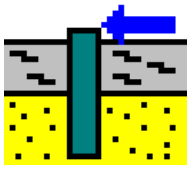

GGU-LATPILE manual

Laterally loaded piles (subgrade reaction / p-y)

Exported on 23.7.2026

Technische Umsetzung, Layout und Vertrieb:
Civilserve GmbH, Steinfeld

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Theorie. Und Praxis.

Geotechnische Softwarelösungen können so einfach sein. Denn Theorie und Praxis lassen sich mit **GGU-Software** und den neuen Angeboten der **civilserve Academy** prima kombinieren: Knackige theoretische Aufgaben lösen und als Sahnehäubchen Ihr

Know-how durch Praxisseminare vertiefen!

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1 GGU-LATPILE: Preface

GGU-LATPILE allows analysis and design of piles subjected to lateral loads and moments. For analysis both the ***partial safety factors*** to EC 7 and the ***global safety factors*** to DIN 1054 (old) may be taken into consideration. Subgrade reaction moduli can be applied to user-defined, linearly variable sections over the length of the pile. By thus dividing the pile into several sections it is possible to model any subgrade reaction modulus profile.

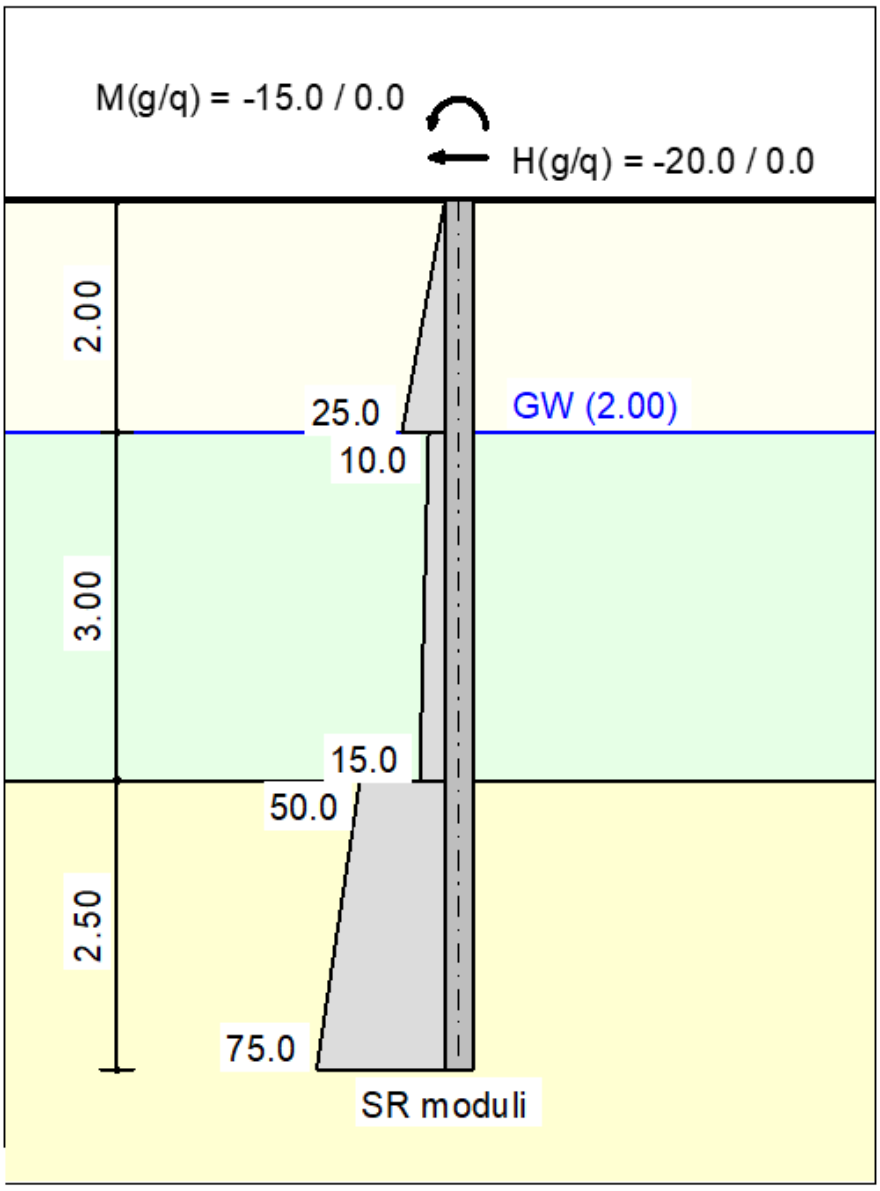


Figure 1 Subgrade reaction modulus profile

Elastic analysis supplies the soil stress determined from the product of the subgrade reaction modulus and the deformation along the length of the pile. This elastic stress must not exceed the passive earth pressure that can be developed in front of the pile. By means of iteration, **GGU-LATPILE** reduces the subgrade reaction modulus such that this condition is adhered to. **GGU-LATPILE** calculates both passive (various methods of analysis can be selected) and active earth pressures.

As an alternative to the subgrade reaction modulus method, you can also perform a pile analysis using the p-y method.

The Code of Practice published by Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV): ***M EBGS-Lsw - Code of Practice for the Design and Analysis of Footings and Steel Posts for Noise Abatement Walls and Bird Overfly Aids on Roads*** (Edition 2018, FGSV no. 552) has been incorporated for the purposes of analysing noise abatement walls.

If you are already working with **GGU-CONNECT**, you can also import soil properties from your subsoil layer model that you have created in **GGU-CONNECT**.

The application is designed to allow simple data input or modification. The input is immediately shown on the screen, giving you optimum control over what you are doing. Reading of the manual can mostly be dispensed with, because

"?" buttons

dealing with almost all geotechnical and program-specific problems are available in the dialog boxes. You are presented with the necessary information by clicking the "?" button.

Graphics output supports the true-type fonts supplied with WINDOWS, so that excellent layout is guaranteed. Colour output and any graphics (e.g. files in formats BMP, JPG, PSP, TIF, etc.) are supported. PDF and DXF files can also be imported by means of the integrated **Mini-CAD** module (see the "**Mini-CAD**" manual).

The program has been thoroughly tested. No faults have been found. Nevertheless, liability for completeness and correctness of the program and the manual, and for any damage resulting from incompleteness or incorrectness, cannot be accepted.

2 GGU-LATPILE: Licence protection

To protect the GGU software from unauthorised access, each GGU program is equipped with the ***CodeMeter software protection system*** from WIBU-Systems. Each GGU program is bound to a so-called ***CmContainer*** via a licence with the corresponding product code.

To be able to use the GGU licences in a CmContainer, a runtime environment, the ***CodeMeter Runtime Kit***, must be installed on your computer via driver software. You can obtain the current version from Software for Users - Wibu-Systems (CodeMeter User Runtime for Windows).

You can work with the following CmContainer types on your PC with the CodeMeter Runtime Kit installed (= ***CodeMeter licence server***):

- **CmStick**
  The licence for your GGU program is stored in a USB dongle.
- **CmActLicense** (soft licence, not for virtual PC/servers)
  The licence for your GGU program is stored in a licence file that is linked to the hardware of a computer.
- **CmCloudContainer**
  The licence is located on a CmCloud server of WIBU-Systems and is mirrored to your CodeMeter licence server. The advantages of this type of licence binding are described on the following website: Licence binding | GGU Software.

The GGU programs check at start-up and during runtime whether a corresponding license is available in a CmContainer.

3 GGU-LATPILE: Language selection

The GGU programs can be used in German and English. The program always starts with the language in which it was terminated.

The language preferences can be changed at any time in the "**Info**" menu, using the menu item "**Spracheinstellung**" (for German) or "**Language preferences**" (for English).

4 GGU-LATPILE: Starting the program

After starting the program, you will see two menus at the top of the window:

- File
- Info

By going to the "**File**" menu, a previously analysed system can be loaded by means of the "**Load**" menu item, or a new one created using "**New**". After clicking the "**New**" menu item a dialog box opens for specifying general preferences for your new system. You leave the dialog box clicking on the button with the desired pile type (e.g. "Steel pile").

You then arrive at the initial program screen, containing an example system with legends and the selected pile type. Now eight menus appear at the top of the window:

- File
- Editor 1
- Editor 2
- System
- Evaluation
- Graphics preferences
- Page size + margins
- Info

After clicking one of these menus, the so-called menu items roll down, allowing you access to all program functions.

The program works on the principle of ***What you see is what you get***. This means that the screen presentation represents, overall, what you will see on your printer. In the last consequence, this would mean that the screen presentation would have to be refreshed after every alteration you make. For reasons of efficiency and as this can take several seconds for complex screen contents, the screen is not refreshed after every alteration.

If you would like to refresh the screen contents, press either [**F2**] or [**Esc**]. The [**Esc**] key also resets the screen display to your current image zoom, which is usually preset to 1.0, which corresponds to an A3 or A4 sheet in most GGU programs (see menu item "**Graphics preferences/Refresh and zoom**").

5 Tips and tricks

5.1 GGU-LATPILE: "?"- and "Info" buttons

Reading of the manual can mostly be dispensed with, because

"**?**" buttons or "**Info**" buttons

dealing with almost all geotechnical and program-specific problems are available in the dialog boxes. You are presented with the necessary information by clicking the buttons.

5.2 GGU-LATPILE: Function keys

Some of the function keys are assigned program functions. The allocations are noted after the corresponding menu items. The individual function key allocations are:

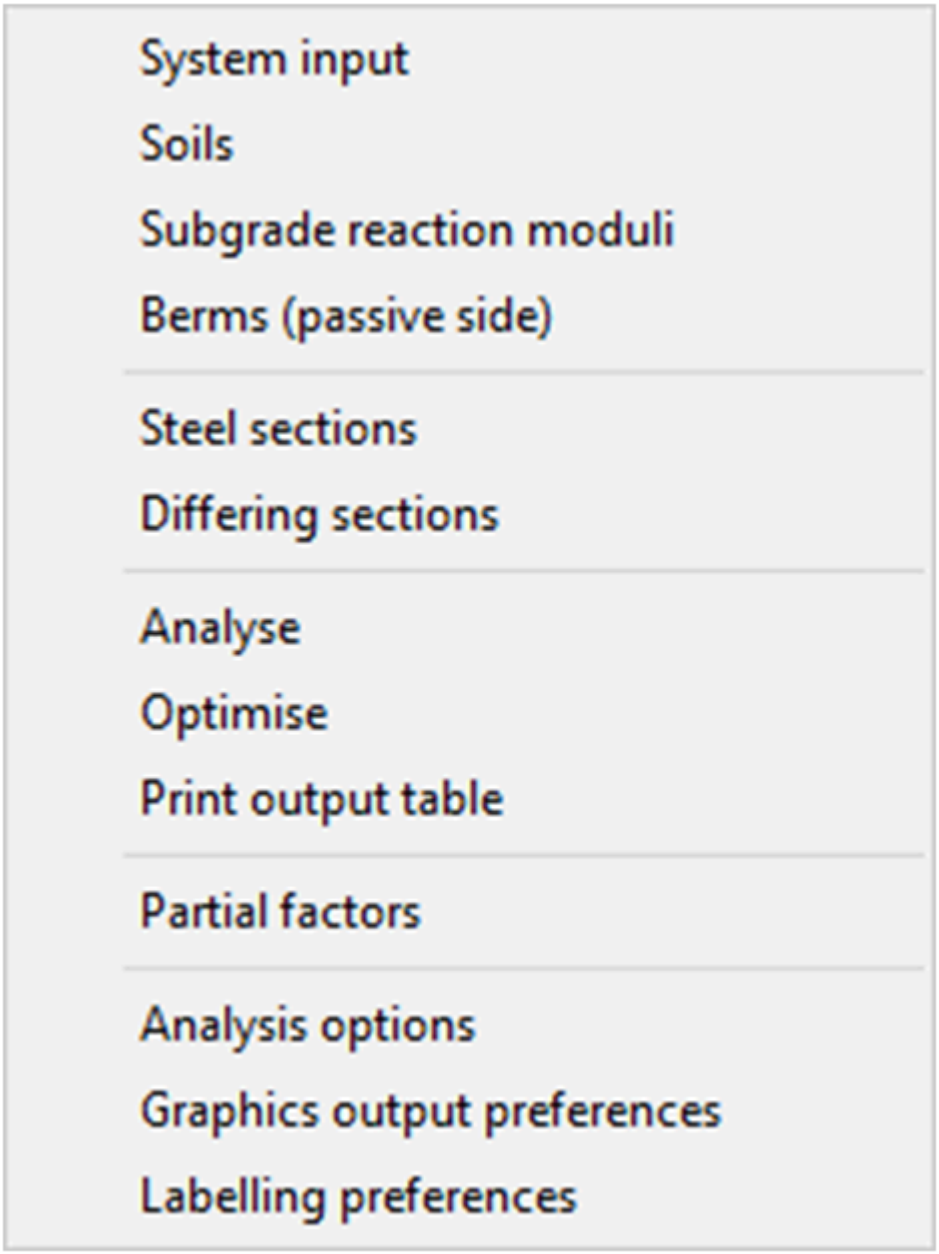
- [**Esc**] refreshes the screen content and resets the screen section to your current image zoom, which is preset to 1.0. This is useful, for example, if you have used the magnifying glass function to display sections of the drawing on the screen and want to quickly return to the overall view.
- [**F1**] opens the manual file.
- [**F2**] refreshes the screen without altering the current magnification.
- [**F11**] activates the menu item "**Move objects**", which appears in the GGU programs under various menu titles, e.g. "**Page size + margins**", "**Graphics preferences**" or "**Output preferences**".

In this GGU program, the following function keys are also assigned to program functions:

- [**F5**] opens the menu item "**System/Analyse**".
- [**F6**] opens the menu item "**Evaluation/Main output summary**".
- [**F7**] opens the menu item "**System/Optimise**".
- [**F9**] opens the menu item "**Page size + margins/Auto-resize**".

5.3 GGU-LATPILE: Keyboard and mouse

If you click the right mouse button anywhere on the screen a context menu containing the principal menu items opens.



By double-clicking the left mouse button on legends or **Mini-CAD** objects, the editor for the selected element immediately opens, allowing it to be edited.

In most dialog boxes, the buttons for leaving the box or buttons for decisive functions are marked thickly and can be reached by clicking the [**Enter**]/[**Return**] key.

In dialog boxes in which you have to make entries, e.g. change soil properties, the quickest way to jump to the next input box is to use the [**Tab**] key. The previous value is marked and can be overwritten directly with the new entry. You do not have to move to the box with the mouse and delete the old entry in advance.

In input boxes with numerical values, you can use the calculation operations listed in "**Tips and tricks: Mathematical functions in input boxes with numbers**" to change them.

You can scroll the screen with the keyboard using the cursor keys and the [**Page up**] and [**Page down**] keys. After activating the zoom functions, click on an area of the screen to enlarge or reduce the display by a factor of 2. Alternatively, by clicking and dragging the mouse while holding down the [**Ctrl**] key, you define a window section which is then displayed in full screen. By clicking and dragging the mouse while holding down the [**Shift**] and [**Ctrl**] keys, you zoom into your system graphic, i.e. you change the scale of your system representation.

You can also use the mouse wheel to zoom in or out or to move the screen display. When the program is started for the first time, the default setting for mouse wheel operation is activated according to Windows conventions:

- Mouse wheel up = move screen image up
- Mouse wheel down = move screen image down
- [**Shift**] + mouse wheel up = move screen image right
- [**Shift**] + mouse wheel down = move screen image left
- [**Strg**] + mouse wheel up = enlarge screen image (zoom in)

[**Strg**] + mouse wheel down = reduce screen image (zoom out)

If you want to change the system coordinates and the scale of your system using the mouse wheel, activate the "**Mouse wheel operation with global coordinates**" check box in the dialog box of the "**Graphics preferences/Zoom info**" menu item. If you close the program with this setting, the setting is still activated the next time you start it. You can now use the following mouse wheel functions to change the system:

- [**Shift**] + mouse wheel up = move system graphics up
- [**Shift**] + mouse wheel down = move system graphics down
- [**Shift**] + [**Strg**] + mouse wheel up = move system graphics right
- [**Shift**] + [**Strg**] + mouse wheel down = move system graphics left
- [**Strg**] + mouse wheel up = enlarge system graphics (change of scale)
- [**Strg**] + mouse wheel down = reduce system graphics (change of scale)

From a zoomed representation you return to the full screen with [**Esc**]. You can undo a change in scale or system coordinates with [**F9**] (= menu item "**Page size + margins/Auto-resize**").

You can view the changed system coordinates in the menu item "**Page size + margins/Manual resize (editor)**" and, if necessary, adjust them manually by entering more precise numbers.

5.4 GGU-LATPILE: Mathematical functions in input boxes with numbers

In input boxes for numerical values, you can use the following arithmetic operations (also in combinations) to determine the desired value or to adjust the existing value. After pressing the [**Return**] or [**Enter**] key, the calculated value is inserted.

Function	**Input**
Add:	
5 + 12,18	5 + 12,18
Subtract:	
25,74 - 12,18	25,74 - 12,18
Multiply:	
5,23 · 4,18	5,23*4,18
π · 2,5³	PI*2,5^3
Divide:	
5,23 / 4,18	5,23/4,18 or 5,23:4,18
Exponentiate:	
25	2^5
Radify:	
Root of 27	w(27) or 27^(1/2)
5th root of 81,5	81,5^(1/5)
Sine, cosine, tangent etc.	

sin(32°)	sin(32)
cos(5,23°)	cos(5,23)
tan(45°)	tan(45)
arctan(1,0)	atan(1,0) = 45°
Natural logarithm:	
ln(4,53)	ln(4,53) = 1,5107
Exponential function:	
e1,5107	ep(1,5107) = 4,53

5.5 GGU-LATPILE: "Copy/print area" icon

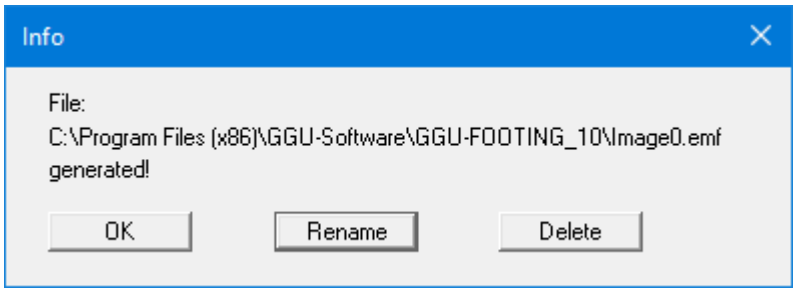
A dialog box opens when the "**Copy/print area**" icon

in the menu toolbar is clicked, describing the options available for this function. For example, using this icon it is possible to either copy areas of the screen graphics and paste them into the report, or send them directly to a printer.

In the dialog box, first select where the copied area should be transferred to: "**Clipboard**", "**File**" or "**Printer**". The cursor is displayed as a cross after leaving the dialog box and, keeping the left mouse button pressed, the required area may be enclosed. If the marked area does not suit your requirements, abort the subsequent boxes and restart the function by clicking the icon again.

If "**Clipboard**" was selected, move to the MS Word document (for example) after marking the area and paste the copied graphics using "*Edit/Paste*".

If "**File**" was selected, , the following dialog box appears after defining the area, shown here as an example for the **GGU-FOOTING** program:



The default location of the file is the folder from which the program is started (here: GGU-FOOTING_10) and, if several files are created, the file is given the file name "**Image0.emf**" with sequential numbering. If the
"**Rename**" button in the dialog box is clicked, a file selector box opens, and the copied area can be saved under a different name in a user-defined folder. Saving can be aborted by pressing the "**Delete**" button.

If the "**Printer**" button was pressed in the first dialog box, a dialog box for defining the printer settings opens after marking the area. Following this, a dialog box for defining the image output settings opens. After confirming the settings, the defined area is output to the selected printer.

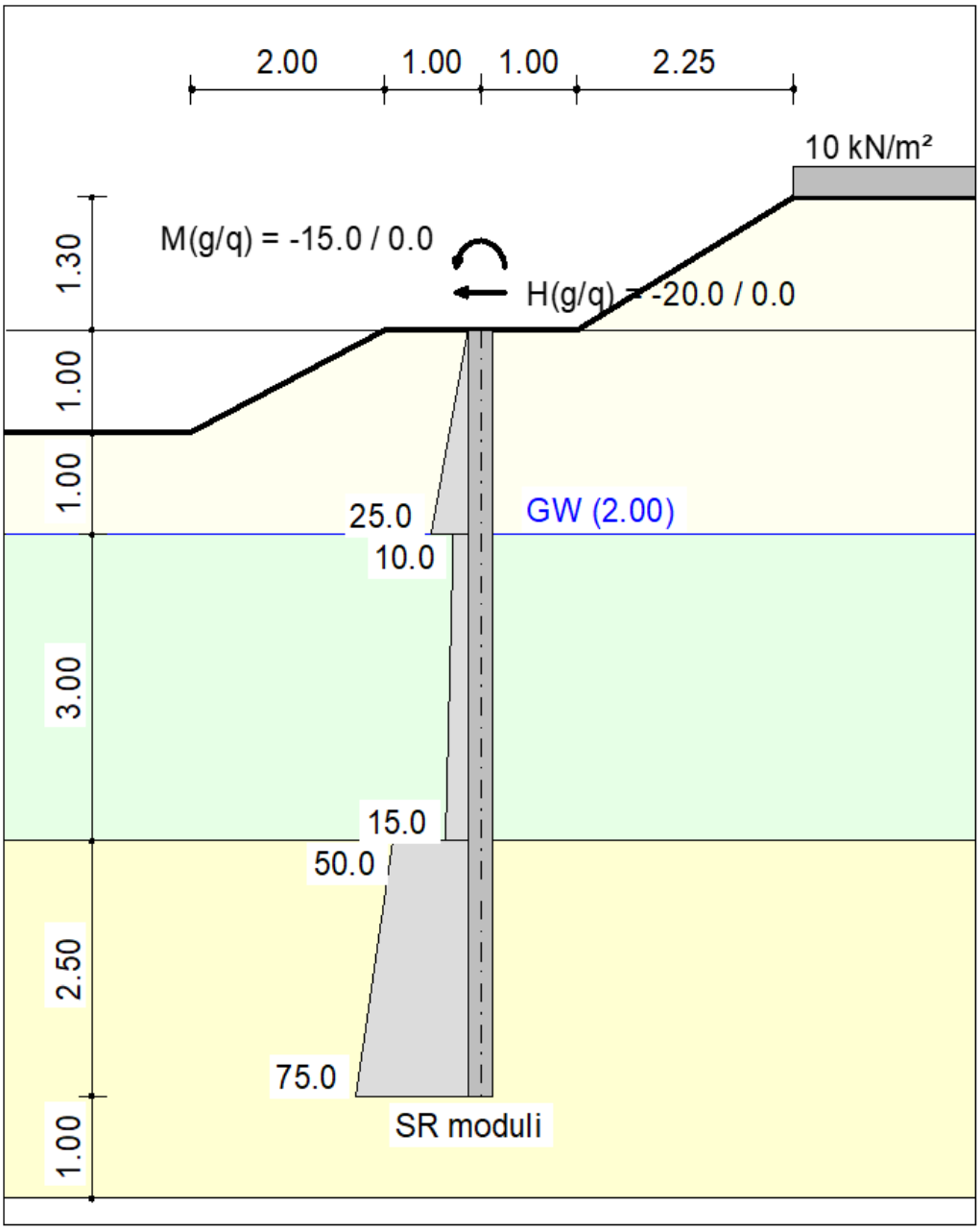
6 First steps using a worked example

6.1 GGU-LATPILE: General note

When using the program for the first time you should enter data starting at the ***left*** and then work through the menu items in sequence ***from top to bottom***. Begin at menu item "**Editor 1/Analysis options**" and click each menu item in the "**Editor 1**" menu, just to get an overview of the multitude of options available in the program. Proceed in analogy for the "**Editor 2**" menu. Once you have worked through these two menus you have completely described the system. Details on the definition of certain input parameters are described in Section 8 pp. An example will describe procedure more closely.

6.2 GGU-LATPILE: System description

As a worked example, the following system is to be analysed:



The system contains three different soils. On the active side is a berm with a surcharge of 10 kN/m². On the passive side is a further berm. The subgrade reaction modulus profile is presented graphically. A steel pile (HEB 300) is to be analysed. A moment of 15 kN m and a horizontal load of 20 kN acts on the pile head. The effective direction of the load can be seen in Figure 2. Groundwater is 2.0 m below the pile head. The pile is 7.5 m long.

6.3 GGU-LATPILE: Step 1: Select analysis options

After starting the program, the logo is displayed. Select the menu item "**File**/**New**". A dialog box will appear where you can define basic preferences of your system.

Enter the values shown in the above dialog box and click "**Steel pile**". A new system is displayed on the screen and the complete menu bar is activated.

6.4 GGU-LATPILE: Step 2: Enter system data

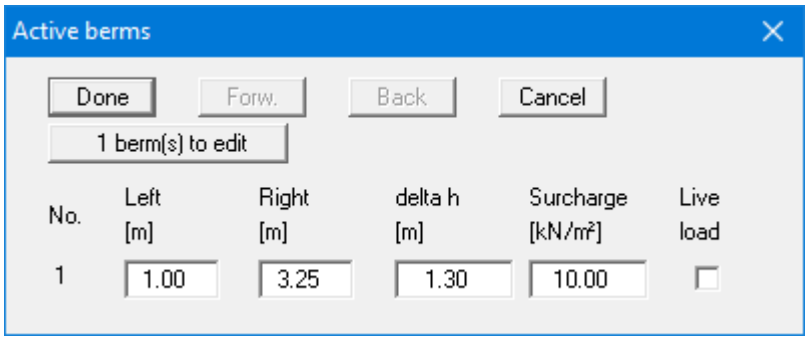
Go to the menu item "**Editor 1/ System input**" and enter the data for the pile head loading.

The pile width is required for determination of the spatial passive earth pressure. Using this menu item, you also enter any groundwater level and distributed loads .

6.5 GGU-LATPILE: Step 3: Define berm on the active side

Go to the "**Editor 1**" menu and select "**Berms (active side)**":

Click "**0 berm(s) to edit**" and enter **1** as the new number of berms. Enter the following values and click "**Done**".



6.6 GGU-LATPILE: Step 4: Define berm on the passive side

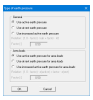
Go to the "**Editor 1**" menu and select "**Berms (passive side)**". Click "**0 berm(s) to edit**" and enter the number **1**. Enter the following values and click "**Done**".

6.7 GGU-LATPILE: Step 5: Define soils

Go to the "**Editor 1**" menu and select "**Soils**". Click the "**Edit no. of soils**" button and enter **3** as new number of soils. Enter the values shown in the following dialog box:

6.8 GGU-LATPILE: Step 6: Define type of earth pressure

Go to the "**Editor 1**" menu and select "**Type of earth pressure**".



The necessary buttons are already selected, so you need not change anything. The same applies to the remaining menu items in "**Editor 1**". However, you should click on these items and take a look at them, in order to familiarise yourself with them.

6.9 GGU-LATPILE: Step 7: Define active earth pressure

Go to the "**Editor 1**" menu and select "**Active earth pressure**".

If necessary, edit the data there in accordance with the dialog box and confirm with "**OK**".

6.10 GGU-LATPILE: Step 8: Define passive earth pressure

Go to the "**Editor 1**" menu and select "**Passive earth pressure**".

Accept the proposed setting.

6.11 GGU-LATPILE: Step 9: Define subgrade reaction modulus profile

Go to the "**Editor 2**" menu and select "**Subgrade reaction moduli**".

Using the "**x subgrade moduli to edit**" button enter "**3**" as new number of subgrade reaction moduli for the example. Edit the values corresponding to the dialog box shown.

6.12 GGU-LATPILE: Step 10: Analyse system

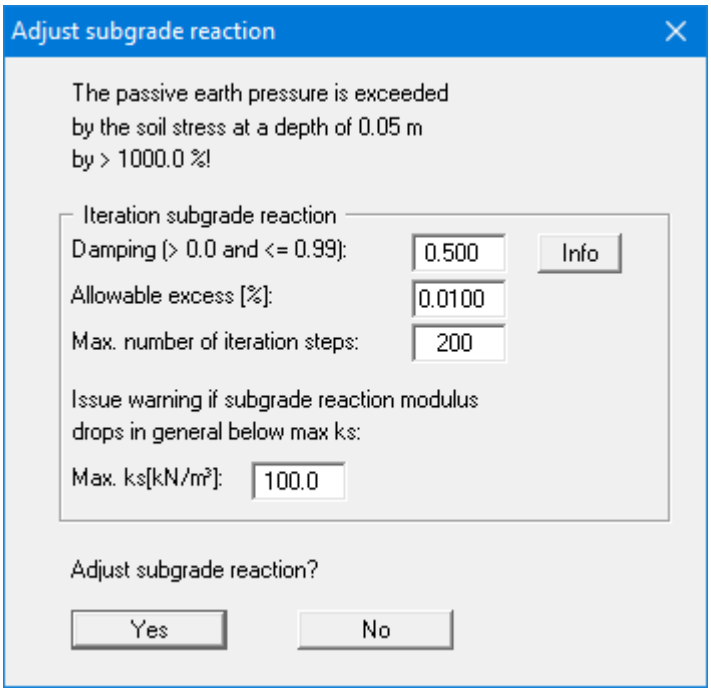
Go to the "**System**" menu and select "**Analyse**".

The pile length and pile width were adopted from the "**Editor 1/System input**" dialog box. If you would prefer to use a different section, click the "**Section: ...**" button and select the required section from the list of sections displayed. Confirm the input by pressing "**OK**".

EC 7 requires that a verification be performed to demonstrate that the soil stress (ks · w)d is smaller than the characteristic passive earth pressure eph,k (not reduced by a partial safety factor!). However, once analysis is complete it must be verified that the sum of the soil stress is smaller than the design passive earth pressure:

$$\Sigma\,(k_s \cdot w)_d \leq E_{ph,k} / \gamma_{Ep}$$

Using the preferences given so far you will see the following dialog box:

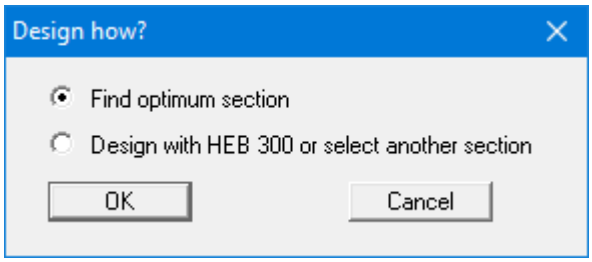


The program has determined that the passive earth pressure is smaller than the resulting soil pressure from the elastic analysis, which is not permitted. Therefore, confirm the question about iteration with "**Yes**". In the dialog box shown above, you can enter the iteration conditions. The ***default values*** have proved themselves in practice and will generally not need to be altered.

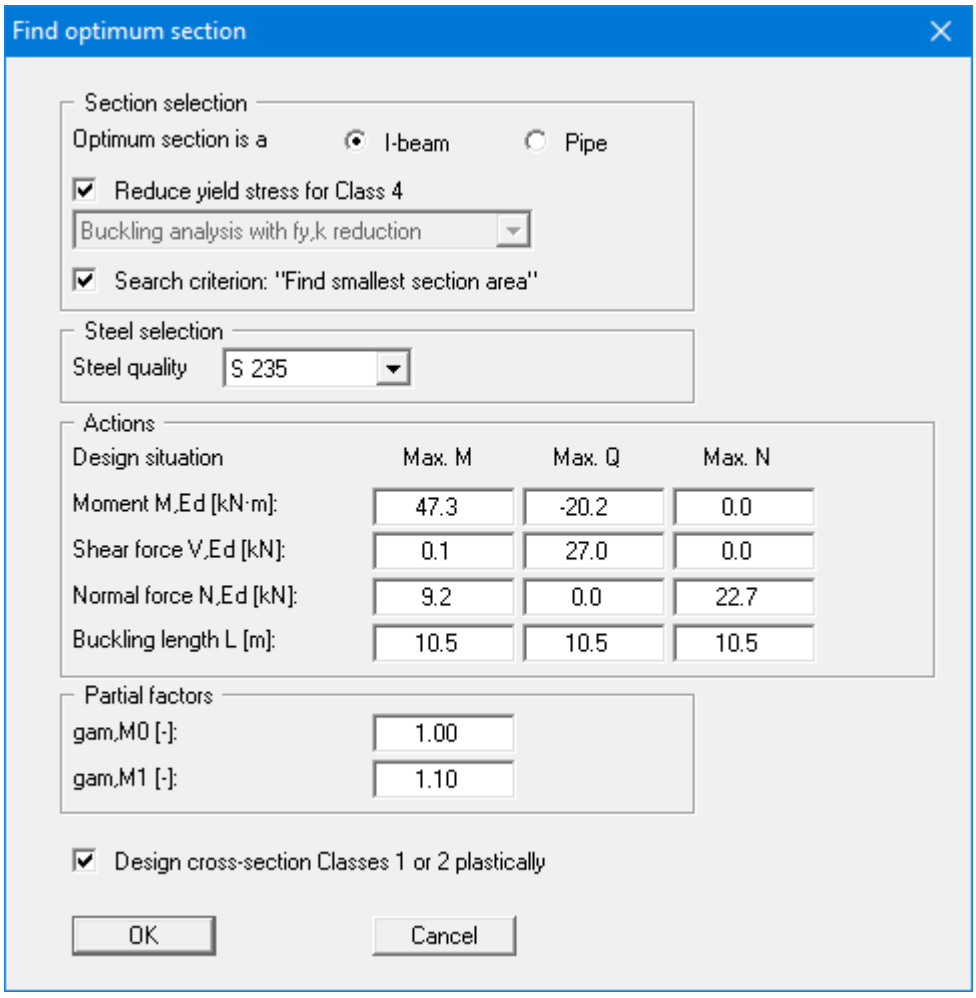
"**Damping**" prevents strong fluctuations around the actual solution during the iteration process. A value of **0.0** produces no damping, while a value of **0.99** produces very strong damping. Using "**Allowable excess > passive**" you specify the percentage by which the elastic stress may exceed the passive earth pressure before the iteration is ended. The "**Max. number of iteration steps**" can also be specified. If, after the specified number of steps, compression due to embedding is still greater than the passive earth pressure, iteration is terminated.

During iteration, the modulus of subgrade reaction is reduced. If the analysis requires a reduction over the whole length of the pile to a value below "**Max. ks**", iteration is aborted. This usually happens when the pile is not long enough to take the load.

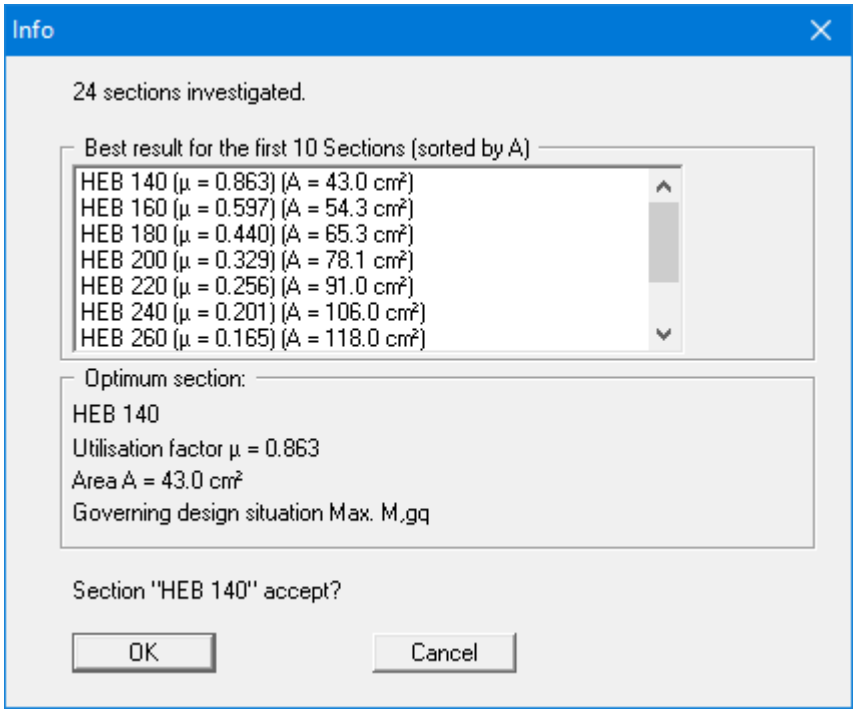
When the iteration is complete info boxes appear; use "**OK**" to close them. You will then see a prompt for subsequent design; use "**Yes**" to close it. Then, select the "Find optimum section" option in the dialog box and confirm by pressing "**OK**".



You will then move directly to the design preferences dialog box (see menu item "**System/Design defaults**").

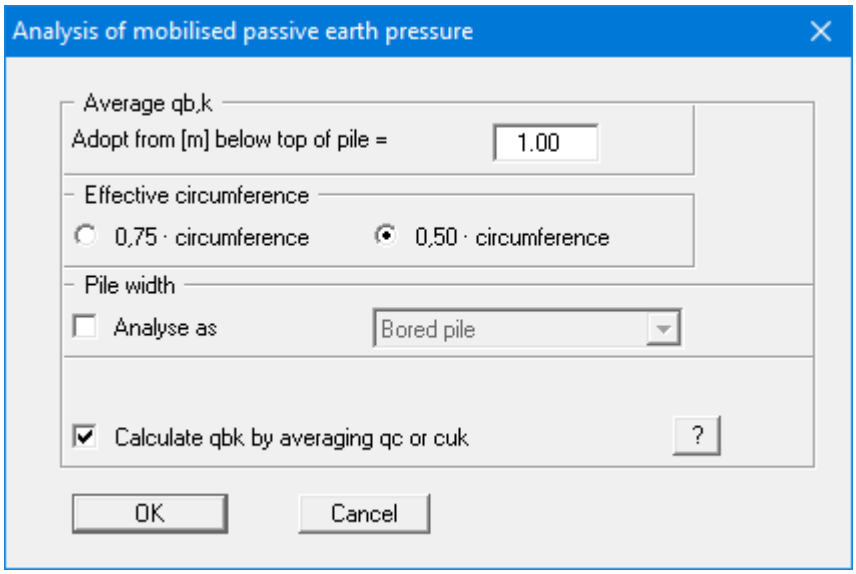


Adopt the data and confirm by pressing "**OK**". An appropriate message box then opens. The settings given in the box for the optimum section can be adopted:

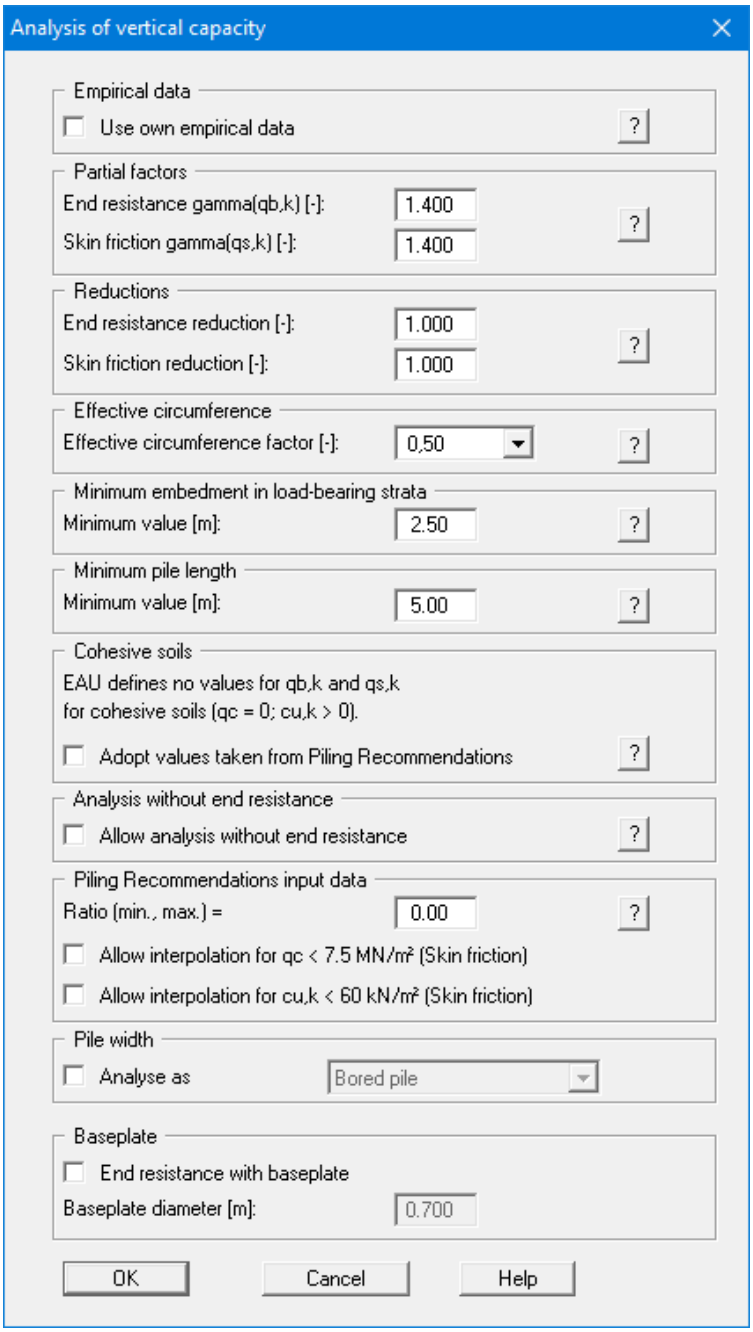


The analysis and design of the pile are complete. The input and results are first displayed in message boxes, which you move through by clicking "**OK**". Because a different section to the originally selected HEB 300 was designed, the analysis should be repeated using the new HEB 140 section. Adopt the pile width of the newly selected pile by pressing the "**Adopt**" button and repeat the analysis and subsequent design of the HEB 140.

When the program starts the Sum V analyses are activated by default (see menu item "**Partial factors + Sum V**"). Immediately after analyses and design you will therefore see the following dialog box on analysis of the mobilised passive earth pressure:



Adopt the data and perform the analysis. The results are displayed in a message box. If you exit the message box by pressing "**OK**", the editor box analysis of the vertical capacity opens:



After accepting the settings by pressing "**OK**" the data are again displayed in a message box. By pressing the "**Analyse again**" button the above dialog box opens again and you can perform the analysis using the modified data.

6.13 GGU-LATPILE: Step 11: Evaluate and visualise the results

After leaving the info box all governing analysis parameters are displayed on the screen for the whole pile length:

- Input subgrade reaction modulus profile,
- Computed subgrade reaction modulus profile,
- Active and passive earth pressures,
- Moment profile,
- Shear force profile,
- Axial force profile,
- Deflection profile.

The graphical visualisation, apart from showing the system, also contains other elements (referred to as ***legends***) which contain further information and user input:

- **General legend**
  This legend contains general information on the system.
- **Soil properties legend**
  This legend contains data relating to the properties of every defined soil type.
- **Design legend**
  This legend contains all data relating to design of steel sections or the cross-section of the analysed reinforced concrete pile.
- **Subgrade modulus legend**
  The legend shows the specified subgrade reaction moduli along the pile section defined for the subgrade reaction modulus profile.

You can print the diagram on the printer (menu item "**File/Print and export**"), as well as a comprehensive table of data (menu item "**File/Print output table**").

Using the program's **zoom function**, you can zoom in on selected sections of the graphics. If you double click with the left mouse button over a particular section of the graphics, the corresponding state variables will appear in an info box.

You can add further explanations or comments to the graphics using the **Mini-CAD** module. Save your work to data file by selecting "**File/Save as**" .

7 Theoretical principles

7.1 GGU-LATPILE: General

GGU-LATPILE solves the differential equation for an elastically embedded pile using the given boundary conditions.

EJ · w"" + kS · b · w = q

with

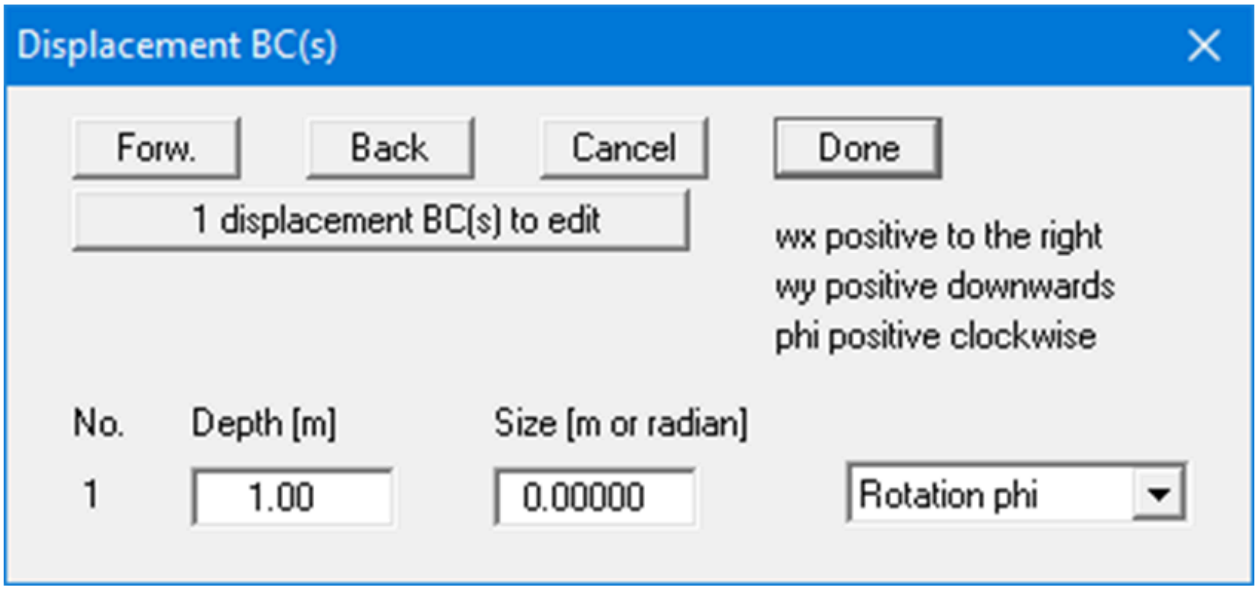
- E = Young's modulus
- J = moment of inertia
- w = pile displacement
- kS = subgrade reaction modulus
- b = pile width
- q = load

The solution is determined numerically using the so-called finite element method.

Action boundary conditions at the pile head can be defined (see menu item "**Editor 1/System input**"). At the pile toe, boundary conditions are generally:

- Moment = 0.0,
- Shear force = 0.0,
- Vertical displacement = 0.0.

If you want to define a moment restraint at the pile head, select the "**Editor 2/Displacement boundary conditions**" menu item and enter this condition directly below the pile head:



Proceed in a similar manner if, for example, you want to set horizontal displacement to zero (**0**).

7.2 GGU-LATPILE: Soil properties

Up to 50 soil layers can be taken into consideration. For each layer the following parameters must be given:

- depth in metres below top of the wall, or absolute depth,
- unit weight [kN/m³] of moist soil γ,
- unit weight [kN/m³] of buoyant soil γ',
- friction angle [°],
- cohesion (active and passive) [kN/m²],
- active angle of wall friction as the ratio δa/φ,
- passive angle of wall friction δp/φ,
- cone resistance from CPT qc or cone resistance qb,k,
- shear strength of the undrained soil cu,k or skin friction qs,k.

If you activate the "**Differentiate active + passive soil properties**" check box in the dialog box in "**File/New**" or "**Editor 1/Analysis options**", you can enter differing friction angles and unit weights for the active and the passive sides.

To analyse the vertical capacity to EAU, EAB and EAP, enter the cone resistance qc and the shear strength of the undrained soil cu,k. When using empirical data, enter the values for qb,k and qs,k instead of qc and cu,k.

If you are already working with **GGU-CONNECT**, you can also import soil properties from your subsoil layer model that you have created in **GGU-CONNECT**.

Further explanations can be found under the menu item “**Editor 1 / Soils**”.

7.3 GGU-LATPILE: Active earth pressure

7.3.1 Active earth pressure is analysed to DIN 4085. DIN 4085 provides two relationships for the coefficients of earth pressure kah (friction) and kch (cohesion). Alternatively, there is the option of determining the cohesion coefficient from kch = kah-2, a method often found in older literature.

7.4 GGU-LATPILE: At-rest earth pressure

The coefficient of at-rest earth pressure, k0 , is obtained after FRANKE (*Die Bautechnik* 1974/No. 1) from:

$$k_0 = 1.0 - \sin\varphi + (\cos\varphi + \sin\varphi - 1.0) \cdot \beta / \varphi$$

φ = wall friction angle
β = ground inclination

The vertical load component resulting from wall friction is obtained from the tangent of the angle of wall friction. However, in accordance with the EAB, a minimum value of 0.5 · the horizontal component is assumed when the tangent of the angle of wall friction is < 0.5.

7.5 GGU-LATPILE: Increased active earth pressure

The coefficient of increased active earth pressure, keh, is obtained from the coefficient of active earth pressure and at-rest earth pressure:

keh = (1.0 - f) · kah + f · k0

0.0 ≤ f ≤ 1.0

7.6 GGU-LATPILE: Passive earth pressure

The coefficient of passive earth pressure can be calculated using several methods:

- DIN 4085:2017,
- DIN 4085: 2017 planar slip surfaces,

- Streck,
- Caquot/Kerisel,
- DIN 4085:2017 planar slip surfaces/Caquot/Kerisel,
- Culmann.

The earth pressure after Culmann is acquired by varying the slip surface angle (see Piling Handbook 1977). The forces at the earth pressure wedge are calculated using a slice method.

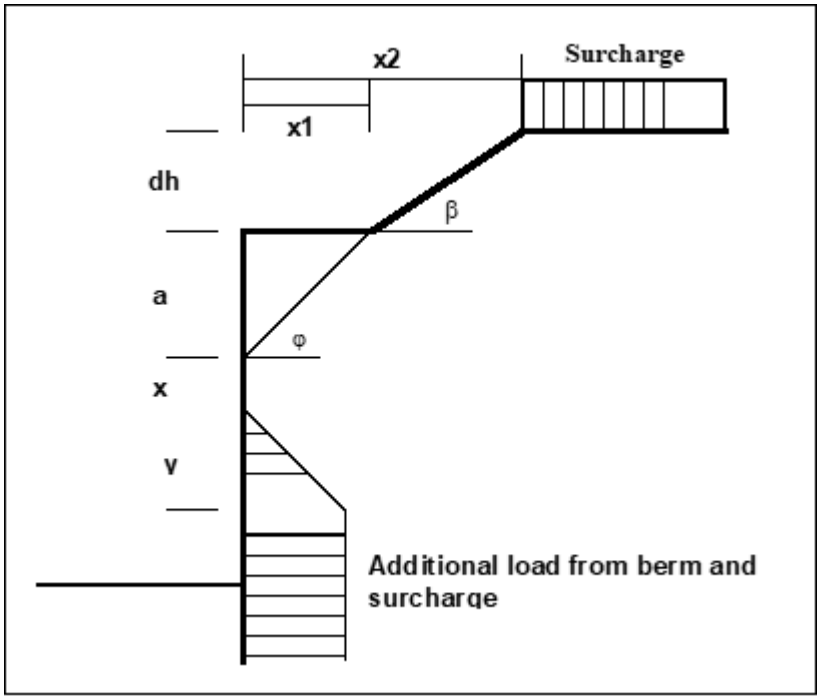
Following a proposal by Vogt (Dr. N. Vogt, *Vorschlag für die Bemessung der Gründung von Lärmschutzwänden* (Proposal for designing the footings of noise abatement walls), Geotechnik 1988, p. 210) a failure system corresponding to the pile width is considered. The friction and cohesion forces acting on both sides of the failure system are incorporated in the calculation after Culmann. This determines a spatial passive earth pressure.

Otherwise, the following options are available for the spatial effect of the passive earth pressure:

- To DIN 4085:2011,
- To DIN 4085:2011 planar slip surfaces,
- To Weißenbach
- Without 3D influence.

7.7 GGU-LATPILE: Berms

The program can handle 40 berms on both the active and the passive sides of the wall. The berms may include surcharges. The effect on earth pressure is taken into consideration according to the Piling Handbook (Krupp Hoesch Stahl).



The following relationships apply for the parameters x and y:

x = kah0 / (kah β - kah0) · a

y = kah0 / (kah β - kah0) · x

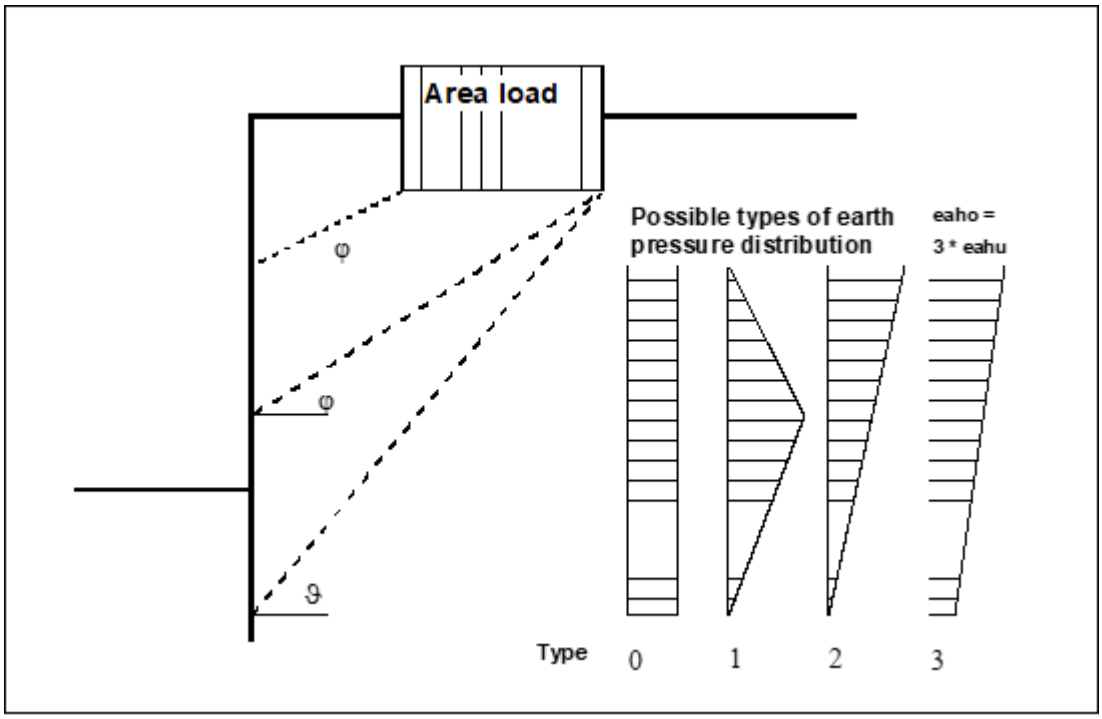
Δeahu = γ · dh + surcharge

γ = unit weight of soil in the berm area

If the angle β is greater than φ, it is assumed that β = φ for analysis. Berms on the passive side are dealt with in the same manner.

7.8 GGU-LATPILE: Area loads

Up to 20 area loads can be positioned on the active side at any height.



The slip surface angle for the active earth pressure resulting from the self-weight of the soil is adopted for analysis compliant to DIN 4085.

$$\vartheta_{ag} = \varphi + \arctan\left(\frac{\cos(\varphi-\alpha)}{\sin(\varphi-\alpha)+\sqrt{\frac{\sin(\varphi+\delta_a)\cdot\cos(\alpha-\beta)}{\sin(\varphi-\beta)\cdot\cos(\alpha+\delta_a)}}}\right)$$

When there are several soil layers, the program moves from layer to layer applying the appropriate angles of friction. The type of the resulting earth pressure distribution can be specified in 4 different ways.

For at-rest earth pressure, the area loads are calculated by increasing by the factor k0/kah in compliance with DIN 4085 Section 6.4.3.

Alternatively, it is possible to determine the demands placed on a wall from area loads using the theory of elastic half-space. The two load concentration factors "**3**" and "**4**" can be taken into consideration (see also the following Figure).

- For over consolidated, cohesive soils the concentration factor "**3**" applies, where:
  eop = q/π · (β2 - β1 + cosβ1 · sinβ2 - cosβ2 · sinβ2)
- For non-cohesive soils, or for cohesive but not over consolidated soils, the concentration factor "**4**" applies, where:
  eop = q/4 · (sin³β2 - sin³β1)

Regarding the kind of earth pressure, area loads can be defined independent of the global preferences (see menu item "**Editor 1/Type of earth pressure**").

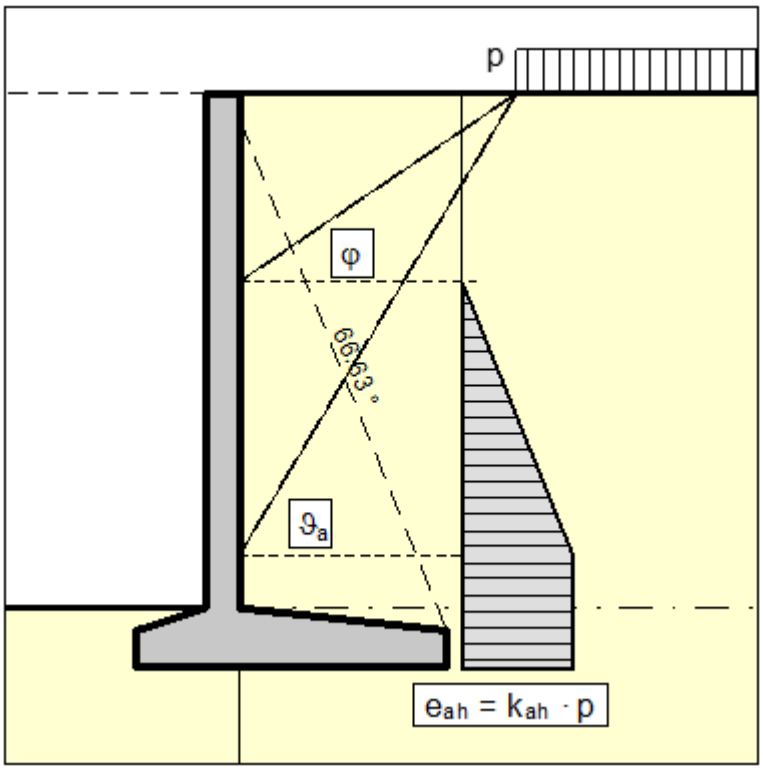
Regarding the kind of earth pressure, area loads can be defined independent of the global preferences (see menu item "**Editor 1/Type of earth pressure**"9.

7.9 GGU-LATPILE: Loads with limited plan dimensions

Loads with limited plan dimensions can be reduced compliant with "Piling Handbook" Figure 4.20 (page 64) or DIN 4085:2017-08 (page 17), see menu item “**Editor 2/Area loads**”.

7.10 GGU-LATPILE: Bounded surcharges (active side)

Up to 40 bounded surcharges can be positioned at any height on the active side.

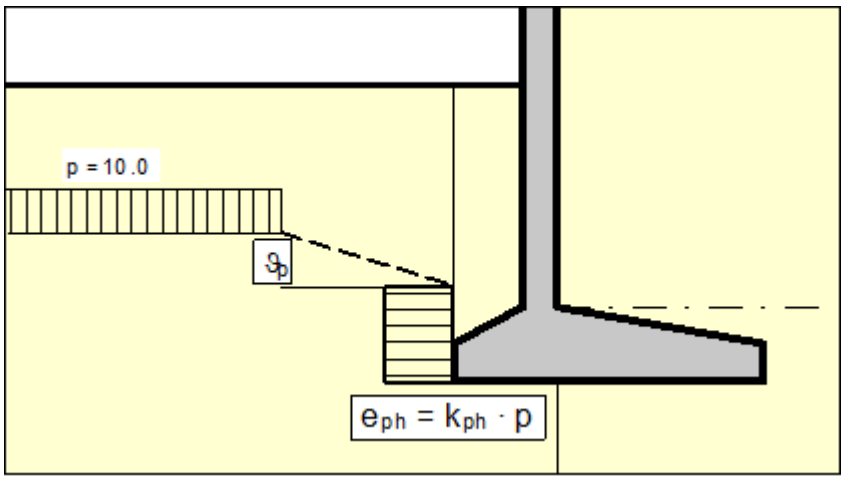


The earth pressure coefficient k is acquired from kah for active earth pressure and from k0 for at-rest earth pressure. If this option is activated, the resulting earth pressure is then redistributed.

If negative values are entered, e.g. to generate a double-bounded surcharge, the linear component between φ and ϑ may not be adopted.

7.11 GGU-LATPILE: Bounded surcharges (passive side)

Up to 40 bounded surcharges may be adopted at any height on the passive side. The passive earth pressure is computed as follows:



7.12 GGU-LATPILE: 2nd order theory

The differential equation for a ***normal*** flexural member is:

$$EI\, w''''(x) = q(x)$$

The normal force N is taken into consideration for a buckling member:

$$EI\, w''''(x) + N\, w''(x) = q(x)$$

For the sake of completeness, the differential equation for an additionally bedded system is shown here since the program also allows parallel processing of systems with 2nd order theory and elastic bedding. The equation is:

$$EI\, w''''(x) + N\, w''(x) + k_s\, w(x) = q(x)$$

Analysis is performed on the deformed system. In

- **DIN EN 1993-5**
  Design of Steel Structures,
  Part 5: Piling

analysis using 2nd order theory is recommended for analysis of piles under buckling loads and

- **DIN EN 1993-1-1**
  Design of Steel Structures,
  Part 1-1: General Rules and Rules for Buildings

referred to. Analysis using 2nd order theory produces more accurate results than the usual and simplified equivalent member method. Analysis of piles under buckling loads is performed in **GGU-LATPILE** compliant with DIN EN 1993-1-1.

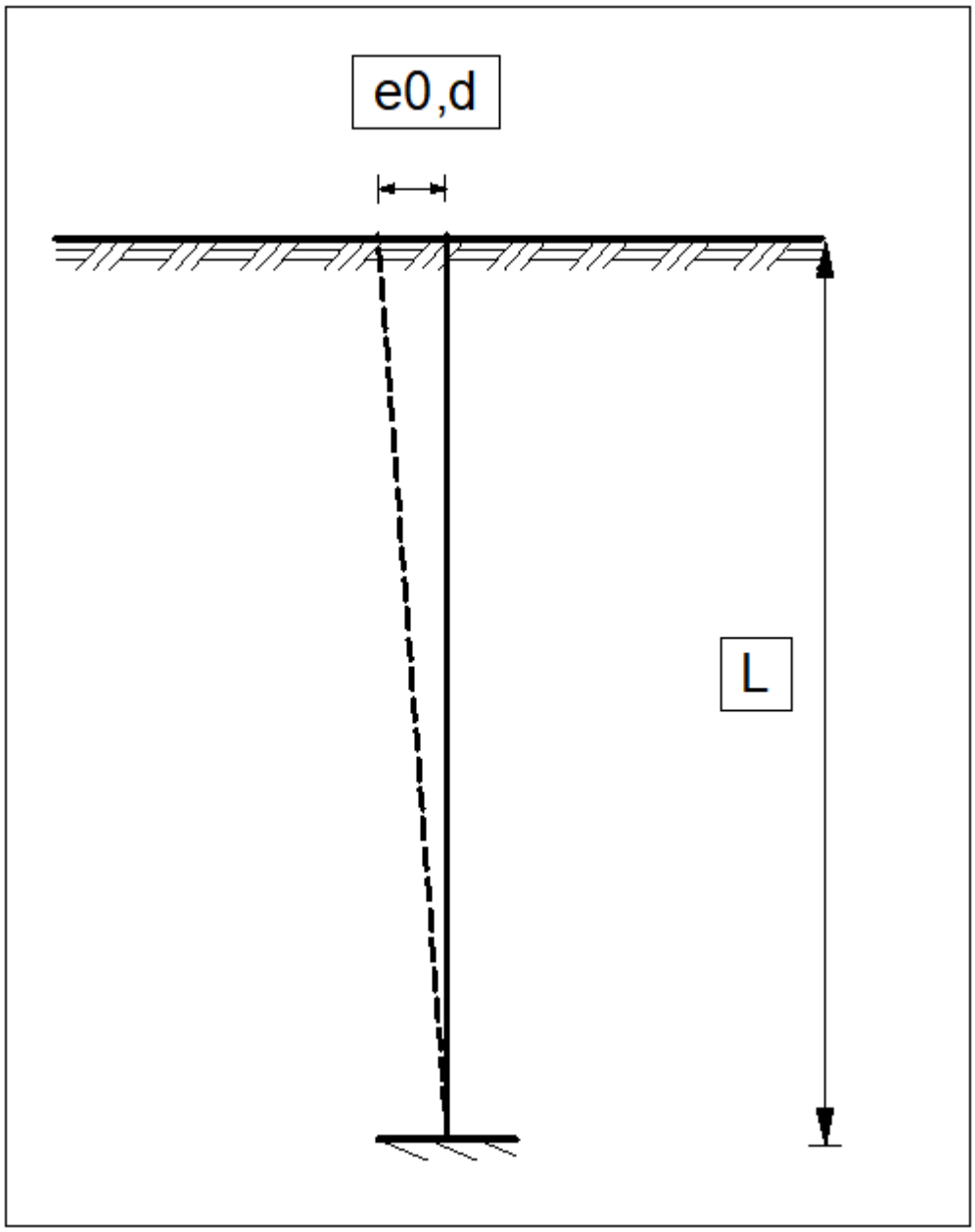
Analysis using 2nd order theory requires a predeformation or pre-curvature of the underlying system. Pre-curvature values are given in Table 5.1 of DIN EN 1993-1-1.

Table 5.1 – Pre-curvature design values $e_{0,d}/L$ for structural elements

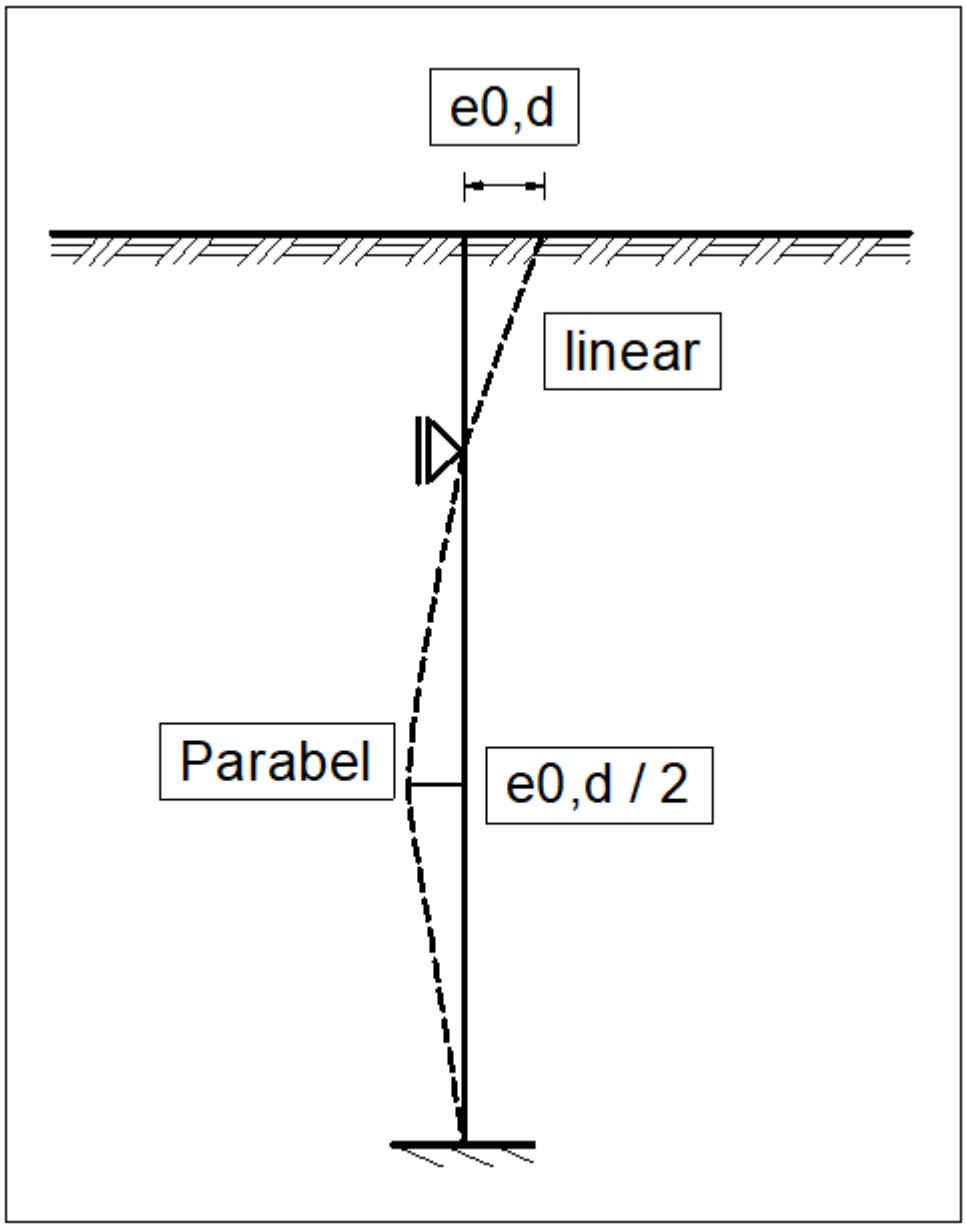
Buckling line from Table 6.1	Elastic analysis	Plastic analysis
	$e_{0,d}/L$	$e_{0,d}/L$
a_0	1/350	1/300
a	1/300	1/250
b	1/250	1/200
c	1/200	1/150
d	1/150	1/100

Pre-curvatures are given as a function of the buckling line. In simplification, piles can be analysed with a pre-curvature of e0,d/L = 1/150.

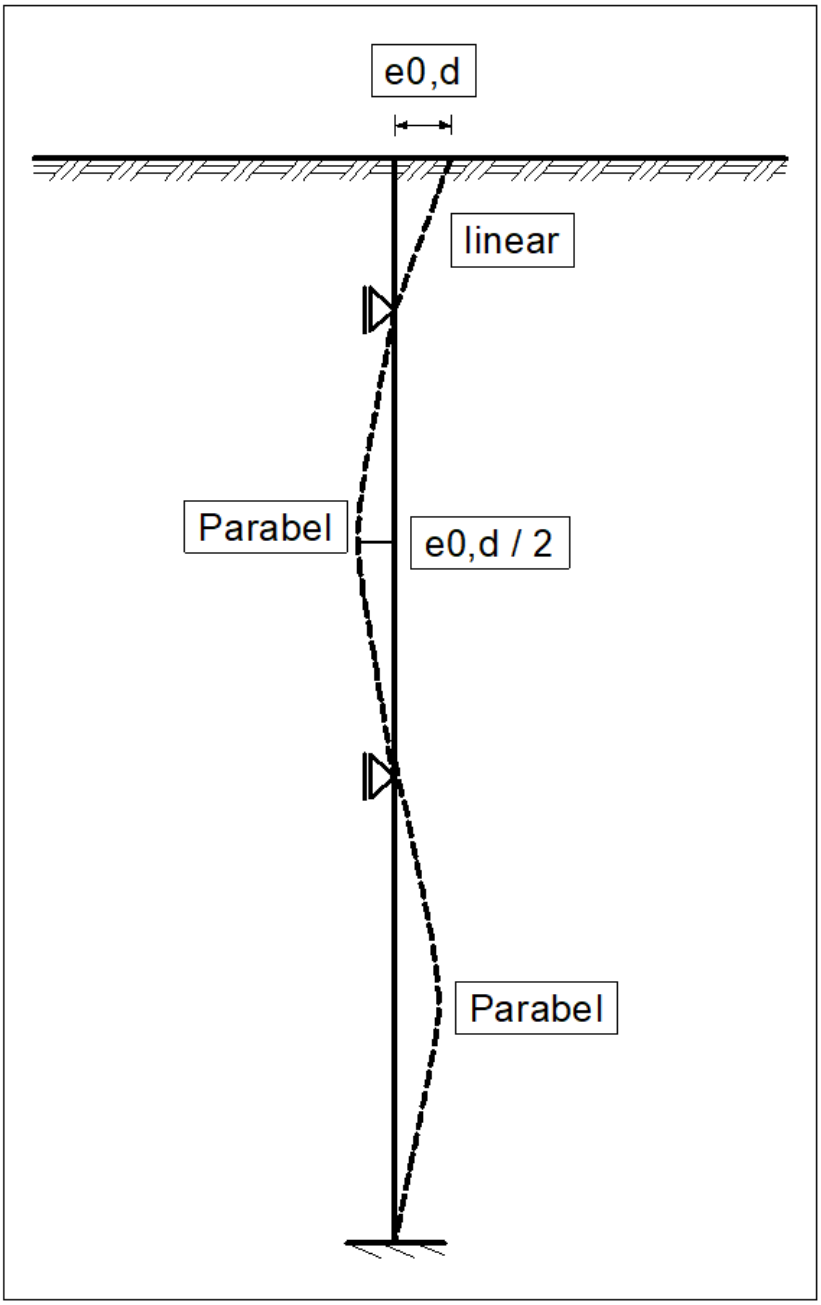
Using embedded piles without additional displacement boundary conditions the deformed system is defined by an inclination of the pile.



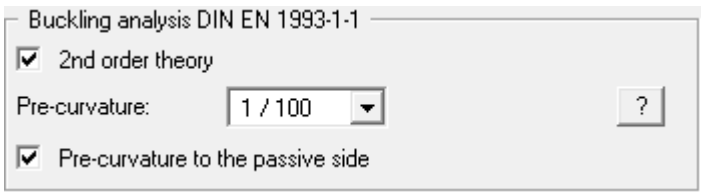
Using embedded piles with a horizontal displacement boundary condition (wx = 0), the deformed system is defined by a linear pre-curvature from the support point to the top of the pile and a parabolic pre-curvature between the support points and the foot of the pile.



The length L is given per field. The procedure for piles with two displacement boundary conditions is shown in Figure 11.



The settings are defined in **GGU-LATPILE** in the analysis menu under "**System/Analyse**".



The size and direction of the pre-curvature can be specified. Whether a pre-curvature towards the passive side or the active side provides the more unfavourable design values is system-dependent: the following message will therefore be displayed once analysis begins:

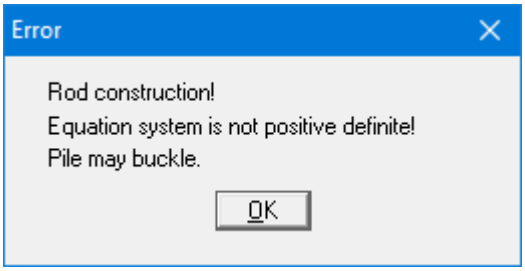
You must therefore deactivate the "**Pre-curvature to passive side**" check box following successful analysis and check, in a new analysis, whether pre-curvature to the active side delivers less favourable values.

In an analysis using 2nd order theory the necessary iteration process in terms of displacement is carried out using the design normal force Nd.

Subsequent design is based on a comparison of stresses

σd ≤ fy,k / γM = fy,k / 1,1 = fy,d

The "Example" folder contains 4 **GGU-LATPILE** files, which deal with the classical Euler cases 1 to 4. If the vertical load V at the pile head is increased slightly using the "**Editor 1/System input**" menu item and the system analysed, the following error message appears:



The normal force given in the data files thus corresponds to the buckling force determined after Euler.

7.13 GGU-LATPILE: Analysis of mobilised passive earth pressure

Detailed notes on this analysis concept are included in EAU 2012, Section 8.2.5.5, and in the Recommendations on Piling (2012).

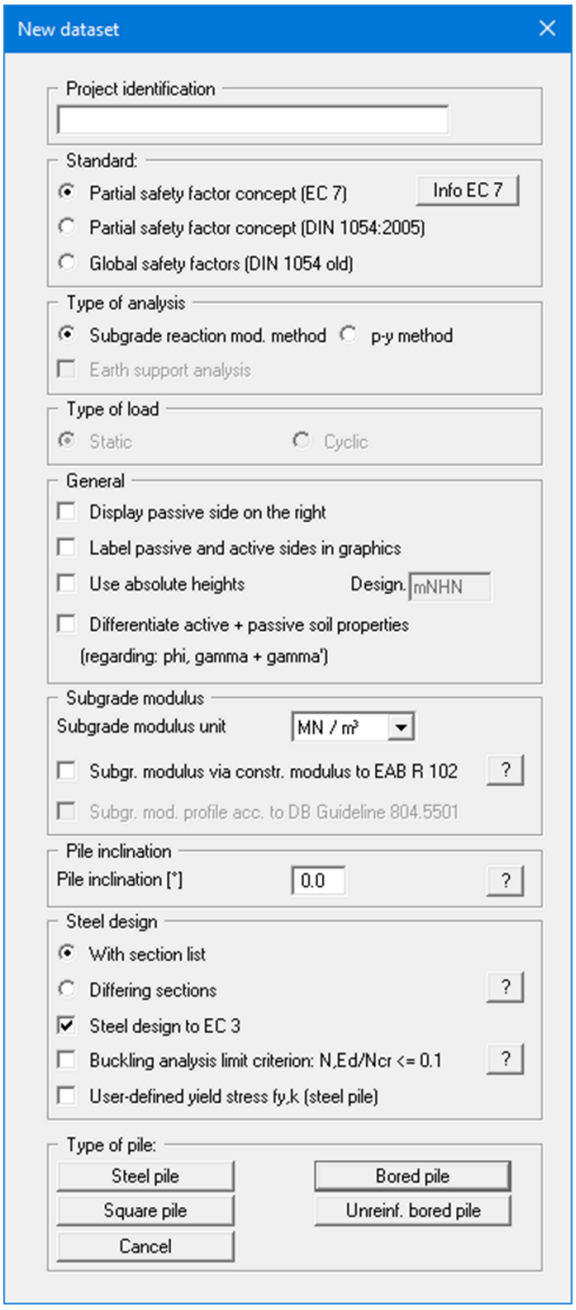
7.14 GGU-LATPILE: Analysis of vertical capacity

Detailed notes on this analysis concept are included in EAU 2012, Section 8.2.5.5, and in the Recommendations on Piling (2012).

8 File menu

8.1 GGU-LATPILE: "New" menu item

You can enter a new system using this menu item. You will see the following dialog box:



You can enter a dataset description ("**Project identification**") of the problem going to process, which will then be used in the ***General Legend***.

In the next group box, the radio buttons are used to specify which safety concept to use for analysis and design. The analysis can be carried out using either the subgrade reaction modulus method or the p-y method. Using the p-y method, you also select the type of load (static or cyclic). Here you can also activate the earth support analysis.

Next, you can activate the display of the passive side to the right. If the "**Label passive and active sides in graphics**" check box is activated, both sides are labelled at the bottom of the system.

If you select the "**Use absolute heights**" check box, you can enter all depths and heights in **mAD** (heights are positive upwards). If this check box is not selected, the top of the wall is assumed to have a height of **0.0** and all further entries, depth of soil layers, for example, are positive downwards. Thanks to ***WYSIWYG*** there is no danger of using incorrect data since all input is immediately visible on the screen. In this example and the following explanations of this manual the check box "**Use absolute heights**" is not selected.

If your system uses differing soil properties on the active and the passive sides, activate the "**Differentiate active + passive soil properties**" check box in the above dialog box. You will then be presented with different input columns for entering the active and passive friction angle and unit weight soil properties in the "**Editor 1/Soils**" menu item. For better visualisation you can define the soil colours on the active and the passive sides differently using the ***Soil properties legend*** (see menu item "**Graphics preferences/Soil properties legend**").

In the following "**Subgrade reaction modulus**" group box you can select kN/m³ or MN/m³ as the dimension. The dimensions can also be modified directly in the "**Editor 2/Subgrade reaction moduli**" menu item dialog box. In accordance with EAB EB 102 the subgrade reaction modulus can be calculated from the constrained modulus. Activate the corresponding check box in the "**Subgrade reaction modulus**" section and enter the constrained modulus under "**Editor 1/Soils**". The subgrade reaction modulus can also be defined in accordance with DB Guideline 804.5501.

Below this, a pile inclination between -6° and +6° can be defined. Please read the information displayed after pressing the "?" button.

In the "**Steel design:**" group box, you can choose whether a section from the section list loaded by the program should be selected to design a steel pile, or whether you wish to design a steel pile with differing sections. If you work with the section list, the search for the optimum section in the list is performed automatically. The section list is loaded automatically when the program starts. However, you can expand and edit this list to suit your requirements. Steel design should always follow EC 3.

The type of pile to be analysed is specified using the buttons in the lower group box. If you decide to use a different pile type during a project, simply select the menu item "**File/New**" and switch to the new pile type. Previously entered system data is retained!

If you select "**Bored pile**", subsequent design to EC 2 will assume a circular cross-section. If you select "**Square pile**", subsequent design to EC 2 will assume a square cross-section. The information regarding "**From section list**" is irrelevant for "**Bored pile**", "**Unreinf. bored pile**" and "**Square pile**".

If you have changed to ***partial safety factor concept*** in the uppermost group box, you will see a further dialog box for specifying the partial factors after clicking the required pile type. Using the "Default values" button, you can accept the partial factors given in DIN 1054:2010 or EC 7 for the different load cases. The partial factors entered can be edited at any time using the "**Editor 1/Partial factors + Sum V**" menu item.

8.2 GGU-LATPILE: "Load" menu item

You can load a file with system data, which was created and saved at a previous sitting, and then edit the system.

8.3 GGU-LATPILE: "Save" menu item

You can save data entered or edited during program use to a file, to have them available later, or to archive them. The data is saved without prompting with the name of the current file. The file contains all system information. Loading again later creates the same visualisation as was present at the time of saving.

8.4 GGU-LATPILE: "Save as" menu item

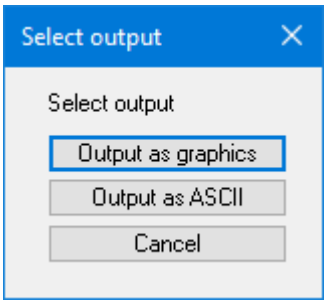
You can save data entered during program use to an existing file or to a new file, i.e. using a new file name. For reasons of clarity, it makes sense to use "**.p20**" as file suffix, as this is the suffix used in the file requester box for the menu item "**File/Load**". If you choose not to enter an extension when saving, "**.p20**" will be used automatically. If the current system has been analysed at the time of saving, the analysis results are saved in the file.

8.5 "Print output table" menu item

8.5.1 GGU-LATPILE: Selecting the output format (Print output table)

You can have a table printed containing the current analysis results. The results can be sent to the printer or to a file (e.g. for further editing in a word processor). The output contains all information on the current state of analysis, including the system data.

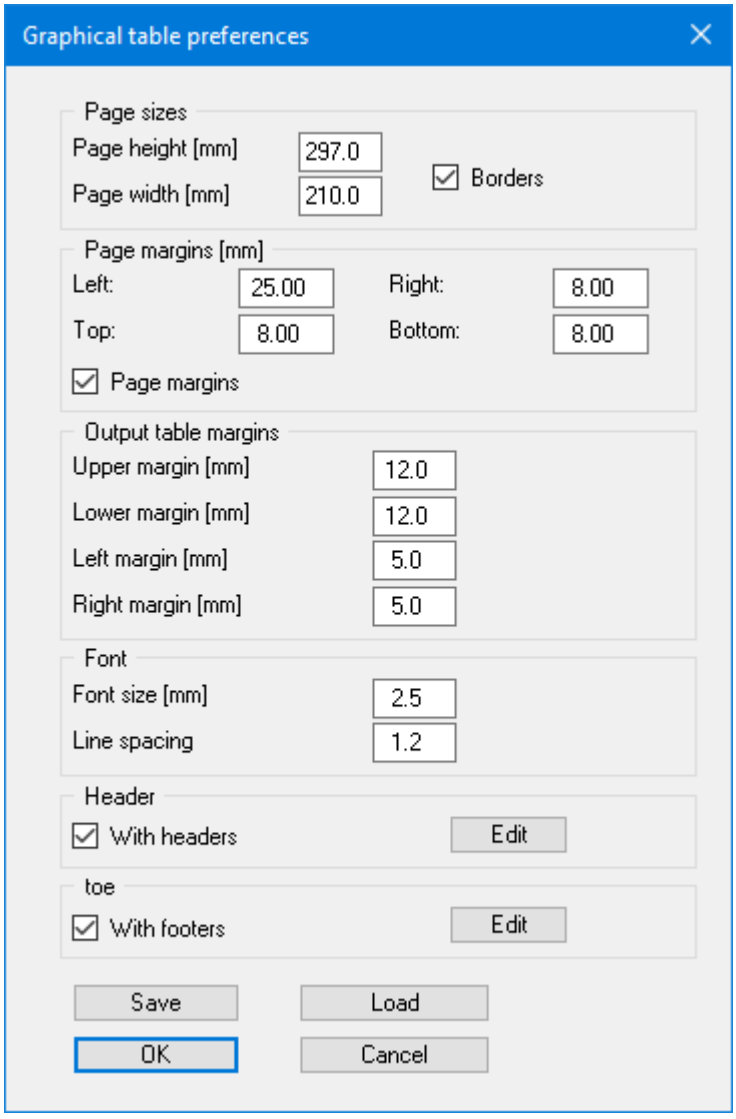
You have the option of designing and printing the output table as an annex to your report within the GGU program. To do this, select "**Output as graphics**" from the following options.



If you prefer to easily print or process the data in a different application, you can send them directly to the printer or save them to a file using the "**Output as ASCII**" button.

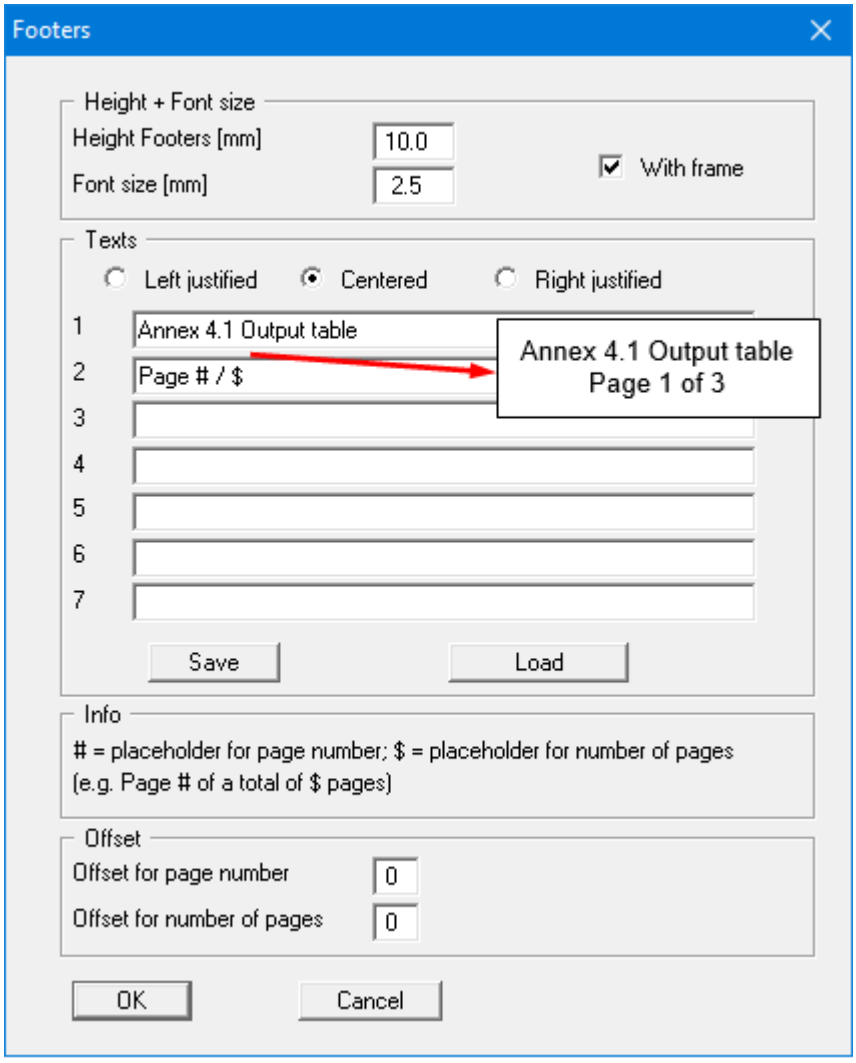
8.5.2 GGU-LATPILE: Button "Output as graphics" button (Print output table)

If you selected the "**Output as graphics**" button in the previous dialog box a further dialog box opens, in which you can define further preferences for result visualisation.

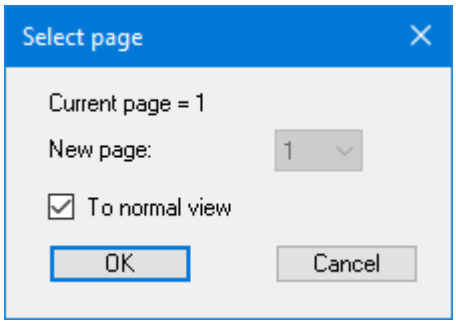


In the various group boxes of the dialog box, you can define preferences for the table output and layout. In some GGU programs a sketch of the system is integrated in the output table by activating an additional "**Incorporate graphics**" button.

If you need to add a header or footer (e.g. for page numbering), activate the appropriate check boxes "**With headers**" and/or "**With footers**" and click on the "**Edit**" button. You can then edit as required in a further dialog box. You can save your settings for the graphical output table presentation in a "**Protokoll.pin_ggu**" file at the program level so that they are loaded when the program starts. Using the "**Load**" button, the output table settings can also be subsequently loaded into an existing file, including that of another GGU program.

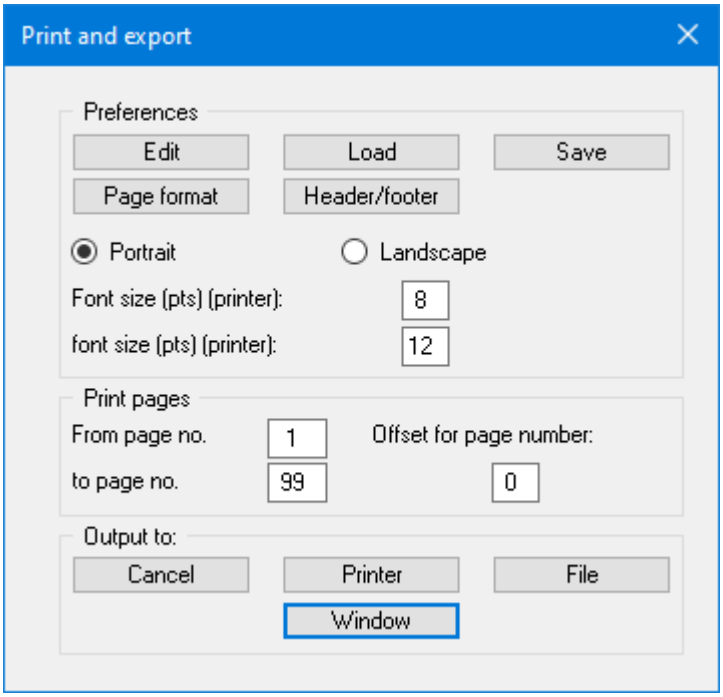


Automatic pagination can also be employed here if you work with the placeholders as described. After exiting the dialog boxes using "**OK**" you will see a further dialog box in which you can select the parameters to be used in the output table. After confirmation, the dialog box the output table is presented on the screen page by page. To navigate between the pages, use the arrow tools in the toolbar. If you need to jump to a certain page or back to the graphical visualisation, click on the tool. You will then see the following box:



8.5.3 GGU-LATPILE: Button "Output as ASCII" button (Print output table)

You can have your analysis data sent to the printer, without further work on the layout, or save it to a file for further processing using a different program, e.g. a word processing application.



In the dialog box you can define output preferences.

- "**Output preferences**" group box
  Using the "**Edit**" button the current output preferences can be changed or a different printer selected. Using the "**Save**" button, all preferences from this dialog box can be saved to a file in order to have them available for a later session. If you select the program name with the extension "**.drk**" as the file name and save this file at program level (default setting), this file will be loaded automatically the next time the program is started.
  Using the "**Page format**" button you can define, amongst other things, the size of the left margin and the number of lines per page. The "**Header/footer**" button allows you to enter a header and footer text for each page. If the "#" symbol appears within the text, the current page number will be entered during printing (e.g. "***Page #***"). The text size is given in "**Pts**". You can also change between "**Portrait**" and "**Landscape**" formats.
- "**Print pages**" group box
  If you do not wish pagination to begin with **1** you can add an offset number to the check box. This offset will be added to the current page number. The output range is defined using "**From page no.**" "**to page no.**".
- "**Output to:**" group box
  Start output by clicking on "**Printer**" or "**File**". The file name can then be selected from or entered into the box. If you select the "**Window**" button the results are sent to a separate window. Further text editing options are available in this window, as well as loading, saving and printing.

8.6 GGU-LATPILE: "Export" menu item

The general stability can be simply verified by exporting the data to **GGU-STABILITY** (GGU slope stability application).

After clicking this menu item an appropriate file ("**.boe**") can be generated with the required **GGU-STABILITY** version status.

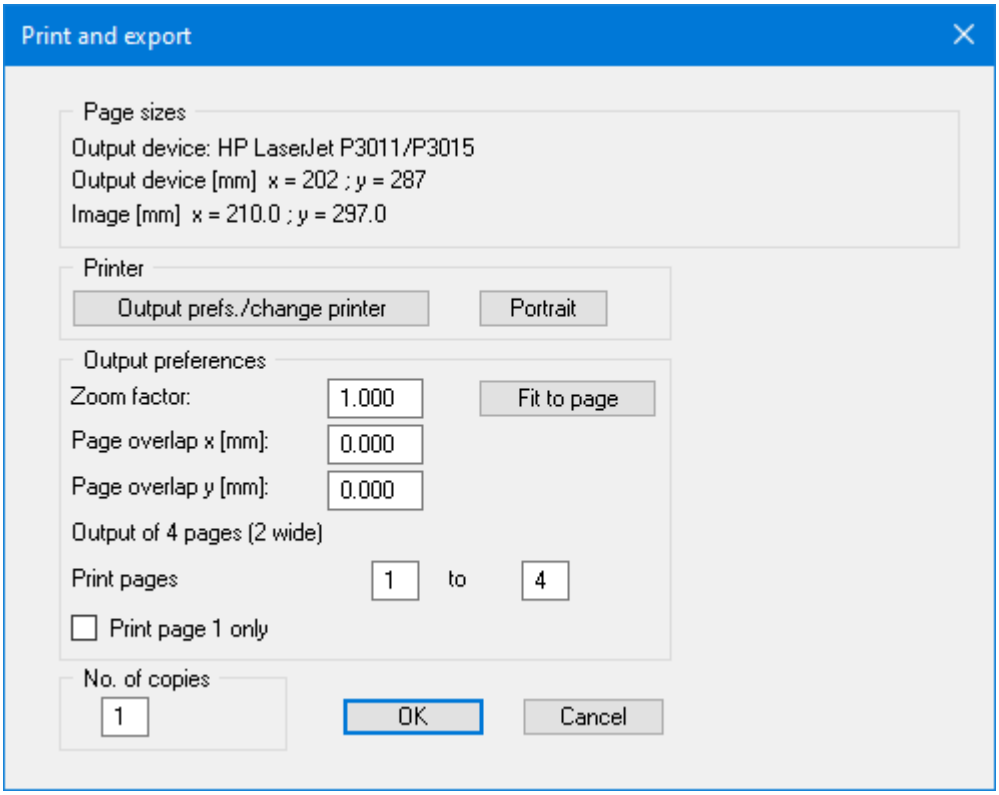
8.7 GGU-LATPILE: "Output preferences" menu item

You can edit output preferences (e.g. swap between portrait and landscape) or change the printer in accordance with WINDOWS conventions.

8.8 GGU-LATPILE: "Print and export" menu item

You can select your output format in a dialog box. You have the following possibilities:

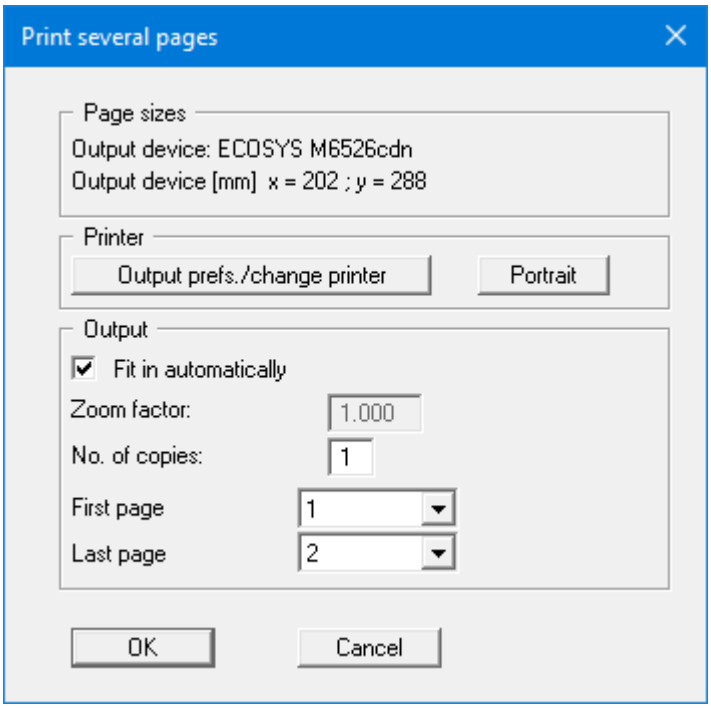
- "**Printer**"
  allows graphic output of the current screen contents (***graphical representation***) to the WINDOWS standard printer or to any other printer selected using the menu item "**File/Output preferences**". But you may also select a different printer in the following dialog box by pressing the "**Output prefs./change printer**" button.



In the upper group box, the maximum dimensions which the printer can accept are given. Below this, the dimensions of the image to be printed are given. If the image is larger than the output format of the printer, the image will be printed to several pages (in the above example, 4). To facilitate better re-connection of the images, the possibility of entering an overlap for each page, in x and y direction, is given.

Alternatively, you also have the possibility of selecting a smaller zoom factor, ensuring output to one page ("**Fit to page**" button). Following this, you can enlarge to the original format on a copying machine, to ensure true scaling. You can also print only the 1st page with zoom factor = 1.0, in which case the bottom left-hand area is printed. Furthermore, you may enter the number of copies to be printed.

If you have activated the ***table representation*** on the screen, you will see a different dialog box for output by means of the "**File/Print and export**" menu item button "**Printer**".



You can select the pages of the report to be printed here. To obtain an output with a zoom factor of **1** (button "**Fit in automatically**" is deactivated), you must reduce the page format of your report page so that it lies within the printable area of the output device. To do this, use the dialog box in "**File/Print output table**" button "**Output as graphics**".

In some programs, you can transfer a representation of the system graphic to the output table if you activate the "**Print main graphic**" check box available there.

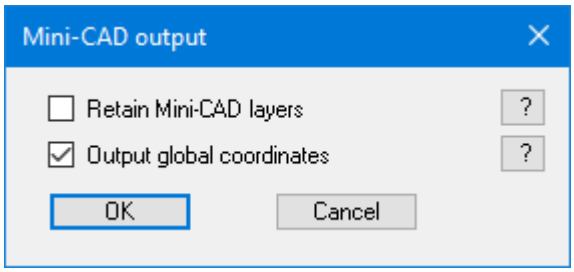
- "**DXF file**"
  allows output of the graphics to a DXF file. DXF is a common file format for transferring graphics between a variety of applications.
- "**GGU-CAD file**"
  allows output of the graphics to a file, in order to enable further processing with the **GGU-CAD** program. Compared to output as a DXF file this has the advantage that no loss of colour quality occurs during export.
- "**Clipboard**"
  The graphics are copied to the WINDOWS clipboard. From there, they can be imported into other WINDOWS programs for further processing, e.g. into a word processor. In order to import into any other WINDOWS program, you must generally use the "*Edit/Paste*" function of the respective application.
- "**Metafile**"
  allows output of the graphics to a file in order to be further processed with third party software. Output is in the standardised EMF format (Enhanced Metafile format). Use of the Metafile format guarantees the best possible quality when transferring graphics.

If you select the "**Copy/print area**" tool

from the toolbar, you can copy parts of the graphics to the clipboard or save them to an EMF file. Alternatively you can send the marked area directly to your printer (see "**Tips and tricks**").

Using the "**Mini-CAD**" program module you can also import EMF files generated using other GGU applications into your graphics (see menu item "**Graphics preferences/Mini-CAD**").

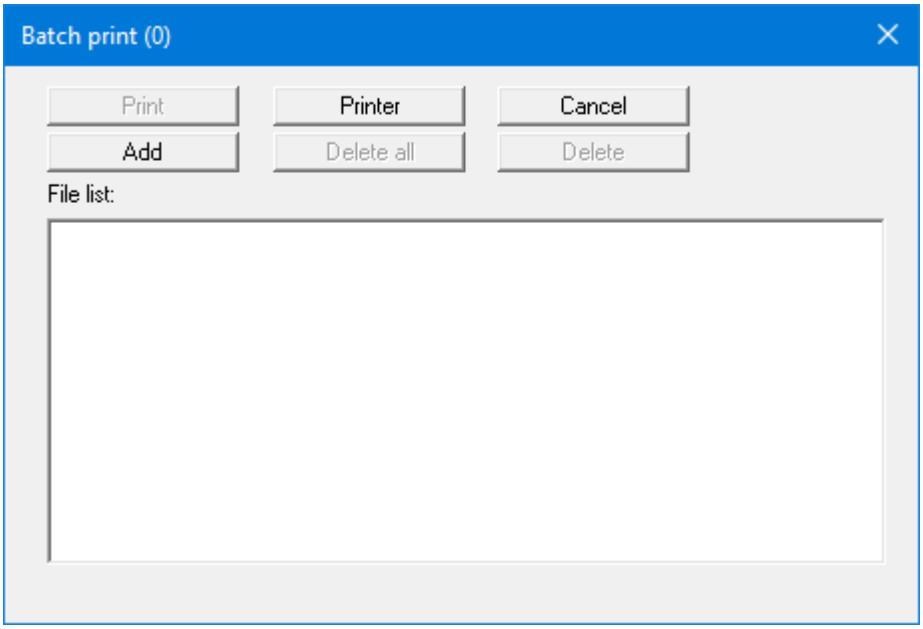
- "**Mini-CAD**"
  allows export of the graphics to a file to enable importing to different GGU applications with the **Mini-CAD** module.



If the "**Retain Mini-CAD layers**" check box is activated, the layer allocations for any existing **Mini-CAD** elements are saved. Otherwise, all **Mini-CAD** elements are saved on Layer 1 and are also inserted into Layer 1 in other GGU programs via the "**Load**" function in the **Mini-CAD** pop-up menu.
By activating the "**Output global coordinates**" check box, the present graphics are saved in the system coordinates [m]. Otherwise, they are saved in the page coordinates [mm]. If you import the **Mini-CAD** file saved using "**Global coordinates**" into a different GGU program, the coordinates are also transferred. After importing the file and pressing the [**F9**] function key (menu item "**Page size + margins/Auto-resize**") the system coordinates and the scale are corrected according to the transferred world coordinates. - "**GGUMiniCAD**"
allows export of the graphics to a file in order to enable processing in the **GGUMiniCAD** program. - "**Cancel**"
Printing is cancelled.

8.9 GGU-LATPILE: "Batch print" menu item

If you would like to print several appendices at once, select this menu item. You will see the following dialog box:



Create a list of files for printing using "**Add**" and selecting the desired files. The number of files is displayed in the dialog box header. Using "**Delete**" you can mark and delete selected individual files from the list. After selecting the "**Delete all**" button, you can compile a new list. Selection of the desired printer and printer preferences is achieved by pressing the "**Printer**" button.

You then start printing by using the "**Print**" button. In the dialog box which then appears you can select further preferences for printer output such as, e.g., the number of copies. These preferences will be applied to all files in the list.

8.10 GGU-LATPILE: "Exit" menu item

After a confirmation prompt, you can quit the program.

8.11 GGU-LATPILE: "1, 2, 3, ..." menu items

If you have not stored a working directory for the program icon, the program jumps to the program directory after starting to load or save a file.

Under the menu items of the File menu, the most recently edited files are listed with the respective storage path ("**1, 2, 3, ...**"). Selecting one of these files loads the selected file. The next time the "**File/Load**" or "**File/Save**" menu items are called up in the same program session, the program automatically jumps to the directory of the last file loaded.

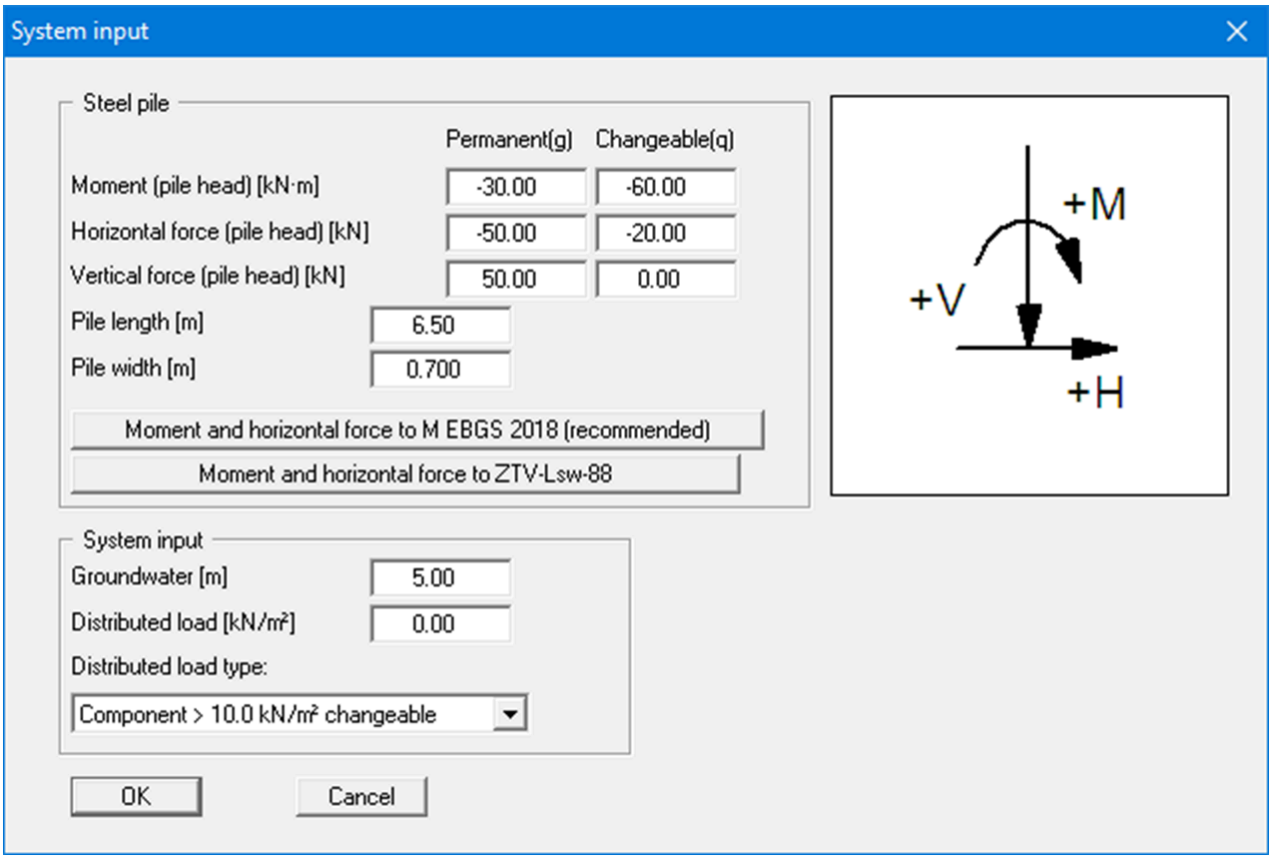
9 Editor 1 menu

9.1 GGU-LATPILE: "Analysis options" menu item

Using this menu item, you can edit the default preferences of the current system. The dialog box corresponds to the box in the menu item "**File/New**" (see descriptions there).

9.2 GGU-LATPILE: "System input" menu item

Enter the forces at the pile head for the pile you have used into a dialog box, as well as further system parameters.



You see the above dialog box if you have selected the ***partial safety factors*** in "**File/New**" or "**Editor 1/Analysis options**" menu items. The permanent and changeable loads are entered separately in accordance with the partial safety factor concept. You define both the pile length and the pile width. The width is required for determination of the spatial passive earth pressure.

The loads specified in ***M EBGS-Lsw 2018*** can be determined for analysis of piles for noise abatement walls. In the dialog box that opens after clicking the respective button, select the required data. A dynamic wind loading factor can be defined.

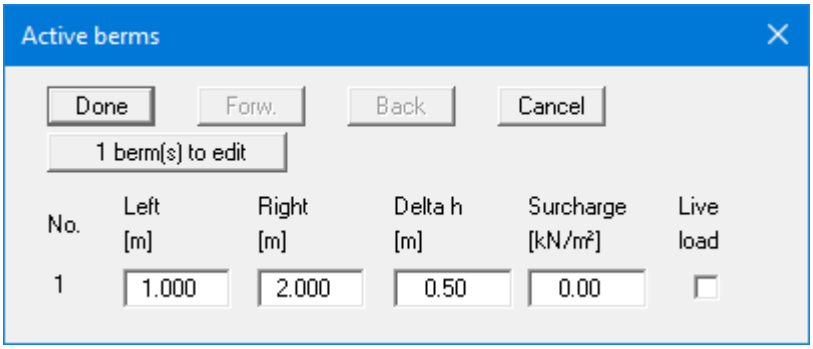
If you checked the "**Use absolute heights**" box when defining the system, an additional entry, "**Top of pile**", appears in the dialog box for specifying the absolute position. In this case, all heights are measured in m AD or m site zero, i.e. the y-axis is positive upwards. You can then enter a value, for example, of 86.42 [m AD] in the "Top of pile" field. All further input must then be with reference to this value.

If the height of a previously defined system is subsequently set to absolute heights, a query follows after leaving the dialog box above asking for confirmation of whether soil strata and defined elements such as area loads, for example, should be adapted to the new pile top. Adaptation would mean that the depth of a soil layer entered as a positive value would be converted from, for example, 7.5 m to an absolute height of -7.5 m AD. If then, you only convert your system to [m AD], do not select any elements in the query box and press the "**OK**" button.

In the lower group box, you can define the groundwater level and a distributed load. If you are working with the ***partial safety factors*** used in DIN 1054 (new), decide whether the distributed load is "**Permanent**", "**Changeable**" or the "**Component above 10.0 kN/m² changeable**" (see the following dialog box). "**Component above 10.0 kN/m² changeable**" means, for example, that for an input of 13.5 kN/m², 10 kN/m² are adopted as permanent and 3.5 kN/m² as changeable in the analysis.

9.3 GGU-LATPILE: "Berms (active side)" menu item

You can define a maximum of ten berms on the active side.



Enter the x-ordinates of the toe and head of the berm. With "**delta h**" you define the height of the berm; whereby negative values are also permitted. Finally, a "**Surcharge**" on the horizontal surface behind the head of the berm can be entered.

If more than one berm is present in the system, click "**x berm(s) to edit**" and enter the number of berms.

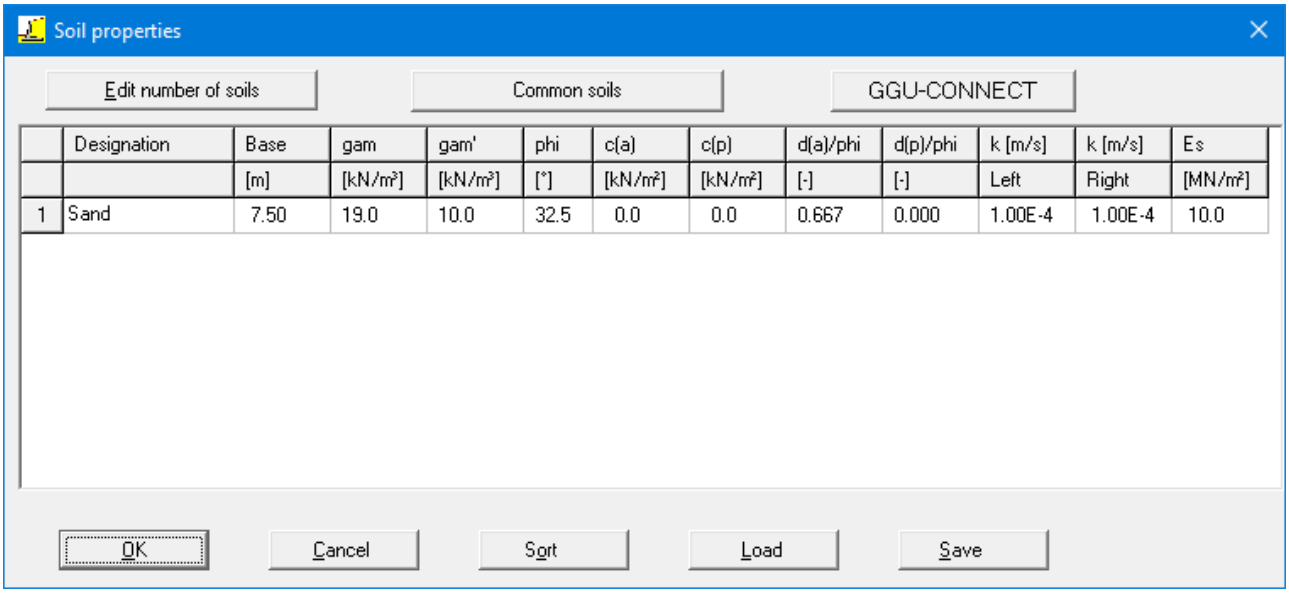
Berms may not overlap. The program checks that this condition is adhered to and warns of any errors.

9.4 GGU-LATPILE: "Berms (passive side)" menu item

Berms on the passive side are defined in the same manner as for the active side, but without the "**Live load**" check box.

9.5 GGU-LATPILE: "Soils" menu item

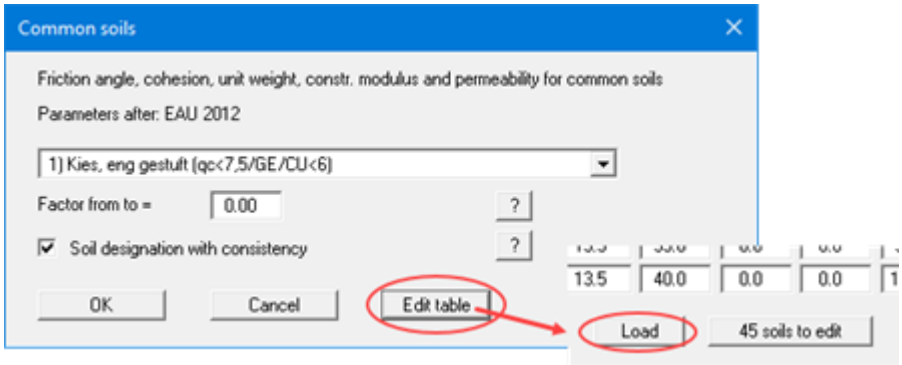
You can define the soil properties in the following dialog box:



If you would like to edit the number of soils, select the "**Edit number of soils**" or "**x soils to edit**" button and then enter the new number of soils. Using the "**Sort**" button, you can have the soils sorted according to depth. This sorting will be carried out automatically when leaving the dialog box, without the function being explicitly called-up. Erroneous input is thus impossible from the outset.

If several soils have been entered, and you would like to delete a soil which is not at the end of the list, you can assign this soil a large depth (e.g. 99.0). Then select the "**Sort**" button. The soil will now be at the end of the table and can be ***deleted*** by reducing the number of soils.

Using the "**Common soils**" button, you can easily select the soil properties of many common soils from a database or determine intermediate values.



In the dialog box, which you open by pressing the "**Common soils**" button, open the "**Soils_*english*.gng_ggu**" file when first starting the program in English ("**Edit table**"/"**Load**" buttons). Then save the data set in the "**Soils.gng_ggu**" file on the program level to open your modified database file when the program starts. You can also enter your own data ("**Edit table**"/"**x soils to edit**" button) and save it in the "**Soils.gng_ggu**" file. You can also use your adapted file in other GGU programs by means of the "**Common soils**" function if you copy the file into the appropriate GGU program folder.

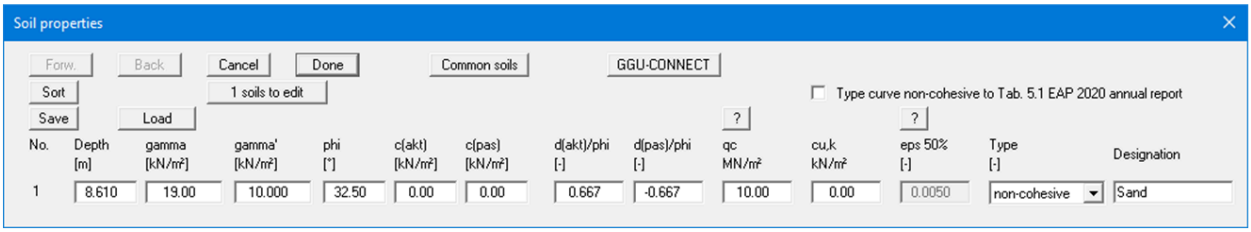
All project data can be entered and managed in the **GGU-CONNECT** program. If you have already stored your drilling data as a soil strata model in your project, you can load the soil strata and properties as an xml file using the "**GGU-CONNECT**" button in the above dialog box. A brief overview of the procedure in **GGU-CONNECT** for exporting the data to the GGU analysis programs can be found here:
GGU-CONNECT - Export contents for GGU analysis programs

Layer depths are always with reference to the top of the wall, or are absolute heights (m AD), if this was selected in the initial dialog box of the "**File/New**" menu item.

If you have activated the "**Differentiate active + passive soil properties**" check box in the dialog box under "**File/New**" or "**Editor 1/Analysis options**", you can enter different weights and friction angles for the active and passive sides.

To analyse the vertical capacity to EAU, EAB and EAP, enter the cone resistance qc and the shear strength of the undrained soil cu,k. When using empirical data, enter the values for qb,k and qs,k instead of qc and cu,k. To do this, activate the "**Use own empirical data (not recommended)**" check box in the "**Editor 1/Partial factors + Sum V**" menu item dialog box.

If you select analysis using the p-y method, you will see an adapted dialog box:



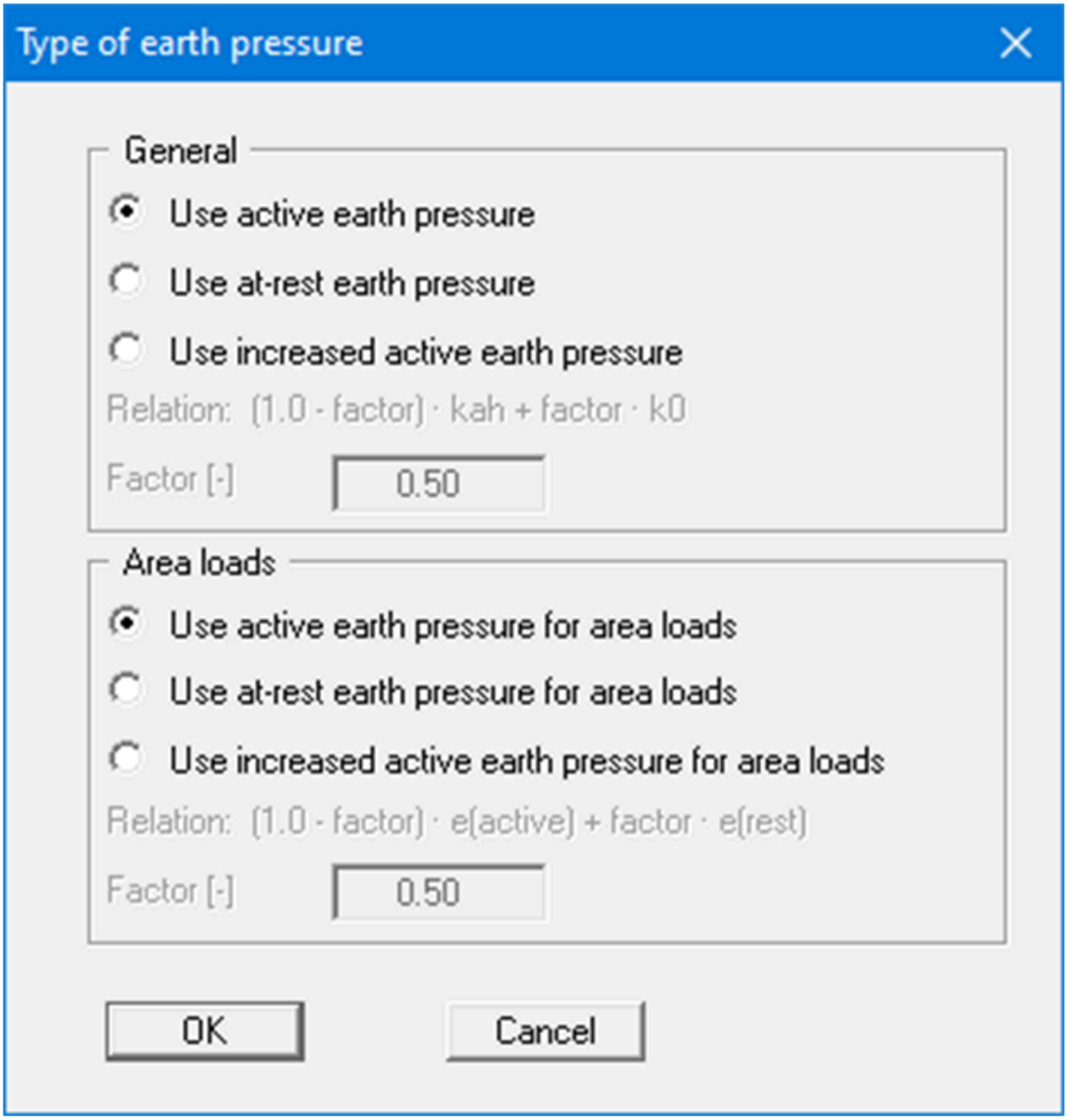
Three types of soil are differentiated:

- non-cohesive
- cohesive soft
- cohesive stiff

An eps(50) value can also be defined for cohesive soils. More detailed explanations can be found by clicking the "?" button.

9.6 GGU-LATPILE: "Type of earth pressure" menu item

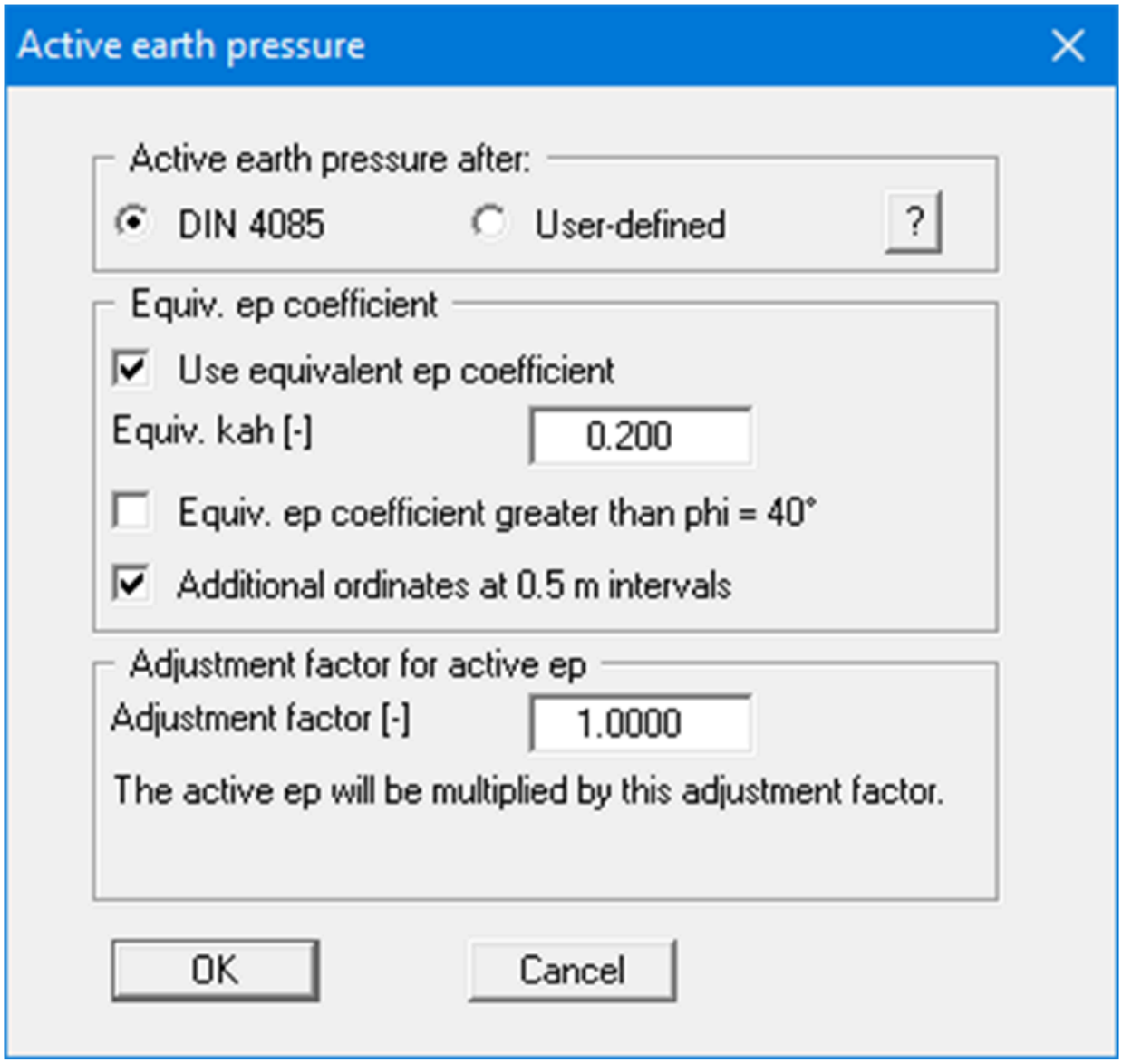
In this dialog box you define the type of earth pressure on which the analysis is to be based.



The options for ***area loads*** can be specified separately.

9.7 GGU-LATPILE: "Active earth pressure" menu item

You can specify active earth pressure preferences using this dialog box:



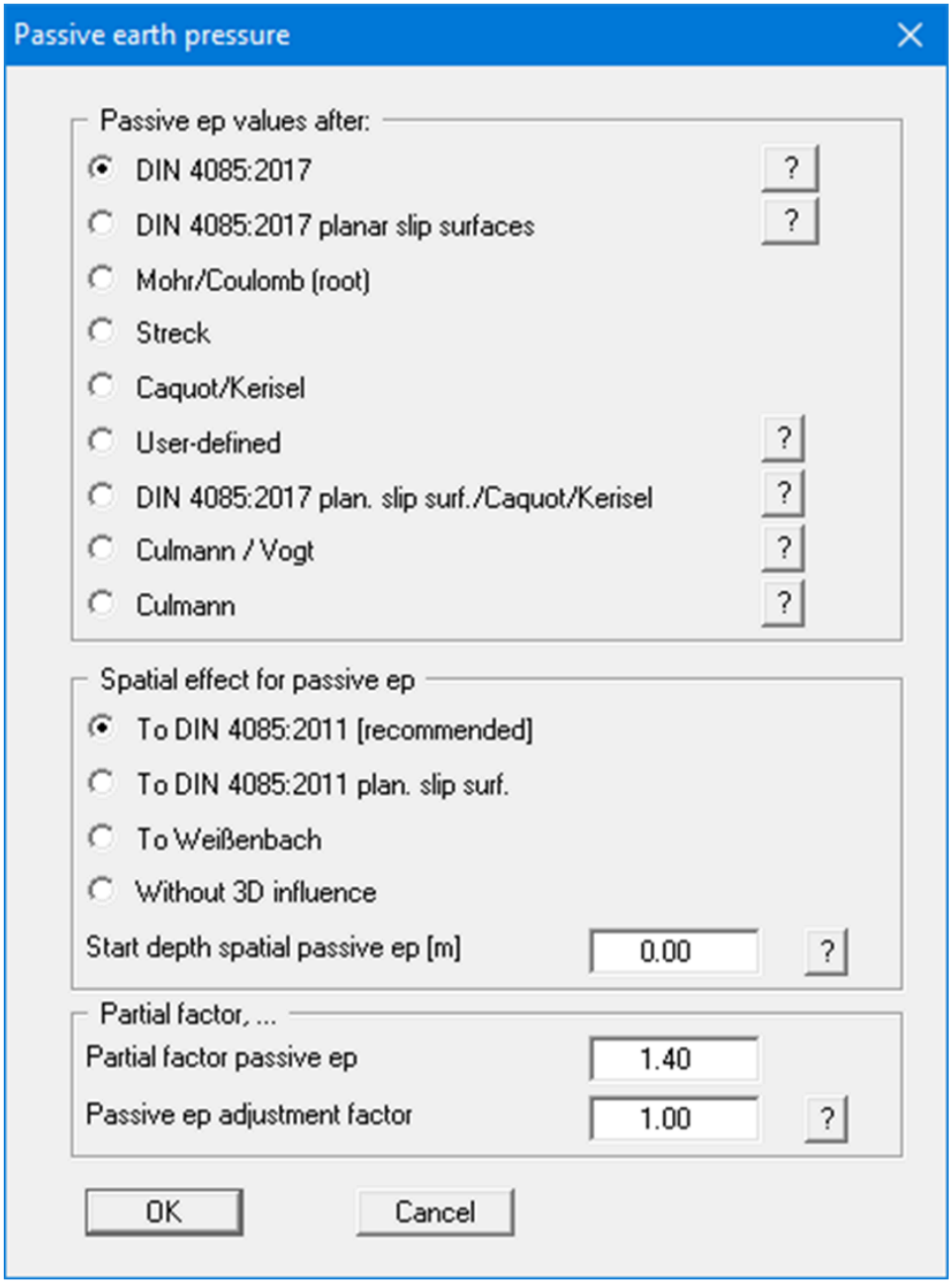
In the upper group box, you specify the type of active earth pressure calculation. The other two methods are only of interest if you wish to analyse an example from older literature sources or check certain results.

The "**Use equivalent ep coefficient**" check box should only be deactivated in exceptional circumstances (see EAB R 4). The equivalent earth pressure coefficient can only be smaller than 0.2 in special circumstances (see EAB R 4). It only makes sense to deactivate this check box when re-examining existing analyses (for instance, all the examples used in the Piling Handbook). Alternatively, the equivalent earth pressure coefficient can be defined by means of a friction angle phi = 40°. This procedure also takes the defined wall friction angle into consideration.

Several applications on the market also provide the option of a general increase in active earth pressure, apart from certain forms or earth pressure redistribution. To be able to check analysis performed with such an application, **GGU-LATPILE** also offers the possibility.

9.8 GGU-LATPILE: "Passive earth pressure" menu item

You can specify passive earth pressure preferences using this dialog box:



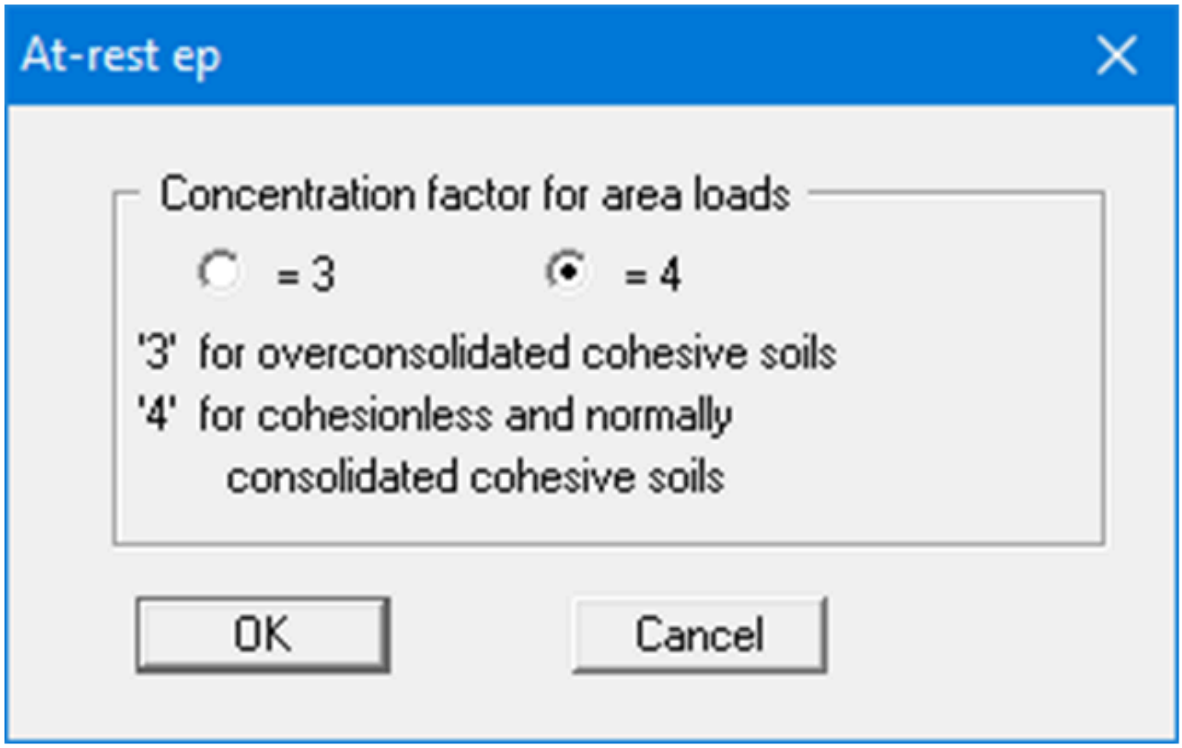
In the upper group box you specify the type of passive earth pressure calculation .

The spatial effect of the passive earth pressure can be set to the mid-region.

If you have selected ***partial safety factors***, enter the partial factor for passive earth pressure and the calibration factor in the dialog box in accordance with the information in DIN 1054:2010/EC 7.

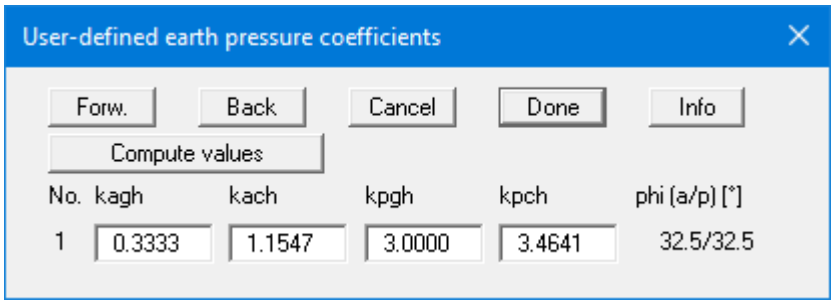
9.9 GGU-LATPILE: "At-rest earth pressure" menu item

Using the at-rest earth pressure function, the demands placed on the pile by area loads are determined according to the theory of elastic half-space. The required concentration factor is specified in the following dialog box.



9.10 GGU-LATPILE: "User-defined earth pressure coefficients" menu item

If you want to work with user-defined earth pressure coefficients instead of with those computed by the program you can enter them here. Enter the coefficients for horizontal ground. If necessary, the program will convert them for sloping ground using equation values for kah0 and kah (see "**Theoretical principles: Berms**").

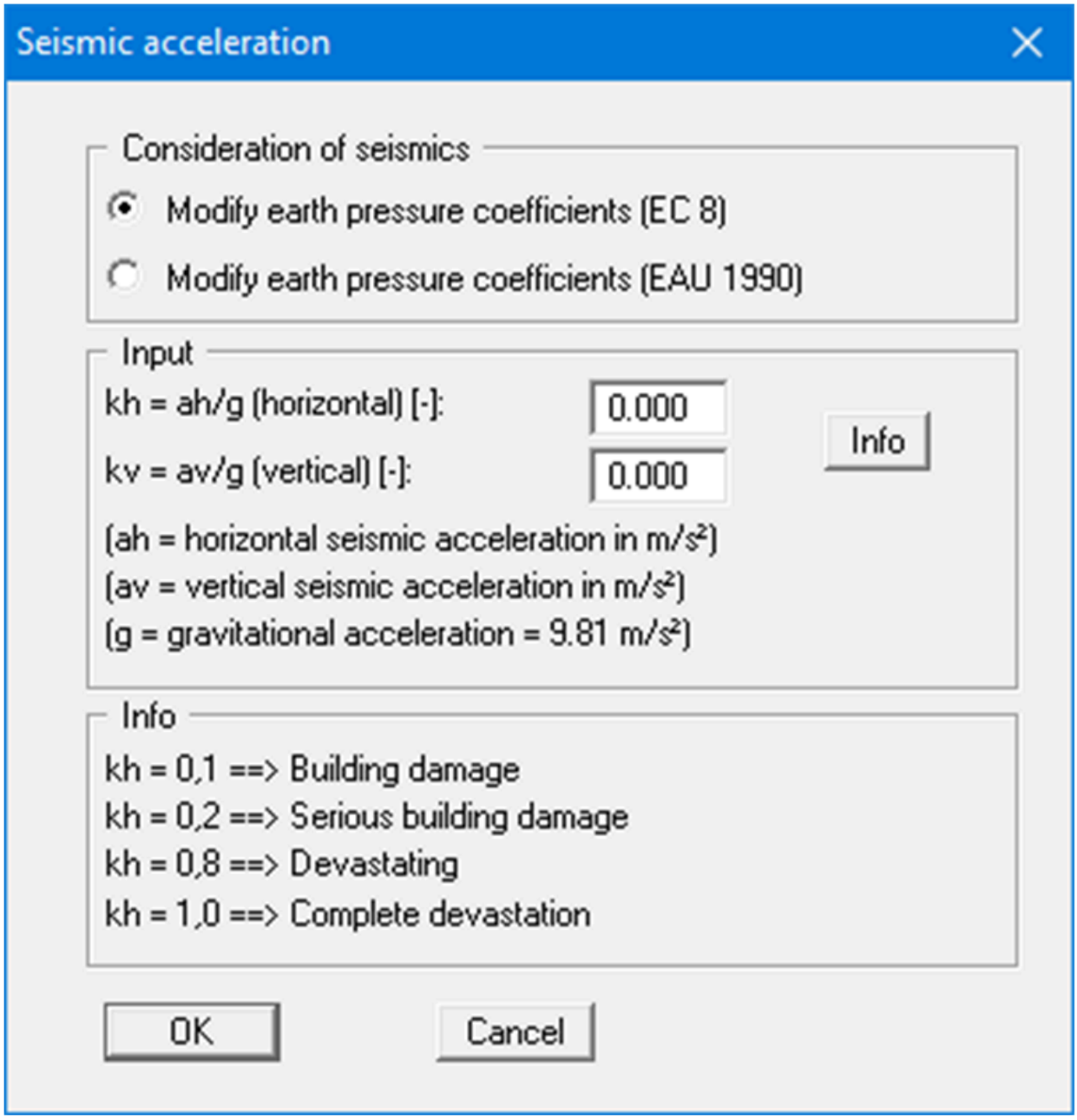


If the "**Compute values**" button is pressed the earth pressure coefficients can be calculated by the program in accordance with the required standard and slope angle.

The earth pressure coefficients entered here are only adopted if the "User-defined" check box is activated in "**Editor 1/Active earth pressure**" and/or in "**Editor 1/Passive earth pressure**" menu items.

9.11 GGU-LATPILE: "Seismic acceleration" menu item

Seismic loads can be taken into consideration as described in EC 8 or EAU 1990, Section 2.14, by increasing the active earth pressure coefficients and reducing the passive earth pressure coefficients. Seismic loads are given in multiples of gravitational acceleration (g).



9.12 GGU-LATPILE: "Analysis of Sum V" menu item

If you are analysing with the ***global safety factor concept*** to DIN 1054 (old), you can activate the analysis of mobilised passive earth pressure using this menu item.

If the check box is activated, the dialog box allowing selection of the analysis options for the mobilised passive earth pressure opens immediately following your analysis and design.

If the system has already been analysed the modifications required for analysis of mobilised passive earth pressure can be more easily made using the menu item "**Evaluation/Sum V analyses**", because the system then need not be analysed once again.

9.13 GGU-LATPILE: "Partial factors + Sum V" menu item

If you are analysing with the ***partial safety factor concept***, you will see a dialog box for defining the partial factors.

In the dialog box's lower group box, activate required Sum V analyses using the two check boxes. When the check boxes are activated, analysis is performed automatically following your system analysis and design (see the example in Section 6.12).

On a previously analysed system, you can perform the analyses with a variety of settings via the menu item "**Evaluation/Sum V analyses**", without having to reanalyse the system.

In the "**Default values**" group box the partial factors for the various load cases and subsoil conditions given in the DIN 1054:2010 and in the EC 7 can be selected by means of the dialog box reached by clicking the "**To DIN 1054:2010**" button. The selected design situation is automatically entered at the top of the dialog box and shown later in the ***General legend***. However, you can also use your own designations. The load case designations were altered for the EC 7 partial safety factor concept:

- Load Case 1 is now DS-P: Persistent Design Situation
- Load Case 2 is now DS-T: Transient Design Situation
- Load Case 3 is now DS-A: Accidental Design Situation

In addition, there is a seismic design situation (DS-E). In the DS-E design situation all partial factors = '**1.0**'. It is also possible to select the partial safety factors compliant with Austrian standards using the "**To ÖNORM EN 1997-1**" button.

10 Editor 2 menu

10.1 GGU-LATPILE: "Subgrade reaction moduli" menu item

As the analysis is to be performed for an elastically embedded pile toe, it is necessary to enter a modulus of subgrade reaction. In this dialog box you can enter the profile of the subgrade reaction moduli.

The number of subgrade reaction moduli can be adapted to your system using the "**x subgrade moduli to edit**" button.

In the field designated "**mu ks**" the tangential bedding is given as a multiple of the horizontal bedding. However, the factor is generally of little importance, since the pile toe is considered to be vertically non-displaceable, meaning that deformations in a longitudinal direction, and any associated tangential subgrade reaction moduli, are small.

The units can be changed from MN/m³ to kN/m³ and vice versa using the "**Subgrade reaction modulus unit: kN/m³**" check box.

10.2 GGU-LATPILE: "Displacement boundary conditions" menu item

You can introduce additional displacement boundary conditions anywhere along the pile.

In the above example, a rotation phi of 0.0 has been entered 2.0 m below the top of the pile. Alternatively, to "**Rotation phi**" you can select "**Displ. wx**" or " **Displ. wy**", which stand for horizontal and vertical displacement, respectively.

10.3 GGU-LATPILE: "Action boundary conditions" menu item

You can introduce additional action boundary conditions anywhere along the pile.

The direction of the forces is defined by means of the sign. In the example above a horizontal force of 15 kN/m has been entered at the top of the pile, acting towards the left.

10.4 GGU-LATPILE: "Lateral pressures" menu item

If, in addition to the diverse possibilities for determining earth pressure on the pile, you also need to take additional surcharges on the active side into consideration, this is where to enter them.

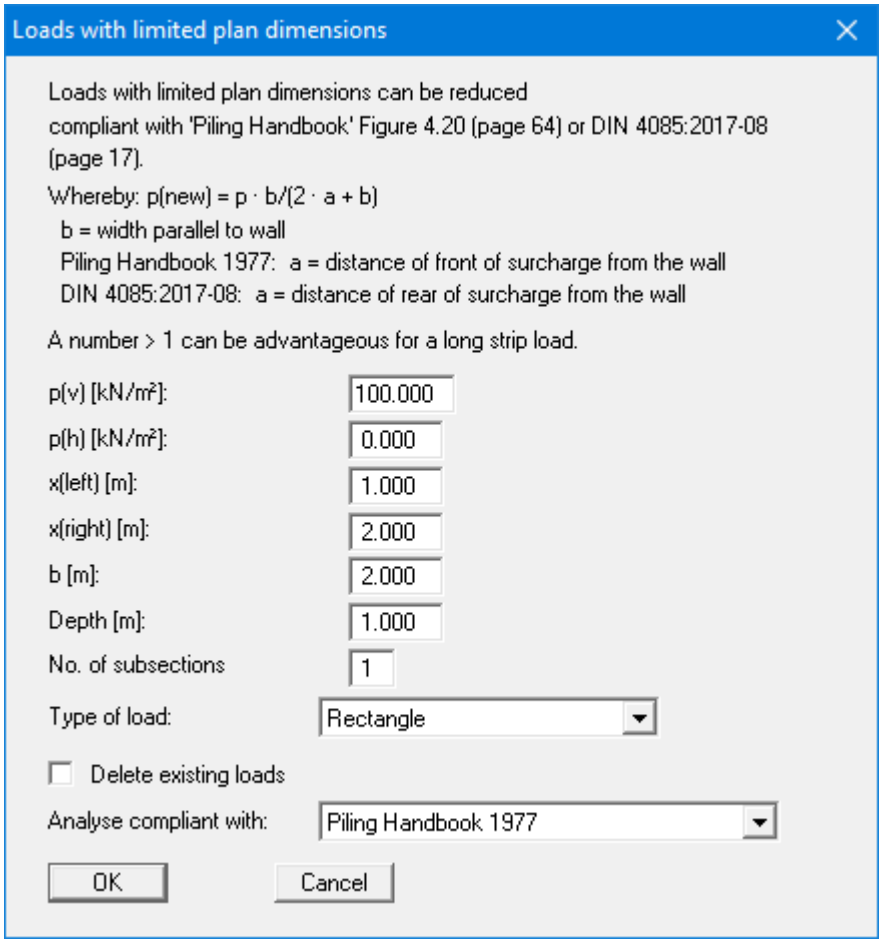
The number of lateral pressures can be modified using the "**x lateral pressure(s) to edit**" button. Then enter the ordinates in metres from the top of the pile or as absolute heights, and the values for the lateral pressures.

10.5 GGU-LATPILE: "Area loads" menu item

Using this menu item you define area loads and loads with limited plan dimensions.

The "**x area load(s) to edit**" button allows you to determine the number of area loads to be considered. Subsequently you can enter the sizes "**p(v)**" (= vertical) and "**p(h)**" (= horizontal), the ordinates and the "Depth" of the area loads. You must also enter the "**Type**" (shape) of the resultant horizontal forces on the pile. For defining an area load as a live load, select the corresponding check box on the right.

Use the "**Loads with limited plan dimensions**" button, to define such loads :



10.6 GGU-LATPILE: "Bounded surcharges" menu item

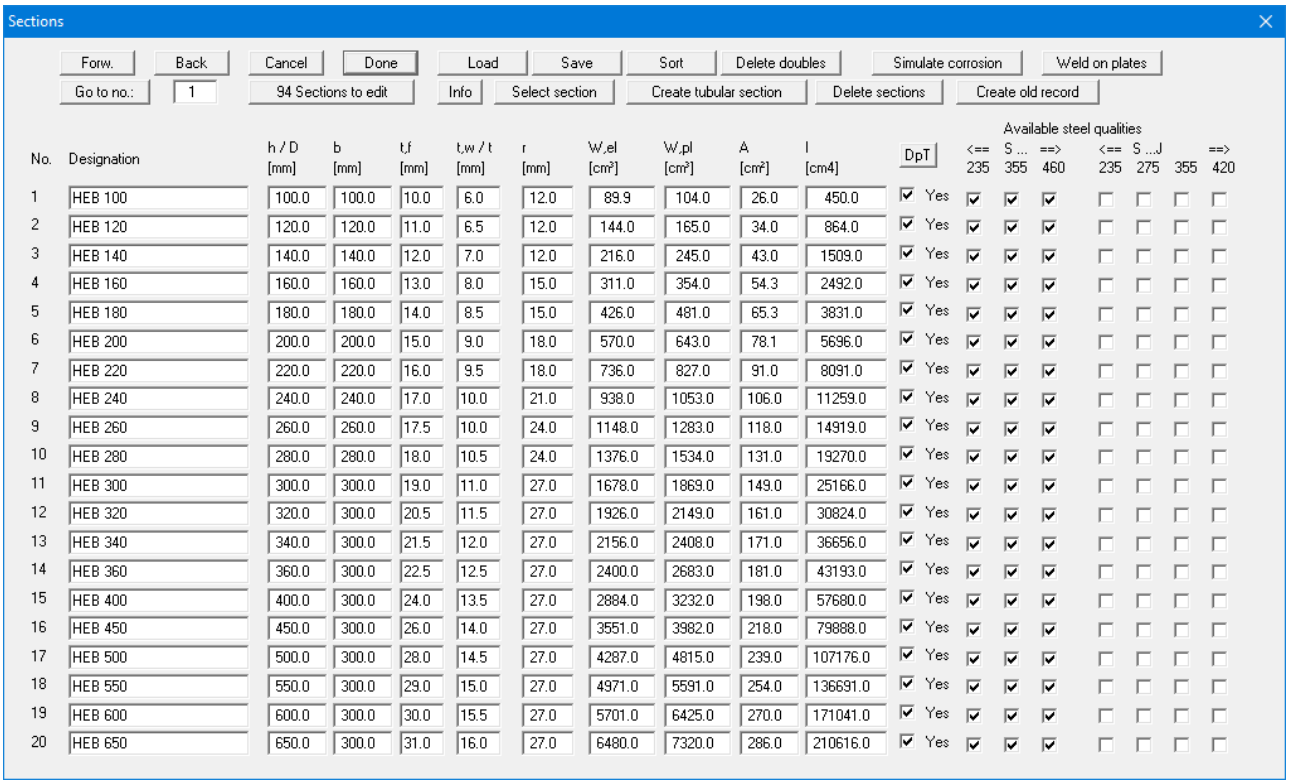
Bounded surcharges are defined in the following dialog box. You are first queried whether the surcharges are entered to be on the active or the passive side. The following dialog box opens for active side input:

Using "**x bounded surcharge(s) to edit**" you can determine the number of bounded surcharges. You can then enter the size of the surcharges, the ordinates and the depth in metres from the top of the pile or as absolute heights.

Input of bounded surcharges on the passive side is analogous, but without the "Live" check box.

10.7 GGU-LATPILE: "Steel sections" menu item

If you want to design a ***steel pile*** to ***EC 3*** via the ***section list***, this menu item will open a dialog box containing the current list of steel sections.



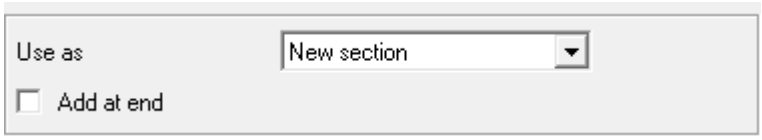
No.	Designation	h / D [mm]	b [mm]	t,f [mm]	t,w / t [mm]	r [mm]	W,el [cm³]	W,pl [cm³]	A [cm²]	I [cm4]	DpT	<== 235	S ... 355	==> 460	<== 235	S ...J 275	355	==> 420
1	HEB 100	100.0	100.0	10.0	6.0	12.0	89.9	104.0	26.0	450.0	Yes	☑	☑	☑	☐	☐	☐	☐
2	HEB 120	120.0	120.0	11.0	6.5	12.0	144.0	165.0	34.0	864.0	Yes	☑	☑	☑	☐	☐	☐	☐
3	HEB 140	140.0	140.0	12.0	7.0	12.0	216.0	245.0	43.0	1509.0	Yes	☑	☑	☑	☐	☐	☐	☐
4	HEB 160	160.0	160.0	13.0	8.0	15.0	311.0	354.0	54.3	2492.0	Yes	☑	☑	☑	☐	☐	☐	☐
5	HEB 180	180.0	180.0	14.0	8.5	15.0	426.0	481.0	65.3	3831.0	Yes	☑	☑	☑	☐	☐	☐	☐
6	HEB 200	200.0	200.0	15.0	9.0	18.0	570.0	643.0	78.1	5696.0	Yes	☑	☑	☑	☐	☐	☐	☐
7	HEB 220	220.0	220.0	16.0	9.5	18.0	736.0	827.0	91.0	8091.0	Yes	☑	☑	☑	☐	☐	☐	☐
8	HEB 240	240.0	240.0	17.0	10.0	21.0	938.0	1053.0	106.0	11259.0	Yes	☑	☑	☑	☐	☐	☐	☐
9	HEB 260	260.0	260.0	17.5	10.0	24.0	1148.0	1283.0	118.0	14919.0	Yes	☑	☑	☑	☐	☐	☐	☐
10	HEB 280	280.0	280.0	18.0	10.5	24.0	1376.0	1534.0	131.0	19270.0	Yes	☑	☑	☑	☐	☐	☐	☐
11	HEB 300	300.0	300.0	19.0	11.0	27.0	1678.0	1869.0	149.0	25166.0	Yes	☑	☑	☑	☐	☐	☐	☐
12	HEB 320	320.0	300.0	20.5	11.5	27.0	1926.0	2149.0	161.0	30824.0	Yes	☑	☑	☑	☐	☐	☐	☐
13	HEB 340	340.0	300.0	21.5	12.0	27.0	2156.0	2408.0	171.0	36656.0	Yes	☑	☑	☑	☐	☐	☐	☐
14	HEB 360	360.0	300.0	22.5	12.5	27.0	2400.0	2683.0	181.0	43193.0	Yes	☑	☑	☑	☐	☐	☐	☐
15	HEB 400	400.0	300.0	24.0	13.5	27.0	2884.0	3232.0	198.0	57680.0	Yes	☑	☑	☑	☐	☐	☐	☐
16	HEB 450	450.0	300.0	26.0	14.0	27.0	3551.0	3982.0	218.0	79888.0	Yes	☑	☑	☑	☐	☐	☐	☐
17	HEB 500	500.0	300.0	28.0	14.5	27.0	4287.0	4815.0	239.0	107176.0	Yes	☑	☑	☑	☐	☐	☐	☐
18	HEB 550	550.0	300.0	29.0	15.0	27.0	4971.0	5591.0	254.0	136691.0	Yes	☑	☑	☑	☐	☐	☐	☐
19	HEB 600	600.0	300.0	30.0	15.5	27.0	5701.0	6425.0	270.0	171041.0	Yes	☑	☑	☑	☐	☐	☐	☐
20	HEB 650	650.0	300.0	31.0	16.0	27.0	6480.0	7320.0	286.0	210616.0	Yes	☑	☑	☑	☐	☐	☐	☐

The following options are available:

- **"Forw.", "Back", "Go to no."**
  You can navigate through the list using "**Forw**." and "**Back**". "**Go to no.**" allows you to jump to the section specified.
- **"Cancel", "Done"**
  Exit the dialog box either saving or rejecting your modifications using these buttons.

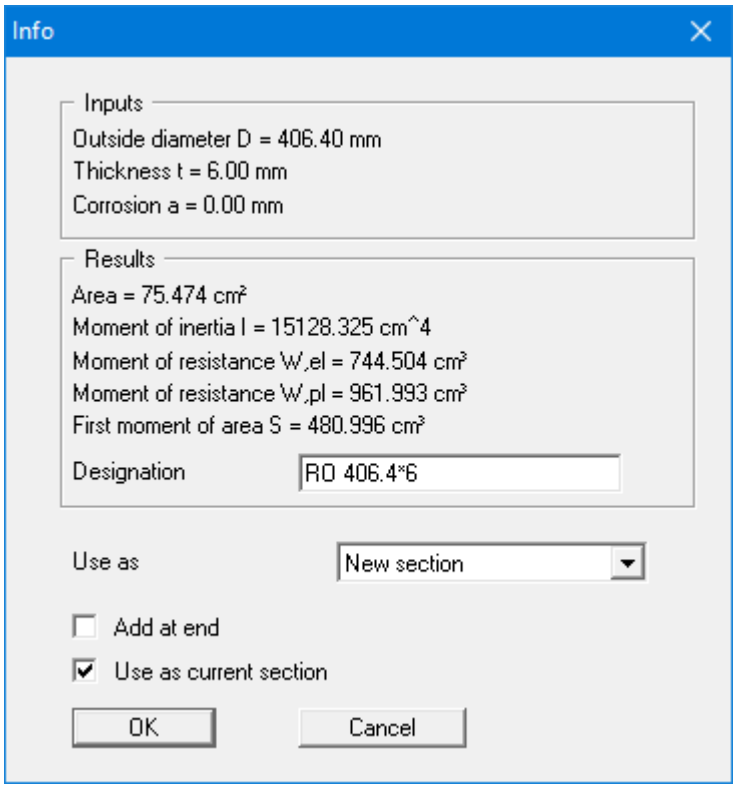
- **"x Sections to edit", "Info"**
  Using this button you may expand or reduce the list of steel sections. New sections are added to the end of the list. A description of the abbreviations used to enter the section data is available via the "**Info**" button.
- **"Load", "Save", "Sort", "Delete doubles"**
  A different section list can be opened by pressing the "**Load**" button. It is then possible to append the new list to an already open section list. After appending sections, it may be expedient to delete any double sections in the list by pressing the "**Delete doubles**" button. The sections can then be sorted either by moment of inertia or by name by pressing the "**Sort**" button. The modified section list may then be saved to the program folder as "**.tbw_ggu**" file for subsequent analyses by pressing the "**Save**" button.
- **"Select section"**
  A dialog box opens in which you select the required section for design.

- **"Simulate corrosion"**
  You can define the corrosion for any sections, which is then used to calculate the new section data. The new section data can be allocated to the selected section, or to a different, existing section. The data can also be allocated to a new section, which is added to the existing list.

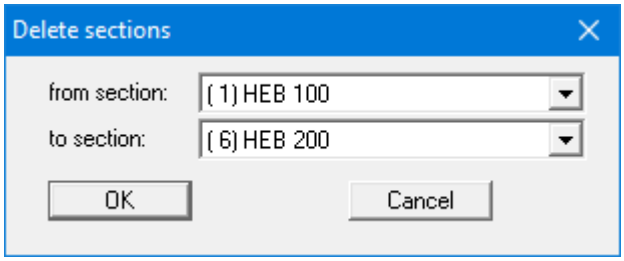


Corrosion in tubular sections can be generated using the "Create tubular section" button (see next side).

- **"Weld on plates"**
  If you need to simulate reinforcement using weld-on plates, click the previous "**Simulate corrosion**" button and enter a negative corrosion.
- **"Create tubular section"**
  A new tubular section can be generated. A dialog box opens for entering the dimensions and identification. In the following dialog box, you can then save the section as a new section, or using a previously allocated name:



- **"Delete sections"**
  Any number of sections in a sequence in the list can be deleted using this button.



- **"Create old record"**
  Using this button you can save a record containing the old section tables based on the global safety factors ("**.tbw**", "**.spw**").

If ***Steel design to EC 3*** is not activated, the old dialog box opens. A check box in front of the number of each steel section can be activated. This is used to select the respective steel section. If you then press the "**Selected section as design section**" button, this section is used as the design section. The section parameters ("**h**" = height; "**b**" = width; "**A**" = area; "**I**" = moment of inertia) can be edited. The program uses **I** and **h** to determine the section modulus **W** during the subsequent design phase. The variable **S** is the first moment of area of the section and s is the web thickness. The value of "**S/s**" is required for verification of shear stress.

10.8 GGU-LATPILE: "Differing sections" menu item

If you want to design a steel pile using differing sections at different depths, you can use this menu item to define the different individual sections for the pile. For example, this can be used to represent partial corrosion of the steel pile, as shown in the following dialog box:

First, define the required number of sections using the "**x Different sections to edit**" button. After clicking the button with the section designation, you will see a dialog box in which you can select the required section from the section list. You can save your section compilation in a "**.sol_ggu**" file and load it again when needed using the "**Load**" and "**Save**" buttons. The sections are sorted according to depth using "**Sort**".

If you are working with differing sections, you specify the steel grade and buckling analysis for the individual sections in the dialog box for this menu item.

If you exit this menu item and have previously selected "**With section list**" in "**Editor 1/Analysis options**", you will be asked whether you wish to convert to steel design using differing sections. You will see a similar question if the case is vice versa. If you have already selected "**Differing sections**" and would like to add a section (e.g. with corrosion), you can go to the "**Editor 2/Steel sections**" and add the required section without having to immediately move back to "**With section list**" again. When you exit this menu item you will see the reverse question: whether to change to steel design using the section list. In this case, respond negatively and supplement your new section using the menu item "**Editor 2/Differing sections**".

10.9 GGU-LATPILE: "Young's modulus/Specific weight" or "Specific weight" menu items

This menu item has two separate designations and opens two different dialog boxes depending on whether you are working with a section list or with user-defined section data:

- **"Young's modulus/Specific weight"**
  When working with the ***section list***, you must enter Young's modulus and specific weight of the pile. From the former the bending line is calculated, from the latter the self-weight of the pile.
- **"Specific weight"**
  Using ***differing sections*** Young's modulus is entered in the corresponding dialog box, so that here it is only necessary to specify the specific weight of the pile.

11 System menu

11.1 GGU-LATPILE: "Info" menu item

You will see information on the current system in a message box.

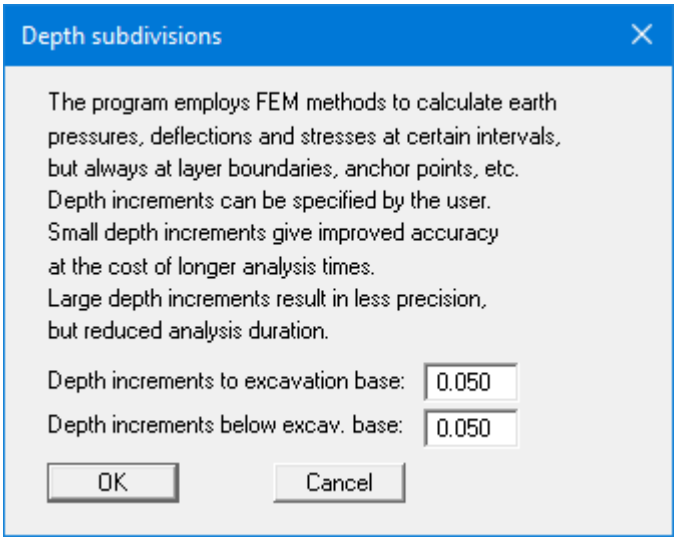
11.2 GGU-LATPILE: "Special preferences" menu item

The program performs a multitude of plausibility checks. After starting the analysis, the preferences specified by the user are displayed in a message box; for problematical preferences separate information or warning are displayed. It is therefore recommended to leave the "**Show warnings in future**" check box activated.

If you do not want to see the automatic display when the analysis starts, deactivate the check box. You can subsequently view your special preferences using this menu item.

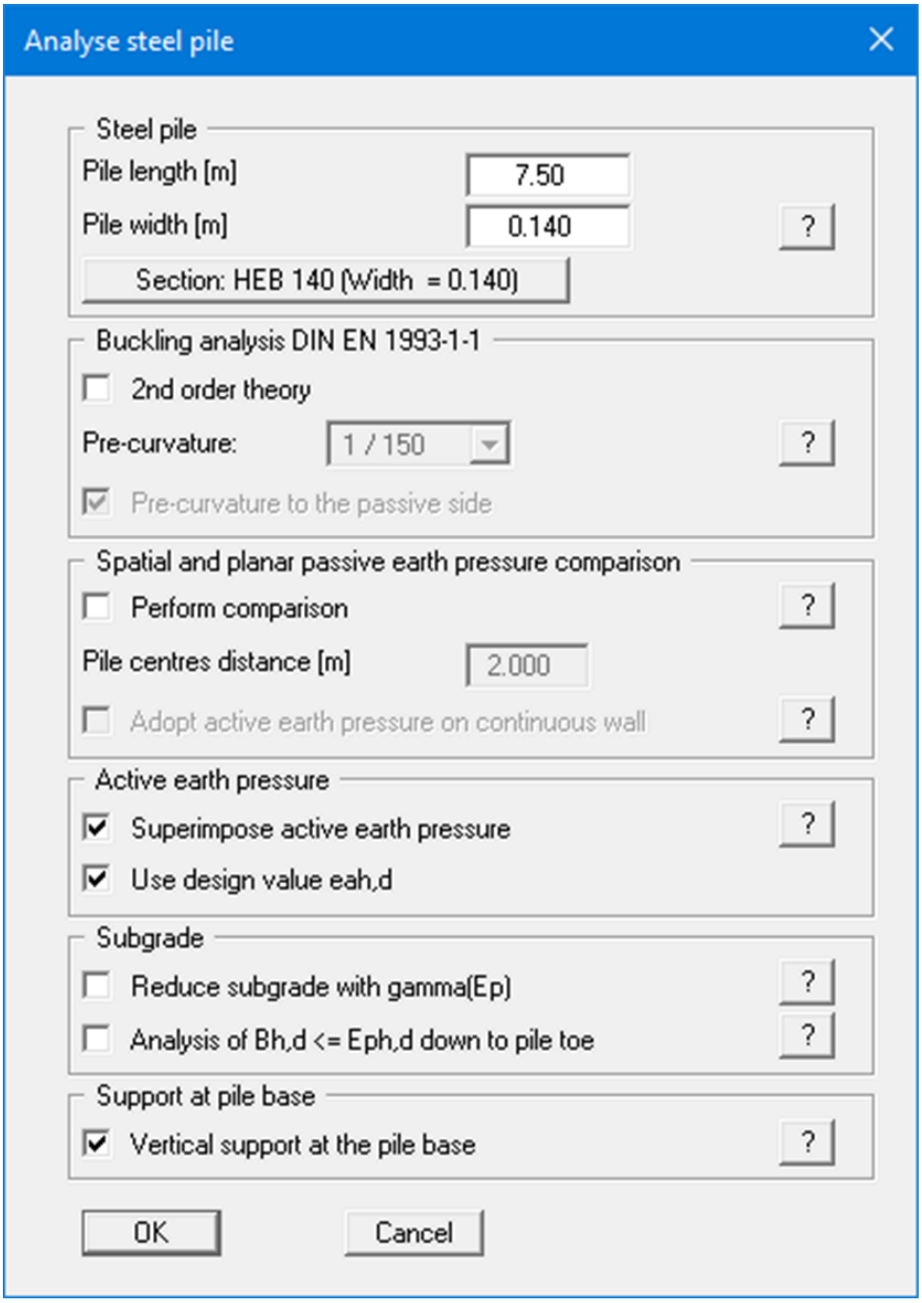
11.3 GGU-LATPILE: "Depth subdivisions" menu item

The program uses the finite element method, which requires the system to be divided into a number of finite elements (rods, see "**Theoretical principles: Structural system**"). You can specify the size of these depth increments for the region above and below the excavation base.



11.4 GGU-LATPILE: "Analyse" menu item

Once you have entered all data required to fully describe the system it can be analysed. For a "**Steel pile**" you will see the following dialog box. You can also initiate the analysis using the [**F5**] function key.



Pile length and pile width have already been entered using "**Editor 1/System input**" in accordance with your input. You can edit the data here to suit your needs. The three-dimensional passive earth pressure is calculated using this pile width. This value may deviate from that of the beam if the steel pile is placed in a pre-drilled bore and is subsequently concreted.

Using the button with the name of the selected steel section, i.e. "**Section: ….**", you can now select a different section as the design section via the usual option box. If you are analysing a "Bored pile", you enter the "**Pile diameter**" in the dialog box for subsequent design of the reinforced concrete cross-section.

Piles subject to buckling hazards can be analysed using "**2nd order theory**". A system pre-curvature, which can be adopted at 1/150, must be defined for buckling analysis to DIN EN 1993-5 or DIN EN 1993-1-1. The direction of pre-curvature must also be defined (to the passive side or the active side). Whether a pre-curvature towards the passive side or the active side provides the more unfavourable design values is system-dependent: it is therefore absolutely vital that both directions are investigated in a buckling analysis (see "**Theoretical principles/2nd order theory**").

EC 7 requires that a verification be performed to demonstrate that the soil stress (ks · w)d is smaller than the characteristic passive earth pressure eph,k (not reduced by a partial safety factor!). However, once analysis is complete it must be verified that the sum of the soil stress is smaller than the design passive earth pressure:

$$\Sigma\,(k_s \cdot w)_d \leq E_{ph,k} / \gamma_{Ep}$$

If the check box is deactivated, Bh,d and Eph,d are only cumulated to the pile pivot.

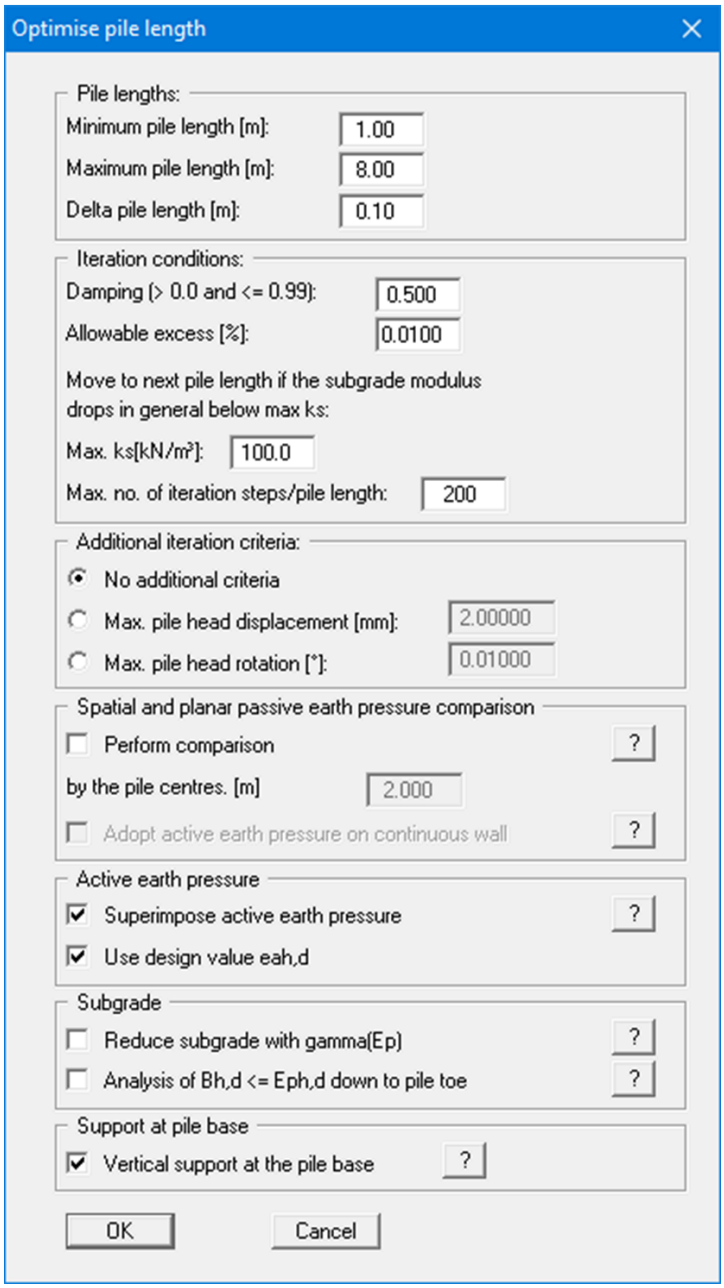
In some systems, tensile forces can occur at the pile base.This is due to the vertical immovability of the wall toe generated by the program.In bedded systems this boundary condition can be deactivated.However, when adopting the subgrade reaction modulus definition it is necessary that a tangential subgrade with the factor "**µ(ks)**"<> 0.0 is defined.The resulting normal force at the pile base is then more realistic.The value of "**µ(ks)**" generally has no great influence on the analysis results.The "**Vertical support at the pile base**" check box should only be deactivated if tensile forces occur at the pile base when the check box is activated!

After leaving the dialog box with "**OK**", the program checks whether the passive earth pressure is smaller than the resulting soil pressure from the elastic analysis, which is not permitted. In this case you see a dialog box for adjusting the subgrade reaction (see further explanations in the worked example).

Following the analysis, you can immediately carry out the design after confirming at the prompt. You then move directly to a dialog box, which can also be reached via the "**System/Design defaults**" menu item.

11.5 GGU-LATPILE: "Optimise" menu item

Using this function, it is possible to optimise pile length. You can also initiate this function pressing the [**F7**] function key.



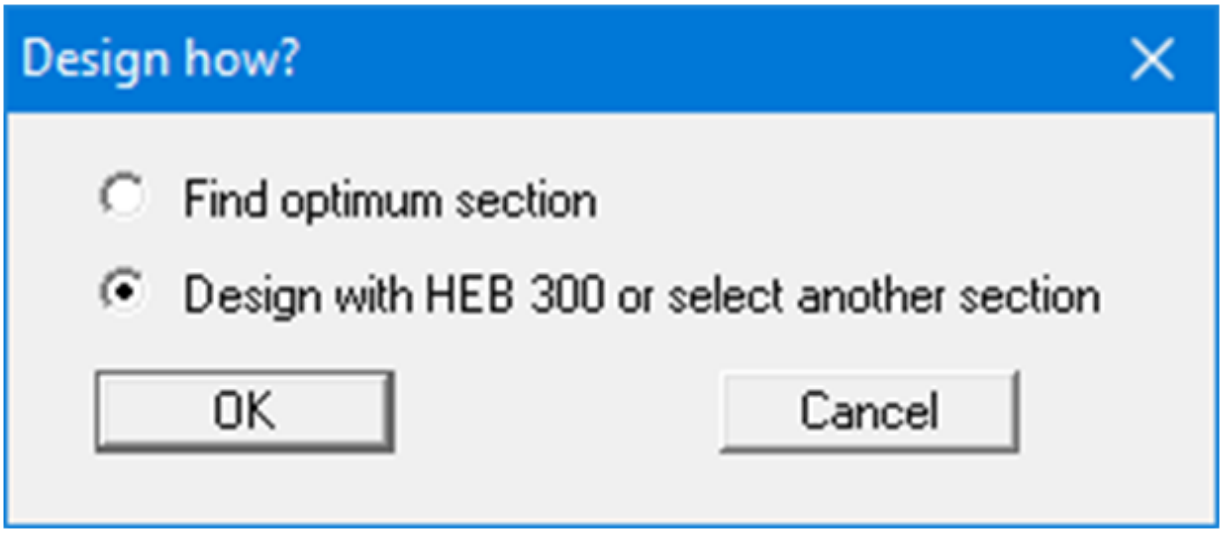
In the top section of the dialog box, you enter the minimum and maximum pile length, as well as a delta pile length, thereby defining the range of lengths from which the optimum length should be selected. For example, the values in the dialog box shown above will result in the lengths 6.00, 6.25, 6.50, 6.75,..., 8.00 m being investigated. The middle section of the dialog box relates to the iteration process. The ***default values*** have proved themselves in practice and will generally not need to be altered (see further explanations in the worked example). In the bottom section of the dialog box, additional iteration criteria can be defined.

Once optimisation is complete, the optimum pile length can be transferred to your system. The system should then be reanalysed.

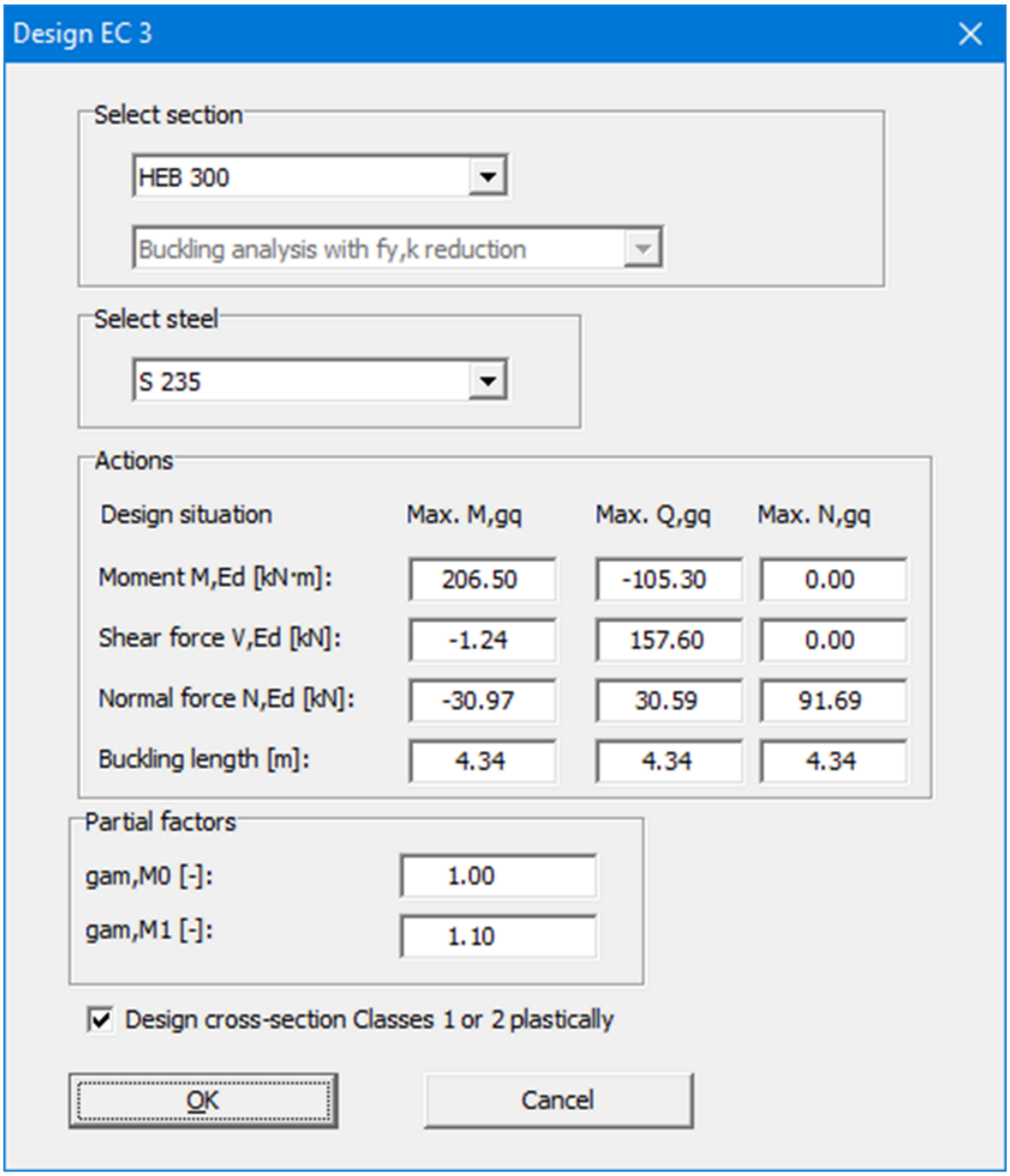
11.6 GGU-LATPILE: "Design defaults" menu item

Once the current system has been analysed you can progress directly to the pile design (see menu item "**System/Analyse**"). In addition, using this menu item, you can also carry out subsequent design for a different section to that used for the analysis.

When designing a steel pile, the following dialog box opens containing two options for selecting the section:



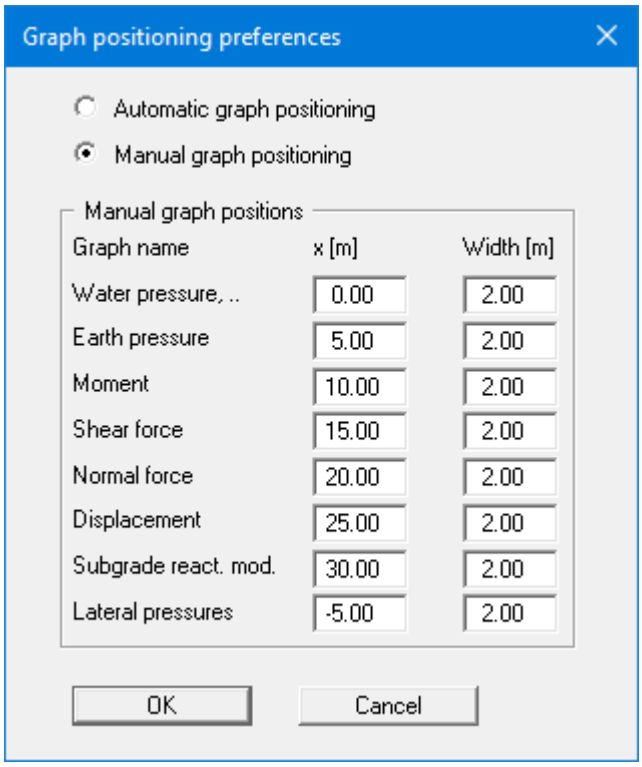
You can search for the optimum section in the section list (see the example in Section “Step 10: Analyse system”). By activating the bottom option, the analysis is performed using the previously selected design section. However, in the subsequent dialog box you can also select a different design section.



When design is complete you are informed of the verification results in an information box and are presented with the principal data on which the design was based. After confirming with "**OK**", the state variables and the system are presented on the screen.

11.7 GGU-LATPILE: "Graph positioning preferences" menu item

If you are not happy with the automatic graph arrangement, you can use this menu item to create an arbitrary arrangement. The dialog box of the **GGU-RETAIN** program is shown here as an example. Other graphs may be listed in other GGU programs.

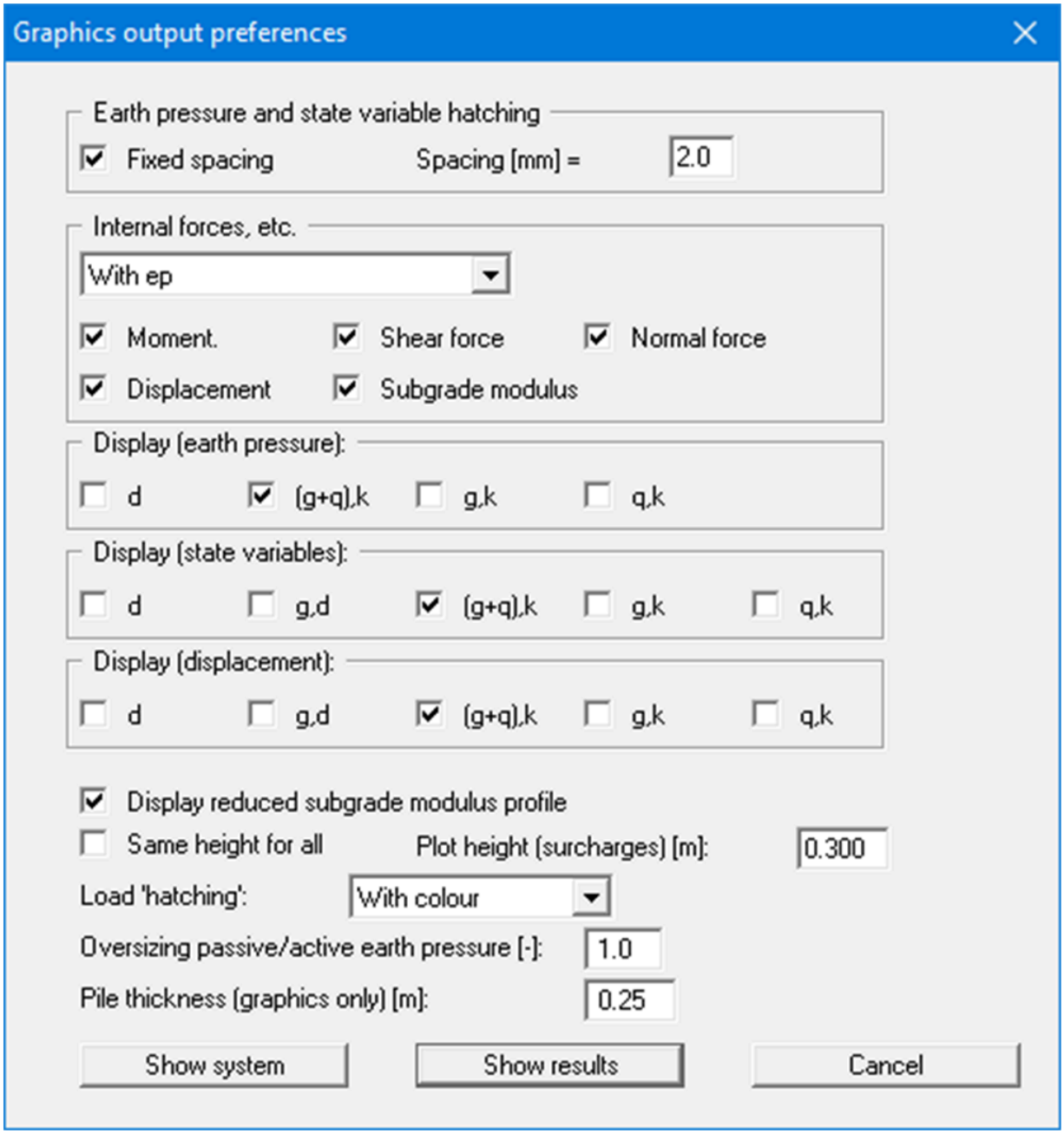


For a customised graph arrangement, activate the "**Manual graph positioning**" check box. The graphs are then displayed centred at the sheet position "**x**" with the specified "**Width**".

The fastest way to modify the position of a graph is to press the [**F11**] function key and then to pull the diagram to the new position holding the left mouse button pressed.

11.8 GGU-LATPILE: "Graphics output preferences" menu item

Among other things, the screen graphics consist of several graphs, presenting depth-oriented results. This menu item opens a dialog box which allows you to visualise the selected state variables on the screen by activating the corresponding check boxes. Overall, the dialog box is self-explanatory.



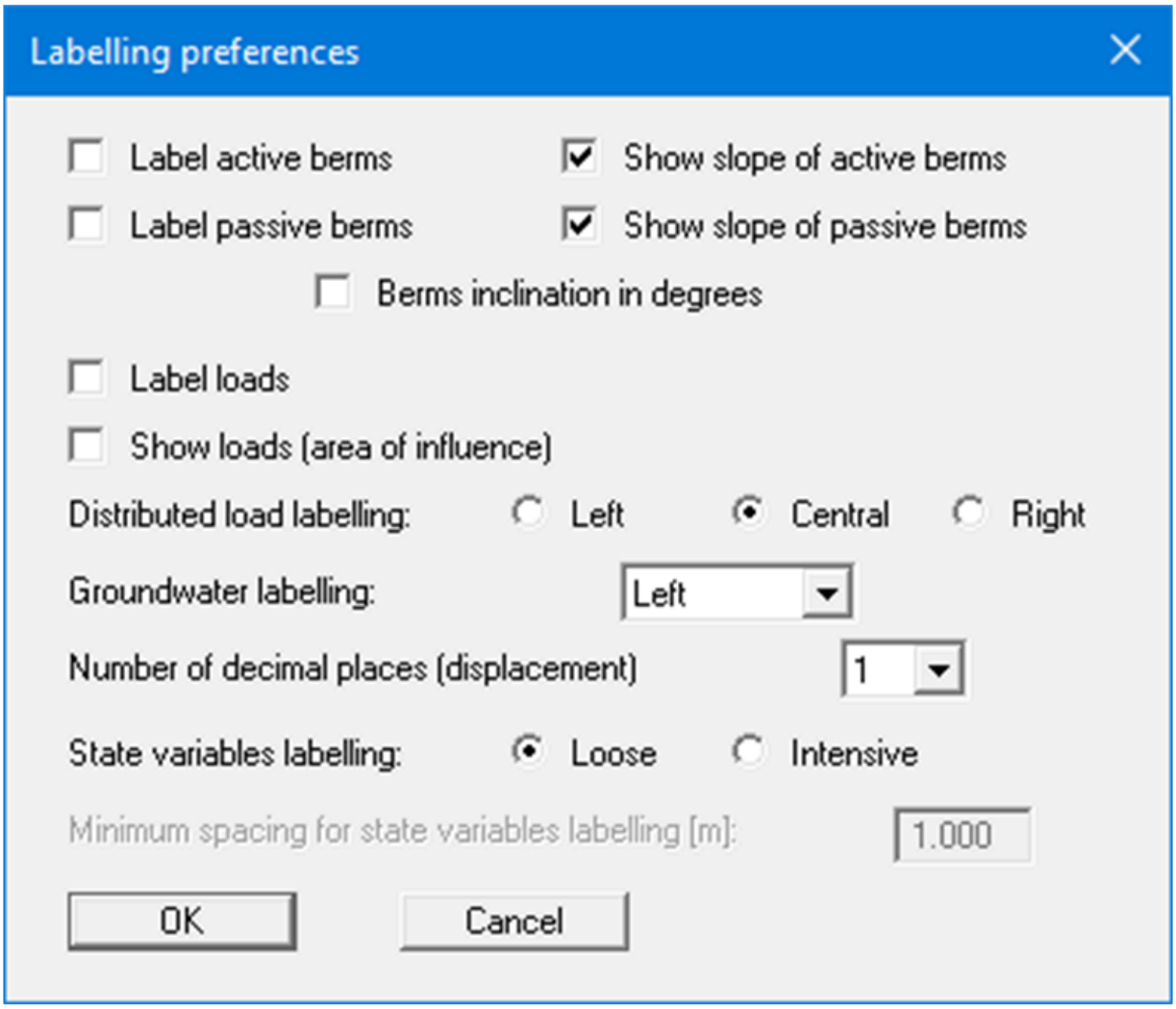
If a system has been analysed using 2nd order theory with buckling analysis to DIN EN 1993-1-1 activated, either the "**Displacement**" or the "**Pre-curvature**" can be selected for display in the result graphics in the dialog box shown above. Any adopted pre-curvature will always be given in the output table.

When analysing using ***partial safety factors*** you will also see the group boxes "**Display (earth pressure):**", "**Display (state variables):**" and "**Display (displacement):**", in which you can activate display of the permanent (g) and/or live loads (q). In addition, the design values (d) can be displayed.

You can also specify hatching and the presentation height of loads. If the "**Same height for all**" check box is not selected, load visualisation is based on load size, the height of the presentation indicating the maximum load. Leave the dialog box by pressing "**Show system**". If the system has already been analysed, you can leave the box by pressing "**Show results**" and then view the result graphics on the screen.

11.9 GGU-LATPILE: "Labelling preferences" menu item

This menu item allows you to specify labelling preferences for the system visualisation and the result graphics.



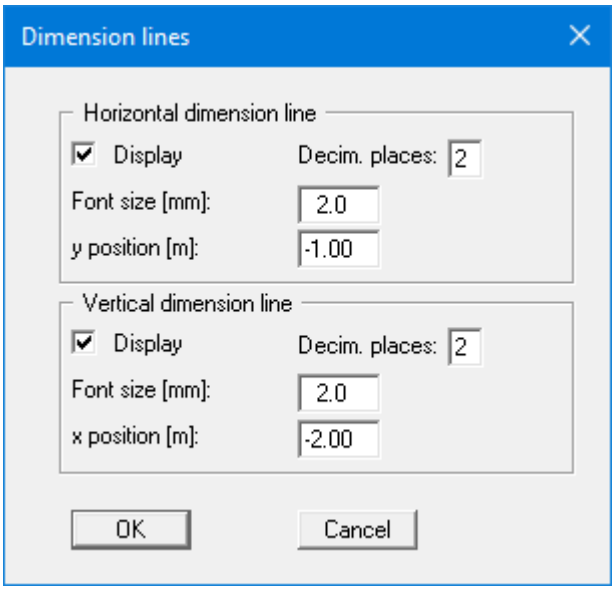
In the dialog box, you activate the required check boxes and select the preferences for alignment or font sizes. IIn addition, groundwater and distributed load labelling can be edited.

11.10 GGU-LATPILE: "Graph grid preferences" menu item

Here you can define graph grids for moments, shear forces and normal forces.

11.11 GGU-LATPILE: "Dimension lines" menu item

You can include a vertical and/or horizontal dimension line in the graphic to illustrate the system dimensions. If the dimension lines are displayed on the screen, you can also open the following dialog box directly by double-clicking the left mouse button over a dimension line.



The distance to the wall or pile is defined by means of the "**y position**" for the horizontal dimension line and "**x position**" for the vertical dimension line. Negative values define a position above or to the left of the wall or pile. All values are in metres in the scale selected (see the menu item "**Page size + margins/Manual resize (editor)**").

The fastest way to modify the position of the dimension lines is to press the [**F11**] function key and then to pull the legend to the new position with the left mouse button pressed.

11.12 GGU-LATPILE: "Display system" menu item

Once a system has been analysed, all the state variables are automatically shown on screen. So as not to overburden the screen, certain elements of the system (for example, surcharges) are no longer shown. If you want to view all the system data without state variables, clicking this menu item will enable you to do so.

11.13 GGU-LATPILE: "Display results" menu item

After a system has been analysed, all state variables are automatically presented on the screen. If you used the menu item "**System/Display system**" to return to the system visualisation, you can go to this menu item to return to the result presentation without renewed analysis. Of course, this only works if the system has already been analysed.

12 Evaluation menu

12.1 GGU-LATPILE: "Main output summary" menu item

A message box appears containing the main system analysis parameters. This function can also be initialized pressing the [**F6**] function key.

You are also informed that double-clicking the left mouse button (after you have closed the message box) on any part of the graphics will cause the corresponding state variables to be shown on screen.

12.2 GGU-LATPILE: "Maximum reaction summary" menu item

You will see the maximum values for all state variables.

12.3 GGU-LATPILE: "Sum V analyses" menu item

Using this menu item, it is possible to analyse Sum V once again for a previously analysed system. If analysis of Sum V was not previously activated, it is activated now via a prompt box. The activation is then shown in the "**Editor 1/Analysis of Sum V**" or "**Editor 1/Partial factors + Sum V**" dialog boxes.

The circumference is required for analysis of Sum V. Both rectangular steel sections (HEB) and circular, tubular sections may be adopted as steel sections. If the analysis is activated a dialog box opens allowing the steel cross-section to be selected.

In the subsequent dialog box, the type of analysis or the effective circumference may be modified for the analysed system. This dialog box always opens immediately following analysis and design if analysis of Sum V is activated. For a bored pile analysis, you can also specify whether the bored pile should be designed as a driven pile. When analysing a bored pile, you can also specify whether the bored pile should be designed as a driven pile. You can choose between four analysis methods from a drop-down menu when analysing a steel pile (see the following dialog box).

Once the modifications are confirmed by pressing "**OK**" the data is displayed in a message box. After closing the box, the results for analysis of Sum V are displayed in the ***General legend***, if the appropriate check box is activated.

12.4 GGU-LATPILE: "Working capacity" menu item

You can determine the working capacity for dolphin analysis from H,k and w,k.

12.5 GGU-LATPILE: "Move section bases" menu item

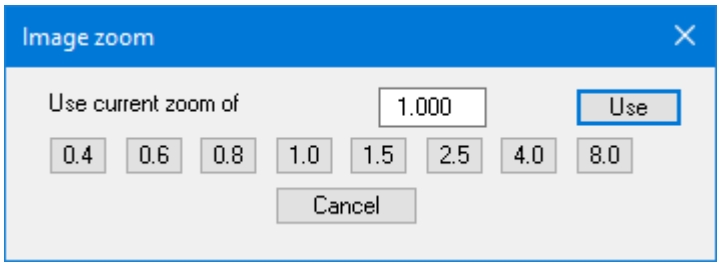
If you are analysing using several sections, you can move the bottom edges of the sections using the mouse to achieve optimised section utilisation. The system is recalculated immediately after moving the bottom edge. You can also activate movement by pressing the [**F8**] function key.

13 Graphics preferences menu

13.1 GGU-LATPILE: "Refresh and zoom" menu item

The program works on the principle of ***What you see is what you get***. This means that the screen presentation represents, overall, what you will see on your printer. In the last consequence, this would mean that the screen presentation would have to be refreshed after every alteration you make. For reasons of efficiency and as this can take several seconds for complex screen contents, the screen is not refreshed after every alteration.

If, e.g., after using the zoom function (see below), only part of the image is visible, you can achieve a complete view using this menu item.

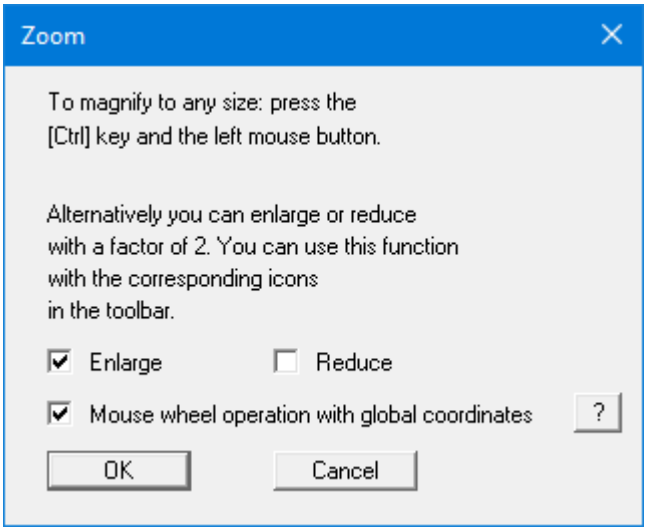


A zoom factor between 0.4 and 8.0 can be entered in the input box. By then clicking on "**Use**" to exit the box the current factor is accepted. By clicking on the "0.4", "0.6", etc. buttons, the selected factor is used directly, and the dialog box closed.

It is much simpler, however, to get a complete overview using [**Esc**]. Pressing [**Esc**] allows a complete screen presentation using the zoom factor specified in this menu item. The [**F2**] key allows screen refreshing without altering the coordinates and zoom factor.

13.2 GGU-LATPILE: "Zoom info" menu item

An info box informs you about the activation and possibilities of the zoom functions.



A quick way to enlarge a specific section of the screen is to open a magnifying glass window by holding down the [**Ctrl**] key and the mouse button.

A quicker way to zoom in and out of the system graphics is to use the mouse wheel. When the program is started for the first time, the default setting for mouse wheel operation is activated according to Windows conventions.

If you want to change the system coordinates and the scale of your system using the mouse wheel, activate the "**Mouse wheel operation with global coordinates**" check box. If you close the program with this setting, the setting is still activated the next time you start it.

The functions via the mouse wheel can be found in the chapter "**Tips and Tricks: Keyboard and Mouse**".

13.3 GGU-LAPTILE: "Legend font selection" menu item

With this menu item you can switch to a different true-type font. All available true-type fonts are displayed in the dialog box.

13.4 GGU-LATPILE: "Pen colour and width" menu item

In order to enhance the clarity of the graphics you can preset the pen settings for various graphic elements in the GGU programs.

You can change the pen widths for the elements listed in the dialog box and adjust the pen and/or fill colours by clicking on the button with the element name. In some GGU programs you can also define a line colour for selected elements.

For the graphic output of colours on ***monochrome printers*** (e.g. laser printers), colours are replaced by an equivalent shade of grey. In the case of very light colours, the corresponding graphic elements are then barely visible on the printer. In such cases, it makes sense to change the colour setting to darker colours.

13.5 GGU-LATPILE: "Mini-CAD toolbar" and "Header toolbar" menu items

Using this menu item you can add free text, lines, circles, polygons and images (e.g. files in formats BMP, JPG, PSP, TIF, etc.) to the main program graphics. PDF files can also be imported as images. A pop-up menu opens, the icons and functions used are described in more detail in the **Mini-CAD manual**.

The differences between the Mini-CAD and Header CAD are as follows:

- Drawing objects created with **Mini-CAD** refer to the coordinate system (generally in [m]) in which the drawing is created and are displayed accordingly. You should therefore select this menu item if you wish to enter additional information on the system. These objects can be saved in a "**.mcd**" file using the

  icon in the pop-up menu and loaded as such in other GGU programs using the

  icon in the pop-up menu.
- Drawing objects created with the **Header CAD** refer to the sheet format (in [mm]). They therefore always remain at the same sheet position, regardless of the coordinate system of the measuring points. You should select this menu item if you want to enter general information on the drawing (e.g. company logo, report number, system number, stamp). If you save this so-called header data in a "**.kpf**" file using the icon

  in the pop-up menu, you can reload this header data for a completely different system (with different system coordinates) and also in other GGU programs using the icon

  in the pop-up menu. The saved header data can then be found in the same position. This considerably simplifies the creation of general sheet information.

13.6 GGU-LATPILE: "Toolbar preferences" menu item

After starting the program, a horizontal toolbar for menu items appears below the program menu bar. If you would rather work with a popup window with several columns, you can specify your preferences using this menu item. The smart icons can also be switched off.

At the bottom of the program window, you find a status bar with further information.
You can also activate or switch off the status bar here. The preferences will be saved in the "**GGU-CANTILEVER.alg_wst**" file (see menu item "**Graphics preferences/Save graphics preferences**") and will be active at the next time the program is started.

By clicking on the tools (smart icons) for the menu items you can directly reach most of the program functions. The meaning of the smart icons appears as a text box if you hover with the mouse pointer over the tools. Some of the tool functions cannot be called up via normal menu titles and menu entries.

Not all of the icons described below are available in all GGU programs.

"**Next page**"/"**Previous page**"
You can use these icons to scroll forwards and backwards between individual pages. In many GGU programs, you can use this in the ***output table representation***.

"**Select page**" or "**Diagram/Output table**"
If you are in the ***output table representation***, you can use this symbol to jump to a specific page or switch back to the normal display, i.e. your graphic display.

"**Zoom out**"
If you have previously zoomed in, this tool returns to a full screen display.

"**Zoom (-)**"/"**Zoom (+)**"
With the zoom functions you can zoom in or out of parts of the image, by clicking the left mouse button.

"**Copy/print area**"
Use this tool to copy only parts of the graphics in order to paste them, e.g. to a report. You will see information on this function and can then mark an area, which is copied to the clipboard or can be saved in a file. Alternatively, you can send the marked area directly to your printer (see "**Tips and tricks**").

"**Colour on/off**" or "**Colour/hatching**"
If you want to remove the colour from the system display, e.g. to create a black and white printout, you can do this using this on/off switch.
In several GGU programs, 4 colour and hatching settings are possible via this icon, which you can click through in sequence. A colour filled representation is the default setting, the next click shows the hatching, then coloured and hatched. The fourth click shows a representation with neither colour nor hatching. The next click starts again.

"**Move object**"
Use this icon to position legends and diagrams at the desired position on the output sheet.

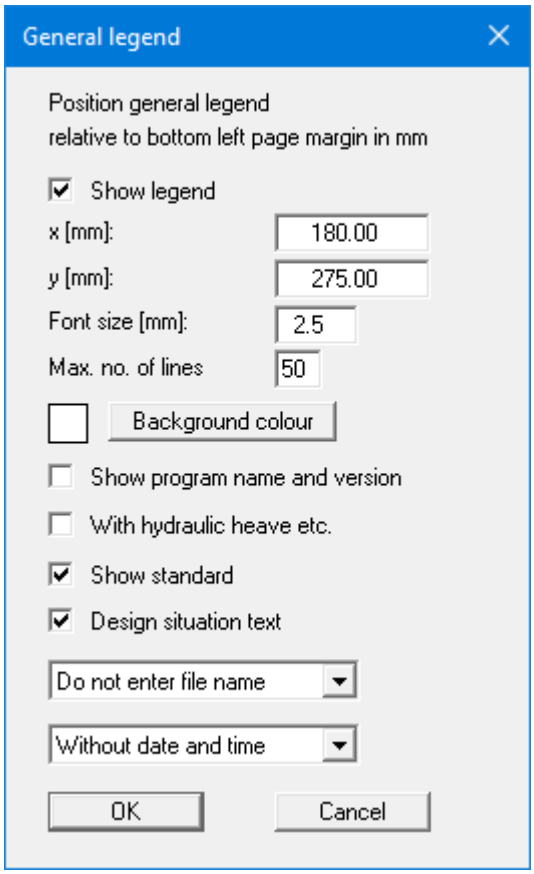
"**Undo move object**"
By clicking this icon the last performed movement of graphical elements made using the [F11] function key or the menu item "**Output preferences/Move objects**" can be undone.

"**Restore move object**"
By clicking this symbol, the last object movement undo carried out using "Undo move object" can be restored.

“**Construction phase back**”/”**Construction phase forward**”
If you are in the display of construction phases, you can use these icons to scroll back and forth between the individual construction phases.

13.7 GGU-LATPILE: "General legend" menu item

A legend with general properties will be displayed on your output sheet, if the "**Show legend**" check box is activated. You can alter the type of visualisation using the dialog box of this menu item.



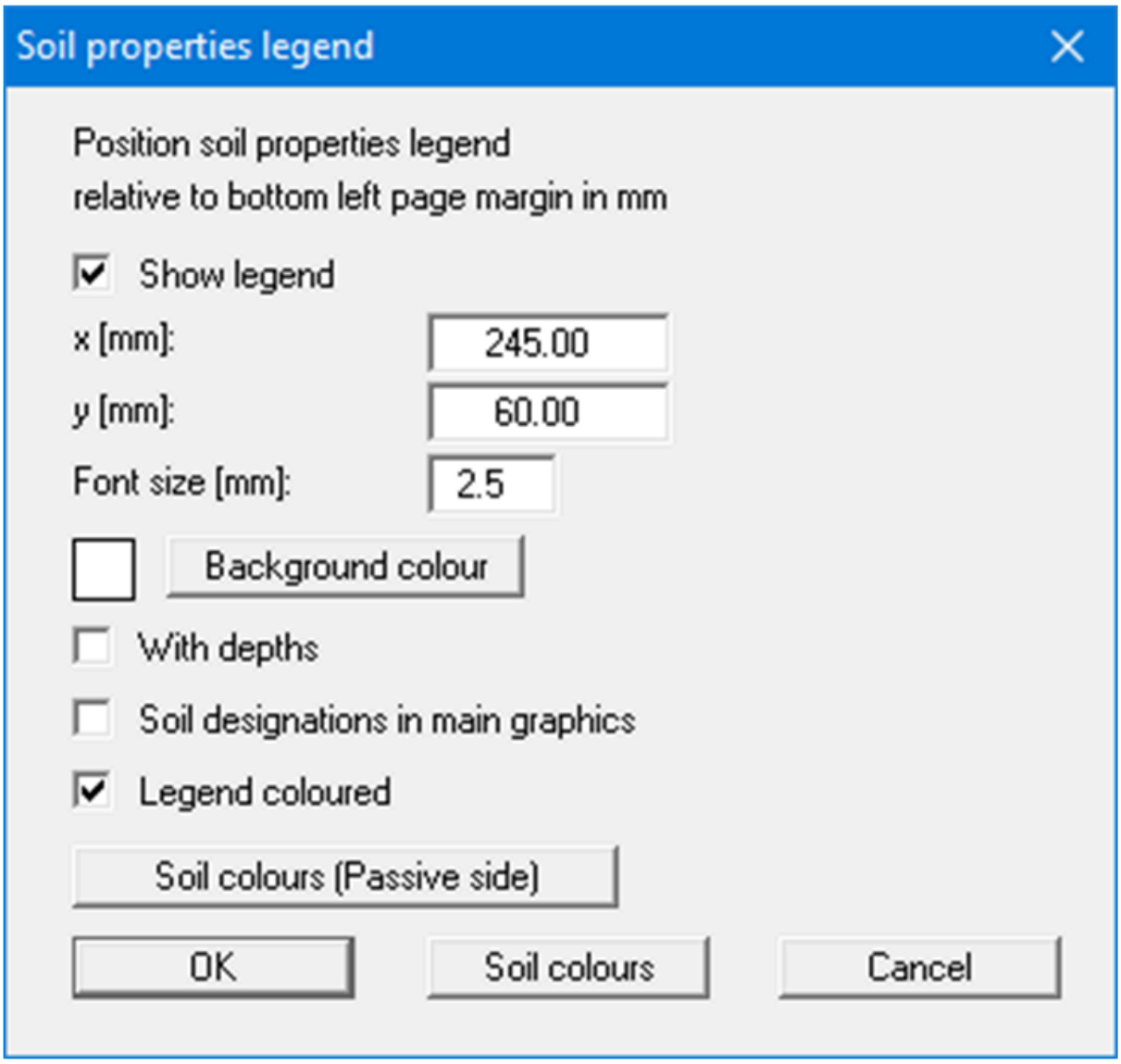
You can define and edit the position of the legend using the values "**x**" and "**y**". You can control the size of the legend via the "**Font size**" and "**Max. no. of lines**"; if necessary, the legend is displayed in several columns. You can also define a background colour in some legends.

The fastest way to modify the position or size of the legend is to press the [**F11**] function key and then to either pull the legend to the new position or to move the sides of the legend to their new size with the left mouse button pressed.

In the ***General legend*** you can, if wished, display information on the program (name and version), on the adopted standard and on the current file (name, path, time info). Any project identification entered in the "**File/New**" or "**Editor 1/Analysis options**" dialog box will also be shown in the General legend , as well as the hydraulic heave if the appropriate check box is activated.

13.8 GGU-LATPILE: "Soil properties legend" menu item

A legend with the soil properties of the individual layers will be displayed on your output sheet. If you have activated the "**Show legend**" check box, you can alter the type of visualisation using the dialog box of this menu item.



You can define and edit the position of the legend using the values "**x**" and "**y**". You can control the size of the legend via the "**Font size**" and "**Max. no. of lines**"; if necessary, the legend is displayed in several columns. You can also define a background colour in some legends.

The fastest way to modify the position or size of the legend is to press the [**F11**] function key and then to either pull the legend to the new position or to move the sides of the legend to their new size with the left mouse button pressed.

- "**With depths**"
  The depths of the individual soil layers will be shown in the soil properties legend.
- "**Soil designations in main graphics**"
  The designations entered for the individual ground layers are displayed in the system graphics adjacent to the layer depths.
- "**Legend coloured**"
  The soil colours are displayed in the legend. Otherwise, they will be numbered.

- "**Soil colours**"/"**Soil colours (passive side)**"
  If, in the menu item "**Editor 1/Analysis options**", you have activated the "**Differentiate active + passive soil properties**" check box, the "**Soil colours (passive side)**" is also displayed.

You will see a dialog box, in which you can define your preferences. After clicking the button with the desired number, you can assign each soil layer a new number or reorganise using the "**Soil colours/Reorganise**" command button. You can save your colour preferences to a file with "**Soil colours/Save**" and use them for different systems by means of the "**Soil colours/Load**" command button. In the lower group box, you can also transfer the colour preferences to the Windows colour management dialog box, or vice versa, as user-defined colour preferences for example. You can read a further description by pressing the "**Info**" button.

13.9 GGU-LATPILE: "Design legend" menu item

Following analysis and design a legend containing the principal system design results is displayed on the screen. Using this menu item, you can alter the type of presentation if the "**Show legend**" check box is activated.

You can define and edit the position of the legend using the values "**x**" and "**y**". You can control the size of the legend via the "**Font size**" and "**Max. no. of lines**"; if necessary, the legend is displayed in several columns. You can also define a background colour in some legends.

The fastest way to modify the position or size of the legend is to press the [**F11**] function key and then to either pull the legend to the new position or to move the sides of the legend to their new size with the left mouse button pressed.

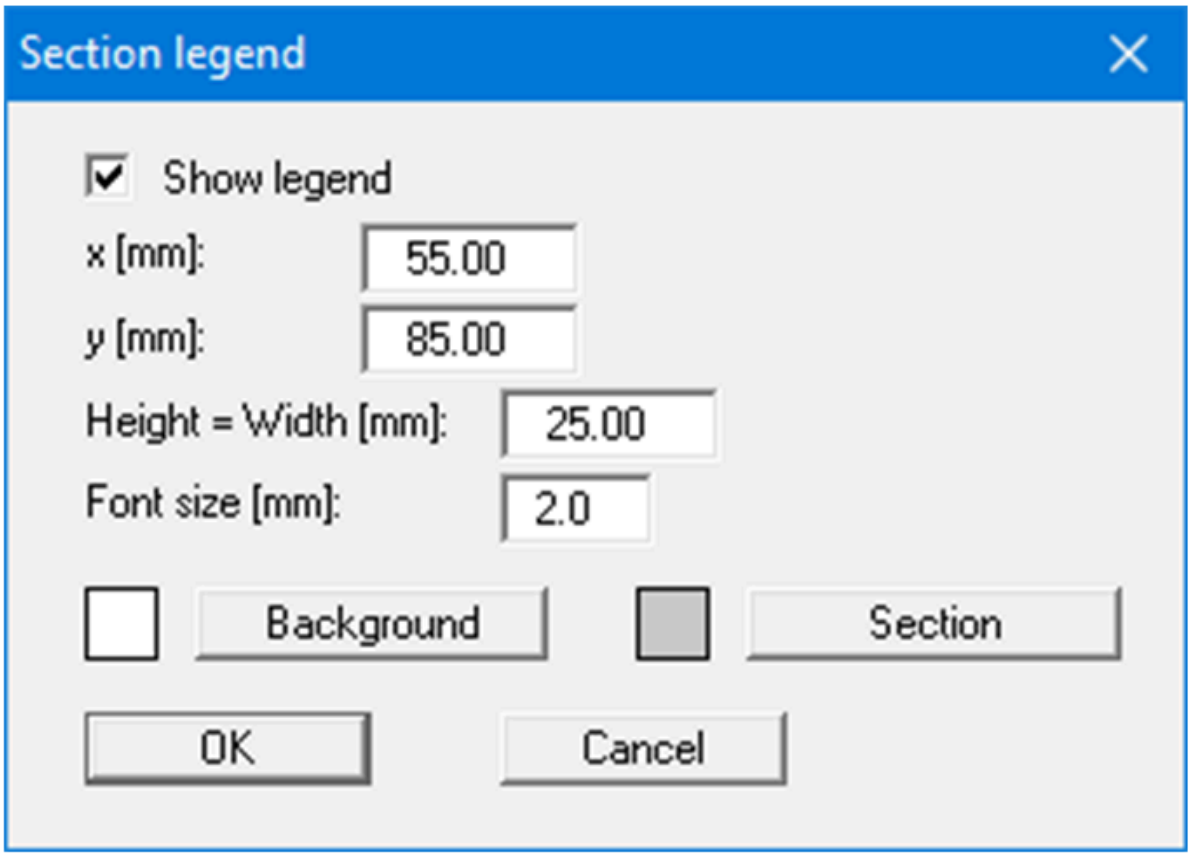
13.10 GGU-LATPILE: "Subgrade modulus legend" menu item

A legend is displayed on the screen containing the subgrade reaction moduli entered for the sections along the pile defined for the subgrade reaction profile. Using this menu item you can alter the type of presentation if the "**Show legend**" check box is activated.

You can define and edit the position of the legend using the values "**x**" and "**y**". The size of the legend is controlled by the values for "**Font size**". The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position while holding the left mouse button.

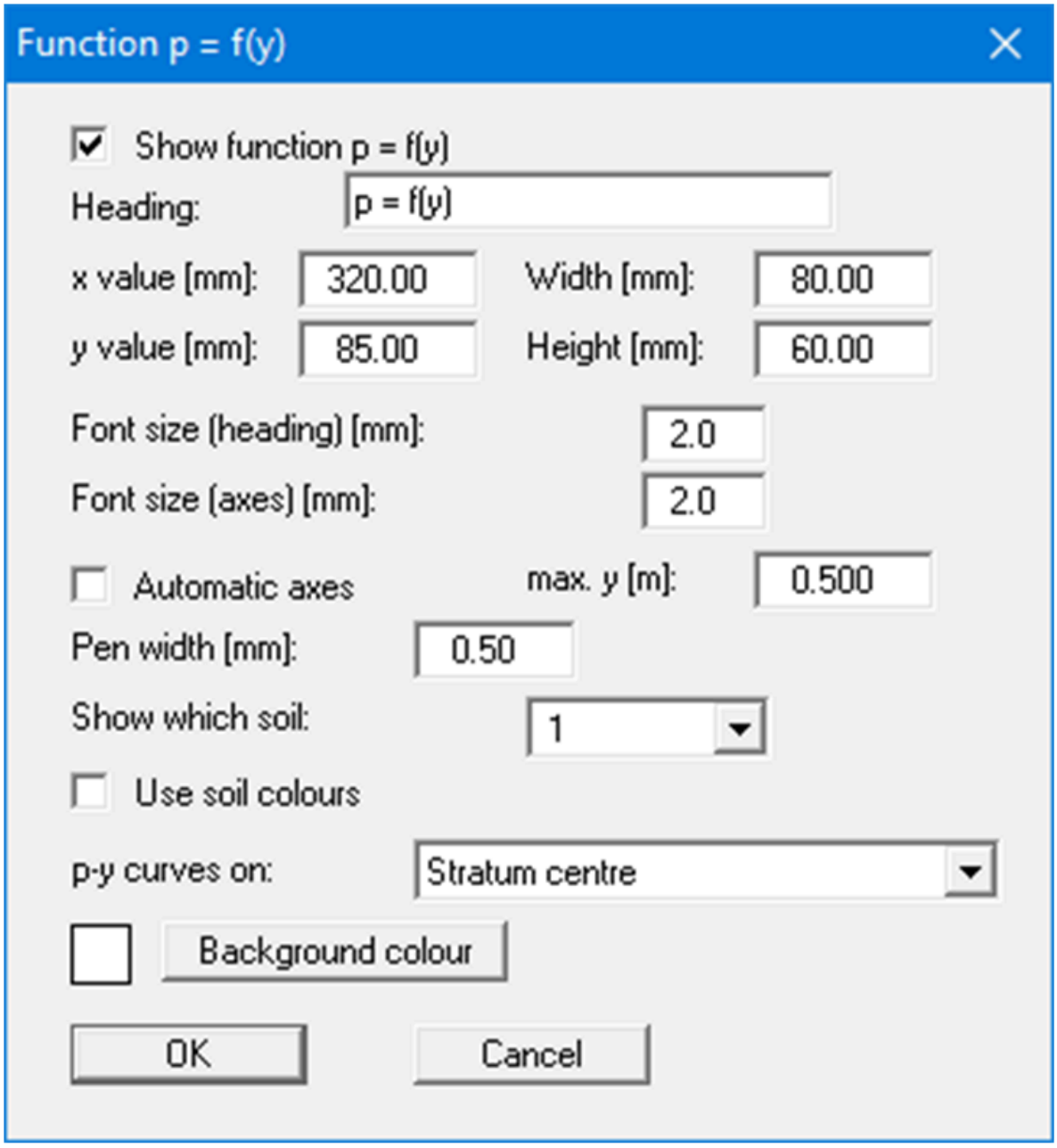
13.11 GGU-LATPILE: "Section legend" menu item

A legend containing a small sketch of the pile section employed is displayed on the screen. Using this menu item you can alter the type of presentation or turn off the legend completely.



13.12 GGU-LATPILE: "p-y curves legend" menu item

You can define and edit the position of the legend using the values "**x**" and "**y**". The size of the legend is controlled by the height-width ratio. The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position while holding the left mouse button.



If you work with the p-y method, a legend of the p-y curves can be displayed. Using this menu item, you can alter the type of presentation or turn off the legend completely.

You can define and edit the position of the legend using the values "**x**" and "**y**". The size of the legend is controlled by the height and width you have entered. The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position while holding the left mouse button.

You can adapt the display of the function p = f(y) to meet your requirements based on the selected soil, alignment of the p-y curves or line colours.

13.13 GGU-LATPILE: "Move objects" menu item

If you select this entry, you can then use the mouse to move the various objects and legends. Move the mouse over the object of your choice. If you are over a movable object, the mouse pointer will take on the shape of a cross. Now press the left mouse button and drag the object to the desired position while holding down the button.

After going to this menu item **only one object** at a time can be moved using the mouse or its size be altered.

If you want to edit several objects, you can also activate the function more quickly by pressing the [**F11**] key or the symbol

. An info box will then no longer appear.

In many GGU programs you can also alter the size of an object using this menu item or the [**F11**] function key. If you are positioned over the frame of a resizable object after activating the function, the mouse takes on the shape of a double arrow. Hold down the left mouse button and drag the frame until the object has reached the desired size. Drag a corner to maintain the aspect ratio of the sides. If you drag on one side, the object becomes taller or wider.

Using the [**Back**] key or by clicking on the icon

you can undo the last change to the position or size of an object.

In programs in which you can position the diagrams yourself (menu item "**System/Graph positioning preferences**"), the result diagrams can also be moved using this function if you have switched to "**Manual graph positioning**".

If "**Manual graph positioning**" has been selected in the "**System/Graph positioning preferences**" menu item, the result graphs can also be repositioned using this function.

13.14 GGU-LATPILE: "Save graphics preferences" menu item

Some of the preferences you made with the menu items of the "**Graphics preferences**" menu can be saved to a file. If you select "**GGU-LATPILE.alg**" as file name and save the file on the same level as the program, the data will be automatically loaded the next time the program is started and need not be entered again.

If you do not go to "**File/New**" upon starting the program, but open a previously saved file instead, the preferences used at the time of saving are shown. If subsequent changes in the general preferences are to be used for existing files, these preferences must be imported using the menu item "**Graphics preferences/Load graphics preferences**".

13.15 GGU-LATPILE: "Load graphics preferences" menu item

You can reload a graphics preferences file into the program, which was saved using the "**Graphics preferences/Save graphics preferences**" menu item. Only the corresponding data will be refreshed.

14 Page size + margins menu

14.1 GGU-LATPILE: "Auto-resize" menu item

This menu item provides a to-scale visualisation, in both x and y coordinates, of the system and result graphics. If you have previously altered the image coordinates graphically or via editor, you can quickly achieve a complete view using this menu item.

This function can also be accessed using the [**F9**] function key.

14.2 GGU-LATPILE: "Manual resize (mouse)" menu item

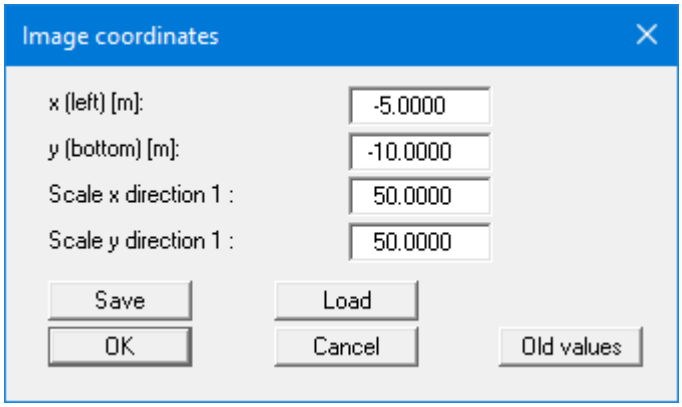
You can transfer the coordinates of a section of your previous graphic display as new image coordinates by holding down the [**Ctrl**] and [**Shift**] keys and marking the desired area with the left mouse button. The scales of the x-direction and y-direction are adjusted accordingly.

In the default setting, the "**Proportional section**" check box is activated. This retains the previous proportions (scale x-direction/scale y-direction).

If you activate the "**Redefine origin**" check box, you can adjust the image coordinates without changing the scale. In this way, you can quickly achieve the desired visualisation without having to try out the x/y coordinates if the scale is set appropriately.

14.3 GGU-LATPILE: "Manual resize (editor)" menu item

You can alter the current image coordinates by direct numerical input in a dialog box. This allows precise scale input. The coordinates refer to the drawing area. This can be defined in the "**Page size + margins/Page size and margins**" menu item by means of the plot margins.



The image coordinates entered here can be saved in a file with the extension "**.bxy**" and be reloaded later for the same file or for different files.

If you want to recover the previous values during input or use the menu item again after editing the coordinates, you can do this by pressing the "**Old values**" button.

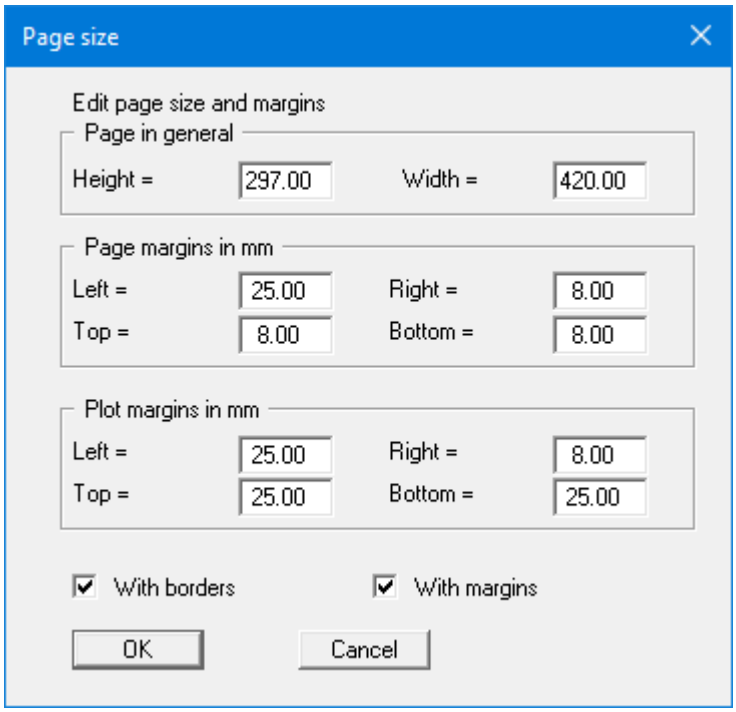
14.4 GGU-LATPILE: "Font size selection" menu item

You can edit font sizes for labelling the various drawing elements.

The font sizes of text within legends are edited in the respective legend editor. Just double-click in a legend to do this.

14.5 GGU-LATPILE: "Page size and margins" menu item

The default page set-up is A3 when the program is started. You can edit the page format in the following dialog box.



- "**Page in general**" defines the size of the output sheet. The A3 format is set as default. The program automatically draws thin cutting borders around the page, which are required when using a plotter on paper rolls. The borders can be switched off deactivating the "**With borders**" check box.
- "**Page margins**" define the position of a frame as a distance to the margins. This frame encloses the subsequent diagram. You can switch off the frame deactivating the "**With margins**" check box.
- The "**Plot margins**" define a set distance between the page margin and the actual ***drawing area*** in which the graphical evaluation of your input is presented.

14.6 GGU-LATPILE: "Undo" menu item

If you have carried out any changes to dialog boxes or moved objects to a different position on the screen after selecting the "**Graphics preferences/Move objects**" menu item or using the [**F11**] function key, this menu item will allow you to undo the movements.

This function can also be reached by using the key combination [**Alt**] + [**Back**] or the icon

in the toolbar.

14.7 GGU-LATPILE: "Restore" menu item

When this menu item is selected the last change made in a dialog box or the last change in the position of objects, which you undid using the menu item "**Page size + margins/Undo**" will be restored.

This function can also be reached by using the key combination [**Ctrl**] + [**Back**] or the icon

in the toolbar.

14.8 GGU-LATPILE: "Preferences" menu item

You can activate or deactivate the undo functions.

15 Info menu

15.1 GGU-LATPILE: "Copyright" menu item

You will see a copyright message and information on the program version number.

The "**System**" button shows information on your computer configuration and the folders used by the GGU program.

15.2 GGU-LATPILE:"GGU on the web" menu item

Using this menu item, you can access the **GGU Software website**.

Check the page of your program module at regular intervals for information about updates and changes. On the "**Changelogs**" subpage, you can also subscribe to an e-mail notification that informs you of all changes on a monthly basis.

15.3 GGU-LATPILE: "GGU support" menu item

This menu takes you directly to the **GGU Software Support Portal**.

Here you can enter your support request directly and upload your edited GGU program file.

15.4 GGU-LATPILE: "Maxima" menu item

Here you can check the defaults for maximum values.

15.5 GGU-LATPILE: "Compare earth pressure coefficients" menu item

Here you can calculate the earth pressure coefficients for given values of phi, delta and beta.

15.6 GGU-LATPILE: "kh method" menu item

Using this menu item, you can design according to the kh method (***DIN 1045 old***), independent of any calculated internal forces.

15.7 GGU-LATPILE: "M-N diagram" menu item

Using this menu item, you can design according to the kh method (***DIN 1045 old***), indepUsing this menu item, you can design circular cross- sections according to DIN 1045 (old), independent of any calculated internal forces. The program calculates steel and concrete strains by means of iteration and from this determines the necessary reinforcement for a symmetrically reinforced circular cross section. Using this routine, you no longer need to rely on barely readable literature diagrams, but can now also design reinforcement that is not given as diagrams the conventional literature.

15.8 GGU-LATPILE: "Steel design to EC3" menu item

You can perform steel design to EC3 for a different section. You will see the same dialog box as in the menu item "**System/Design defaults**".

15.9 GGU-LATPILE: "Help" menu item

You will be directed to the homepage of the online manual for the GGU program. The help function can also be accessed using the [**F1**] function key.

15.10 GGU-LATPILE: "What's new?" menu item

You will see information on program improvements in comparison to older versions.

15.11 GGU-LATPILE: "Language preferences" menu item

This menu item allows you to switch the menus and the graphics from German to English and vice versa. To work in German, deactivate the two check boxes "**Dialoge + Menüs übersetzen (translate dialogues, menus)**" und "**Graphiktexte übersetzen (translate graphics)**".

Alternatively, you can work bilingually, e.g. with German dialog boxes but with graphic output in English. The program always starts with the language setting applicable when it was last ended.