

Earth Pressure Calculation EDB+

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[Basic documentation - overview](#)

In addition to the individual program manuals, you can find basic explanations on how to operate the programs on our homepage www.friilo.eu (▶ Service ▶ Articles Information ▶ Basic Operating Instructions).

Application options

The EDB+ program determines the horizontal earth pressure coordinates on a hypothetical earth pressure wall.

You can calculate the distribution of the earth pressure over the total height of the earth pressure wall as well as over a section defined via elevation levels.

Either a pure earth pressure calculation or a calculation of the lateral pressure is performed.

When selecting the calculation option "earth pressure", the resulting horizontal and vertical earth pressure forces in line with the earth pressure distribution are put out.

When selecting the option "lateral pressure", the resulting earth pressure force is compared to the flow pressure and the lateral pressure is calculated from this.

Calculation mode

- Earth pressure
- Lateral pressure

Earth pressure types

- Active earth pressure
- Earth pressure at rest
- Increased active earth pressure
- Passive earth pressure (earth resistance)

Structural system

- Vertical and inclined earth pressure wall (*only with earth pressure calculation*)
- Any number of soil layers
- Groundwater at different levels on the left and right of the earth pressure wall (*with lateral pressure calculation: same level on both sides*)
- Ground water levels can be selected independently of layer borders
- Automatic consideration of the water pressure based on the groundwater level.
- Level, continuously sloped and broken ground surface (slope).

Load - ground surface loads

The following ground surface loads can be considered in EDB+:

- unlimited area loads
- limited strip loads
- limited block loads and
- line loads

The ground surface loads can be defined at a distance from the earth pressure wall. They can also be located in the soil layers below the ground top edge.

Load cases and superpositions

From the components

- self-weight
- groundwater
- compaction
- and for each ground surface load

load cases are generated, which are considered

- either in superpositions pre-defined by the user
- or in automatic superpositions with a target function.

In the case of pre-defined superpositions, the user defines the load case factors; in the case of an automatic superposition, the decisive superposition for the specified target function is searched for in accordance with EN 1990-1.

Possible target functions are

- max E_h : the maximum horizontal earth pressure force
- min E_h : the minimum horizontal earth pressure force

Calculation

In general, the calculation is performed in accordance with EN 1997-1 and the respective National Annexes for Germany and Austria, which refer to

- DIN 4085
- ÖNORM B 4434

The lateral pressure is calculated according to the Recommendations of the Working Group Piles EA-Pfähle /7/. The minimum earth pressure can be taken into account in the determination of the earth pressure distribution.

Compaction earth pressure

In the case of active earth pressure and earth pressure at rest, layer-by-layer placement and compaction can increase the earth pressure considerably, especially in the upper soil layers.

EDB+ allows you to take the compaction earth pressure into account.

Results

EDB+ provides for the graphical evaluation of the earth pressure distribution for soil self-weight including cohesion

- groundwater levels
- compaction areas
- ground surface loads (individually)
- superposition of the earth pressure components
- complete overview of the respective earth pressure distributions (*with earth pressure calculation mode*)
- resulting earth pressure (*with lateral pressure calculation mode*)
- flow pressure (*with lateral pressure calculation mode*)
- lateral pressure (*with lateral pressure calculation mode*)

In the document output, load cases and superpositions are put out separately.

Basis of calculation

The earth pressure ordinates are calculated in accordance with the earth-pressure theory of Coulomb.

Basic parameters

Note: The available data-entry fields depend on the selected options.

Geotechnical standard the following standards are available for the calculation of the earth pressure

- DIN EN 1997:2010
- ÖNORM EN 1997:2013

Calculation mode allows you to select whether the earth pressure distribution or the lateral pressure distribution is to be calculated.

Earth pressure type *only with earth pressure.* Allows you to select whether the earth pressure distribution for active earth pressure, passive earth pressure or earth pressure at rest is to be put out.

Active earth pressure portion *only with earth pressure.* Increased active earth pressure must be included if the displacement of the wall is insufficient to trigger the limit state of the active earth pressure or to maintain it during the entire service life of the building. You can either pre-select the portions of active earth pressure among the options 0.25 / 0.5 / 0.75 / 1.00 or enter a user-defined value. Selecting 1.00 means that there is no increased active earth pressure.

Earth pressure at rest portion *only with earth pressure.* Example: if the active earth pressure is set to 0.75 (75 %), the earth pressure at rest is automatically set to 0.25 (25 %).

Consolidation state *only with lateral earth pressure.* Allows the selection of the consolidation state the calculation is based on.

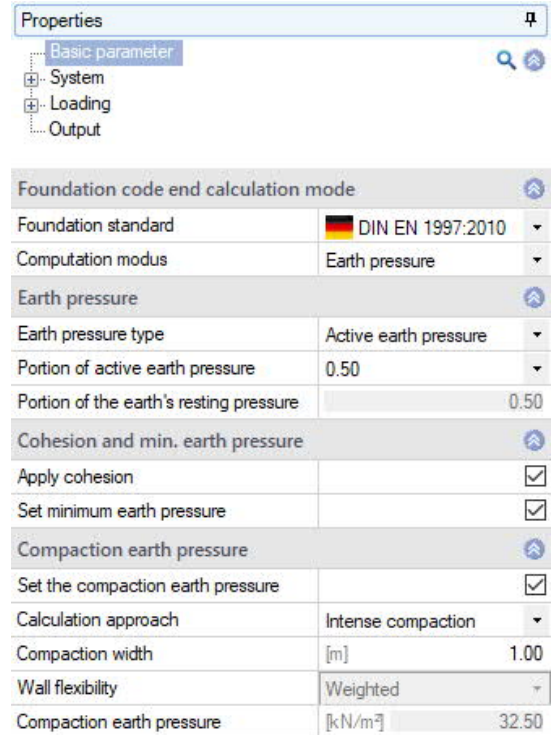
Consideration time *only with lateral pressure.* Allows you to specify the time at which the partial consolidation is to be calculated.

Apply cohesion check this option to take cohesion into account. This has a favourable effect on the subsequent design. Uncheck this option if the cohesions specified for the individual soil layers should not be considered.

Note:

- Tension from cohesion is not included.


- DIN 4085 5.3.1 excludes the consideration of cohesion in connection with earth pressure at rest. Therefore, this option is not available in the calculation of the earth pressure at rest.



The screenshot shows the 'Properties' dialog box with the following settings:

- Basic parameter** (selected in the tree)
- System**
- Loading**
- Output**

Foundation code end calculation mode

Foundation standard	 DIN EN 1997:2010
Computation modus	Earth pressure

Earth pressure

Earth pressure type	Active earth pressure
Portion of active earth pressure	0.50
Portion of the earth's resting pressure	0.50

Cohesion and min. earth pressure

Apply cohesion	<input checked="" type="checkbox"/>
Set minimum earth pressure	<input checked="" type="checkbox"/>

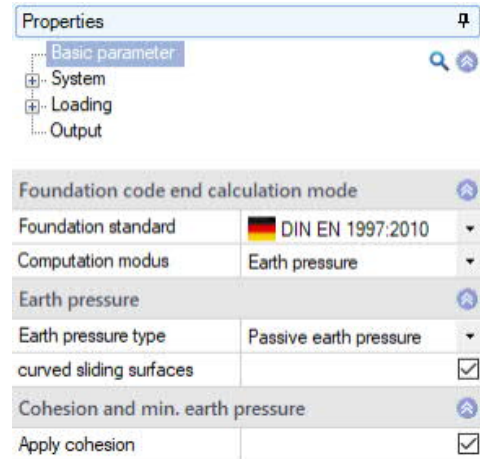
Compaction earth pressure

Set the compaction earth pressure	<input checked="" type="checkbox"/>
Calculation approach	Intense compaction
Compaction width	[m] 1.00
Wall flexibility	Weighted
Compaction earth pressure	[kN/m ²] 32.50

Consider minimum earth pressure if minimum earth pressure is considered (option ticked) with active earth pressure, the software checks for each layer of cohesive soil whether the earth pressure resulting from the self-weight of the soil and a shear strength that corresponds to the angle of inner friction $\varphi = 40^\circ$ becomes decisive at a cohesion of $c = 0 \text{ kN/m}^2$. Calculation in accordance with the Recommendations of the Working Group "Construction Pits" [EAB, 5th edition](#).

Include curved planes of rupture you can calculate passive earth pressure either with linear or curved planes of rupture as per DIN 4085/Sokolovski Pregl. For passive earth pressure, the assumption of linear planes of ruptures is only permissible for the special case $\alpha = \beta = \delta = 0^\circ$ (α : wall inclination, δ : angle of wall friction, β : slope inclination, φ : angle of friction)

The earth pressure coefficients for curved planes of rupture are determined in accordance with DIN 4085, Annex C. The graphical representation is always linear.



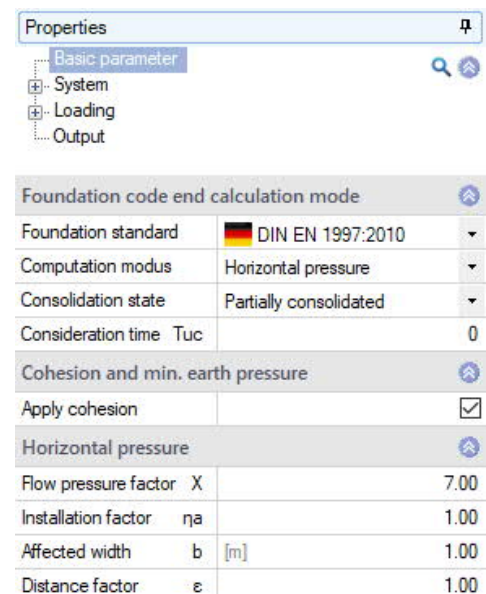
Properties	
Basic parameter	
System	
Loading	
Output	
Foundation code end calculation mode	
Foundation standard	DIN EN 1997:2010
Computation modus	Earth pressure
Earth pressure	
Earth pressure type	Passive earth pressure
curved sliding surfaces	<input checked="" type="checkbox"/>
Cohesion and min. earth pressure	
Apply cohesion	<input checked="" type="checkbox"/>

Compaction earth pressure when soil is backfilled layer by layer and compacted, the earth pressure exceeds the one resulting from the self-weight of the soil.

Calculation approach approach according to the selected National Annex of EN 1997
 - either as per DIN 4085
 - or as per ÖNORM B 4434:
 The compaction earth pressure for intense compaction is calculated as per DIN 4085. For light compaction (vibrating plate with an operating mass of up to 250 kg), the method described by Franke (Franke, D., Verdichtungserddruck bei leichter Verdichtung, BAUTECHNIK 85 (2008) Booklet 3, p. 197 to 198) should be selected.
 Alternatively, you can include the compaction earth pressure as per ÖNORM in addition to the earth pressure at rest.

Compaction width width of the space to be filled. This value has only an influence in combination with earth pressure at rest and increased active earth pressure (with low-yielding walls).

Roller pressure only available with ÖNORM.
 With static rollers, p is the load per length unit of the roller lining; with vibrating rollers, p is composed of the weight of the centrifugal force. If the centrifugal force is unknown, you can set p by approximation to twice the weight per unit length (cf. ÖNORM 4435, clause 8.5).



Properties	
Basic parameter	
System	
Loading	
Output	
Foundation code end calculation mode	
Foundation standard	DIN EN 1997:2010
Computation modus	Horizontal pressure
Consolidation state	Partially consolidated
Consideration time T_{uc}	0
Cohesion and min. earth pressure	
Apply cohesion	<input checked="" type="checkbox"/>
Horizontal pressure	
Flow pressure factor X	7.00
Installation factor η_a	1.00
Affected width b [m]	1.00
Distance factor e	1.00

Flow pressure coefficient *only with lateral pressure*. In accordance with the Recommendations of the Working Group Piles EA-Pfähle/7/, the flow pressure coefficient is set to 7 by default.

Shoring factor *only with lateral pressure*. This factor takes the mutual influence of the shoring and the subsoil into account.
 This factor takes into account the mutual influence of piles in a group compared to a single pile. As a rule, in a pile group there is an increase in the flow pressure on a single

	<p>pile, depending on the pile spacing. The shoring factor also takes into account the geometric arrangement of the piles in the pile group (offset/in a row). Press the F5 key to open a dialog window for determining the installation factor.</p>
Affected width	<p><i>only with lateral pressure.</i> Determination of the decisive affected width. Press the F5 key to open a dialog window for determining the affected width.</p>
Distance factor	<p><i>only with lateral pressure.</i> This factor takes the distance to lateral pressure-generating actions into account. Press the F5 key to open a dialog window for determining the distance factor.</p>

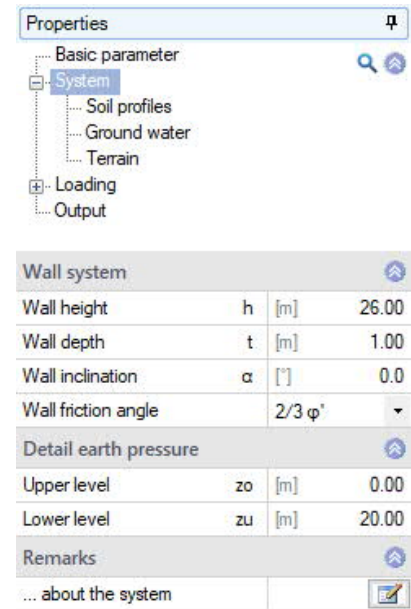
Structural system

Note: You can change the default units via **File** ▶ **Settings** ▶ **Units**.

Wall system

Wall system

Wall height	height of the hypothetical earth pressure wall. Height: positive z-coordinate.
Wall depth	depth of the hypothetical earth pressure wall. Depth: positive y-coordinate
Wall inclination	<i>only with earth pressure.</i> Wall rotation about the upper wall edge. An anti-clockwise rotation corresponds to the positive direction of rotation (α positive). The lateral pressure is determined in accordance with EA-Pfähle /7/, 4.5.4(1) on a vertical wall.
Wall friction angle	<i>only for earth pressure.</i> Friction angle δ between wall and soil. Automatically determined with earth pressure at rest. With lateral pressure, δ is set to zero in accordance with EA-Pfähle /7/, 4.5.4(1).



Earth pressure in wall section

Upper elevation	upper elevation level in relation to the upper edge of the earth pressure wall, of the area for which the earth pressure is to be calculated and put out. Upper elevation: positive z-coordinate
Lower elevation	lower elevation level in relation to the upper edge of the earth pressure wall, of the area for which the earth pressure is to be calculated and put out. Lower elevation: positive z-coordinate

Remarks

You can optionally enter comments to the system that are subsequently included in the output. See also [Remarks Editor](#).

Soil profile

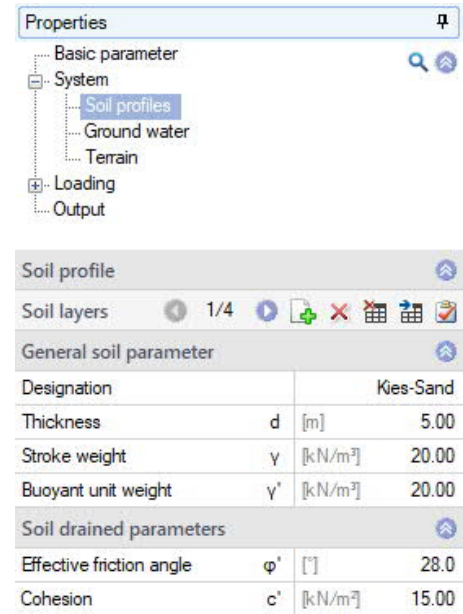
General

See [Data-entry via tables](#) in the document Operating Basics-PLUS.pdf.

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

General soil parameters

Type of soil layer	<i>only with lateral pressure.</i> You can select either a backfill, a soft layer or a base layer in this section.
Filling time	<i>only with lateral pressure.</i> Time of the soil backfill or placement in [days] in relation to the time 0, which represents the initial state (not consolidated). The installation time is only active if a backfill has been selected as the soil layer and a partially consolidated state is considered.
Consolidation period	<i>only with lateral pressure.</i> Period of consolidation of this soil layer in [days].
Designation	name or geotechnical designation of the soil layer.
Thickness d	thickness of the soil layer
Specific weight γ	specific weight of the soil.
Specific weight under buoyancy γ'	specific weight of the soil in the groundwater.



The screenshot shows two overlapping windows. The top window is titled 'Properties' and contains a tree view with the following items: Basic parameter, System, Soil profiles (highlighted), Ground water, Terrain, Loading, and Output. The bottom window is titled 'Soil profile' and contains a table of soil parameters for 'Kies-Sand'.

Soil profile			
Soil layers			
General soil parameter			
Designation			Kies-Sand
Thickness	d	[m]	5.00
Stroke weight	γ	[kN/m ³]	20.00
Buoyant unit weight	γ'	[kN/m ³]	20.00
Soil drained parameters			
Effective friction angle	ϕ'	[°]	28.0
Cohesion	c'	[kN/m ²]	15.00

Parameters of the drained soil

Friction angle ϕ'	friction angle of the drained soil.
Cohesion c'	cohesion of the drained soil.

Parameters of the undrained soil (*only for lateral pressure*)

Friction angle ϕ_u	friction angle of the undrained soil.
Cohesion c_u, k	cohesion of the undrained soil.

Settlement parameters (only with lateral pressure, partially consolidated)

Rigid module E_s enter the stiffness modulus in kN/m^2 .

Consolidation (only with lateral pressure, partially consolidated)

Permeability coefficient k coefficient of permeability in $[m/s]$ for the consolidation speed.

Drained on both sides for the calculation of the consolidation period, half the layer thickness is used for drainage on both sides.

Soil profile		
Soil layers 1/4		
General soil parameter		
Type of soil layer	Back filling	
Time of introduction	TA	0
Duration of consolidation	t_0	0.0
Designation		Kies-Sand
Thickness	d [m]	5.00
Stroke weight	γ [kN/m^3]	20.00
Buoyant unit weight	γ' [kN/m^3]	20.00
Soil drained parameters		
Effective friction angle	ϕ' [°]	28.0
Cohesion	c' [kN/m^2]	15.00
Undrained soil parameters		
Effective friction angle	ϕ_u [°]	0.0
Cohesion	$c_{u,k}$ [kN/m^2]	0.00
Settlement parameter		
Rigid module	E_s [kN/m^2]	0.00
Consolidation		
Permeability coefficient	k [m/s]	1E-07
Drained on both sides		<input type="checkbox"/>

Groundwater

Groundwater existing check the option if groundwater is to be considered.

Groundwater in front of the wall elevation of the groundwater level on the wall face away from the earth.
Height: positive z-coordinate.

Groundwater behind the wall elevation of the groundwater level on the wall face in contact with the earth.
Height: positive z-coordinate.

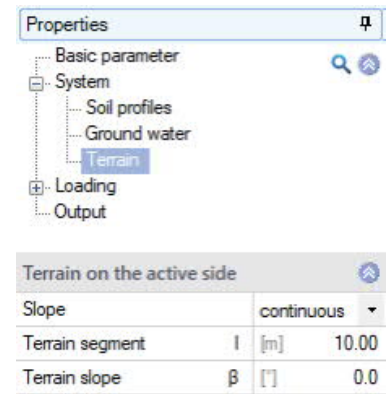
In combination with later pressure, you cannot specify different groundwater levels behind and in front of the wall.

Properties		
Basic parameter		
System		
Soil profiles		
Ground water		
Terrain		
Loading		
Output		
Ground water		
Ground water existing		<input checked="" type="checkbox"/>
Groundwater in front of the wall	[m]	0.00
Groundwater behind the wall	[m]	0.00

Ground surface

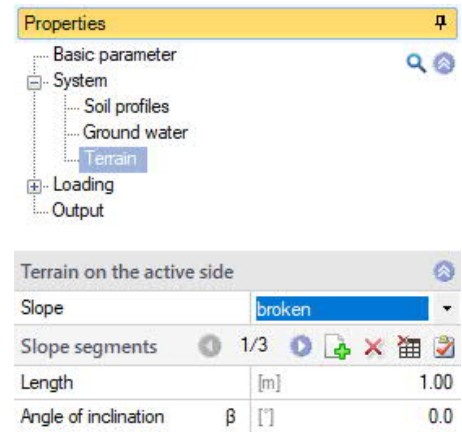
Horizontal or continuously sloping ground surface

- Slope** topology of the ground top edge:
 - horizontal
 - continuous slope
 - broken slope
- Terrain segment** specify the ground surface dimension for horizontal and continuously sloped surfaces. For broken ground surfaces, this value results from the slope sections.
- Terrain slope β** inclination of the slope measured against the horizontal. Anticlockwise is positive. Negative values are also allowed.



Broken ground surface

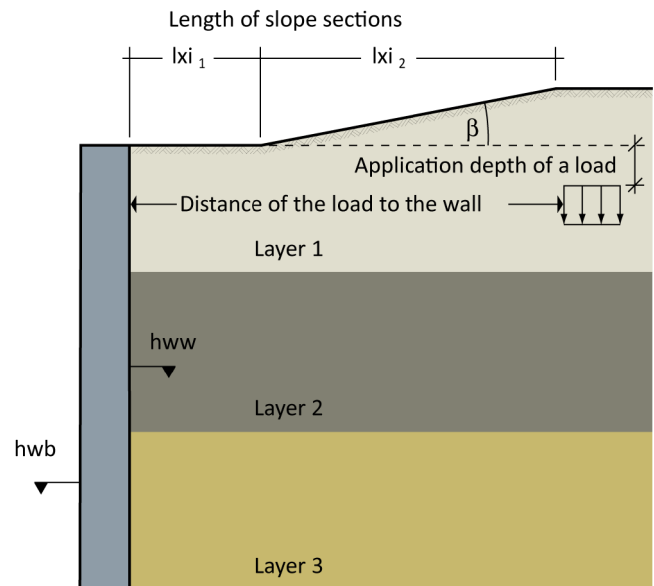
- Length** length of the slope section in the x-direction. The length of the last section is automatically increased if required.
- Inclination β** inclination of the slope measured against the horizontal. Anticlockwise is positive. Negative values are also allowed.



Note concerning slope sections:

The slope section defined last is automatically adjusted to the maximum relevant length.

See also [Data entry via tables](#) in the Basic operating instructions PLUS.pdf



For lateral pressure, a ground surface is defined for each side, the active side and the earth resistance side.

Loading

Ground loads

Load parameters

Load type

- area/surface load
- strip load (not with passive earth pressure)
- block load (not with passive earth pressure)
- line load (not with passive earth pressure)

Name

designation of the load

Earth pressure distribution

(only for strip- or blockloads with distance $a > 0$) rectangular or trapezoidal with block loads and strip loads:


If limited live loads apply, you can select between a rectangular distribution and a trapezoidal distribution of the load.

The ordinates of the trapezoidal distribution result from a linear interpolation that depends on the distance to the wall and the width of the load.

Load values


Load value p_l

load coordinate in kN/m^2 for – area/surface load - strip load - block load.

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

Line load p

load coordinate in kN/m for - line load.

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

Width b

width of the load perpendicular to the wall (with block loads and strip loads).

Length l

load length parallel to the wall (block load).

Location

Distance

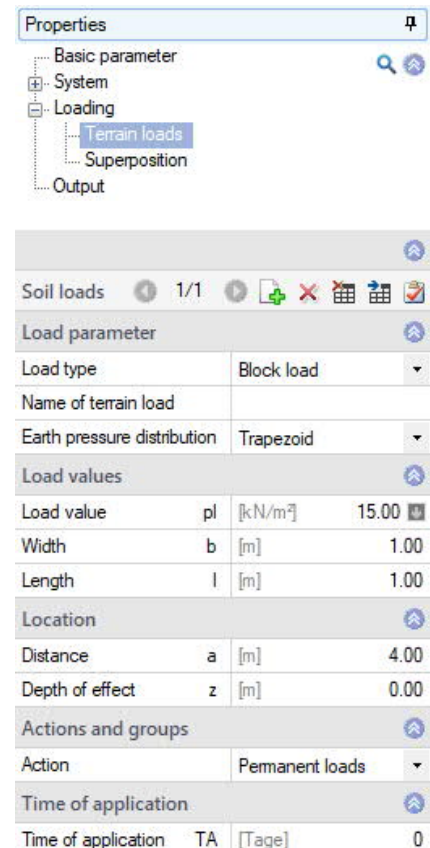
distance of the load to the wall.

In the positive x-direction for active earth pressure and earth pressure at rest.

In the negative x-direction for passive earth pressure.

Application depth z

depth at which the load applies. Positive values mean that the load applies below the wall head.



The screenshot shows the 'Properties' window for a 'Block load'. The tree view on the left includes 'Basic parameter', 'System', 'Loading', 'Terrain loads', 'Superposition', and 'Output'. The main window displays the following parameters:

Soil loads			
Load parameter			
Load type		Block load	
Name of terrain load			
Earth pressure distribution		Trapezoid	
Load values			
Load value	p_l	[kN/m^2]	15.00
Width	b	[m]	1.00
Length	l	[m]	1.00
Location			
Distance	a	[m]	4.00
Depth of effect	z	[m]	0.00
Actions and groups			
Action		Permanent loads	
Time of application			
Time of application	TA	[Tage]	0

Actions and groups

Action	select the action to be assigned to this load from a list.
Concurrency group	you can assign variable loads to groups that always act simultaneously. You can create new groups. Names are assigned automatically. The loads of a group must be assigned to an action. ▶ See the following chapter Load groups .
Alternative group	the loads of an alternative group are always assumed to act individually, i. e. only one load of the alternative group applies at a time. You can create new groups. Names are assigned automatically. ▶ See the following chapter Load groups .

Application time *(only with lateral pressure)*

Time of application TA	Time of application of a load in [days] in relation to time 0, which represents the initial state (not consolidated). The application time is only active if lateral pressure has been selected and a partially consolidated state is being considered.
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Load groups

The load grouping has only an effect on the p loads. g loads are always considered.

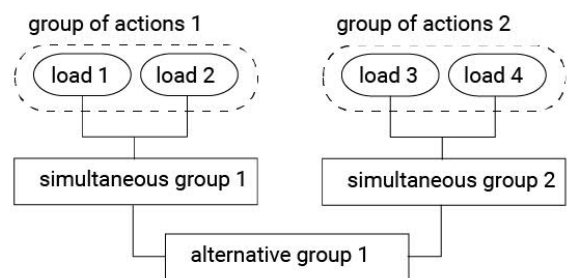
Loads of a particular action group can be defined as "always acting simultaneously" In addition, loads or load groups can be set as mutually exclusive (alternative).

This method corresponds to the typical superposition load case.

Note: In case of conflicting entries in the data-entry fields "Concurrency group" and "Alternative group", the entries in the "Concurrency group" fields have priority.

Example of groups of actions and load groups within an item

- The loads 1 and 2 are assigned to the group of actions 1.
- Correspondingly, the loads 3 and 4 are assigned to the group of actions 2.
- Load 1 and load 2 are assumed to be wind loads, for example, that always apply together because they act in the same direction.
- Load 3 and load 4 are assumed to be wind loads, both acting in the opposite direction.
- As wind can only blow in one or the other direction, both combination groups 1 and 2 are assigned to the alternative group 1.
- The effect is that either the Concurrency group 1 or 2 or none of both is considered depending on whether the loads become decisive for the design or not.



Superposition

Superposition... Choice between predefined and automatically determined superpositions.

Designation name of the superposition

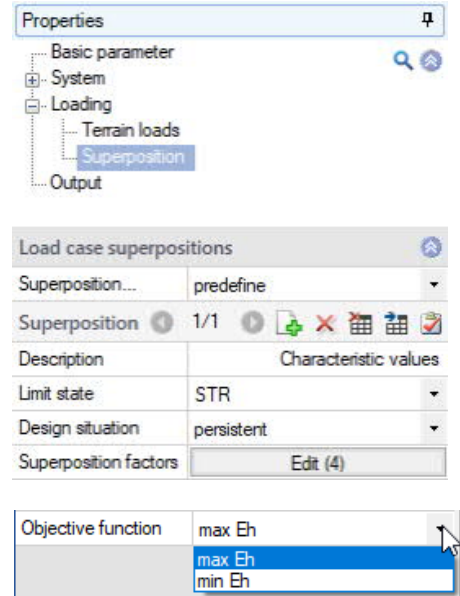
Limit state limit state for which the partial safety factors are applied by the program. This setting has no effect if the partial safety factors are specified by the user.

Design situation design situation for which the partial safety factors are applied by the program. This setting has no effect if the partial safety factors are specified by the user.

Superposition factors with selected predefined superpositions you open a dialog for defining the superposition factors via the edit button.

Target function If the automatic determination of the superpositions is selected, you enter a target function here as a criterion for the automatic load case combinations.

- max Eh maximum horizontal earth pressure force
- min Eh minimum horizontal earth pressure force



Superposition factors

With selected predefined superposition.

	Name of load case	Load case type	Approach	TSBW	Combination coefficient	Factor
1	Ground weight	Soil	free input	---	---	1.00
2	Groundwater	Soil	free input	---	---	1.00
3	Compression earth pressu	Compaction	free input	---	---	1.00
4	Blockload 1	Terrain load	γ Sup	1.35	1.00	1.35

General

The load cases

- soil self-weight
- groundwater
- compaction earth pressure

are created automatically by the software.

For each defined ground surface load, another load case is automatically created. All load cases can then be included in the superposition with the specified partial safety factors.

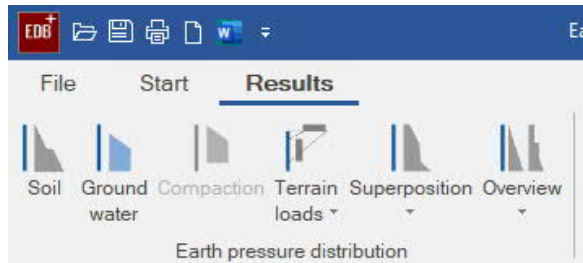
For this purpose, the upper and lower partial safety factors are available depending on the defined limit state and the defined design situation. Alternatively, you can also enter user-defined superposition factors.

Definition of the superposition factors

Designation load case	<p>name of the load case.</p> <p>For the standard load cases soil self-weight, groundwater and compaction earth pressure, the name is assigned automatically by the program.</p> <p>Load cases representing ground surface loads are given the name of the ground surface load.</p> <p>User-defined specifications are not provided.</p>
Load case type	<p>the type of load case gives information about the kind of load case. User-defined specifications are not provided.</p>
Approach	<p>there are three approach options to include load cases in the superposition:</p> <p>γ_{inf} lower partial safety factor</p> <p>γ_{sup} upper partial safety factor</p> <p>user-defined.</p> <p>For the options γ_{inf} and γ_{sup}, the partial safety factors are given depending on the settings for limit state and design situation. Alternatively, the user can specify freely selectable user-defined partial safety factors. In the case of terrain loads, the load can also be set to "not active".</p>
TSBW	<p>partial safety factors in accordance with EN 1990 or the respective National Annex.</p>
Combination coefficient	<p>combination coefficient in accordance with EN 1990 or the respective National Annex.</p>
Factor	<p>final superposition factor.</p>

Results

The respective earth pressure distributions can be called up via the following functions.



Soil	earth pressure from soil self-weight, including cohesion.
Groundwater	hydrostatic pressure from groundwater. Only enabled when groundwater levels have been defined.
Compaction	increased earth pressure due to compaction of the soil. The earth pressure distribution shown here corresponds to the upper limit of the earth pressure to be applied under compaction. Only the area in which the compaction pressure is to be applied is shown. Applies only to active earth pressure and earth pressure at rest. Only enabled if compaction earth pressure has been selected in the parameters section.
Ground surface loads	earth pressure from ground surface loads. Select the appropriate ground surface load from the pull-down menu.
Superposition	earth pressure from the superposition - of soil self-weight, including cohesion and compaction - groundwater - and the sum of all ground surface loads. Select the appropriate superposition from the pull-down menu.
Overview	<i>only with earth pressure.</i> Overview of the earth pressure distribution - for soil self-weight, including cohesion and compaction and groundwater - sum of all ground surface loads - superposition Select the appropriate superposition from the pull-down menu.
Resulting earth pressure	<i>only with lateral pressure.</i> The decisive earth pressure is displayed that results when the affected width is considered.
Flow pressure	<i>only with lateral pressure.</i> Flow pressure distribution.
Lateral pressure	<i>only with lateral pressure.</i> The decisive lateral pressure according to EA-Pfähle /7/ is displayed.

Output

Scope of the output and options

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

Output as a PDF document

On the "Document" tab, a PDF document is displayed.

Tip: colour graphics can optionally be set in the page layout (tab on the right) under "General" - the standard is black and white.

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

Properties 🔍 ↕

- Basic parameter 🔍 ↕
- System 🔍 ↕
- Loading 🔍 ↕
- Output**

Output layout ↕

Output is running ...	brief	▼
Legends	<input type="checkbox"/>	

Output system ↕

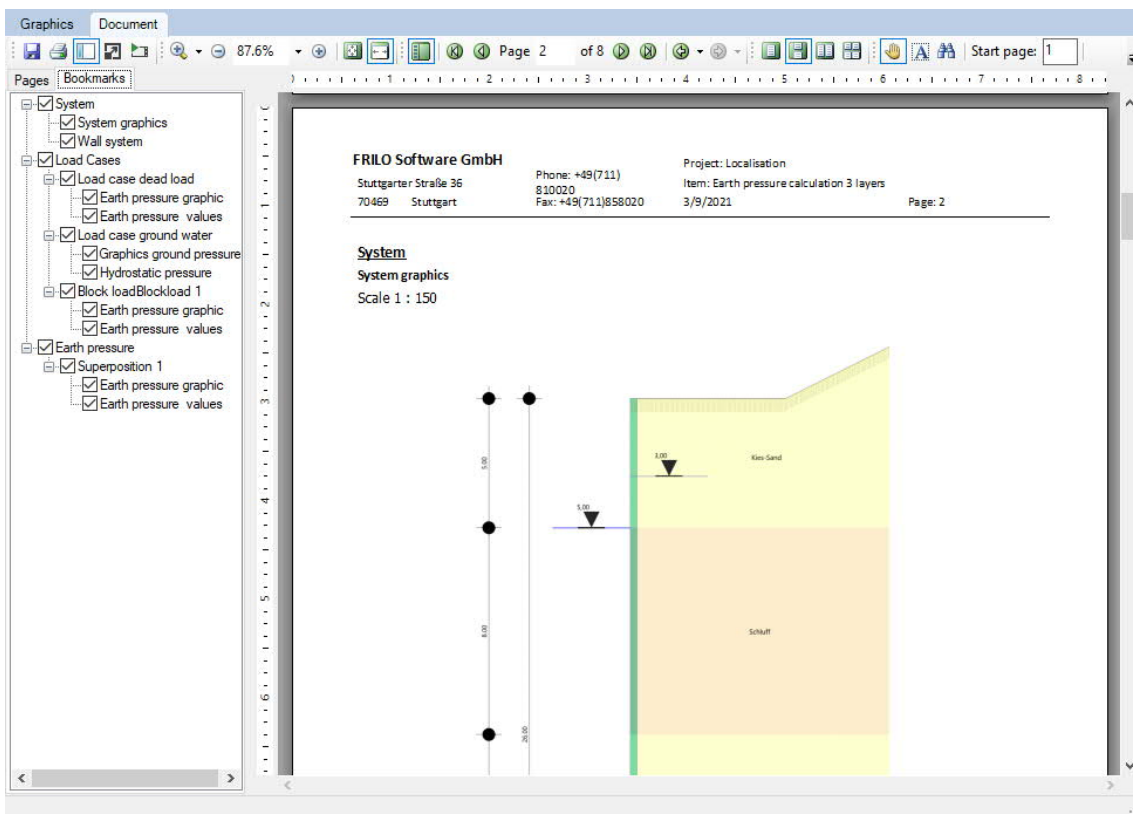
Calculation parameter	<input type="checkbox"/>	
Wall system	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Scale	auto	▼
Soil profile	<input type="checkbox"/>	
Ground water	<input type="checkbox"/>	
Terrain	<input type="checkbox"/>	

Output of terrain loads ↕

Soil loads	<input type="checkbox"/>	
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Output earth pressure ↕

Earth pressure levels	<input type="checkbox"/>	
Earth pressure coefficients	<input type="checkbox"/>	
Superposition factors	<input type="checkbox"/>	
Load Cases	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Scale	auto	▼
Superposition	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	
Scale	auto	▼



Reference literature

- / 1/ EAB, 5th edition, Empfehlungen des Arbeitskreises "Baugruben" (Recommendations of the Construction Pits Working Group)
- /2/ DIN 4085 [2011-05]
- /3/ ÖNORM B 4434
- /4/ Franke, D., Verdichtungserddruck bei leichter Verdichtung, BAUTECHNIK 85 (2008) Booklet 3, pages 197 to 198
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