions in engineering mechanics. Positive moments about the x-axis generate pressure on the bottom and/or in the negative area of the foundation. Positive moments about the y-axis generate pressure on the right and/or in the positive X-area of the foundation. If this option is unchecked (default setting until recently) positive moments generate pressure on top right and/or in the positive X/Y-area of the foundation. In the graphic representation, both variants are shown with their absolute values. The arrows indicate the actual direction of action. The values in the data entry fields and in the output documents are indicated with their signs. If you change the sign definition, the sign of the moments about the y-axis changes as well.

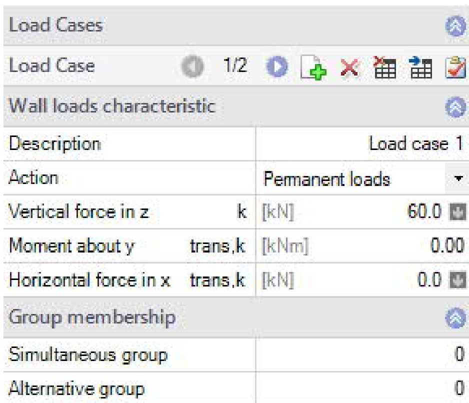
Accidental snow load When you check this option, snow loads are automatically included as accidental action in addition to the typical design situations. The user can either specify a freely selectable load factor for the accidental snow loads or have it determined automatically by the software. The default value is 2.3

Area load from concrete plate Enter the permanent load component of the reinforced concrete slab here, which should act on the foundation.

Remarks

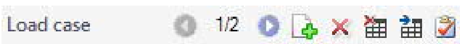
Click on the button to enter your own comments on the actions.

Load Cases



Enter the data of the first load case either in the corresponding data-entry mask or directly in the load case table, which you can display below the graphic by activating the Load Case button.

Load case toolbar:



To add load cases, always set up a new load case first by activating the button (a data-entry mask for the new load case is displayed each time).

- See also Data entry via tables in the Basic operating instructions PLUS.pdf

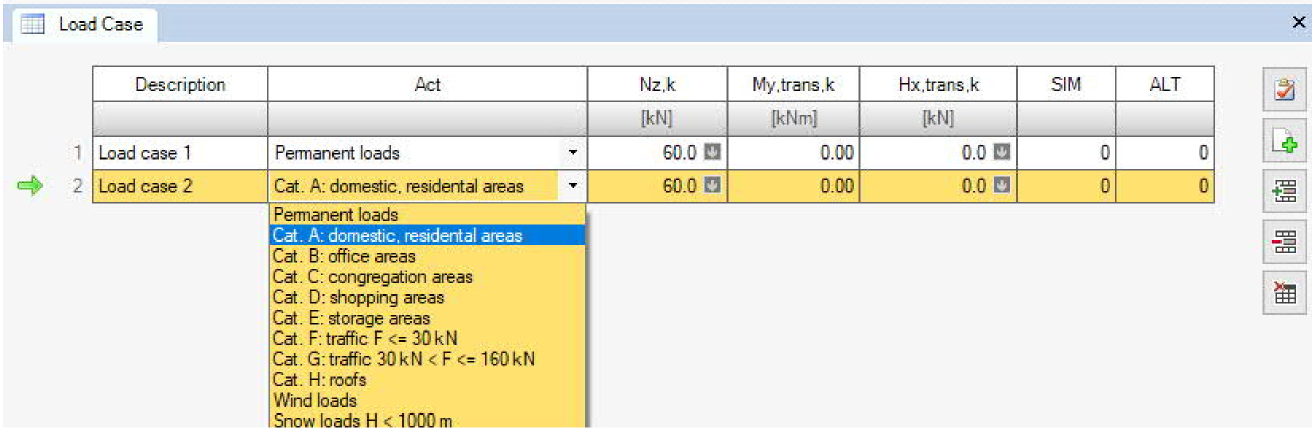
Tip: *A description is displayed in the status line each time you click into a particular data-entry field.*

Load value compilation

By clicking on the arrow icon you can access a load value compilation - see the description of the LOAD+ program.

Characteristic wall loads

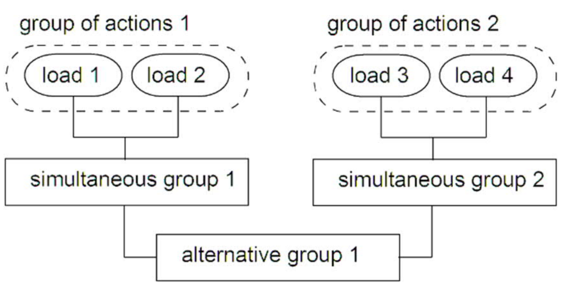
Description	Optional text to the selected action can be entered. This text is included in the output.
Action	The appropriate actions can be selected from a list: Permanent loads ... Earthquake.
Vertical force in z	Vertical force Nz in the centre of the wall
Moment about y	Moment $M_{y,trans}$ defined with for the wall.
Horizontal force in x	Horizontal loads act on the top edge of the foundation. These horizontal loads generate moments on their way down to the foundation base, which are taken into account automatically.



Grouping

Simultaneous group (SIM)

Loads of a particular action group can be defined as "always acting simultaneously"



Ill.: *Example for the functioning of alternative and concurrent groups*

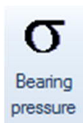
Alternative group (ALT)

Different variable load cases with similar actions can be combined to an alternative load case group by assigning an alternative group number to them. Only the decisive load case of this alternative load case group is invoked in the superposition.

Base pressure

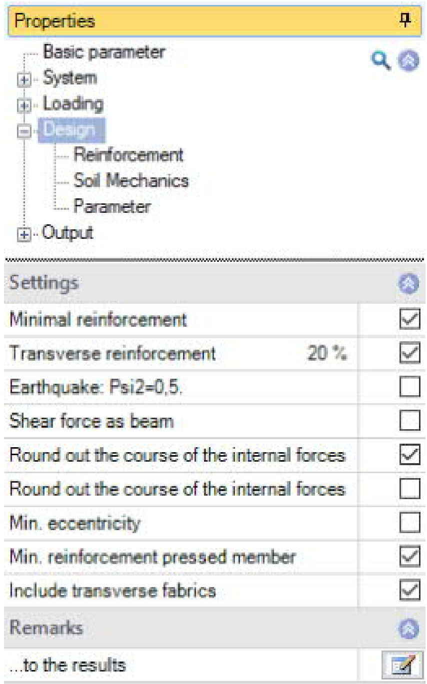
Displaying the base pressure pattern

To ensure traceability, the base pressure pattern with stress ordinates (red and blue arrow icons in the multifunction bar) can be displayed in the 3D representation of the load arrangement for all load cases and superpositions decisive in the verifications. Click on the base pressure icon to activate the function. The graphic is displayed in a pop-up window. See chapter ▸ Design ▸ Soil Engineering.



Design

Settings

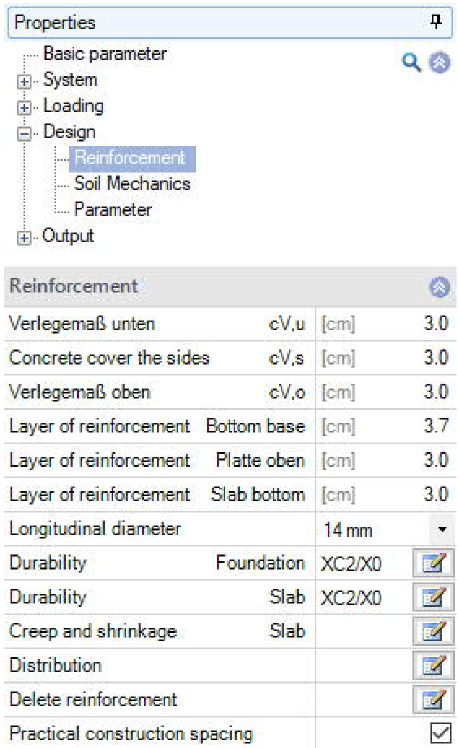


Minimum reinforcement	Ductility reinforcement in accordance with the selected reinforced concrete standard
Earthquake: Psi_2=0.5	In accordance with the introductory decree of DIN 4149 for Baden-Württemberg, the combination coefficient Psi2 = 0.5 for snow loads should be used in the superpositions with earthquake loads.
Shear force as beam	Specification whether the shear resistance should be verified on a slab or a beam.
Round out the course	only affects the graphical representation. Function: see tool tip or info text.
Min. eccentricity	Considering minimum eccentricities for compression member by EN 1992-1-1 6.1 (4).
Minimum reinforcement ..	This option allows you to take a minimum reinforcement for compression members into account.
Include transverse fabrics	The selected mats increase the calculatied predefined reinforcement also in the transverse direction.

Remarks

The remarks editor is called up via the button. This text appears in the output.

Reinforcement



The software allows you to define non-specifically up to two layers of fabric and two layers of bar steel distributed over the entire foundation on top and bottom.

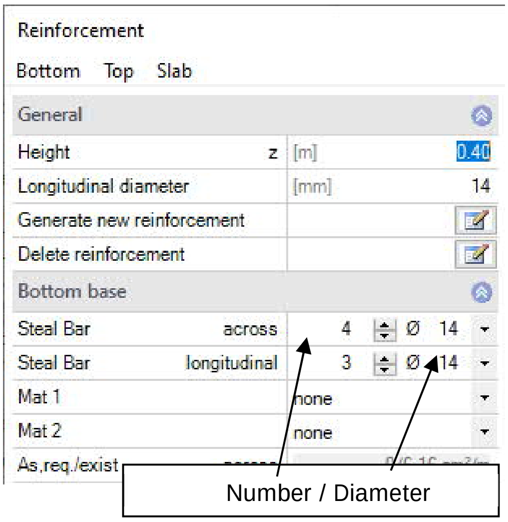
cv,b/s/t	Laying dimensions of the specified reinforcement on the bottom/outside/top of the foundation. The specified reinforcement is designed into the foundation body according to this laying dimension. Based on this, 2D and 3D graphics are created.
Reinforcement layer:	
Bottom base	Reinforcement layer on the bottom of the foundation. The software uses 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.
Slab top/bottom	Reinforcement layer on the top/bottom of the slab.
Longitud. diameter	Selection list of the diameter that shall be used for the generation of the longitudinal reinforcement. The software generates sufficient reinforcement of this diameter to comply with the required reinforcement. If the minimum and maximum spacing cannot be realised with the defined diameter, a greater diameter is used.

Durability	Activating the button displays the corresponding 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.
Creep and shrinkage	Displays the dialog to define the creep factor and the shrinkage strain.
Distribution	Displays the enhanced reinforcement dialog for top/bottom/slab.
Delete reinforcement	Deletes the default reinforcement.
Practical construction spacing	As a standard, the bar spacing is calculated accurately, i.e. the resulting bar spacing is calculated precisely to the millimetre. If the option is ticked the bar spacing is adjusted to 5, 6, 7, 7.5, 8, 9, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5 or 30 cm.

Enhanced reinforcement dialog

The enhanced reinforcement dialog can be accessed via the button or via ▸ Design ▸ Reinforcement ▸ Distribution.

Next to the tabs for the lower and the upper reinforcement the “Slab” tab is displayed.



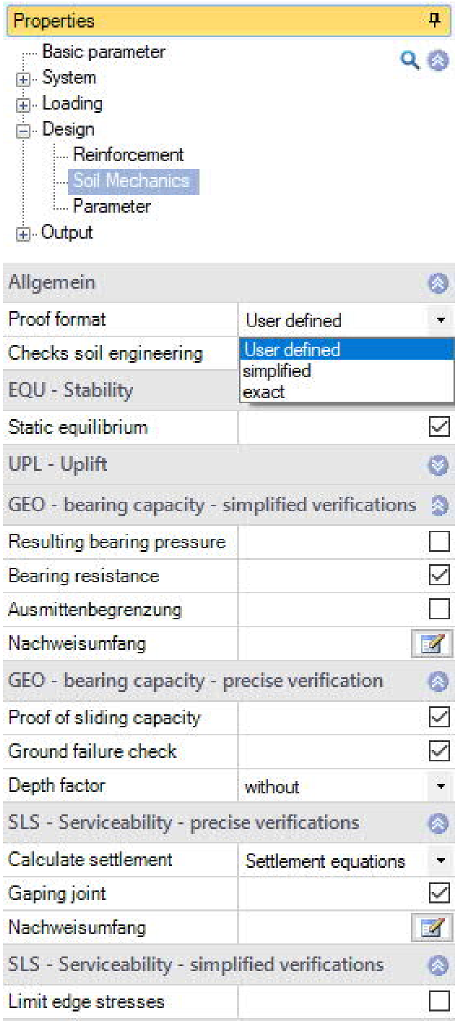
General

Height	Height of the foundation in the x-direction.
Longitud. diamater	As described for the Reinforcement dialog.
Generate new reinforcement	The software calculates a reinforcement that satisfies the requirements as a minimum. If the minimum and maximum spacing cannot be realised with the selected diameter, a greater diameter is used. When you delete the default reinforcement, the automatic generation of the reinforcement is disabled and the default reinforcement remains unchanged. If it turns out to be insufficient, the software displays a warning message. If no reinforcement was pre-set, no warning is displayed. When generating the reinforcement automatically, the software starts with the default longitudinal diameter.
Delete reinforcement	Deletes the default reinforcement and the structurally required reinforcement is used in the calculations.

Foundation bottom/top/slab

Bar steel X/Y	Define the number of bars in the first column and the diameter of the bars in the second column separately for the x-direction and the y-direction.
Fabric (Mat) 1/2	Selection of a reinforcement steel fabric
As, req./exist.	Informative indication

Soil Mechanics



Proof format

Define here whether a
- simplified proof, a
- exact proof or a
- userdefined proof

should be performed.

The simplified verification includes compliance with the design value of the base pressure resistance with limitation of the inclination of the load resultant.

The exact verification format includes a bearing failure verification, a sliding safety verification and a settlement calculation.

Checks soil engineering

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

You can find this function also in the toolbar with the “Bearing Pressure” symbol (*note: if only the simplified verification is carried out, only the "Bearing Pressure" tab is displayed*).

User-defined proof format

All verification options are offered here for individual selection.

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

Bearing resistance
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.

Eccentricity limitation
Proof according to NF P 94-261 13.3 of the eccentricity of the load.

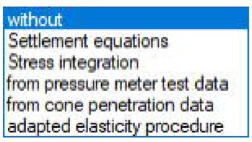
Scope of verification
In a separate dialogue, you define whether the limit states and design situations according to the selected standard are to be used for this verification or whether they are to be adapted individually (user-defined).

Proof of sliding capacity
Verifies the foundations against failure by sliding in the base plane, if the loadfactor isn´t vertical on the base plane.

Ground failure check
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.

Depth factor
The depth coefficients take into account the favorable influence of the shear strength in the fracture joint above the base of the foundation in the bearing failure analysis. In some European countries, this effect can be taken into account with coefficients > 1.

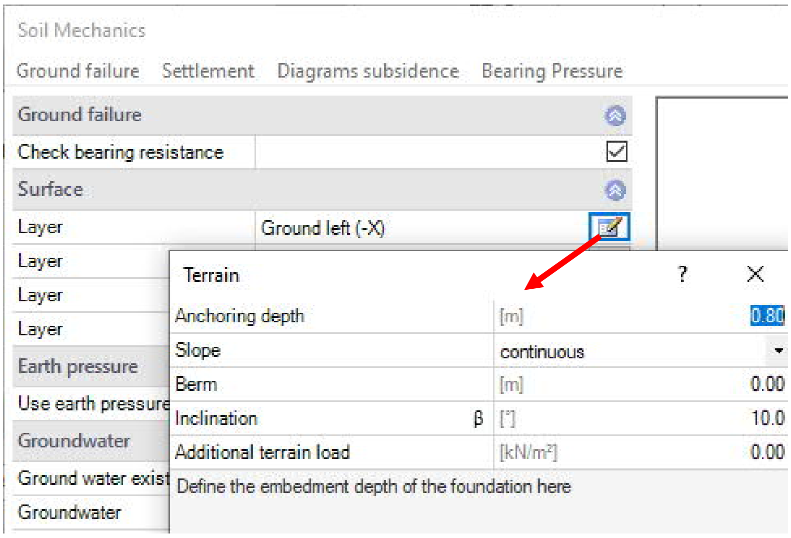
Calculate settlement



For the settlement analysis, the compression of the soil should be taken into account down to the settlement influence depth ts. Ts 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.
One of 5 calculation methods can be selected.

Ground failure – extended soil mechanics dialog

Calling up the dialog on “checks soil engineering ” (exact/simplified verification).



Anchoring depth — Lowest depth of foundation below the ground surface or the top edge of the basement floor.

Slope — The ground level can be horizontal, with a continuous slope, or with a broken embankment.

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

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

Additional Terrain load — Additional characteristic permanent area load of the ground failure mode which increases the characteristic punching resistance.

Ground water

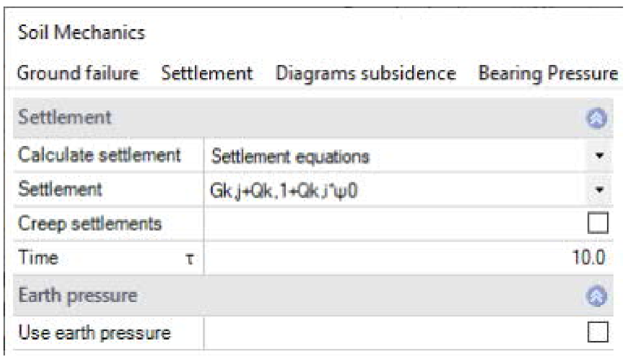
Groundwater exists — Tick this option if groundwater exists in the area.

Groundwater Depth — Absolute depth of the groundwater measured from the bottom edge of the foundation.

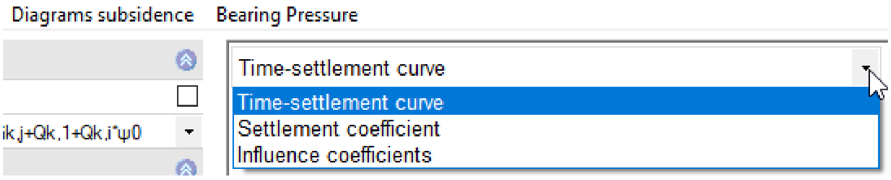
Settlements

Calculate settlements — As already described above.

Settlement — Settlements can be calculated with permanent loads or with permanent and variable loads. You can use combination coefficients for variable loads in characteristic load cases. See also DIN 1054:2010 2.4.8 A (2.8a).



Diagrams subsidence



Bearing pressure

Display of the bearing pressure graphic. The input fields are explained in the chapter Soil.

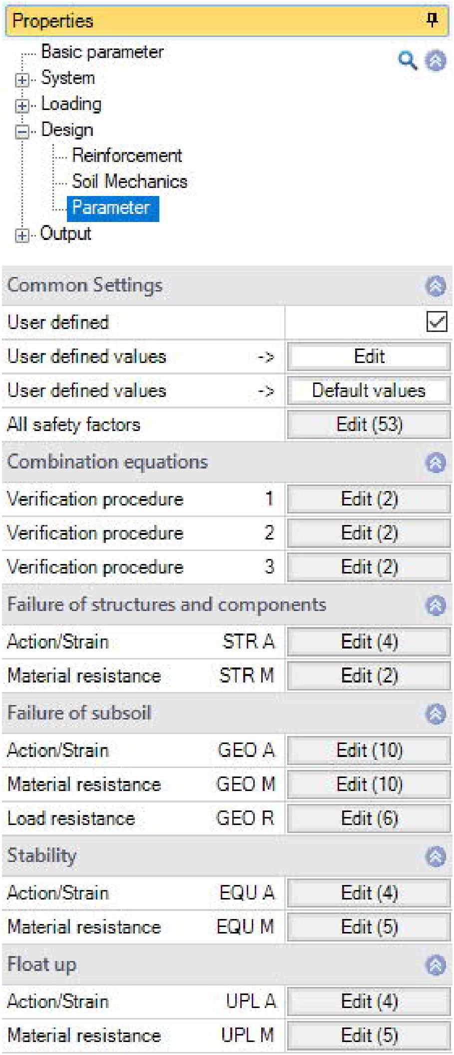
Parameter

User defined

Mark this option if you want to change the safety factors and design rules that deviate from the set standards.

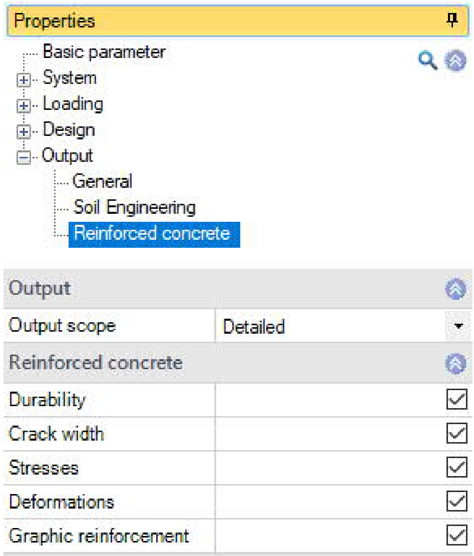
The corresponding input fields/editing buttons are then displayed.

Use the "Edit" button to open the respective tables for changing the values - the information texts for the individual parameters are displayed in the lower window area when you click in an input field.



- Support of all 3 verification methods according to Eurocode 7, adjustable for all national annexes.
- The partial safety factors and combination equations for the geotechnical verifications can be edited.
- Since all table values can be changed, the standard setting for a specific country (e.g. India, Sweden, etc.) can be easily defined.

Output



Scope of the output and options

By checking the desired options, you can determine the scope of texts to be put out. You can adjust the font size and the scale of the graphics to be put out.

Output as a PDF file

On the “Document” tab, a PDF document is displayed.

See also the document Output and printing.