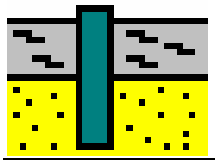
Calculation and graphical representation of piles to DIN 4014, DIN 1054, EC 7, EA-Pfähle and after Franke

GGU-AXPILE

VERSION 6



Last revision:	February 2012
Copyright:	Prof. Dr. Johann Buß
Technical implementation and sales:	Civilserve GmbH, Steinfeld

Contents:

1 Preface 5

2 Licence protection and installation 5

3 Language selection 6

4 Starting the program 6

5 Theoretical principles 7

5.1 General information 7

5.2 Pile design to EAP 7

5.2.1 General 7

5.2.2 Design of Franki piles 9

5.3 Bored piles to DIN 4014 and DIN 1054 13

5.4 Driven piles to Tables C.1 and C.2 in DIN 1054 13

5.5 Driven piles according to FRANKE 14

5.6 Tension piles 15

5.7 Partial factors 15

6 Short description and worked examples 16

6.1 Structure and design of output sheets 16

6.1.1 Generate result graphics 16

6.1.2 Move graphic elements 18

6.1.3 Edit and turn off graphic elements 18

6.1.4 Edit page size and margins 20

6.2 Example 1: Bored pile to EAP 20

6.2.1 Select system preferences (Example 1) 20

6.2.2 Enter system parameters (Example 1) 21

6.2.3 Define soils (Example 1) 23

6.2.4 Analyse with constant pile length (Example 1) 24

6.3 Example 2: Driven pile to EAP 26

6.3.1 Select system preferences (Example 2) 26

6.3.2 Enter system parameters (Example 2) 26

6.3.3 Define soils (Example 2) 27

6.3.4 Analyse with constant pile width (Example 2) 28

6.4 Further EAP examples 29

7 Description of menu items 30

7.1 File menu 30

7.1.1 "New" menu item 30

7.1.2 "Load" menu item 30

7.1.3 "Save" menu item 30

7.1.4 "Save as" menu item 30

7.1.5 "Printer preferences" menu item 30

7.1.6 "Print and export" menu item 31

7.1.7 "Batch print" menu item 33

7.1.8 "Exit" menu item 33

7.1.9 "1, 2, 3, 4" menu items 33

7.2 Edit menu 34
7.2.1 "Project identification" menu item 34
7.2.2 "Pile type" menu item 34
7.2.3 "System parameters" menu item 35
7.2.4 "Partial factors" menu item 36
7.2.5 "Soils" menu item 37
7.2.6 "Piles (diameters)" and "Piles (widths)" menu items 38
7.2.7 "Piles (lengths)" menu item 38
7.2.8 "Single pile" menu item 38
7.2.9 "User-defined bored pile" menu item 39
7.2.10 "User-defined driven pile" menu item 40
7.3 System menu 41
7.3.1 "Analyse" menu item 41
7.4 Output preferences menu 41
7.4.1 "Pile diagram" menu item 41
7.4.2 "Soil properties legend" menu item 43
7.4.3 "System presentation" menu item 44
7.4.4 "General legend" menu item 45
7.4.5 "Output table" menu item 46
7.4.6 "Resistance-settlement curve" menu item 47
7.4.7 "Results" menu item 48
7.4.8 "Pile cross-section" menu item 49
7.4.9 "Empirical data table" menu item 50
7.4.10 "Page size and margins" menu item 51
7.4.11 "Move objects" menu item 51
7.5 Graphics preferences menu 52
7.5.1 "Refresh and zoom" menu item 52
7.5.2 "Fill colours" menu item 52
7.5.3 "Zoom info" menu item 52
7.5.4 "Legend font selection" menu item 52
7.5.5 "Margins and borders" menu item 53
7.5.6 "Pen colour + width" menu item 53
7.5.7 "Mini-CAD toolbar" menu item 53
7.5.8 "Toolbar preferences" menu item 54
7.5.9 "Load graphics preferences" menu item 55
7.5.10 "Save graphics preferences" menu item 55
7.6 ? menu 56
7.6.1 "Copyright" menu item 56
7.6.2 "Help" menu item 56
7.6.3 "GGU on the web" menu item 56
7.6.4 "GGU support" menu item 56
7.6.5 "What's new?" menu item 56
7.6.6 "Language preferences" menu item 56

8 Tips and tricks 57
8.1 Keyboard and mouse 57
8.2 Function keys 57
8.3 "Copy/print area" icon 58
9 Index 59

1 Preface

The **GGU-AXPILE** program allows calculation of bored piles to DIN 4014 and of driven piles according to Franke (Geotechnical Engineering Handbook (GEH) 2003; Part 3) and the graphical representation of the results. Tension piles can also be calculated. Both the ***global safety factors*** to DIN 1054 (old) and the ***partial safety factors*** to DIN 1054:2005 or EC 7 may be taken into consideration.

The Recommendations of the Working Group on "Piles" (***EA-Pfähle*** - EAP) were published in April 2007. These recommendations allow the design of a large number of cored and driven piles via design tables. In these terms, the EAP represents current best practice. Annexes to the DIN 1054 will be replaced in the future by references to the EAP. In the **GGU-AXPILE** program the EAP analyses methods were implemented for pile design.

Depending on the soil properties, the pile length or the pile diameter/pile side width are varied and the allowable pile load calculated. The allowable pile load is represented as a function of the pile diameter or the pile length, determined by the type of variation selected (pile length or pile diameter). Alternatively, the detailed analysis results can also be displayed for a single pile.

Data input is in accordance with conventional WINDOWS operations and can therefore be learned almost entirely without the use of a manual. Graphic 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. 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 Licence protection and installation

In order to guarantee a high degree of quality, a hardware-based copy protection system is used for the **GGU-AXPILE** program.

The GGU software protected by the ***CodeMeter*** copy protection system is only available in conjunction with the ***CodeMeter stick*** copy protection component (hardware for connection to the PC, "***CM stick***"). Because of the way the system is configured, the protected software can only be operated with the corresponding CM stick. This creates a fixed link between the software licence and the CM stick copy protection hardware; the licence as such is thus represented by the CM stick. The correct Runtime Kit for the CodeMeter stick must be installed on your PC.

Upon start-up and during running, the **GGU-AXPILE** program checks that a CM stick is connected. If it has been removed, the program can no longer be executed.

For installation of GGU software and the CodeMeter software please refer to the information in the ***Installation notes for GGU Software International***, which are supplied with the program.

3 Language selection

GGU-AXPILE is a multilingual program. The program always starts with the language setting applicable when it was last ended.

The language preferences can be changed at any time in the "**?**" menu, using the menu item "**Language preferences**" (in German: "**Spracheinstellung**", in Spanish: "**Configuración de idioma**").

4 Starting the program

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

- File
- ?

After clicking on the "**File**" menu, a previously calculated system can be loaded by means of the "**Load**" menu item, or a new one created using "**New**".

The program allows simple input procedures by moving directly to the option box after "**New**" is clicked; this can also be reached by pointing to the "**Edit/Pile type**" menu item. You can now directly select the standard to be adopted and the required pile type. After leaving this box by pressing "**OK**" the relevant load case can also be selected.

You then arrive at the initial program screen, containing an example system with legends and an empty frame, in which the output table the resistance settlements and the pile diagram will later be represented. Six menus then appear at the top of the window:

- File
- Edit
- System
- Output preferences
- Graphics preferences
- ?

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 **GGU-AXPILE** screen is not refreshed after every alteration.

If you would like to refresh the screen contents, press either [**F2**] or [**Esc**]. The [**Esc**] key additionally sets the screen presentation back to your current zoom, which has the default value 1.0, corresponding to an A3 format sheet.

5 Theoretical principles

5.1 General information

Calculation of bored piles and driven piles use differing procedures. Accordingly, some dialog boxes vary when working with the different pile types. Alternatively to input of a pile diameter, the width of a rectangular pile can also be entered. The term "**pile diameter**" is generally used in this manual. If you need to investigate a rectangular pile, the term "**pile diameter**" should be mentally replaced by the equivalent "**pile side width**" or "**pile width**".

5.2 Pile design to EAP

5.2.1 General

The Recommendations of the Working Group on Piles (***EAP***) were published in April 2007. These recommendations allow the design of a large number of cored and driven piles via design tables. In these terms, the EAP represents current best practice. Annexes to the DIN 1054 will be replaced in the future by references to the EAP.

The central input values are the cone pressure q_c of the CPT in cohesion less soils or the shear strength $c_{u,k}$ in cohesive soils. This empirical data is represented in the EAP by way of pile type-related tables. For example, for bored piles these are Tables 5.12 (cone resistance in cohesion less soils), 5.13 (skin friction in cohesion less soils), 5.14 (cone resistance in cohesive soils) and 5.15 (skin friction in cohesive soils). There are two values in each table cell, representing a lower and an upper value. The EAP recommends use of the lower values.

The EAP table data are stored in the **GGU-AXPILE** program and can be summarised in a legend for the selected pile type (see the menu item "**Output preferences/Empirical data table**", Section 7.4.9). Table 1 shows an example of the table containing empirical data for a bored pile, as it is shown in the program.

Empirical data for: Bored pile			
s/D_s	Pile end resistance $q_{b,k}$ [MN/m²]		
	q_c = 7,5 MN/m²	q_c = 15 MN/m²	q_c = 25 MN/m²
0,02	0,550 - 0,800	1,050 - 1,400	1,750 - 2,300
0,03	0,700 - 1,050	1,350 - 1,800	2,250 - 2,950
0,10	1,600 - 2,300	3,000 - 4,000	4,000 - 5,300
	$c_{u,k}$ = 100 kN/m²	$c_{u,k}$ = 150 kN/m²	$c_{u,k}$ = 250 kN/m²
0,02	0,350 - 0,450	0,600 - 0,750	0,950 - 1,200
0,03	0,450 - 0,550	0,700 - 0,900	1,200 - 1,450
0,10	0,800 - 1,000	1,200 - 1,500	1,600 - 2,000
Skin friction $q_{s,k}$ [MN/m²]			
q_c = 7,5 MN/m²	q_c = 15 MN/m²	q_c = 25 MN/m²	
0,055 - 0,080	0,105 - 0,140	0,130 - 0,170	
$c_{u,k}$ = 60 kN/m²	$c_{u,k}$ = 150 kN/m²	$c_{u,k}$ = 250 kN/m²	
0,030 - 0,040	0,050 - 0,065	0,065 - 0,085	

=> Table 5.12 EAP

=> Table 5.14 EAP

=> Table 5.13 EAP

=> Table 5.15 EAP

Table 1 Empirical data for a bored pile

Previously, the values for sig02, sig03, sig10 and tau ($q_{b,k02}$, $q_{b,k03}$, $q_{b,k10}$, $q_{s,k}$) had to be defined for each soil type for bored pile analysis (see Section 5.3). These values are determined automatically to EAP via q_c and $c_{u,k}$ from the appropriate tables.

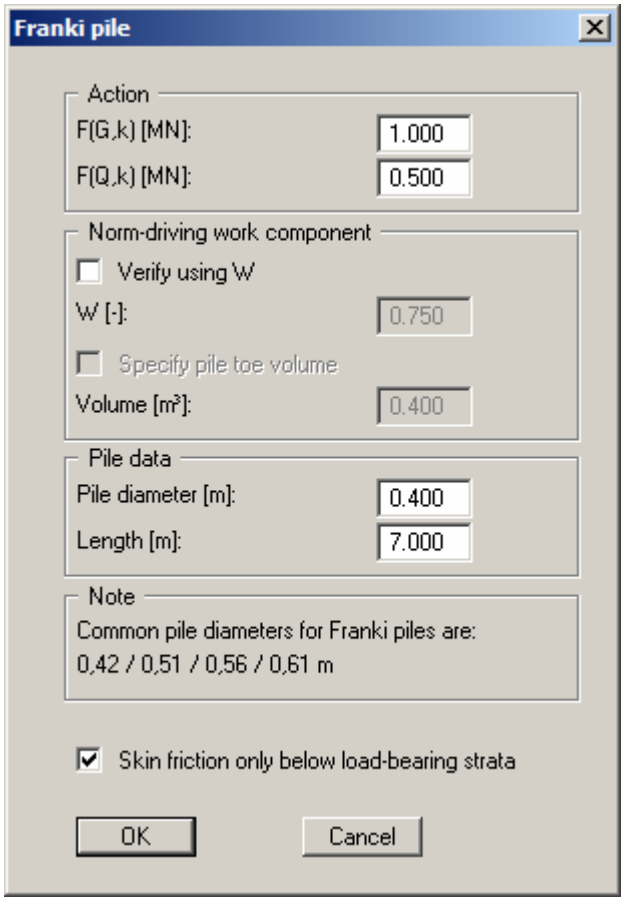
If q_c and $c_{u,k}$ are specified the program can also differentiate between load-bearing and non-load-bearing soil. This now makes queries in terms of the embedment in load-bearing strata possible. This has been implemented in **GGU-AXPILE** together with numerous other confirmation prompts.

In terms of the magnitude of the pile tip resistance and the pile skin friction, reductions are required for the analysis of pre-cast driven piles. They are defined in the EAP (Table 5.5) by means of calibration factors. These calibration factors are incorporated in **GGU-AXPILE**.

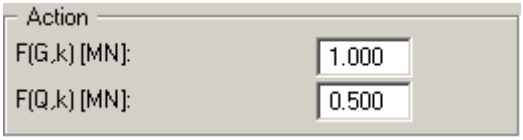
5.2.2 Design of Franki piles

The design of Franki piles is slightly different to the design of the other piles dealt with in the recommendations. The two example file provided, "**Example B7 lower values.phl**" and "**Example B7 upper values.phl**" contain the calculation for the corresponding examples in the EAP.

If you have selected the Franki pile in the "**Edit/Pile type**" menu item, the Franki pile dialog box opens by clicking the "**Edit/Single pile**" menu item:



The characteristic action of the pile is defined first.



The design load E_d is given by the characteristic action.

$$\mathbf{E_d = F_{G,k} \cdot \gamma_G + F_{Q,k} \cdot \gamma_Q}$$

γ_G = partial safety factor for permanent actions
γ_Q = partial safety factor for changeable actions

This in turn gives the required, characteristic bearing resistance $R_{1,k}$.

$$\mathbf{R_{1,k} = E_d \cdot \gamma_P}$$

The characteristic bearing resistance $R_{1,k}$ comprises the pile shaft resistance $R_{s1,k}$ and the pile base resistance $R_{1b,k}$. The characteristic pile shaft resistance is calculated ***classically*** using the values from Tables 5.10 and 5.11 of the EAP, whereby the lower 0.8 m of the pile may not be adopted. The required pile base resistance $R_{1b,k}$ can now be calculated from this:

$$\mathbf{R_{1b,k} = R_{1,k} - R_{1s,k}}$$

Using the mean values for the CPT cone resistance q_c or for the shear strength $c_{u,k}$ of the undrained soil and the required pile base resistance $R_{1b,k}$, the required pile toe volume V can be determined from the nomograms in Figs. 5.5 to 5.10 of the EAP.

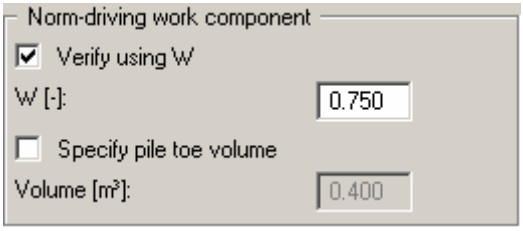
> However, we expressly point out that the thus determined pile toe volume is only used for draft design. Verification of the ultimate limit state must be performed on the basis of the driving work expended on the final two driven metres. Please observe the notes on this in EAP 5.4.5.3.

Beside the volume V the norm-driving work component W is determined.

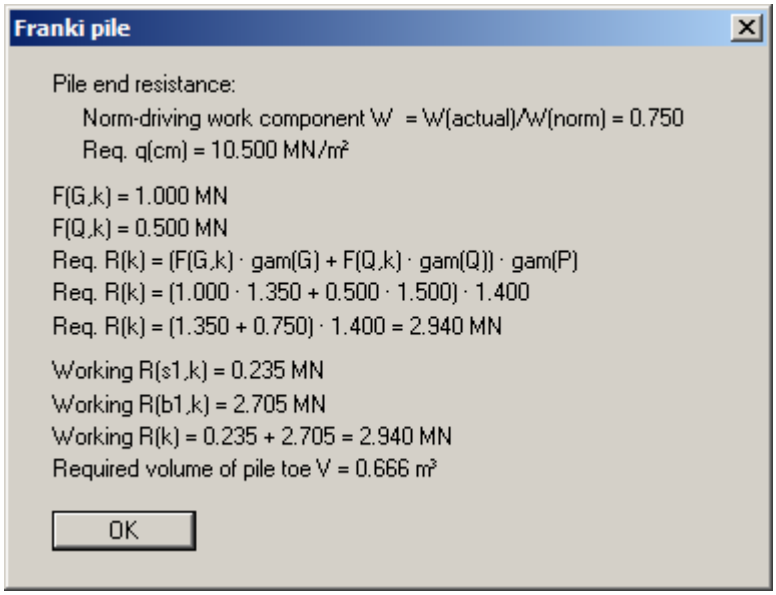
$$\mathbf{W = W_{actual}/W_{norm}}$$

The norm-driving work W_{norm} is given in Table 5.9 in the EAP for a variety of tube diameters. It is thus possible to determine the required driving work W_{actual} for the final 2 metres. The example file provided "**Example B7 lower values.phl**" contains the analyses used for the corresponding example in the EAP.

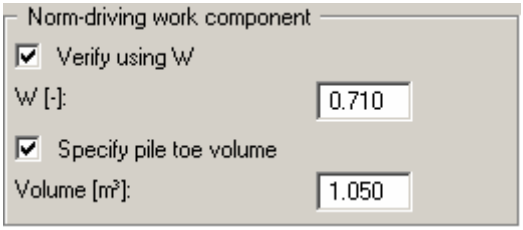
When the file has reached depth during manufacture and the actual driving work expended W_{actual} is known, the required pile toe volume V necessary to transfer the characteristic load E_d can also be determined. For this purpose activate the "**Verify using W**" check box in the "**Edit/Single pile**" dialog box and enter the norm-driving work component W.



The program then calculates the required pile toe volume V.

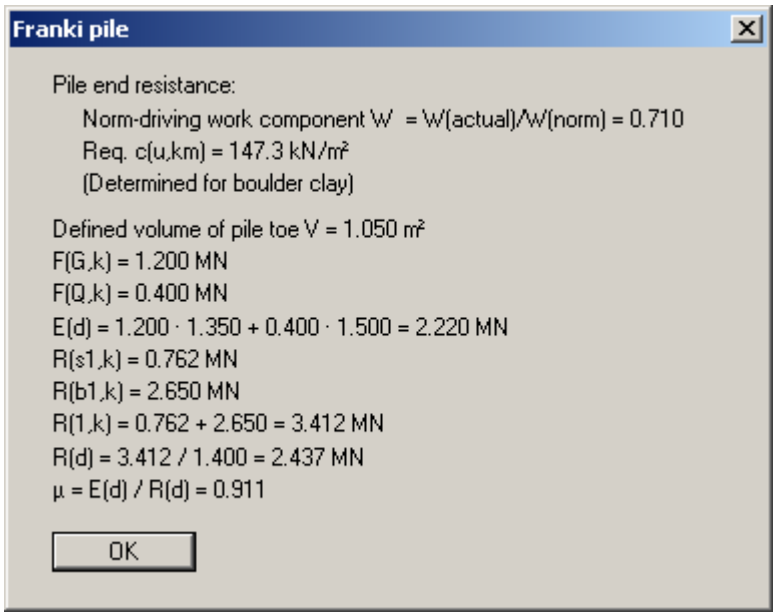


In the case that the file is already complete and both W and V are known, also activate the "**Specify pile toe volume**" check box in the "**Edit/Single pile**" dialog box. First open the file "**Example B7 lower values.phl**".



The program then calculates the utilisation factor μ for the characteristic load E_d.

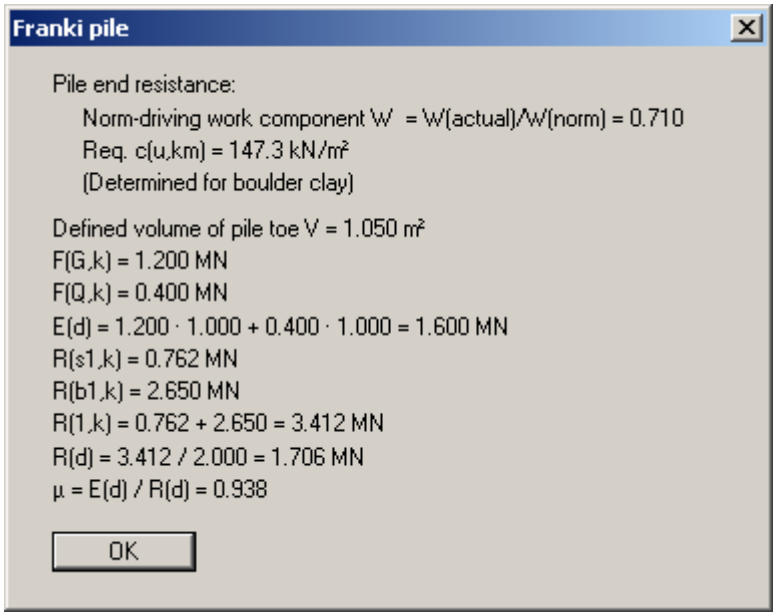
$$\mu = E_d/R_d$$



Result for the example used in the file "**Example B7 lower values.phl**"

The calculation also works using the global safety factor approach. However, because the end is in sight in terms of the validity of the global safety factor approach, the designations are no longer kept up to date. When analysing using the global safety factor approach the partial safety factors for actions are set to **1.0**. The ***partial factor*** (= global factor) for the bearing resistance is set to 2.00 (LC1), 1.75 (LC2) or 1.50 (LC3) depending on the selected load case.

Applying the global safety factor approach to the example above gives:



The utilisation factor of 0.938 is in terms of a global safety factor of 2.0 (LC1) and means that the safety η is 2.0/0.938 = 2.13.

5.3 Bored piles to DIN 4014 and DIN 1054

The calculation of bored piles is comprehensively described in DIN 4014 and DIN 1054. Using the information given there a synthetic resistance-settlement curve can be calculated from which, beside the failure settlement, the settlement behaviour of the bored pile may be derived. The end resistance for a settlement s of

- s = 0.02 · D (pile diameter)
- s = 0.03 · D (pile diameter)
- s = 0.10 · D (pile diameter) = failure settlement

must be given. The corresponding end resistances are designated sig02, sig03 and sig10 or qb,k02 etc. in the program. The end resistances given in the DIN can be adopted directly from within the program. However, it is also possible to enter values deviating from the DIN.

In addition to the end resistances the skin friction must also be given for each soil. This is known as tau or qs,k by the program. Here, too, the values given in the DIN can be adopted directly from within the program. You can also enter user-defined values deviating from the DIN here. The skin friction increases linearly from "**0**" to the full value for settlements of up to 2 cm. It then remains constant.

> The DIN 4014 demands that the bored pile is embedded at least 2.5 m into load-bearing soil. This condition is not checked by the **GGU-AXPILE** program when using this type of pile. From the pile length and the ground stratification, the program only determines in which soil layer the pile is located. The values of sig02, sig03 and sig10 given for this soil are utilised to determine the end resistance. The skin friction forces are determined for the layers above this.

5.4 Driven piles to Tables C.1 and C.2 in DIN 1054

In Tables C.1 and C.2 of DIN 1054:2005 pile end resistances and pile skin friction for driven prefabricated steel or prestressed concrete piles are given for ***cohesion less*** soils. Failure values for pile end resistance and pile skin friction are given as a function of the cone resistance of the CPT. The table values are integrated in the program so that only the CPT cone resistance need be given for the individual soils.

The January 2003 DIN 1054 defines different values for the end resistance and skin friction than the January 2005 issue of DIN 1054. In order to retain the compatibility of older records it is possible to switch between the year versions when selecting a driven pile to Tables C.1 and C.2 of DIN 1054.

5.5 Driven piles according to FRANKE

The approach after FRANKE is applied to driven piles (e.g. in the Geotechnical Engineering Handbook 2003, Part 3), allowing calculation of a resistance-settlement curve also for driven piles. The relationship given by Franke is:

$$\textbf{End resistance } \sigma = \beta \cdot (s/b^*)^{1/c}$$

$$\textbf{Skin friction } \tau = \alpha \cdot q_s$$

Where:

s = pile settlement [mm]

q_s = cone resistance of the CPT to DIN 4094 [MN/m²]

α, β, b^*, c = coefficients according to the following table

Pile type	β [–]	b^* [mm^{2c}/MN]	c [-]	α [–]
Reinforced concrete driven piles	1.0	0.25	1.63	0.003
In-situ concrete driven piles	1.0	0.55	1.55	0.004
"Franki" piles	2.0	0.55	1.55	0.004
Plain steel piles	1.0	0.65	1.90	0.002

Table 2 Coefficients for driven piles to FRANKE

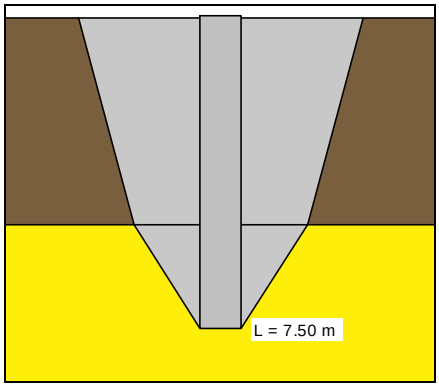
The skin friction increases linearly from "**0**" to the full value for settlements of up to 0.5 cm. It then remains constant. The above values can be adopted directly from within the program. However, you can also use your own values.

The values for the end resistance increase uninterrupted. A failure settlement cannot be read from the curve after Franke. You must therefore additionally define a failure settlement s_g. This can be achieved either by means of an absolute value definition (e.g. s_g = 0.5 cm) or a ***relative value*** as a function of the pile diameter (e.g. s_g = 0.025 · pile diameter).

The **GGU-AXPILE** program does not examine the minimum embedment in load-bearing soil according to standard when using this type of pile. The parameters β, b^* and c listed in the above table describe the end resistance of a driven pile. The end resistance of a driven pile that can be activated is thus completely independent of the soil parameters entered in the menu item "**Edit/Soils**". You must therefore examine whether the ground in the region of the pile toe fulfils the requirements of parameters β, b^* and c. This is generally the case if the soil displays at least medium dense compaction or at least firm to semi-solid consistency. The soil parameter q_s, together with the parameter α, is solely responsible for skin friction. The soil parameters γ' and γ are only important when working with ***tension piles***.

5.6 Tension piles

Of course, for tension piles, no data is required with regard to the end resistance. The allowable pile load is determined from the skin friction only. This value is compared to the value for the weight of the so-called pull-out cone.



The determining factor for the size of the pull-out cone is the friction angle (see figure above). The weight is determined from the unit weights entered, taking the groundwater level into consideration. The weight is divided by the safety factor eta (pull-out); this can be given in the menu item "**Edit/System parameters**" when defining the driven piles. If the thus reduced weight is smaller than the force from skin friction, the value is used as the allowable pile loading.

For tension piles, reductions are necessary dependent upon the expected number of load cycles. This reduction is not performed by the current program version.

5.7 Partial factors

The characteristic bearing resistance R_k is determined in the same manner for partial factors as it is for global factors. Using the partial factor concept, the failure resistance is divided by the partial factor γ_P for the bearing resistance according to Table 3 of DIN 1054:2005. The thus determined design value for the bearing resistance R_d must be greater than the design value for the effect E_d. The design value of the effect is obtained from the characteristic effect E_k i multiplied by the partial factor for actions and effects ($\gamma_{G,Q}$) according to Table 2 of DIN 1054:2005.

$$\gamma_{G,Q} \cdot E_k \leq \frac{R_k}{\gamma_P}$$

If this equation is divided by $\gamma_{G,Q}$, an allowable (acceptable) pile load can be determined in analogy to the global factor concept.

$$Allowable\ E = \frac{R_k}{\gamma_P \cdot \gamma_{G,Q}}$$

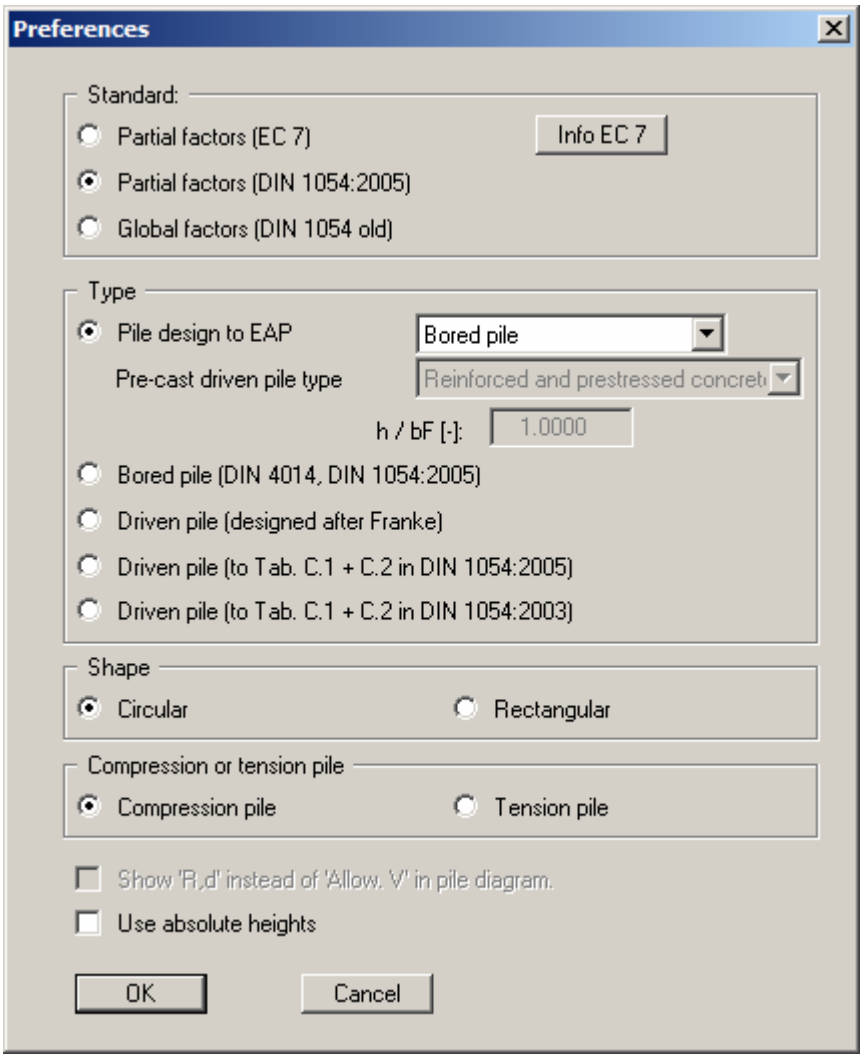
The allowable pile loads can then be compared to characteristic effects.

6 Short description and worked examples

6.1 Structure and design of output sheets

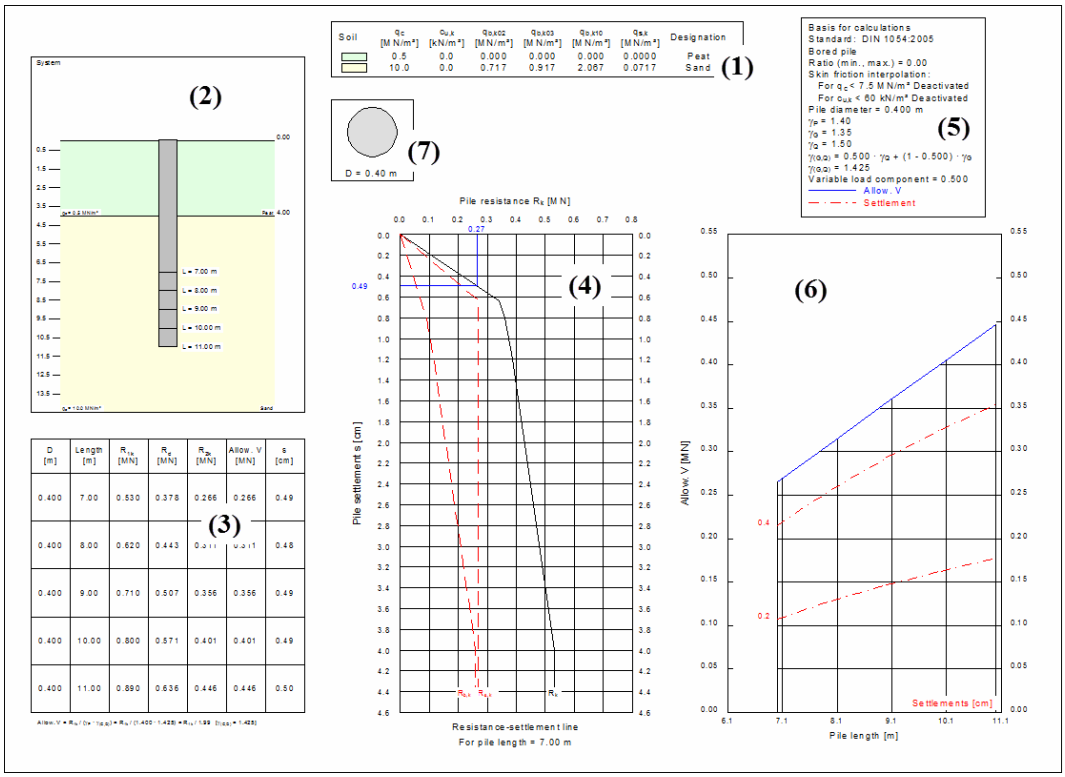
6.1.1 Generate result graphics

After starting the program the logo is at first displayed. Select the menu item "**File/New**". The program allows simple input procedures by moving directly to the input box after "**New**" is clicked; this can also be reached by pointing to the "**Edit/Pile type**" menu item. Here, you can define the fundamental specifications for the type of calculation to be performed.



The program opens with a sample system. Keep the default settings. After confirming with "**OK**" you will see a dialog box, in which you can select the load case to be analysed. The safety factors corresponding to the selected load case are automatically used in the system data.

Leave the dialog box clicking on the "**Load case 1**" button and then select "**System/Analyse**" menu item. The output sheet with all graphics for the values given is shown on the screen.



The graphics above consist of a total of seven elements (also see "**Output preferences**" menu):

- Legend with **soil properties (1)**;
- Graphical representation of the **system (2)** (soil structure, pile or piles, among others);
- **Output table (3)** with analysis results;
- **Resistance-settlement diagram (4)** with the resistance-settlement curve for a selected pile length or pile diameter;
- Legend with **analysis fundamentals (5)** such as pile type, pile length, safety factor, groundwater level, etc.;
- **Pile diagram (6)** with analysis results for allowable pile loading and settlements,
- Legend displaying the **pile cross-section (7)**.

6.1.2 Move graphic elements

All graphic elements can be rearranged at will. Select the "**Move objects**" menu item from the "**Output preferences**" menu. Confirm the info box with "**OK**". Move the mouse over the object to be moved, press the left mouse button and keep it pressed whilst moving the object. After releasing the mouse button the object is shown at its new position.

The size of some objects can also be altered. To alter the size of an object, move the mouse to the top or right-hand edge of the object in question and move the edge with the left mouse button pressed. If you are within the boundaries of a graphic element, the mouse pointer changes to a cross with double arrows pointing ***left-right*** and ***up-down***. If the mouse pointer is at the top or right-hand edge of a resizable element, the mouse pointer changes to a simple double-arrow, pointing either ***left-right*** or ***up-down***. To carry out further alterations, the menu item must be reactivated after each movement.

> You can activate this program function without the info box by pressing the [**F11**] function key.

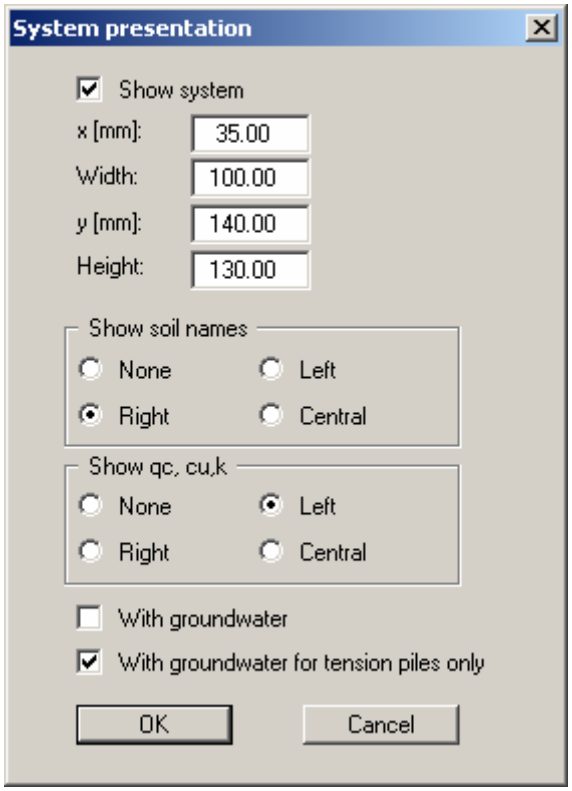
6.1.3 Edit and turn off graphic elements

You can completely remove graphic elements or alter their size and position. Select one of the following menu items from the "**Output preferences**" menu:

- "**Pile diagram**";
- "**Soil properties legend**";
- "**System presentation**";
- "**General legend**";
- "**Output table**";
- "**Resistance-settlement curve**";
- "**Results**";
- "**Pile cross-section**";
- "**Empirical data table**".

> This can be achieved even more easily by double-clicking in the appropriate element.

For example, you will see the following dialog box by selecting the "**Output preferences/System presentation**" menu item:



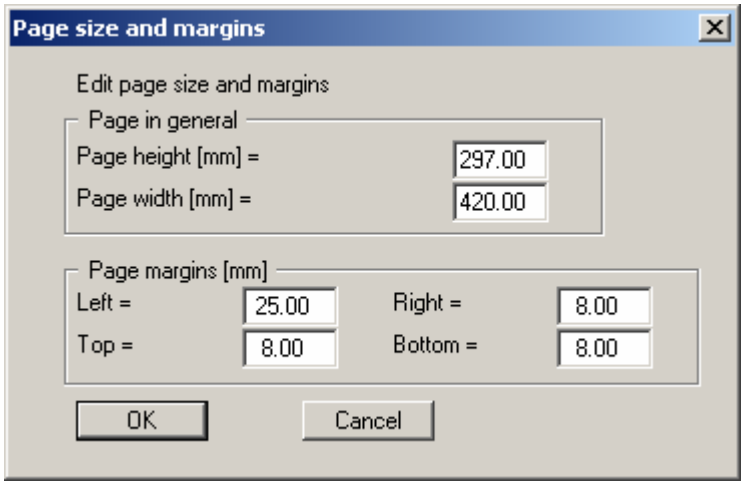
Right at the top you can clear the "**Show system**" check box. If you leave the dialog box by means of "**OK**", the system presentation will no longer be displayed.

With activated check box the size and position of the system presentation can be defined in the dialog box. You can also decide whether certain elements and labelling should be displayed in the graphic.

The dialog boxes for other graphic elements are similarly structured.

6.1.4 Edit page size and margins

The program uses A3 format as the default drawing size. However, the size can be edited to suit your needs. Go to "**Output preferences/Page size and margins**" menu item and enter your personal page format.



Page margins defines the position of a frame as a distance to the cutting borders. This frame encloses the subsequent diagram.

6.2 Example 1: Bored pile to EAP

6.2.1 Select system preferences (Example 1)

To define the preferences for a new calculation go to the menu item "**File/New**" or "**Edit/Pile type**". You will see the same dialog box (see Section 7.2.2) and can then select:

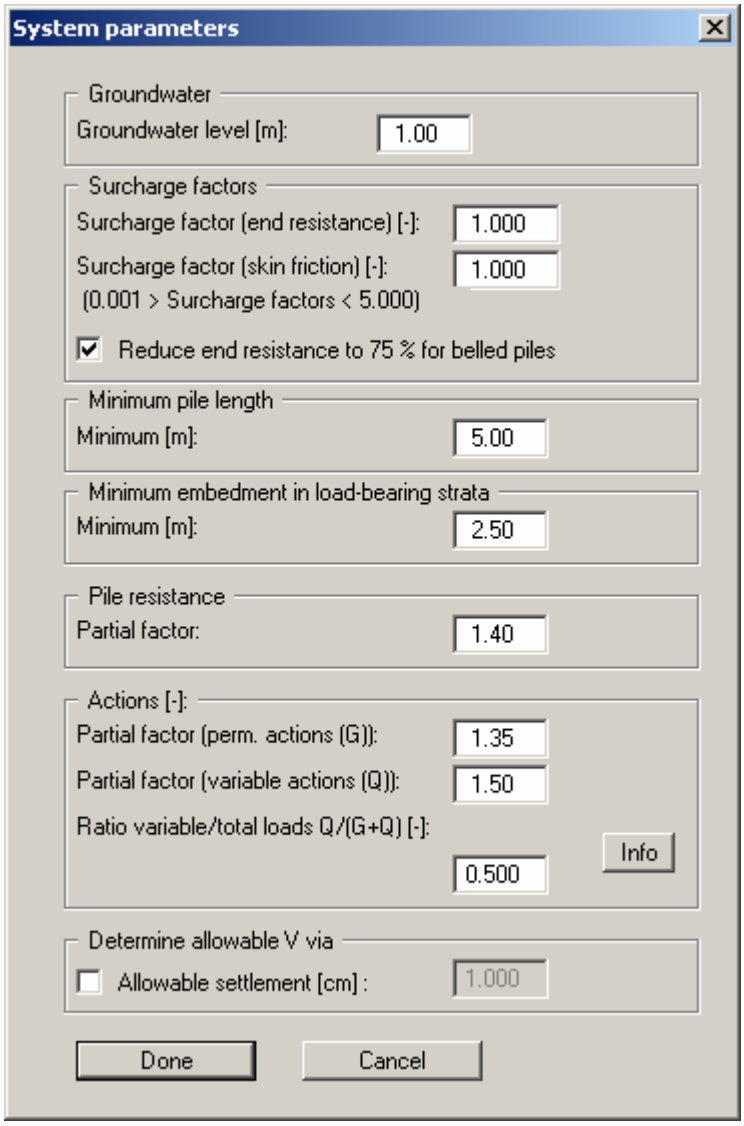
- "**Partial factors (DIN 1054:2005)**" or "**Partial factors (EC 7)**";
- "**Pile design to EAP**" select "**Bored pile**";
- "**Circular**";
- "**Compression pile**".

Clear the "**Use absolute heights**" check box. After confirming with "**OK**" you can select the load case. Click the "**Load case 1**" button or, if using EC 7, "**DS-P**". The partial factors are used in the system parameters.

If you wish you can enter a description of the problem being worked on, using the "**Edit/Project identification**" menu item; this will then be used in the ***General legend***.

6.2.2 Enter system parameters (Example 1)

The appropriate partial factors have already been entered into the "**Edit/System parameters**" menu item. They are the same for DIN 1054:2005 and EC 7.



The following parameters can also be entered:

- "**Groundwater**" group box
  The groundwater level is entered as a positive value in [m] from ground level down. If you activate the "**Use absolute heights**" check box, the groundwater level input will be positive upwards, e.g. in [m AD]. Information on the groundwater level is only important when working with ***tension piles***.
- "**Surcharge factors**" group box
  If you need to introduce surcharge factors for end resistance and skin friction over and above those in the EAP, enter the values here.

  DIN 4014 states that the end resistance must be reduced to 75% for bored piles with belled toes. The appropriate check box must be activated.

- "**Minimum pile length**" group box
  DIN 4014 demands a minimum pile length of 5 m. The **GGU-AXPILE** program examines this condition for the value entered. If the minimum pile length is not adhered to there will be no analysis for this length.

  If a reduction in the minimum pile length is acceptable from a geotechnical point of view, this value can be lowered. The program will issue an appropriate warning message during analysis.

- "**Minimum embedment in load-bearing strata**" group box
  DIN 4014 demands that the bored pile embeds at least 2.5 m into load-bearing subsoil. The **GGU-AXPILE** program examines this condition for the value entered. If the minimum embedment is not adhered to there will be no analysis for this pile.

  If a reduction in the minimum embedment depth is acceptable from a geotechnical point of view, this value can be lowered. The program will issue an appropriate warning message during analysis.

- "**Pile resistance**" group box
  The partial factor to Table 3 of DIN 1054:2005 has been entered.

- "**Actions**" group box
  The partial safety factors for permanent (G) and changeable (Q) actions in Table 2 of DIN 1054:2005 were entered.

  It is still possible to alter the "**Ratio variable/total loads Q/(G+Q)**". The failure stress is first divided by the bearing capacity partial factor. This gives the bearing capacity stress. A further reduction by the partial factors for actions is necessary for calculation of an allowable foundation pressure. In load case 1, e.g., a partial factor of gam(G) = 1.35 for permanent loads and one of gam(Q) = 1.50 for changeable loads is demanded. From a ratio of 0.40, for example, a ***total partial factor*** results from:

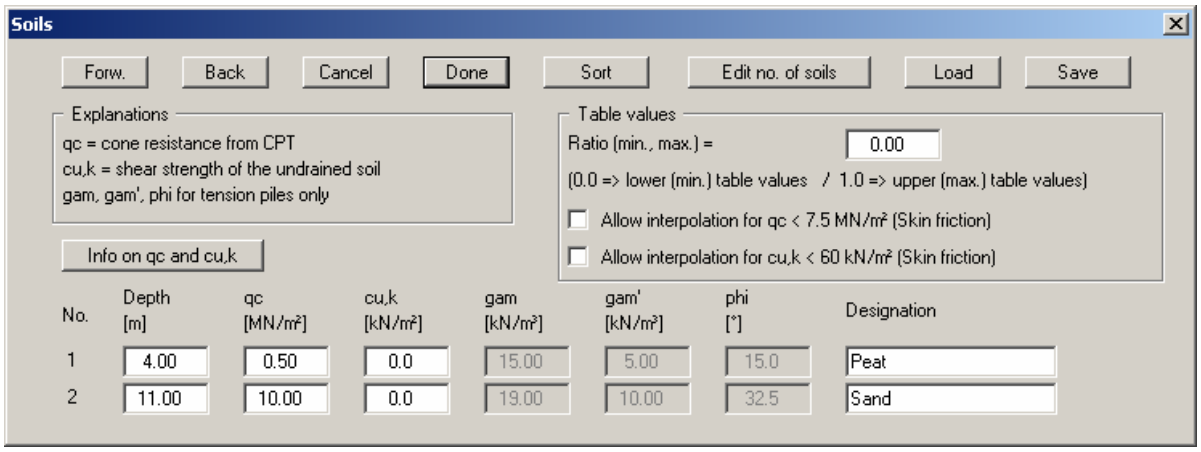
  $$\text{Ratio} \cdot 1.50 + (1.0 - \text{ratio}) \cdot 1.35 = 1.410$$

- "**Determine allowable V via**"/"**Determine R(E,k) via**" group box
  You can specify how ***Allow. V*** is to be determined. Enter the allowable heave instead of the allowable settlement for a tension pile. If working with the old global safety factor approach ***Allow. V*** can alternatively be determined via the "**Required safety**".

  If the partial safety factor concept to EC 7 is adopted it is possible to determine the characteristic bearing resistance in the serviceability limit state ***R(E,k)*** via the allowable settlement, instead of ***allow. V***.

6.2.3 Define soils (Example 1)

Use the values of the existing soils layers in the menu item "**Edit/Soils**".



If you would like to edit the number of soils, select the "**Edit no. of soils**" 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.

The layer depths are with reference to grade and are positive downwards, as are all other inputs. Explanations of the soil properties can be found directly in the dialog box and in the theoretical principles in Section 5.2.1 (Pile design to EAP: General). If the check box in the "**Table values**" group box is activated, the skin friction is interpolated even for a cone pressure $q_c < 7.5$ MN/m² or a shear strength $c_{u,k} < 60$ MN/m². Otherwise the skin friction is set to **0**.

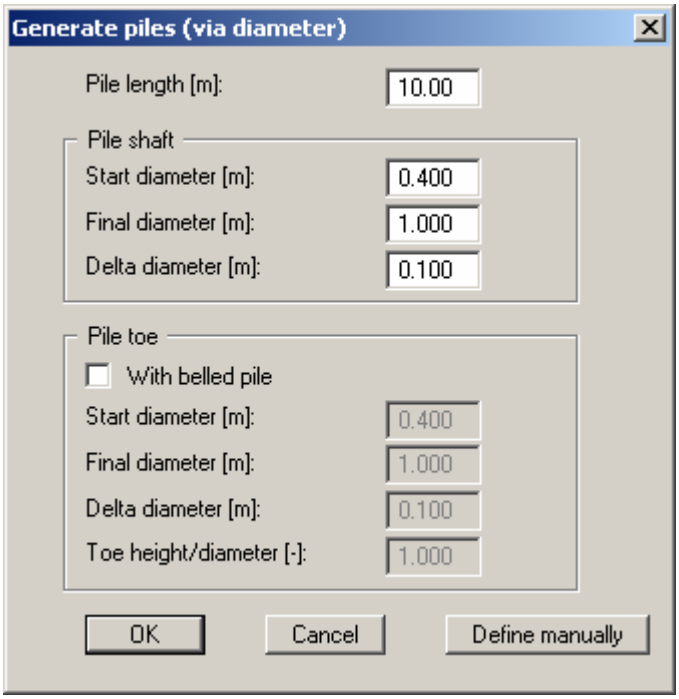
The data for unit weights and friction angle are only required when working with ***tension piles***. They are therefore not represented in the dialog box shown above.

6.2.4 Analyse with constant pile length (Example 1)

The program offers two types of variation of the pile system:

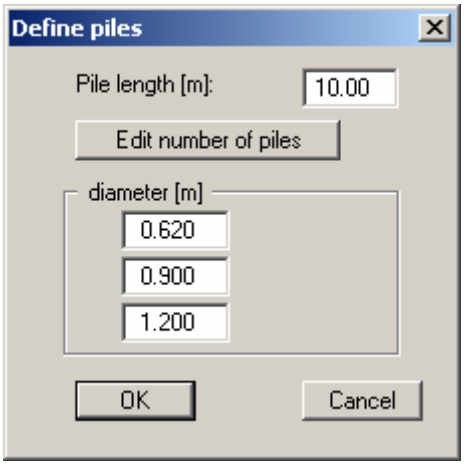
- Constant pile length: The pile diameter is varied.
- Constant pile diameter: The pile length is varied.

In this example the pile diameter shall be varied for a constant pile length. Select the menu item "**Edit/Piles (diameters)**".



First enter the "**Pile length**". Below this, the pile shaft diameter variation range is given. If the pile does have a belled toe, activate the "**With belled pile**" check box and enter the range of variation for the pile toe diameter.

When the "**Define manually**" button is pressed a dialog box opens which allows a fixed diameter to be specified for a user-defined number of piles:



After editing one of the previous dialog boxes, the system is first represented without the analysis results. If you want to have the foundation reanalysed with the new values go to the "**System**" menu and select "**Analyse**". Alternatively, press the [**F5**] function key or click on the ***Calculator*** in the tool bar. The analysis results are then presented to you in the various graphic elements on the screen.

The current screen contents can be sent to the printer at any stage of project processing. Select the "**Print and export**" menu item from the "**File**" menu (see Section 7.1.6).

6.3.1 Select system preferences (Example 2)

To define the preferences for a new calculation go to the menu item "**File/New**" or "**Edit/Pile type**". You will see the same dialog box and can then select:

- "**Partial factors (DIN 1054:2005)**" or "**Partial factors (EC 7)**";
- "**Pile design to EAP**" select "**Pre-cast driven pile**";
- "**Rectangular**";
- "**Compression pile**".

Activate the "**Use absolute heights**" check box. After confirming with "**OK**" you can select the load case. Click the "**Load case 1**" button or, if using EC 7, "**DS-P**". The partial factors are used in the system parameters.

If you wish you can enter a description of the problem being worked on, using the "**Edit/Project identification**" menu item; this will then be used in the ***General legend***.

6.3.2 Enter system parameters (Example 2)

In the "**Edit/System parameters**" menu item a number of different dialog boxes are displayed, depending on the selected pile type. The system parameter dialog box for the selected driven pile corresponds to that for a bored pile. A description of the required input can therefore be found in the "**Worked example 1: Bored pile to EAP**" in Section 6.2.2. The partial factors are already entered in accordance with the selected load case.

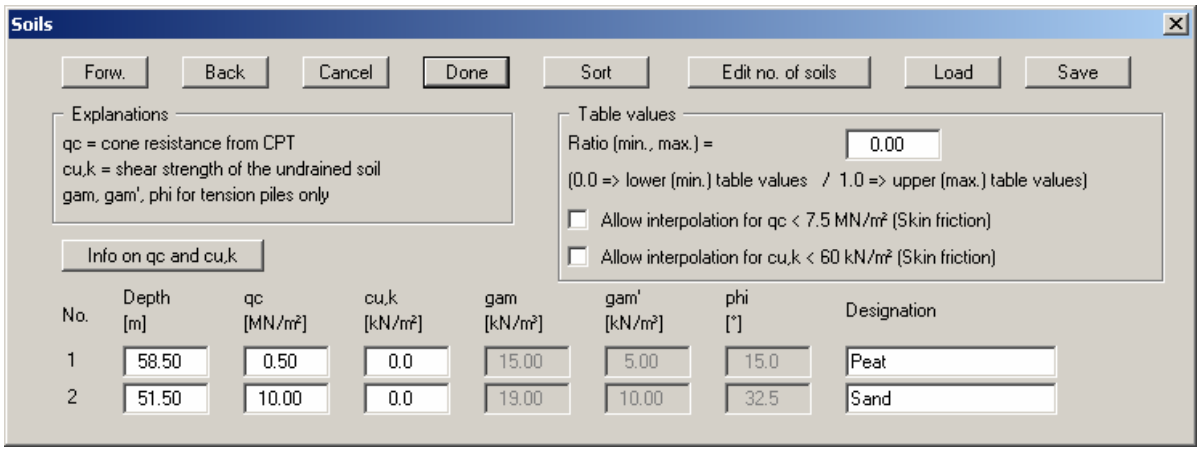
Because the "**Use absolute heights**" check box is activated, a further input box, "**Grade**" is active. Enter the ground height at **62.50 m AD**; you do not need to convert the groundwater level. If you only alter the ground height the groundwater level is automatically determined from the previous depth data when the box is closed (62.50 m AD - 1 m = 61.50 m AD) and displayed next time the dialog box is opened.

After closing the box you will see the following prompt:

Click "**No**" in order to have the previous depth data for the soil layers in m AD converted to fit your newly entered grade. If you close the box by clicking "**Yes**", the soil layers are adapted, i.e. extended to the new grade.

6.3.3 Define soils (Example 2)

Use the values of the existing soils layers in the menu item "**Edit/Soils**".



If you would like to edit the number of soils, select the "**Edit no. of soils**" 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.

Because you have checked the "**Use absolute heights**" box in the dialog box in menu item "**File/New**" or "**Edit/Pile type**", the layer depths are positive upwards, i.e. the layer depths are entered in m AD.

Explanations of the soil properties can be found directly in the dialog box and in the theoretical principles in Section 5.2.1 (Pile design to EAP: General). If the check box in the "**Table values**" group box is activated, the skin friction is interpolated even for a cone pressure $q_c < 7.5$ MN/m² or a shear strength $c_{u,k} < 60$ MN/m². Otherwise the skin friction is set to **0**.

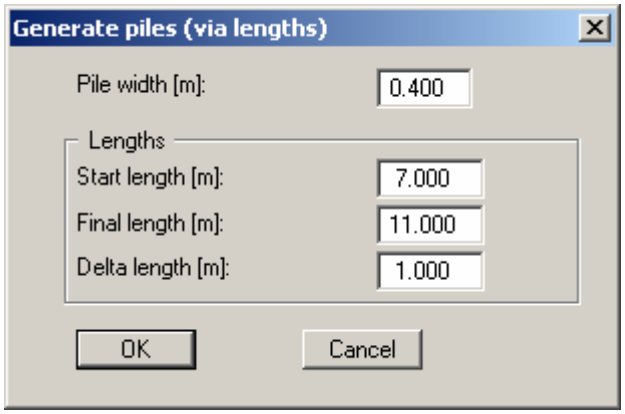
The data for unit weights and friction angles are only required when working with ***tension piles***. They are therefore not represented in the dialog box shown above.

6.3.4 Analyse with constant pile width (Example 2)

The program offers two types of variation of the pile system:

- Constant pile length: The pile diameter/width is varied.
- Constant pile diameter/width: Pile length is varied.

In this example the pile length shall be varied for a constant pile width. Select the menu item "**Edit/Piles (lengths)**".



You must first define the constant "**Pile width**". Below this the range of variation for the pile length is defined. Because this example deals with a driven pile, the belled pile group box, which is otherwise displayed, is missing from the dialog box.

After editing one of the previous dialog boxes, the system is first represented without the analysis results. If you want to have the foundation reanalysed with the new values go to the "**System**" menu and select "**Analyse**". Alternatively, press the [**F5**] function key or click on the ***Calculator*** in the tool bar. The analysis results are then presented to you in the various graphic elements on the screen.

> If a driven pile is selected (designed to Tables C.1 + C.2 of DIN 1054) you will see a message before analysis commence, notifying you that Tables C.1 and C.2 of the new DIN 1054 only apply for ***cohesion less*** soils.

The current screen contents can be sent to the printer at any stage of project processing. Select the "**Print and export**" menu item from the "**File**" menu (see Section 7.1.6).

6.4 Further EAP examples

A variety of further pile designs can be found in the EAP. The EAP examples below can be found in the example files provided. Analysis was carried out using the lower and the upper table values.

EAP example	Pile type	Page in EAP
B3	Bored pile	274
B4	Pre-cast driven pile	277
B5	Fundex pile	281
B6	Pre-cast driven pile	284
B7	Franki pile (pressure-injected toe)	288

Table 3 EAP examples

Example 7 demonstrates design of a Franki pile. The design of Franki piles is essentially different to that of normal driven piles. The die characteristic load F(G,k) for permanent and F(Q,k) for changeable loads must be specified. The subsequent analysis then provides the required pile toe volume and the norm-driving work component W (see Section 5.2.2 "**Design of Franki piles**").

7 Description of menu items

7.1 File menu

7.1.1 "New" menu item

You commence a new analysis here. A dialog box opens, which can also be reached via the "**Edit/Pile type**" menu item (see Section 7.2.2). You may edit the system parameters (standard used, pile type).

7.1.2 "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.

7.1.3 "Save" menu item

You can save data entered or edited during program use to a file, in order to have them available at a later date, or to archive them. The data is saved without prompting with the name of the current file.

7.1.4 "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 "**.phl**" 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, "**.phl**" will be used automatically.

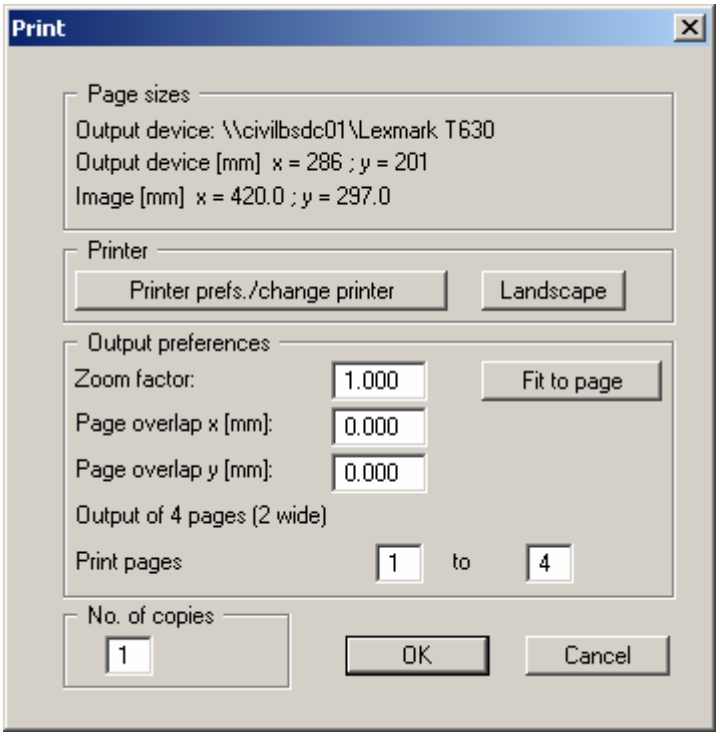
7.1.5 "Printer preferences" menu item

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

7.1.6 "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. to the WINDOWS standard printer or to any other printer selected using the menu item "**File/Printer preferences**". But you may also select a different printer in the following dialog box by pressing the "**Printer prefs./change printer**" button.



  In the upper part of the dialog 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). In order 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. Furthermore, you may enter the number of copies to be printed.

- "**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.

- "**GGUCAD file**"
  allows output of the graphics to a file, in order to enable further processing with the **GGUCAD** program. Compared to output as a DXF file this has the advantage that no loss of colour quality occurs during export.

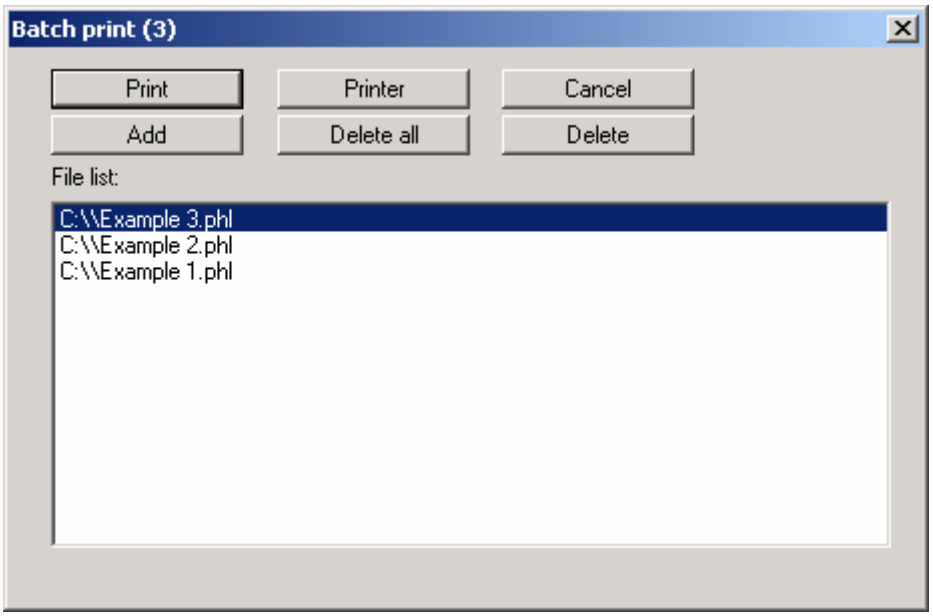
- "**Clipboard**"
  The graphics are copied to the WINDOWS clipboard. From there, they can be imported into other WINDOWS programs for further processing, e.g. into a word processor. In order to import into any other WINDOWS program you must generally use the "*Edit/Paste*" function of the respective 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 ticks**", Section 8.3).
>
> Using the "**Mini-CAD**" program module you can also import EMF files generated using other GGU applications into your graphics.

- "**MiniCAD**"
  allows export of the graphics to a file in order to enable importing to different GGU applications with the **Mini-CAD** module.
- "**GGUMiniCAD**"
  allows export of the graphics to a file in order to enable processing in the **GGUMiniCAD** program.
- "**Cancel**"
  Printing is cancelled.

7.1.7 "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.

7.1.8 "Exit" menu item

After a confirmation prompt, you can quit the program.

7.1.9 "1, 2, 3, 4" menu items

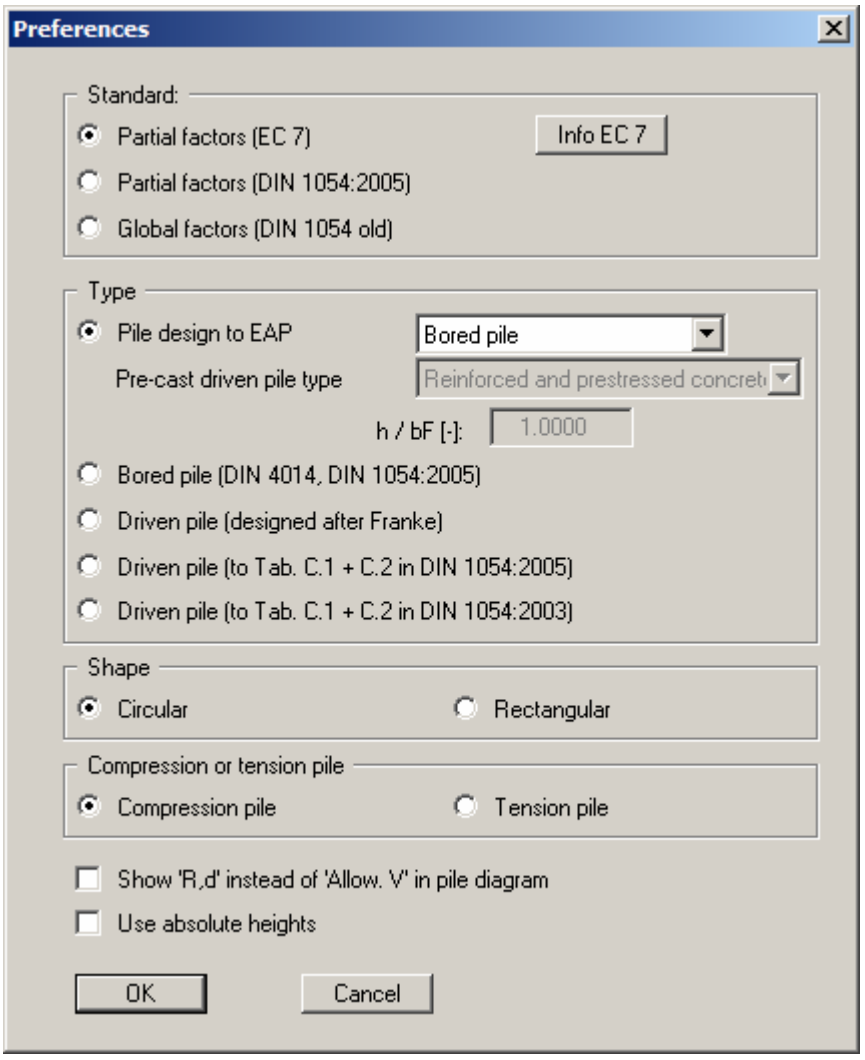
The "**1, 2, 3, 4**" menu items show the last four files worked on. By selecting one of these menu items the listed file will be loaded. If you have saved files in any other folder than the program folder, you can save yourself the occasionally onerous ***rummaging*** through various sub-folders.

7.2.1 "Project identification" menu item

You can enter a description of the problem being worked on; this will then be used in the ***General legend*** (see Section 7.4.4).

7.2.2 "Pile type" menu item

This menu item opens the dialog box already known to you from the examples. The standard selected in the example dialog box shown below uses the partial safety factor concept to EC 7. Further information is available by pressing the "**Info EC 7**" button, for example on the new load case designations.



You may edit the system parameters, i.e. the standard used and the pile type. The EAP tables were implemented for pile design. In these terms, the EAP represents current best practice. You can therefore select any pile type described in the EAP from the following combo box if the "**Pile design to EAP**" check box is activated. It is also possible to define your own bored or driven pile (see Sections 7.2.9 and 7.2.10).

If a "**Pre-cast driven pile**" is selected the type of section must also be chosen from the combo box below. The ratio of section height h to flange width bF can be given for steel girder sections or double steel girder sections. An image of the selected pile section is displayed on the output sheet if it has been activated using the menu item "**Output preferences/Pile cross-section**" (see Section 7.4.7).

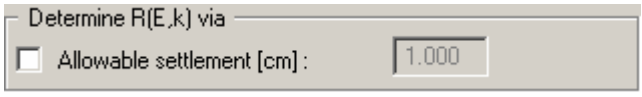
The previous designs to DIN 4014, etc. remain available but now include a pointer to the EAP if used for analysis. Two check boxes are available for design of a driven pile using Tables C.1 and C.2 of DIN 1054, because the January 2003 DIN 1054 defines different values for the end resistance and skin friction than the January 2005 issue of DIN 1054.

If you have selected the partial safety factor concept to EC 7 it is possible to display the bearing resistance design value "**R,d**" instead of "**allow. V**" in the pile diagram by activating the lower check box.

If you select the "**Use absolute heights**" check box, you can enter all depths and heights in **m AD** (heights are positive upwards). If this check box is not selected, the top of the pile is assumed to have a height of **0.0** and all further entries, depth of soil layers, for example, are positive downwards.

7.2.3 "System parameters" menu item

You can enter data for the current system. Descriptions of the required input can be found in the "**Worked example 1: Bored pile to EAP**" in Section 6.2.2. If the partial safety factor concept to EC 7 is adopted it is possible to determine the characteristic bearing resistance in the serviceability limit state ***R(E,k)*** via the allowable settlement, instead of ***allow. V***.



If a "**Tension pile**" has been selected, information on the groundwater level is required for analysis. An additional "**Pull-out cone**" group box is shown in the dialog box, where you may enter the "**Partial factor (pull-out)**" and the "**Calibration factor eta**". The radius of the pull-out cone may be limited. The allowable heave is specified for determination of ***Allow. V*** or ***R(E,k)*** of tension piles.

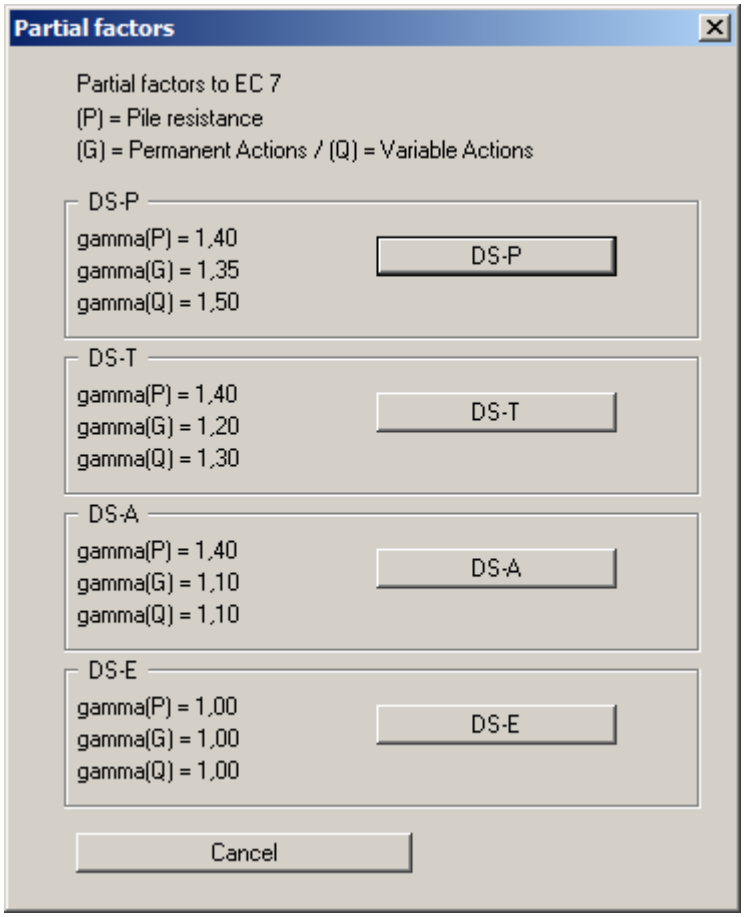
If you have selected the pile type "**Driven pile (designed after Franke)**", you can also enter the following variables:

- "**Failure settlement s/D**"
  A failure settlement must be provided for calculation of the ***synthetic*** resistance-settlement curve after Franke. The program divides the load associated with this settlement by the given safety factor and thus determines the allowable pile load. If the "**Relative**" option button is selected, the failure settlement is determined by multiplying the value entered by the pile toe diameter. If the "**Absolute**" option button is selected, the settlement value given is used as the failure settlement, independent of the pile toe diameter.
- "**Values after Franke (GEH Part 3)**"
  Here, you enter the coefficients defined after Franke for calculation of the resistance-settlement curve. If desired, you can use the values directly by means of the "**Info**" button.

If you would like to perform calculations using the ***global factors*** (DIN 1054 old), the required safety factor corresponding to the Load case selected upon leaving the "**Edit/Pile type**" dialog box is used in the system parameters. In the dialog box you can then specify whether ***allowable V*** is to be determined via the "**Required safety**" or by means of the "**Allowable settlement**".

7.2.4 "Partial factors" menu item

A different load case may be selected for analysis directly using this menu item.



The load case designations to EC 7 have been altered:

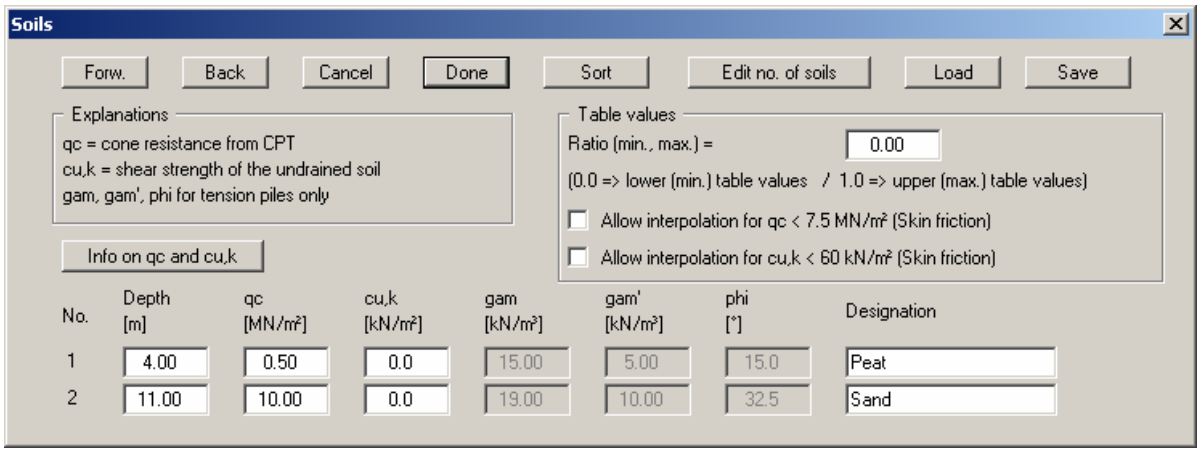
- Load Case 1 is now DS-P: Persistent Design Situation
- Load Case 2 is now DS-T: Transient Design Situation
- Load Case 3 is now DS-A: Accidental Design Situation

In addition, there is a seismic design situation (DS-E). In the DS-E design situation all partial factors = "**1,0**".

In tension piles the partial factor is now "**1,50**", compared to the previous "**1,40**".

7.2.5 "Soils" menu item

You enter the properties of the soil layers present in the current system using the following dialog box.



If you would like to edit the number of soils, select the "**Edit no. of soils**" 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. You can reduce the number by ***1*** using the "**Edit no. of soils**" button. The soil has now been deleted from the list - without a lot of typing.

The layer depths are with reference to grade and are positive downwards, as are all other inputs. But if you have checked the "**Use absolute heights**" box in the dialog box in menu item "**File/New**" or "**Edit/Pile type**", the layer depths are positive upwards, i.e. the layer depths must be entered in m AD.

Explanations of the soil properties can be found directly in the dialog box and in the theoretical principles in Section 5.2.1 (Pile design to EAP: General). If the check box in the "**Table values**" group box is activated, the skin friction is interpolated even for a cone pressure q_c < 7.5 MN/m² or a shear strength $c_{u,k}$ < 60 MN/m². Otherwise the skin friction is set to **0**.

Previously, the values for sig02, sig03, sig10 and tau ($q_{b,k02}$, $q_{b,k03}$, $q_{b,k10}$, $q_{s,k}$) had to be defined for each soil type for bored pile analysis (see Section 5.3). These values are determined automatically to EAP via q_c and $c_{u,k}$ from the appropriate tables.

The data for units weights and friction angle are only required when working with ***tension piles***. They are therefore not represented in the dialog box shown above.

7.2.6 "Piles (diameters)" and "Piles (widths)" menu items

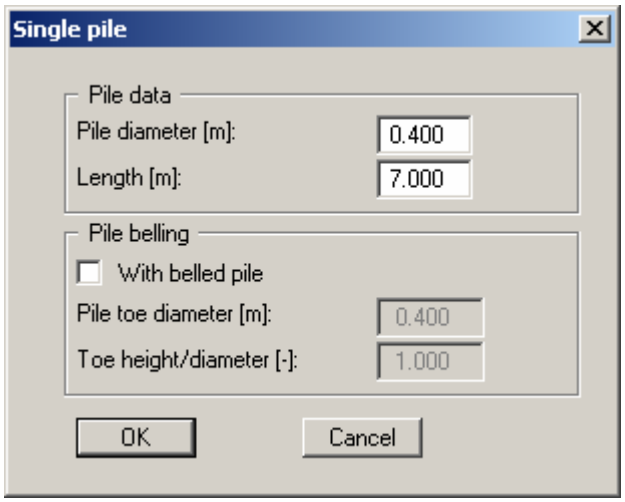
Here, you specify values for the variation of the pile diameter or the pile width for a constant pile length. A further description can be found in the worked example "**Bored pile to EAP**" under "**Analysis with constant pile length**" in Section 6.2.4.

7.2.7 "Piles (lengths)" menu item

Here, you specify values for the variation of the pile length for a constant pile diameter or pile width. A further description can be found in the worked example "**Driven pile to EAP**" under "**Analysis with constant pile width**" in Section 6.3.4.

7.2.8 "Single pile" menu item

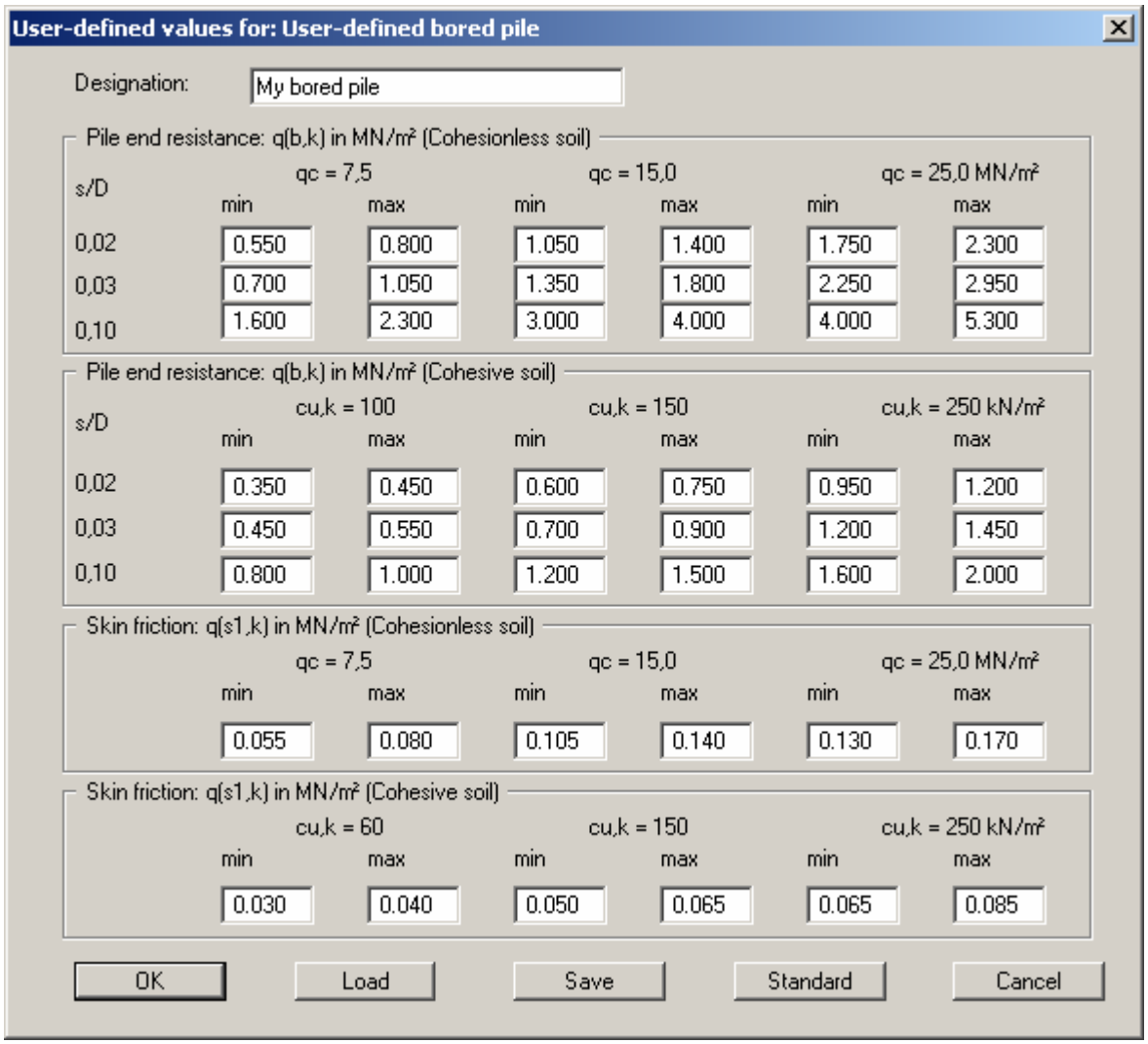
If analysing via the menu item "**Edit/Piles (diameters)**" or "**Edit/Piles (lengths)**" the final results are shown in a table after designing several piles (see menu item "**Output preferences/Output table**"). If you are interested in seeing a detailed breakdown of the analysis results select this menu item and specify the required dimensions, as shown in the following example for a single bored pile.



After designing the single pile (preferences in the dialog box above and subsequent analysis using "**System/Analyse**" menu item) a legend containing comprehensive results is displayed instead of the output table (see menu item "**Output preferences/Results**", Section 7.4.7). Naturally, it is then not possible to display the pile analysis diagram and the element is not shown on the output sheet.

7.2.9 "User-defined bored pile" menu item

Using this menu item user-defined tables can be created for a bored pile, beside the table values in the EAP.

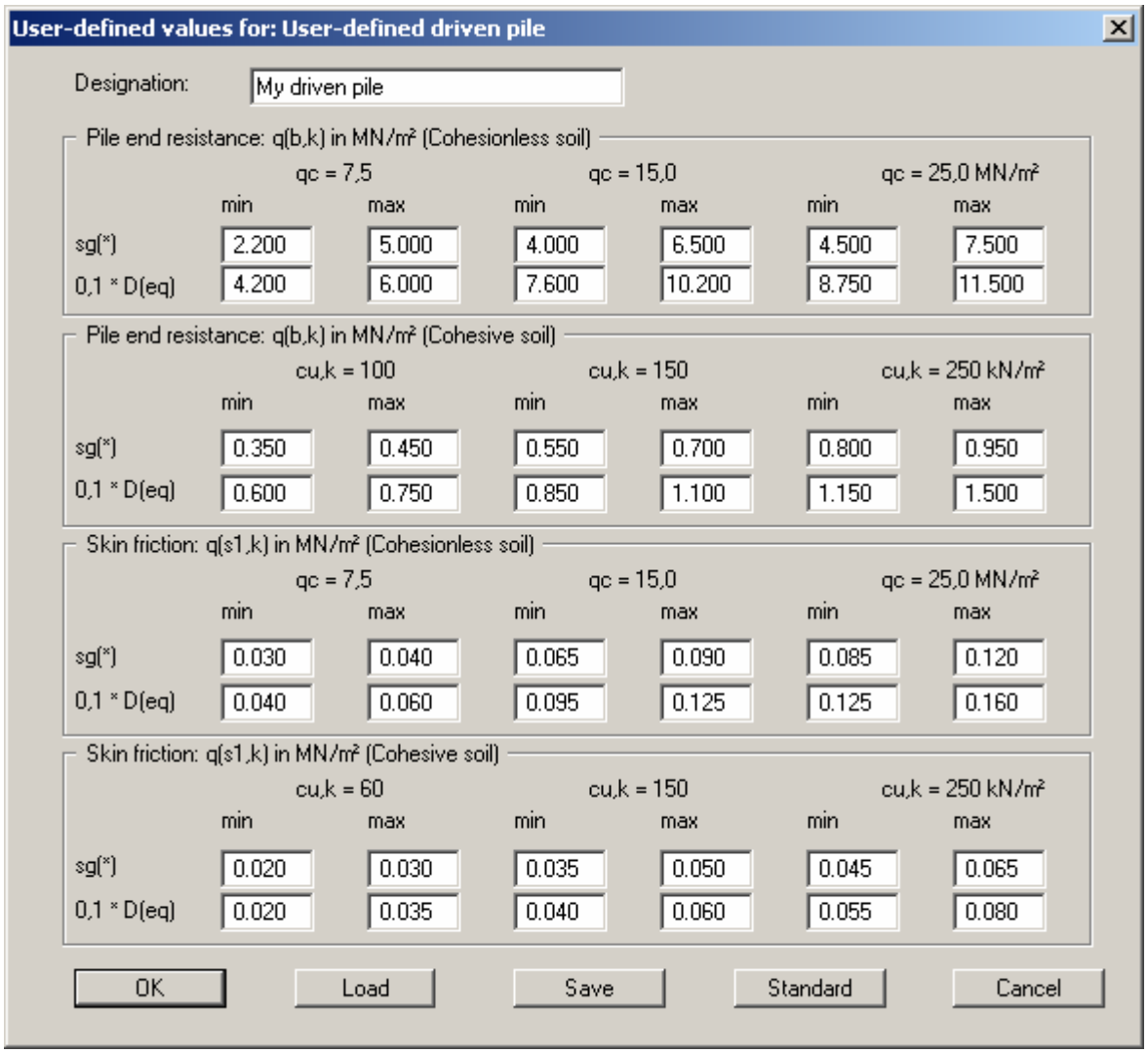


The default values shown in the dialog box correspond to Tables 5.12 to 5.15 in the EAP and can be restored at any time after editing by pressing the "**Default**" button. The user-defined table values can be saved in a "**·.ggu_bohr**" file by pressing the "**Save**" button and be opened again later using the "**Load**" button. It is also possible to load the table values for different pile types into the dialog box using the "**Default**" button.

> This values entered are not subject to a plausibility check by the **GGU-AXPILE** program. This menu item should therefore be used with the necessary caution and is only recommended for experts.

7.2.10 "User-defined driven pile" menu item

Using this menu item user-defined tables can be created for a driven pile, beside the table values in the EAP.



The default values shown in the dialog box correspond to Tables 5.1 to 5.4 in the EAP and can be restored at any time after editing by pressing the "**Default**" button. The user-defined table values can be saved in a "**·.ggu_ramm**" file by pressing the "**Save**" button and be opened again later using the "**Load**" button. It is also possible to load the table values for different pile types into the dialog box using the "**Default**" button.

> This values entered are not subject to a plausibility check by the **GGU-AXPILE** program. This menu item should therefore be used with the necessary caution and is only recommended for experts.

7.3 System menu

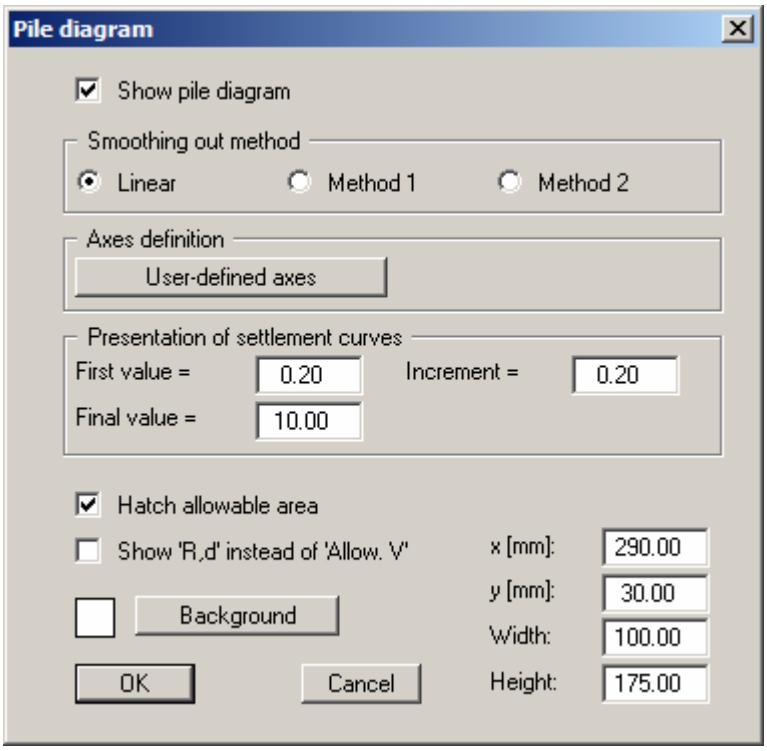
7.3.1 "Analyse" menu item

If you edit any of the system parameters using the menu items of the "**Edit**" menu, the diagrams displayed do not represent the current analysis results. Only after using this menu item is the modified system reanalysed and subsequently displayed with the new results. Alternatively, press the [**F5**] function key or click on the ***Calculator*** in the tool bar. The analysis results are then presented to you in the various graphic elements on the screen.

7.4 Output preferences menu

7.4.1 "Pile diagram" menu item

After selecting this menu item a dialog box opens which allows preferences to be defined for representation of the pile analysis diagram. The allowable pile load is represented in the pile diagram as a function of the pile diameter or the pile length, determined by the type of variation selected (pile length or pile diameter). If you do not want the evaluation displayed, clear the "**Show pile diagram**" check box.



In the first group box you can select a smoothing out method with which the allowable pile load curves and the settlement curves are drawn in the pile diagram:

- "**Linear**" = no smoothing
- "**Method 1**" = ***strict*** Bezier spline
- "**Method 2**" = ***loose*** Bezier spline

Using the "**User-defined axes**" button, you can define the axes scales. Otherwise, axes scaling will be carried out automatically. After clicking the button a dialog box opens in which you must first activate the "**Use the following axes values**" check box. You can edit the automatic scaling values to suit your requirements.

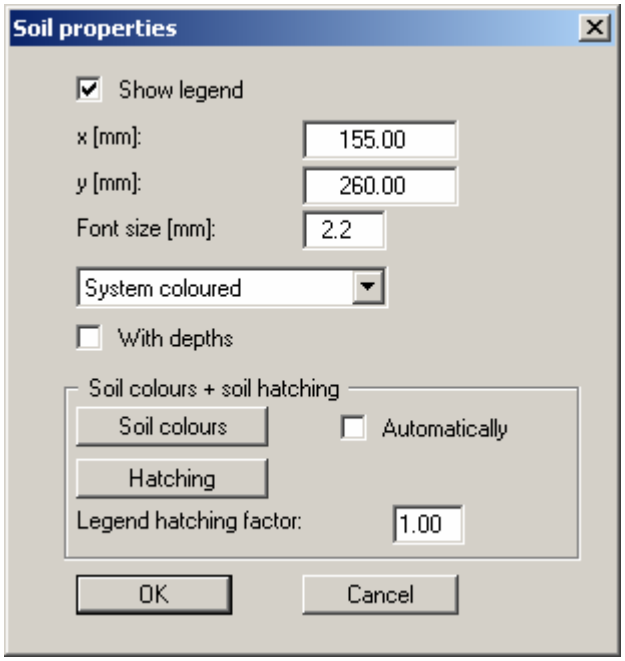
In the third group box you can influence the representation of the settlement curves. Using the applicable resistance-settlement curve, the program calculates the settlement (heave) corresponding to a given pile length or pile width.

In the fourth group box you specify general preferences for the pile diagram, such as the size and the position on the output sheet. If you activate the "**Hatch allowable area**" check box, reference lines are drawn in the allowable area only. Otherwise, lines are drawn across the whole of the plan width and height. If you have selected the partial safety factor concept to EC 7 it is possible to display the bearing resistance design value "**R,d**" instead of "**allow. V**" in the pile diagram by activating the lower check box.

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

7.4.2 "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 clicked the "**Show legend**" check box. Using this menu item you can alter the shape and appearance of the legend.



You can define and edit the position of the legend using the values "**x**" and "**y**". You control the size of the legend using "**Font size**".

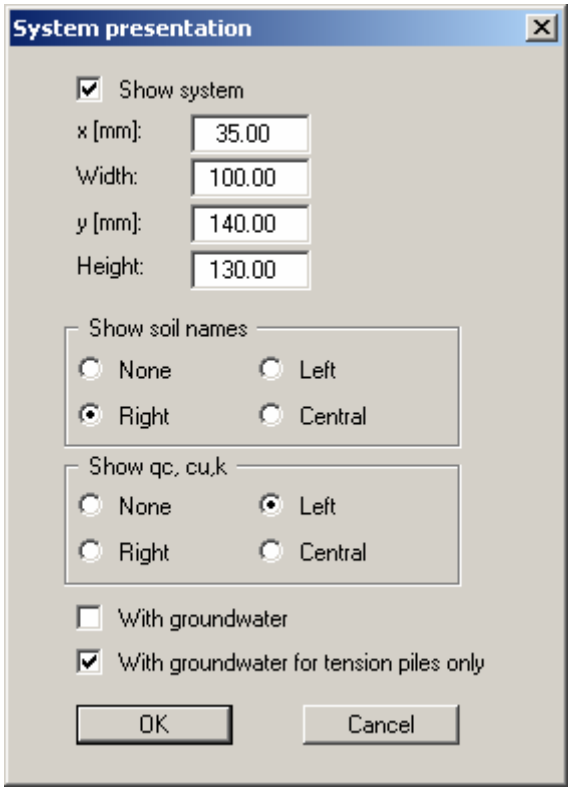
> The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position with the left mouse button pressed.

If the "**System coloured**" combo-box is activated, the soils will be displayed coloured in the soil properties legend and in the system presentation. Otherwise, they will be numbered in the legend. If you deactivate the "**Automatic**" check box in the "**Soil colours + hatching**" field, the soil colours will be selected according to your individual preferences, which you can edit using the "**Soil colours**" button (see below). Alternatively, you have the option of applying a variety of hatches. Using the "**Legend hatching factor**", closer hatching of the soil legend can be achieved than is possible in the "**System**" diagram.

To define your individual colour preferences click on the "**Soil colours**" button. A dialog box opens: after clicking the button with the desired number you can assign each soil layer a new colour or reorganise the colour allocations by pressing the "**Soil colours/Reorganise**" 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.

7.4.3 "System presentation" menu item

The system is graphically represented if you have clicked the "**Show system**" check box. You can alter the shape and appearance of the system presentation.



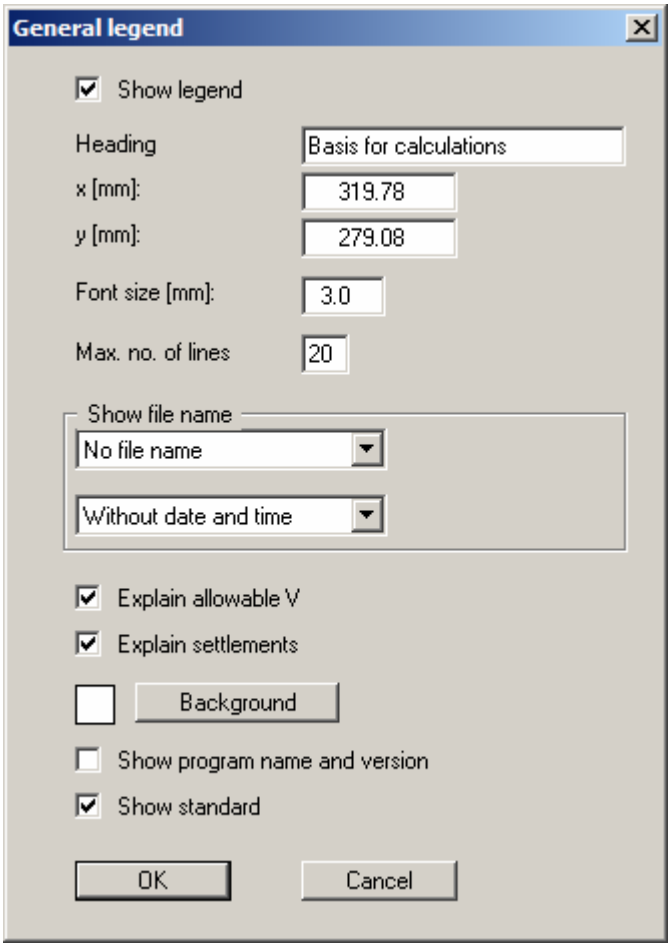
You can define and edit the position and size of the system presentation using the values "**x**", "**y**", "**Width**" and "**Height**".

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

In addition, you specify preferences for displaying the soil names, end resistance and shear strength, as well as groundwater in the system visualisation.

7.4.4 "General legend" menu item

If you click the "**Show legend**" check box, the legend with calculation data will be displayed. You can alter the shape and appearance of the legend.



You can define and edit the position of the legend using the values "**x**" and "**y**". You control the size of the legend using "**Font size**" and "**Max. no. of lines**"; where necessary, several columns are used. The legend background can also be given a colour fill. 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 with the left mouse button pressed.

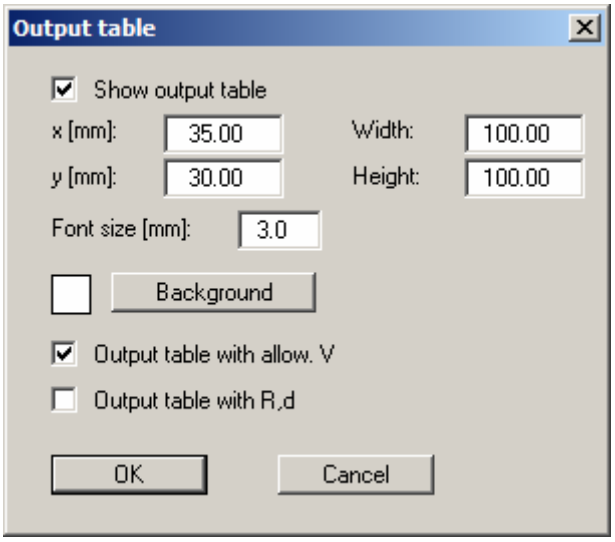
By selecting the corresponding options the current file name can be shown in the legend, either with or without path and time information. Any project identification entered (see Section 7.2.1) will also be shown in the general legend.

If one of the "**Explain ...**" check boxes is activated, the lines used in the pile diagram are explained in the general legend. These may be: allow. V, settlement or R,d, if working with the partial safety factor concept to EC 7 and visualisation of "**R,d**" has been activated in the pile diagram (see Section 7.2.2).

In addition, the program name, version number and adopted standard may be displayed in the legend.

7.4.5 "Output table" menu item

When analysing a number of piles using diameter or length variation, the final results are displayed in a table in the graphics if the "**Show output table**" check box is activated. You can alter the shape and appearance of the output table.

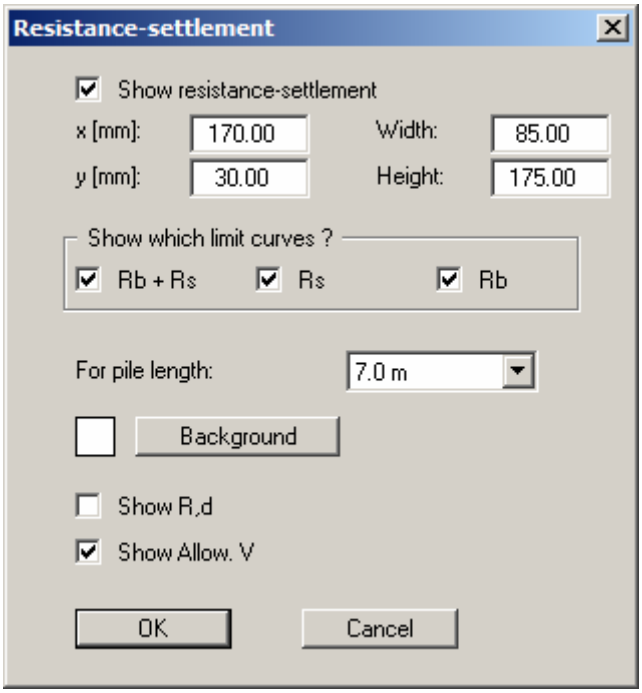


You can define and edit the position and size of the output table using the values "**x**", "**y**", "**Width**" and "**Height**". The "**Font size**" can be varied to suit the size of the output table. The output table background can be given a colour fill. The display of ***Allow. V*** and ***R,d*** can be activated.

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

7.4.6 "Resistance-settlement curve" menu item

If you have clicked the "**Show resistance-settlement**" check box, a resistance-settlement curve is graphically represented on the output sheet.



You can define and edit the position and size of the diagram using the values "**x**", "**y**", "**Width**" and "**Height**". The diagram background can be given a colour fill.

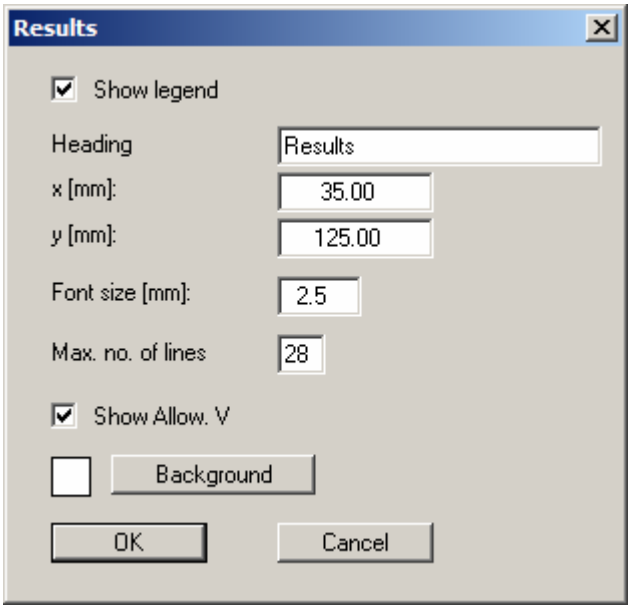
> The fastest way to modify the position or size of the diagram is to press the [**F11**] function key and then to either pull the diagram to the new position or to move the sides of the diagram to their new size with the left mouse button pressed.

Resistance-settlement curves can be displayed for the skin friction, the end resistance and for the sum of these. Resistance-settlement curves are represented in the graphics for one pile diameter or one pile length only. The pile diameter or the pile length to be adopted in the presentation is selected from the drop-down combo box at the bottom of the dialog box.

The display of ***Allow. V*** and ***R,d*** can be activated. If the partial safety factor concept to EC 7 is adopted it is possible to display the characteristic bearing resistance in the serviceability limit state ***R(E,k)***, instead of ***allow. V***.

7.4.7 "Results" menu item

If you have analysed a single pile the detailed analysis results can be shown in a legend by activating the "**Show legend**" check box.

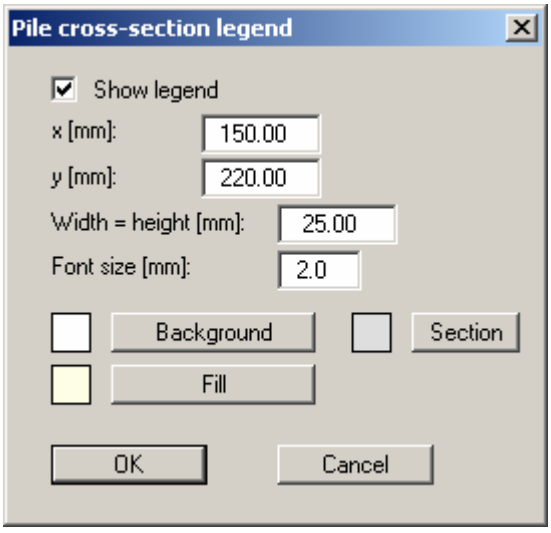


The position of the legend is defined by the values "**x**" and "**y**". The size of the legend is controlled using "**Font size**" and "**Max. no. of lines**"; where necessary, several columns are used.

> 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 with the left mouse button pressed.

7.4.8 "Pile cross-section" menu item

If the "**Show legend**" check box is activated, a drawing of the section is displayed in the screen graphics for the selected pile.

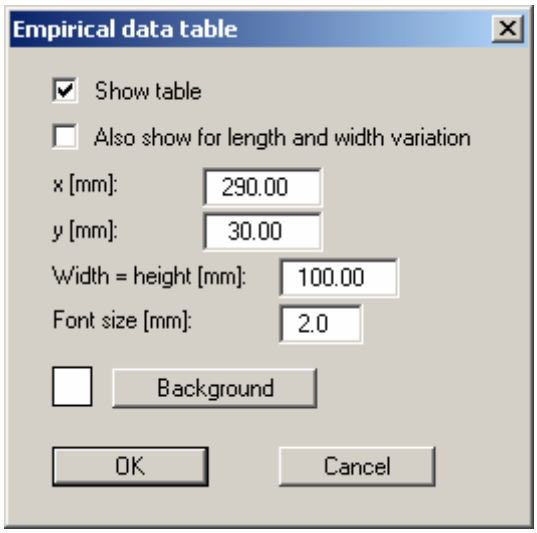


The position of the legend on the output sheet can be defined and edited by means of the variables "***x***" and "***y***"; "**Width = Height**" controls its size. The font size and the background, section and fill colouring can be edited to suit your requirements.

> 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 with the left mouse button pressed.

7.4.9 "Empirical data table" menu item

If the "**Show table**" check box is activated, a summary table is displayed on the screen for your selected pile containing the empirical values for end resistance and skin friction in cohesion less and cohesive soils in accordance with the individual tables in the EAP. Display for an analysis of several piles of varying length or width is deactivated by default, but can be activated using the check box.

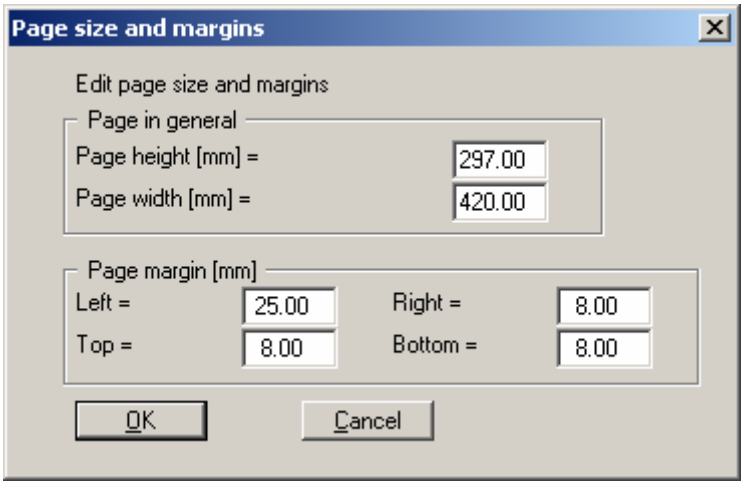


The position of the table on the output sheet can be defined and edited by means of the variables "***x***" and "***y***"; "**Width = Height**" controls its size. The font size and the background fill colouring can be edited to suit your requirements.

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

7.4.10 "Page size and margins" menu item

The program uses A3 format as default. You can edit the page format in the following dialog box.



- "**Page in general**" defines the size of the output sheet. 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 using the menu item "**Graphics preferences/Margins and borders**" (see Section 7.5.5).
- "**Page margin**" defines the position of a frame as a distance to the margins. This frame encloses the subsequent diagram. The margins can be switched off using the menu item "**Graphics preferences/Margins and borders**" (see Section 7.5.5).

7.4.11 "Move objects" menu item

When you go to this item you can move the various objects and legends with the aid of the mouse. Move the mouse over the object to be moved. When you are located above a moveable object the mouse pointer appears in the shape of a cross. You can now press and hold the left mouse button and drag the object to the required position.

> After going to this menu item only one object at a time can be moved using the mouse or its size be altered.
>
> In order to move or edit several objects, this function can be more quickly activated by pressing [**F11**] or the icon.

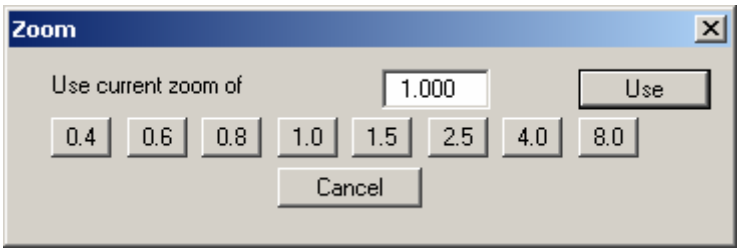
The size of an object can also be altered using this menu item or the [**F11**] key. If you move over the frame of a changeable object after activating this function the mouse assumed the shape of a double-headed arrow. Hold the left mouse button and move the frame until the element has reached the required size. To retain the ratio of the sides, pull at one corner only. If on one side only is pulled the object will become higher or wider.

7.5 Graphics preferences menu

7.5.1 "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.

7.5.2 "Fill colours" menu item

In addition to hatching the allowable area in the pile diagram (see menu item "**Output preferences/Pile diagram**") it can also be given a background colour. Click the "**Diagram with colour**" check box. The default colour is light grey. You can use any colour by means of the "**Edit colour**" button. The colour of the pile in the system representation can be edited by means of the "**Edit pile colour**" button.

7.5.3 "Zoom info" menu item

By clicking two diametrically opposed points you can enlarge a section of the screen in order to view details better. An information box provides information on activating the zoom function and on available options.

7.5.4 "Legend font selection" menu item

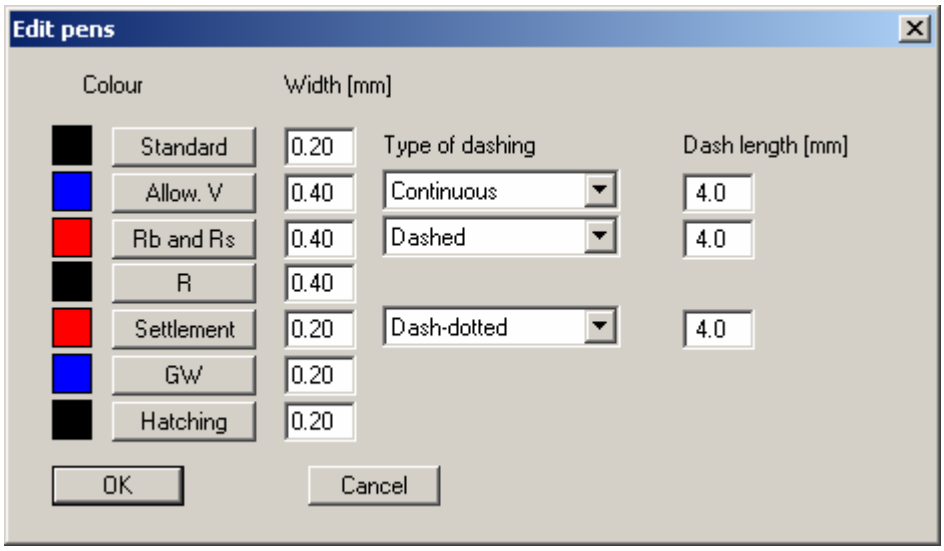
With this menu item you can switch to a different true-type font. All available true-type fonts are displayed in the dialog box.

7.5.5 "Margins and borders" menu item

The program automatically draws thin cutting edges around the page, which are required when using a plotter on paper rolls. Page margins (see menu item "**Page size + margins/Page size and margins**") defines the position of a frame as a distance to the cutting border. This frame encloses the subsequent diagram. You can switch off the lines by deactivating the "**With margins**" and "**With borders**" check boxes.

7.5.6 "Pen colour + width" menu item

In order to enhance the clarity of the graphics you can edit the pen settings for various graphic elements.



You can edit the pen widths for the elements shown in the dialog box; by clicking on the button with the element designation you can also edit the pen or fill colours. Furthermore, you can define dashing for the allowable V, the sum of skin friction and the end resistance or the settlement curves.

On ***monochrome printers*** (e.g. laser printers), colours are shown in a corresponding grey scale. Graphic elements employing very light colours may be difficult to see. In such cases it makes sense to edit the colour preferences.

7.5.7 "Mini-CAD toolbar" menu item

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

Objects created with the "**Mini-CAD**" tool are based on the page format (in mm). This makes you independent of the coordinate system and keeps you in the same position on the page. You should select the "**Mini-CAD toolbar**" if you wish to place general information on the drawing (company logo, report numbers, plan numbers, stamp etc.). Once you have saved the header information to disk (see **Mini-CAD** user manual), you can load it into completely different systems (with different system coordinates). The saved header information will appear in exactly the same position on the page, which greatly simplifies the creation of general page information

7.5.8 "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-AXPILE.alg**" 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 activated from the normal menu items.

"**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**", Section 8.3).

"**Colour/hatching**"
Four colour settings are possible; you can click through them 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.

7.5.9 "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.

7.5.10 "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-AXPILE.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**".

7.6.1 "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 **GGU-AXPILE**.

7.6.2 "Help" menu item

The **GGU-AXPILE** manual is opened as a PDF document. The help function can also be accessed using the [**F1**] function key.

7.6.3 "GGU on the web" menu item

Using this menu item you can access the GGU Software website: www.ggu-software.com.
Keep in touch with new program versions and the regular ***download*** offers.

If you would like to be automatically notified about program innovations, please register for the Newsletter in our Knowledge Base. Go to the following website: http://kbase.civilserve.com.

7.6.4 "GGU support" menu item

This menu item takes to the GGU-Software Support area at www.ggu-software.com.

7.6.5 "What's new?" menu item

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

7.6.6 "Language preferences" menu item

This menu item allows you to switch the menus and graphics from German to English or Spanish and vice versa. The program always starts with the language setting applicable when it was last ended.

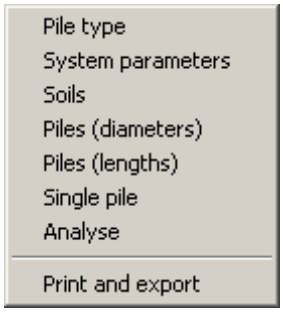
8 Tips and tricks

8.1 Keyboard and mouse

You can scroll the screen with the keyboard using the cursor keys and the [**Page up**] and [**Page down**] keys. By clicking and pulling with the mouse, with [**Ctrl**] pressed, you activate the zoom function, i.e. the selected section will fill the screen. Furthermore you can use the mouse wheel to zoom in/out or scrolling the screen presentation. The following mouse wheel functions are available:

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

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, diagrams or **Mini-CAD** objects, you will immediately move to the editor for the selected object and can then edit it.

8.2 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 contents and sets the screen back to the given page format (A3). This is useful if, for example, you have used the zoom function to display parts of the screen and would like to quickly return to a complete overview.
- [**F1**] opens the manual file.
- [**F2**] refreshes the screen without altering the current magnification.
- [**F3**] opens the menu item "**Edit/System parameters**".
- [**F5**] opens the menu item "**System/Analyse**".

[**F11**] activates the menu item "**Output preferences/Move objects**".

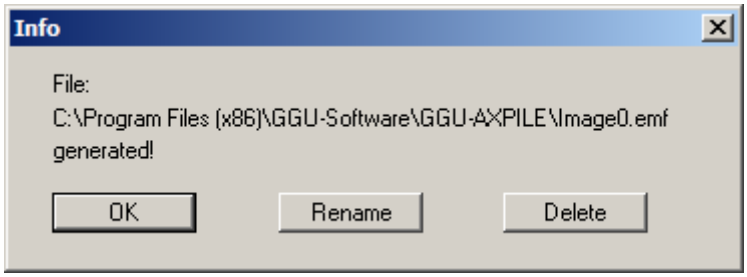
8.3 "Copy/print area" icon

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 opens once the area has been defined:



The default location of the file is the folder from which the program is started 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.

9 Index

A

Absolute heights, use ... 35, 37
Absolute value, for failure settlement definition ... 14
Actions, enter to DIN 1054 ... 22
Allow. V, activate display in output table ... 46
Allow. V, activate display in resistance-settlement diagram ... 47
Allowable area, activate visualisation ... 42
Allowable area, define fill colour ... 52
Allowable pile load, determination principles ... 15
Allowable V, define determination ... 22
Analysis results, display for single pile ... 48
Analysis results, display using pile variations ... 46
Axes scales, user-defined for pile diagram ... 42

B

Bearing resistance $R_{1,k}$, in Franki pile design ... 10
Bearing resistance, characteristic/design value ... 15
Bezier spline, for settlement curves ... 41
Bored pile, analysis to DIN 4014 ... 13
Bored pile, analysis with user-defined tables ... 39

C

Calibration factors, EAP ... 8
Characteristic bearing resistance R_k, determination ... 15
Characteristic effect E_k, determination ... 15
Clipboard ... 32
CodeMeter stick ... 5
Colour, define for allowable area fill ... 52
Colour, define for end resistance ... 53
Colour, define for groundwater ... 53
Colour, define for pile fill ... 52
Colour, define for settlement curves ... 53
Colour, define for skin friction ... 53
Colour/hatching, define for soils ... 43
Colour/hatching, switch on/off ... 54
Colour/pens, define for graphical elements ... 53
Company data, add via Mini-CAD ... 53
Cone pressure, in EAP tables ... 7
Context menu, open ... 57
Copy/print area ... 32, 54, 58
Cutting borders, switch on/off ... 53

D

Design load E_d, in Franki pile design ... 9
Design tables, EAP ... 7
Design value, for bearing resistance R_d ... 15
Design value, for effect E_d ... 15
Driven pile, analysis to Franke ... 14
Driven pile, analysis using tables of DIN 1054 ... 13
Driven pile, analysis with user-defined tables ... 40
DXF file, export ... 31
DXF file, import ... 5

E

EAP, examples ... 29
EAP, principles ... 7
Earth quake, as design situation to EC 7 ... 36
Embedment in load-bearing strata, input for check ... 8
EMF format ... 32
Empirical values of EAP, display in a table ... 50
End resistance, define colour ... 53
End resistance, designation to DIN 4014 ... 13
End resistance, display as resistance-settlement curve ... 47
End resistance, display empirical values of EAP ... 50
End resistance, display in system presentation ... 44
End resistance, enter ... 23
End resistance, in EAP tables ... 7

F

Failure settlement, definition for driven piles to Franke ... 14
Failure settlement, enter for driven piles to Franke ... 35
File, display name in legend ... 45
File, load/save ... 30
Fill colour, define for allowable area ... 52
Fill colour, define for pile ... 52
Flange width ... 35
Font, select ... 52
Franke ... 14, 35
Friction angle, enter for tension pile ... 23
Function keys ... 57

G

General page informations, add via Mini-CAD ... 53
GGUCAD file, export ... 31
GGUMiniCAD file, export ... 32
Graphics, add via Mini-CAD ... 53
Ground height, enter ... 26
Groundwater, adapt to absolute heights ... 26
Groundwater, define colour ... 53
Groundwater, display in system presentation ... 44
Groundwater, enter ... 21

H

Hatching, define for soils ... 43
Hatching, switch on/off ... 54
Heave curves, display ... 42

I

Installation 5
Interpolation of skin friction 37

K

Knowledge Base, access 56

L

Language preferences 6, 56
Layer depths, enter 37
Legend, alter position/size using mouse 18, 51
Licence protection 5
Limiting values, in EAP tables 7
Load case, select 16, 20, 36
Load cases, to EC 7 36

M

Manual, open as PDF file 56
Metafile, export 32
Mini-CAD file, export 32
Mini-CAD, use 53
Minimum embedment, enter for examination 22
Minimum pile length, enter for examination 22
Mouse click functions 57
Mouse wheel functions 57

N

Norm-driving work W, determination 10

O

Objects, alter position/size using mouse 18, 51

P

Page format, define 51
Page margins, define 51
Page margins, switch on/off 53
Page section, copy/print 54, 58
Pile base resistance $R_{1b,k}$, in Franki pile design 10
Pile cross-section, display in legend 49
Pile diagram, activate display 41
Pile diagram, activate lines explanation 45
Pile shaft resistance $R_{s1,k}$, in Franki pile design 10
Pile toe volume, determination from EAP nomograms 10
Pile type, select 34
Pile visualisation, define fill colour 52
Piles with belled toes, reduction of end resistance 21
Pre-cast driven piles, required reductions 8
Print, graphics 31
Print, section 32, 54, 58
Print, several files 33
Printer preferences 30, 31
Program, display name in legend 45
Program, load/save preferences 55
Program, show improvements 56
Program, show information 56
Project data, add via Mini-CAD 53
Project identification, display 45
Project identification, enter 34
Pull-out cone, determination for tension piles 15

R

R(E,k), activate display in resistance-settlement diagram 47
R(E,k), define determination 22, 35
R,d, activate display in output table 46
R,d, activate display in pile diagram 35, 42
R,d, activate display in resistance-settlement diagram 47
Record description, display 45
Record description, enter 34
Relative value, for failure settlement definition 14
Resistance-settlement curve, calculate for bored piles 13
Resistance-settlement curve, calculate for driven piles to Franke 14
Resistance-settlement curve, display in legend 47

S

Safety factor eta (pull-out), for tension pile design 15
Safety, required 36
Scroll the screen 57
Section, select type for pre-cast driven pile 35
Settlement behaviour, bored pile to DIN 4014 13
Settlement curves, define colour 53
Settlement curves, display 42
Settlement, allowable 36
Shear strength, display in system presentation 44
Shear strength, in EAP tables 7
Skin friction forces, determination for bored pile to DIN 4014 13
Skin friction, define colour 53
Skin friction, designation to DIN 4014 13
Skin friction, display as resistance-settlement curve 47
Skin friction, display empirical values of EAP 50
Skin friction, enter 23
Skin friction, in EAP tables 7
Smarticons, for menu items 54
Smoothing out method, pile diagram 41
Soil layers, adapt to absolute heights 26
Soil layers, define/delete 23, 37
Soil properties, define 23, 37
Soil properties, display in legend 43
Soil, define colour/hatching 43
Soil, names in system presentation 44
Soil, select coloured/hatched display 43, 54
Standard, display in legend 45
Standard, select 34
Status bar main program, activate 54

Surcharge factors, enter additionally 21
System parameters, descriptions..... 21, 35
System properties, display in legend 45
System, activate visualisation..... 44
System, analyse 41
System, select coloured/hatched display 43, 54
System, show information 56

T

Toolbar, edit for menu items 54
Translation, activate 56
True-type font..... 52

U

Unit weight, enter for tension pile 23

V

Variation, pile diameter 24
Variation, pile length 28
Verification of ultimate limit state..... 10
Version number, display in a message box..... 56
Version number, display in legend 45

W

What you see is what you get 52

Z

Zoom factor, define for full-screen display 52
Zoom function, activate..... 52, 54, 57