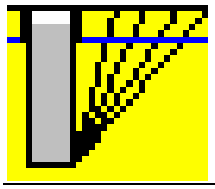
Stability analysis for diaphragm walls to DIN 4126

GGU-TRENCH

VERSION 8



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

Contents:

1 Preface 4

2 Licence protection and installation 4

3 Language selection 5

4 Starting the program 5

5 Analysis principles 6

5.1 General notes 6

5.2 Safety against groundwater ingress into the trench 6

5.3 Safety against slippage of single grains or grain groups 7

5.4 Safety against slip surfaces endangering the stability of the trench 7

6 Description of menu items 10

6.1 File menu 10

6.1.1 "New" menu item 10

6.1.2 "Load" menu item 11

6.1.3 "Save" menu item 11

6.1.4 "Save as" menu item 11

6.1.5 "Print output table" menu item 11

6.1.5.1 Selecting the output format 11

6.1.5.2 Button "Output as graphics" 12

6.1.5.3 Button "Output as ASCII" 14

6.1.6 "Printer preferences" menu item 15

6.1.7 "Print and export" menu item 15

6.1.8 "Batch print" menu item 17

6.1.9 "Exit" menu item 17

6.1.10 "1, 2, 3, 4" menu items 17

6.2 Edit menu 18

6.2.1 "Project identification" menu item 18

6.2.2 "Verification concept" menu item 18

6.2.3 "Diaphragm wall" menu item 19

6.2.4 "Suspension + GW" menu item 21

6.2.5 "Soils" menu item 21

6.2.6 "Line loads" menu item 22

6.2.7 "Terrace" menu item 23

6.2.8 "Water pressure (manually)" menu item 24

6.3 System menu 25

6.3.1 "Analyse" menu item 25

6.3.2 "Minimum safety factors" menu item 26

6.3.3 "Maximum utilisation factors" menu item 26

6.3.4 "Allowable FOS preferences" menu item 26

6.3.5 "Graphics output preferences" menu item 27

6.3.6 "Graph positioning preferences" menu item 28

6.3.7 "Dimension lines" menu item 29

6.4 Graphics preferences menu 30
6.4.1 "Refresh and zoom" menu item 30
6.4.2 "Zoom info" menu item 30
6.4.3 "Legend font selection" menu item 30
6.4.4 "Pen colour and width" menu item 30
6.4.5 "Mini-CAD toolbar" and "Header toolbar" menu items 31
6.4.6 "Margins and borders" menu item 31
6.4.7 "Toolbar preferences" menu item 31
6.4.8 "General legend" menu item 33
6.4.9 "Soil properties legend" menu item 34
6.4.10 "Move objects" menu item 35
6.4.11 "Save graphics preferences" menu item 35
6.4.12 "Load graphics preferences" menu item 35
6.5 Page menu 35
6.5.1 "Auto-resize" menu item 35
6.5.2 "Manual resize (mouse)" menu item 35
6.5.3 "Manual resize (editor)" menu item 35
6.5.4 "Font size selection" menu item 36
6.5.5 "Page size and margins" menu item 36
6.6 ? menu 37
6.6.1 "Copyright" menu item 37
6.6.2 "GGU on the web" menu item 37
6.6.3 "GGU support" menu item 37
6.6.4 "Maxima" menu item 37
6.6.5 "Help" menu item 37
6.6.6 "What's new?" menu item 37
6.6.7 "Language preferences" menu item 37
7 Tips and tricks 38
7.1 Keyboard and mouse 38
7.2 Function keys 39
7.3 "Copy/print area" icon 40
8 Index 41

1 Preface

The **GGU-TRENCH** program allows analysis and representation of the inner and outer stability of diaphragm walls. Analysis can be performed using the ***global safety factors*** employed by the old DIN 4126 or with the ***partial safety factors*** used by the new DIN 4126, August 2004.

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-TRENCH** 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-TRENCH** 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-TRENCH is a bilingual 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 "**Spracheinstellung**" (for German) or "**Language preferences**" (for English).

4 Starting the program

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

- File
- ?

By going to the "**File**" menu, a previously analysed system can be loaded by means of the "**Load**" menu item, or a new one created using "**New**". After clicking the "**New**" menu item a dialog box opens for specifying general preferences for your new system (see Section 6.1.1). After leaving the box you then see six menus in the menu bar:

- File
- Edit
- System
- Graphics preferences
- Page size + margins
- ?

After clicking one of these menus, the 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-TRENCH** 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 Analysis principles

5.1 General notes

Four safety factors must be determined to verify the stability of a diaphragm wall:

1. Safety against groundwater ingress
   (DIN 4126 (old); 9.1.1 or DIN 4126 Aug. 2004; 6.1)
2. Safety against slippage of single grains or grain groups
   (DIN 4126 (old); 9.1.2 or DIN 4126 Aug. 2004; 6.2)
3. Safety against the slurry level falling below the minimum level required for stability
   (DIN 4126 (old); 9.1.2 or DIN 4126 Aug. 2004; 6.3)
4. Safety against slip surfaces endangering the stability of the trench
   (DIN 4126 (old); 9.1.2 or DIN 4126 Aug. 2004; 6.4)

The verifications for 1, 2 and 4 are performed by the program. A verification for 3 must be estimated pursuant to DIN 4126 (old), 9.1.3 or DIN 4126 Aug. 2004; 6.3.

In comparison to the old safety factor concept, the new DIN 4126 Aug. 2004 does not bring with it any substantial changes. The old standard requires the following verification for the stability of the trench (see Table 2 in old DIN 4126):

$$\eta = \frac{S - W}{E} \geq 1{,}1 \;\; or \;\; 1{,}3$$

The new standard requires the following verification:

$$\gamma_H \cdot (S - W) - \gamma_E \cdot E \geq 0$$

where γ_H = 1.0 and γ_E = 1.1 or 1.3 (see Table 4 in DIN 4126 Aug. 2004).

Solved for γ_E we get

$$\gamma_E = \frac{1{,}0 \cdot (S - W)}{E} \geq 1{,}1 \;\; or \;\; 1{,}3 \;\; ,$$

which corresponds to the relationship given in DIN 4126 (old).

5.2 Safety against groundwater ingress into the trench

The program calculates the pressure exerted by the slurry p_s and the pressure exerted by the groundwater p_w at the toe of the diaphragm wall. The FOS, eta(gw), is then

$$\mathbf{eta(gw) = p_s / p_w.}$$

The old DIN 4126, (9.1.1) and DIN 4126 Aug. 2004 (6.1) require a safety factor of 1.05.

5.3 Safety against slippage of single grains or grain groups

The safety against slippage of single grains or grain groups eta(i) (also known as inner stability) is calculated pursuant to old DIN 4126 (Section 9.1.2) from

$$\mathbf{eta(i) = \tau_F \ / (d_{10} * \gamma'' / \tan(\varphi))}$$

The program simplifies γ" by adopting the buoyant (effective) unit weight of the soil.

The old DIN 4126 (9.1.2) and DIN 4126 Aug. 2004 (6.2) require a safety factor of 1.0.

5.4 Safety against slip surfaces endangering the stability of the trench

The safety against slip surfaces endangering the stability of the trench eta(a) (also known as external stability) is calculated pursuant to the old DIN 4126 from

$$\mathbf{eta(a) = (S - W) / E}$$

S = support force of the suspension [kN]
W = water pressure exerted by groundwater [kN]
E = earth pressure [kN]

The numerator is obtained from the hydrostatic supporting pressure of the suspension, reduced by the water pressure W from groundwater. Because of the finite length of the trench the current earth pressure problem can no longer be treated as a plane earth pressure case. The default method used in the program is the so-called shoulder theory as shown in Figure 7 of DIN 4126 (old). This employs a finite, triangular earth pressure wedge. The friction forces generated on both flanks of the wedge are utilised for consideration of equilibrium conditions, which gives higher factors of safety as opposed to the plane situation. Friction forces on both flanks ensue from the self-weight of the soil, the distributed load and, if required, any line loads present. A linear increase in the lateral pressure stress consistent with the unit weight of the soil is assumed to a depth equal to the width of the trench. Below this depth the lateral pressure stress is constant. This method is therefore also known as "**bilinear**". DIN 4126 (old) demands a FOS of 1.1 or 1.3 (if loads from structures act in the critical area). With regard to their influence on the lateral pressure stress, any distributed loads present are assumed to decrease linearly from the ground surface (full distributed load) to **0** at a depth corresponding to the trench width.

Alternatively to the bilinear approach, a so-called "**sublinear**" approach after Terzaghi is often used for the depth distributione stress of the lateral pressure stress. The theoretical principles are described in detail in, for example, "*KILCHERT/KARSTEDT, Standsicherheitsberechnung von Schlitzwänden nach DIN 4126*" (KILCHERT/KARSTEDT, Stability analysis of diaphragm walls to DIN 4126 – no translation published) (Beuth Verlag GmbH). The method after Terzaghi is based on the so-called silo theory. The sublinear approach after Terzaghi can also be selected. According to WALZ and PULSFORT (1983; "*Rechnerische Standsicherheit suspensionsgestützter Erdwände"; Teil 1 und 2, Tiefbau, Ingenieurbau, Straßenbau, Heft 1 und 2* - "Computed stability of suspension-supported earth walls"; Parts 1 and 2, *Tiefbau, Ingenieurbau, Straßenbau*, Issues 1 and 2), the sublinear approach after Terzaghi is acceptable if the bilinear approach after DIN 4126 (old) using the bending point defined by the depth z = trench width is not exceeded. This restriction can also be entered in the program.

In contrast to a distributed load, line loads can only act on a limited area beside the guide wall. If you set the check boxes described later in this manual so that line loads act to increase the lateral pressure stress, the program proceeds as follows:

- **The proportion of the line load inside the respective slip body is converted to an equivalent distributed load ("smearing") and then treated as a distributed load.**

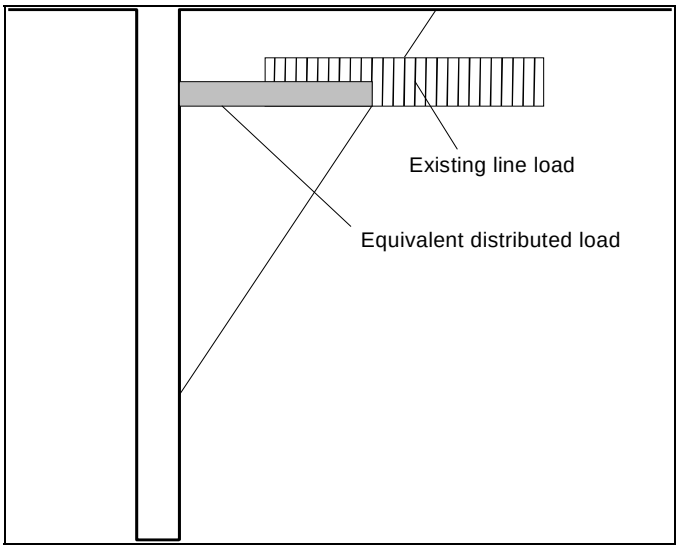


Figure 1 Influence of line loads

If footings substantially smaller than the trench width exist in the area of a trench, the point load must be converted to an equivalent line load. However, you should then consider whether the point load contributes at all to the lateral pressure stress on the wall. The proportion giving rise to a corresponding equivalent load that increases the favourably acting lateral pressure stress can therefore be individually defined in the program for each line loading by means of a factor (>= 0.0 and <= 1.0).

If the pressure gradient f_{S0}

$$\mathbf{f_{S0} = 2 * \tau_F \ / d_{10}}$$

lies below 200 kN/m² the full membrane effect of the suspension is no longer available, requiring a reduction in the support force. The reduction depends on the penetration depth of the suspension into the respective soil. The program calculates the reduction in the support force. Therefore, instead of the expression

$$(S - W)$$

in the above equation, the program calculates the effective support force S'. Even for limit gradients > 200.0, penetration depths are > "0.0", leading, in principle, to a reduction in the effective support force. In agreement with the DIN 4126 (old), however, the program assumes a penetration depth of "0.0" for limit gradients > 200.0, giving rise to somewhat higher factors of safety.

When determining the support force S in the region of the guide walls pursuant to old DIN 4126 (9.1.4.2), the earth pressure from soil self-weight and permanent, uniformly distributed surcharge may be adopted up to the value of the at-rest earth pressure, instead of the pressure of the supporting suspension, if the guide walls and their bracing are designed for this. The program has a switch which you can use to select from the options offered in the DIN standard. You can incorporate both distributed loads or line loads into the calculation of the guide wall earth pressure. If line loads contribute to the guide wall earth pressure (can be specified), its component will be taken into consideration completely, independent of the factor described above for the lateral pressure component. In addition, for determination of the at-rest pressure on the guide wall from line loads, the line load, in accordance with Figure 1 is converted to an equivalent line load.

Calculation of the earth pressure to be supported by the slurry fluid is for various user-defined depths, varying the slip surface angle. The variation range of the slip surface angle is user-defined.

In accordance with DIN 4126 (old), a safety factor of 1.5 is to be adopted for any cohesion in the slip surface. The **GGU-TRENCH** program allows a further reduction of the cohesion components in both flanks and in the slip surface, beside the general reduction.

The new standard stipulates that safety is sufficient if the condition

$$\gamma_H \cdot (S_k - W_k) - \gamma_E \cdot E_{ahk} \geq 0$$

is shown.

S_k = characteristic value of support force to 6.4.2 of DIN 4126 Aug. 2004

W_k = characteristic value of groundwater pressure

E_{ahk} = characteristic value of earth pressure to 6.4.3 of DIN 4126 Aug. 2004

γ_H = partial factor for the groundwater pressure and the slurry fluid pressure

γ_E = partial factor for earth pressure

The variables in the equation are calculated according to the old DIN 4126. If calculations are consistently performed according to DIN 4126 Aug. 2004, a safety definition in the sense of the old standard, which provides a guide for the degree of safety, is not obtained. The only statement that can be made is "***Stable***" or "***Instable***".

In order to still arrive at a measure of safety, the utilisation factor μ is defined, obtained from:

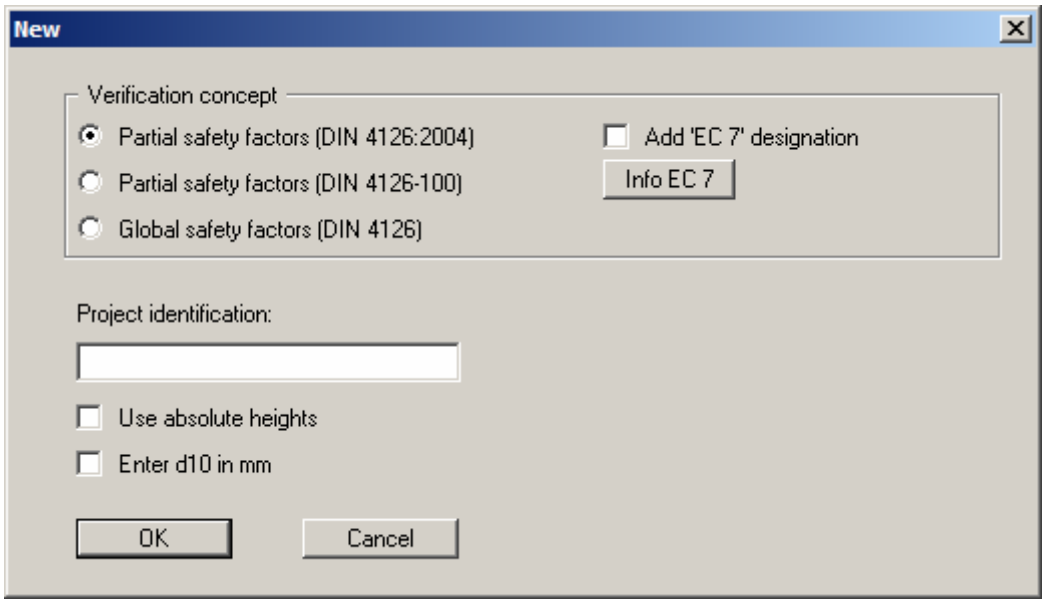
$$\mu = \frac{\gamma_E \cdot E_{ahk}}{\gamma_H \cdot (S_k - W_k)}$$

6 Description of menu items

6.1 File menu

6.1.1 "New" menu item

Click on this menu item to create a new wall system.



You decide whether the necessary verifications are to be performed using the ***partial safety factors*** to DIN 4126:2004, or using the ***global safety factors*** to the old DIN 4126. In order to guarantee the compatibility of the older records it is still possible to select DIN 4126-100 here. Eurocode 7 with national annex 'DIN 1054:2010' refers to the DIN 4126:2004. For the sake of formality the expression 'DIN 4126' can be prefixed by 'EC 7' when printing. Just activate the "**Add 'EC 7' designation**" check box.

You can enter a project identification, which will subsequently be entered in the ***General legend*** (see Section 6.4.8).

If you activate the "**Use absolute heights**" check box, all information with regard to trench depth, guide wall depth, suspension level, groundwater level and depth of soil layers can be given in absolute heights (e.g. in m AD). In the dialog box for diaphragm wall input (see menu item "**Edit/Diaphragm wall**", Section 6.2.3) the height of the ground level must then also be entered in absolute figures. In all relevant dialog boxes the input value will be shown as [m AD] instead of [m]. This simply provides clarity. You are, of course, free to select a reference level other than [m AD]. If you do not activate the "**Use absolute heights**" check box, ground level is assumed to be 0.0 m and all depth information is positive downwards.

Here, you can predefine the unit for the "**d10**" soil property (see Section 6.2.5, "**Edit/Soils**"). If the check box is not activated, this will be in [m].

6.1.2 "Load" menu item

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

6.1.3 "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. Loading again later creates exactly the same presentation as was present at the time of saving.

6.1.4 "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 "**.scl**" 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, "**.Sscl** will be used automatically.

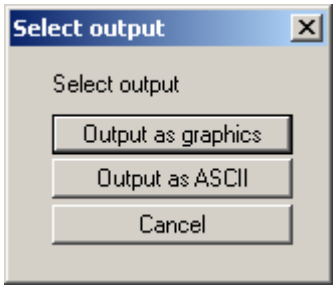
If, at the time of saving, the current system has been analysed, you can decide in a dialog box whether to save the analysis results with the document. If you select "**No**" here you must reanalyse the file if it is opened again later.

6.1.5 "Print output table" menu item

6.1.5.1 Selecting the output format

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

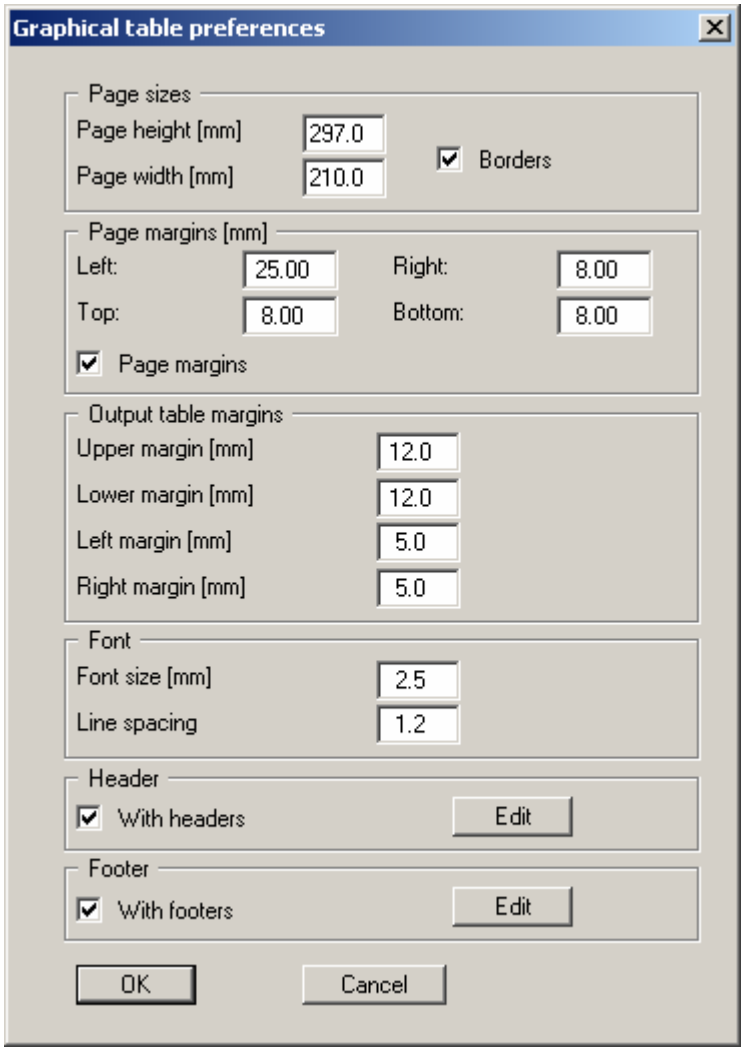
You have the option of designing and printing the output table as an annex to your report within the **GGU-TRENCH** program. To do this, select "**Output as graphics**" from the following options.



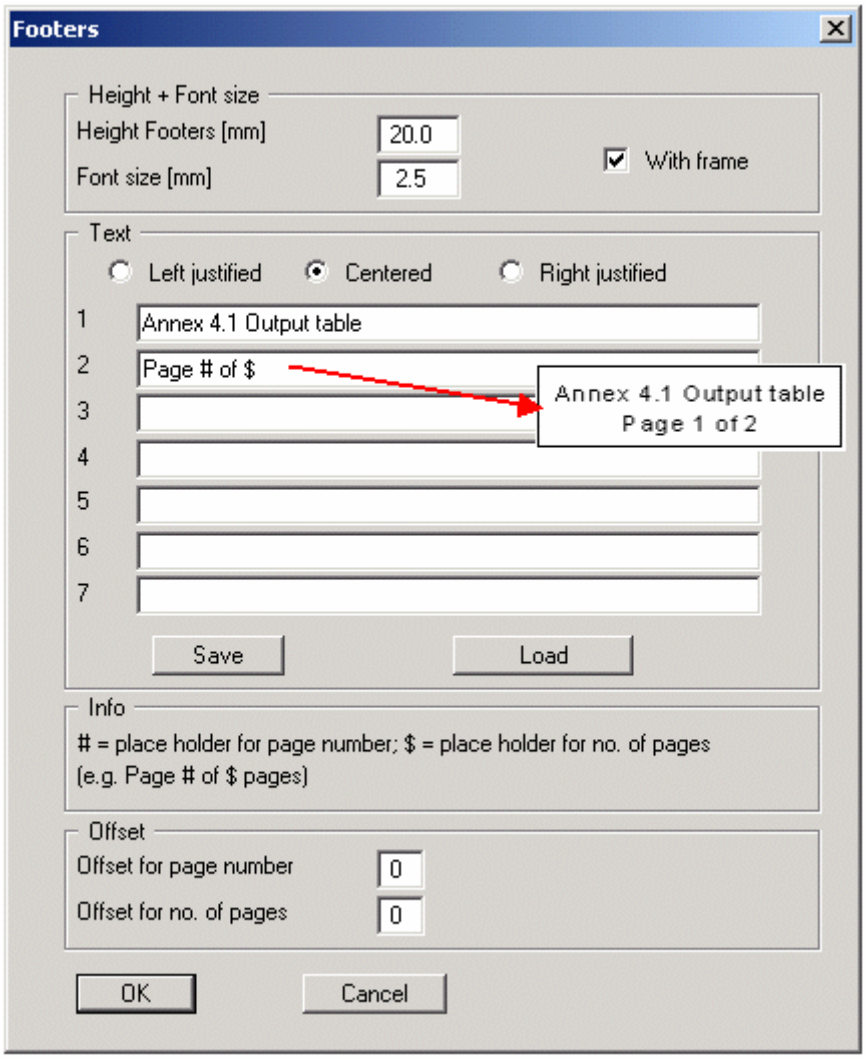
If you prefer to easily print or process the data in a different application, you can send them directly to the printer or save them to a file using the "**Output as ASCII**" command button.

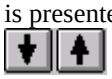
6.1.5.2 Button "Output as graphics"

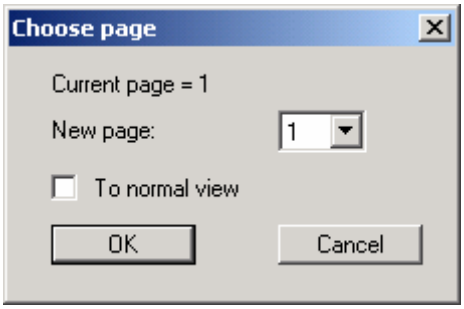
If you selected the "**Output as graphics**" button in the previous dialog box a further dialog box, in which you can define further preferences for result presentation.



You can define the desired layout for the output table in various areas of the dialog box. If you need to add a header or footer (e.g. for page numbering), activate the appropriate check boxes "**With headers**" and/or "**With footers**" and click on the "**Edit**" button. You can then edit as required in a further dialog box.

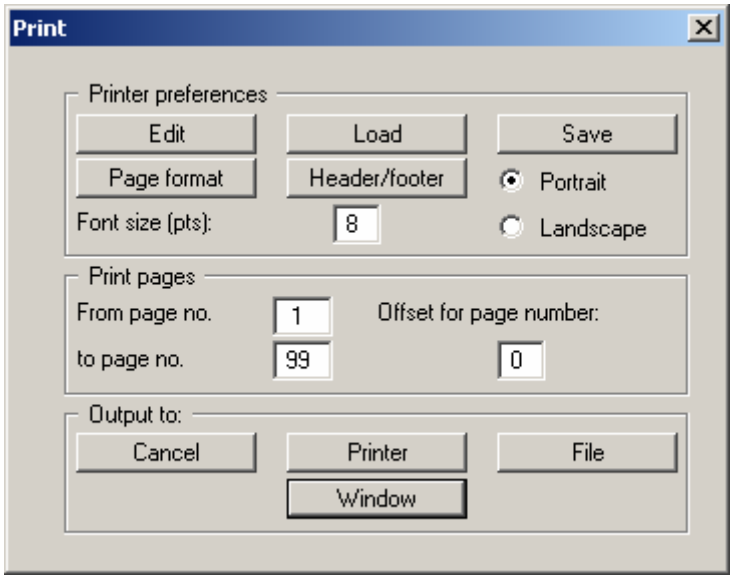


Automatic pagination can also be employed here if you work with the placeholders as described. After exiting the dialog boxes using "**OK**" you will see a further dialog box in which you can select the parameters to be used in the output table. If you click the "**Start**" button the output table is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



6.1.5.3 Button "Output as ASCII"

You can have your analysis data sent to the printer, without further work on the layout, or save it to a file for further processing using a different program, e.g. a word processing application. After selecting the button "**Output as ASCII**" you will see a further dialog box in which you can select the parameters to be used. If you click the "**Start**" button, the following dialog box appears in which you can define output preferences.



In the dialog box you can define output preferences:

- "**Printer preferences**" group box
  Using the "**Edit**" button the current printer preferences can be changed or a different printer selected. Using the "**Save**" button, all preferences from this dialog box can be saved to a file in order to have them available for a later session. If you select "**GGU-TRENCH.drk**" as file name and save the file in the program folder (default), the file will be automatically loaded the next time you start the program.

  Using the "**Page format**" button you can define, amongst other things, the size of the left margin and the number of rows per page. The "**Header/footer**" button allows you to enter a header and footer text for each page. If the "#" symbol appears within the text, the current page number will be entered during printing (e.g. "***Page*** #"). The text size is given in "**Pts**". You can also change between "**Portrait**" and "**Landscape**" formats.

- "**Print pages**" group box
  If you do not wish pagination to begin with "***1***" you can add an ***offset number*** to the check box. This offset will be added to the current page number. The output range is defined using "**From page no.**" "**to page no.**".

- "**Output to:**" group box
  Start output by clicking on "**Printer**" or "**File**". The file name can then be selected from or entered into the box. If you select the "**Window**" button the results are sent to a separate window. Further text editing options are available in this window, as well as loading, saving and printing.

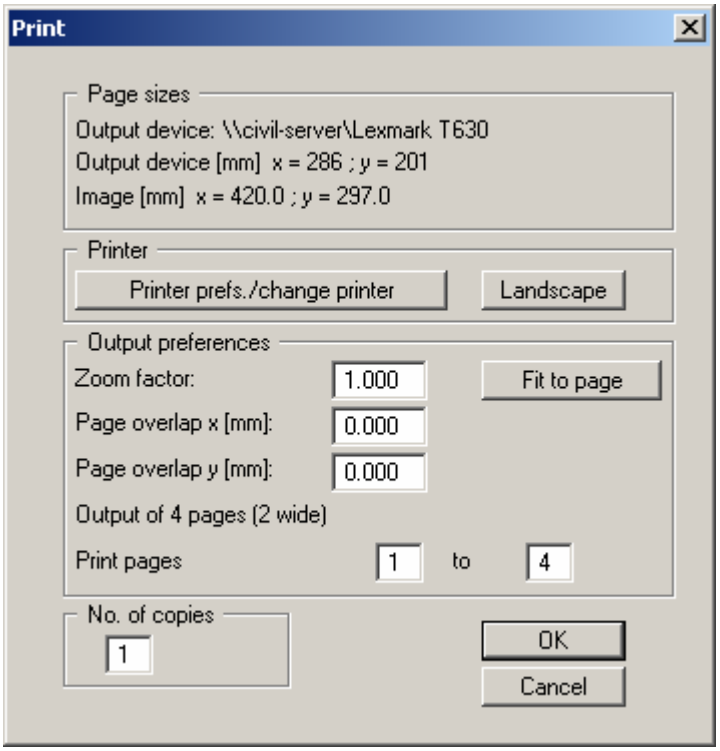
6.1.6 "Printer preferences" menu item

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

6.1.7 "Print and export" menu item

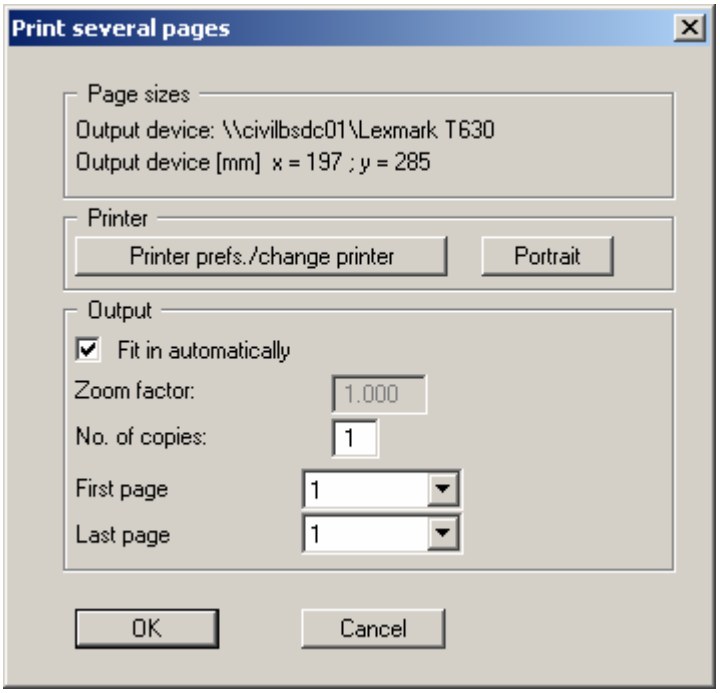
You can select your output format in a dialog box. You have the following possibilities:

- "**Printer**"
  allows graphic output of the current screen contents (***graphical representation***) to the WINDOWS standard printer or to any other printer selected using the menu item "**File/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 group box, the maximum dimensions which the printer can accept are given. Below this, the dimensions of the image to be printed are given. If the image is larger than the output format of the printer, the image will be printed to several pages (in the above example, 4). 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.

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



Here, you can select the table pages to be printed. In order to achieve output with a zoom factor of 1 (button "**Fit in automatically**" is deactivated), you must adjust the page format to suit the size format of the output device. To do this, use the dialog box in "**File/Print output table**" button "**Output as graphics**".

- "**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.

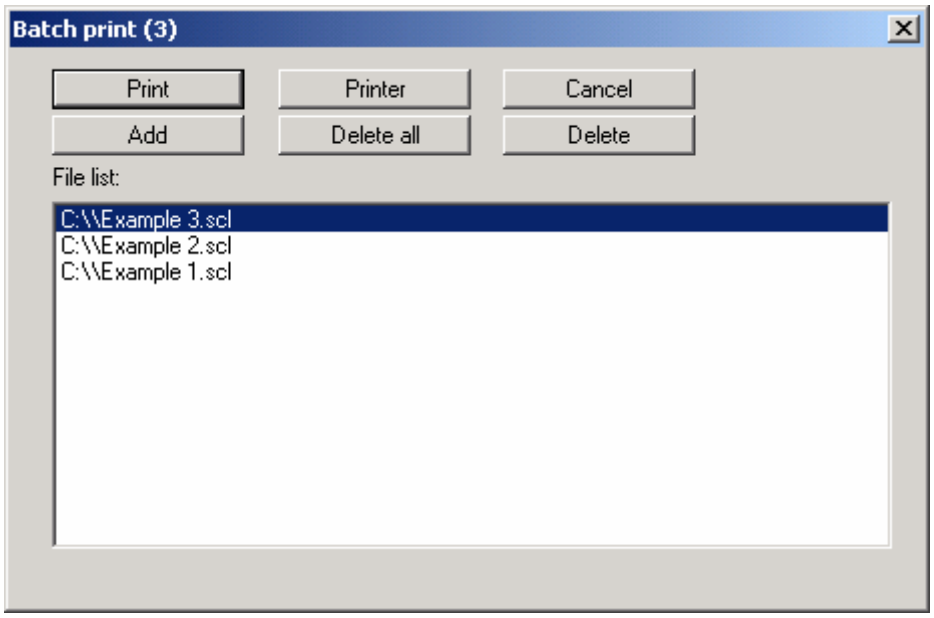
If you select the "**Copy/print area**" tool from the toolbar, you can copy parts of the graphics to the clipboard or save them to an EMF file. Alternatively you can send the marked area directly to your printer (see "**Tips and tricks**", Section 7.3).

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.

6.1.8 "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.

6.1.9 "Exit" menu item

After a confirmation prompt, you can quit the program.

6.1.10 "1, 2, 3, 4" menu items

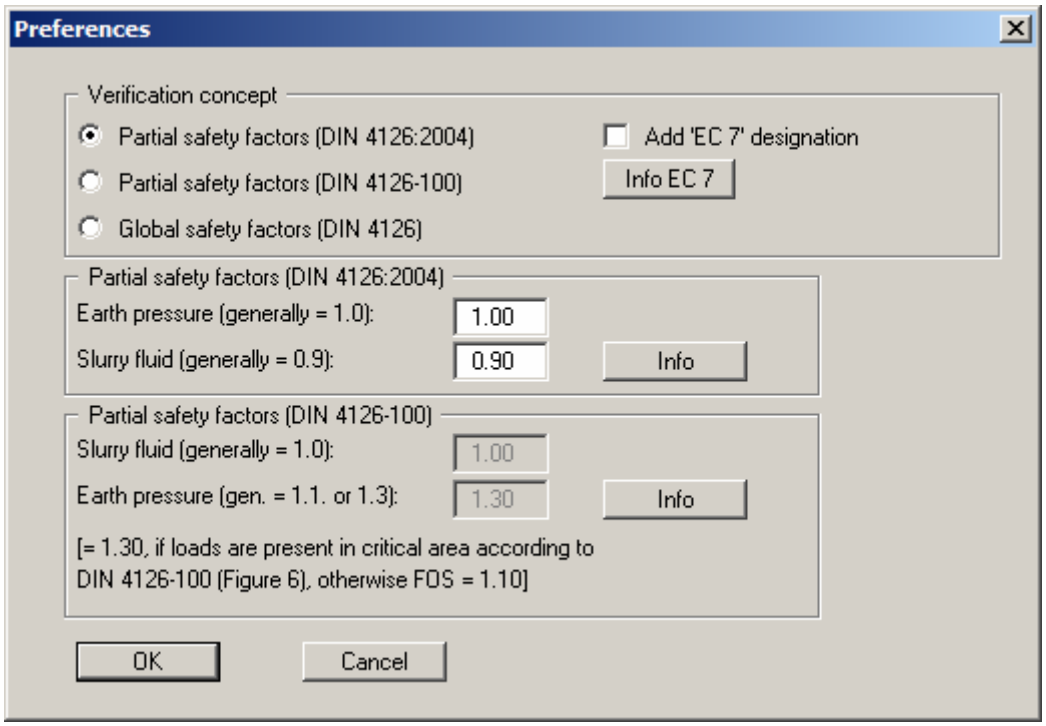
The "**1, 2, 3, 4**" menu items show the last four files worked on. By selecting one of these menu items the listed file will be loaded. If you have saved files in any other folder than the program folder, you can save yourself the occasionally onerous ***rummaging*** through various sub-folders.

6.2.1 "Project identification" menu item

You can enter a description of the current system; this will then be used in the general legend (see Section 6.4.8).

6.2.2 "Verification concept" menu item

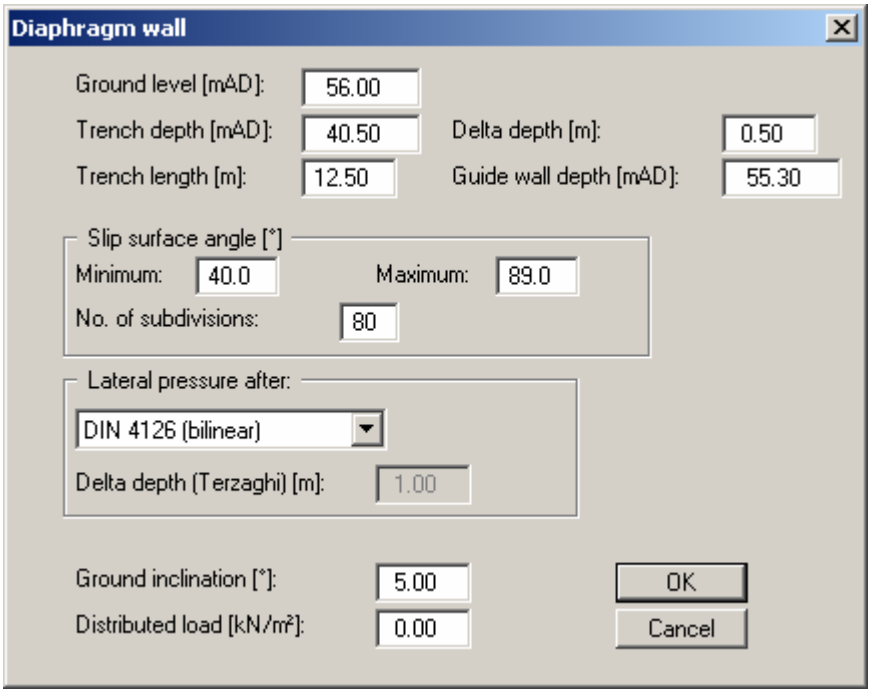
You can select the desired verification concept. If a ***partial factor concept*** is selected, the partial factors for "**Slurry fluid**" (γ_H) and "**Earth pressure**" (γ_E) can be entered. Further information on the partial factors is available by pressing the "**Info**" buttons (see also Section 5, "**Analysis principles**").



In order to guarantee the compatibility of the older records it is still possible to select DIN 4126-100 here.

6.2.3 "Diaphragm wall" menu item

This menu item consists of the central data input for your system and the initial analysis data. You will see a dialog box, in which almost all the basic data necessary for analysis of the diaphragm wall can be entered.



In the upper group box you enter the dimensions of the diaphragm wall and the guide wall. The "**Delta depth**" defines the model points at which safety factors are computed. Distinctive points in the system such as the base of the guide wall and layer boundaries are always taken into consideration.

If you have activated the "**Use absolute heights**" check box, an additional "**Ground level**" input box will be displayed. All height input is then in [m AD]. If you do not use absolute heights, ground level is assumed to be 0.0 m and all depth information is positive downwards.

The range of variation of the slip surface angle is then specified.

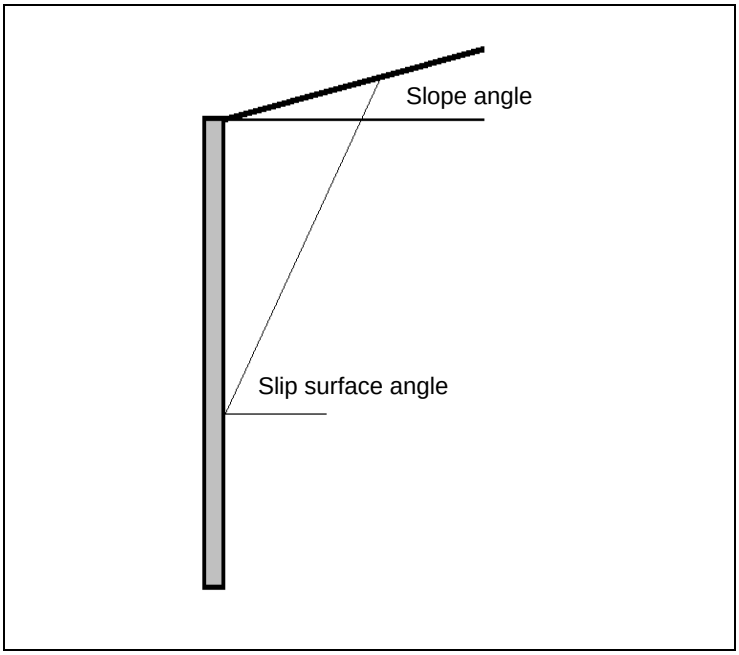


Figure 1 Slip surface angle

The number of intermediate angles between the two slip surface angles ("**minimum**" and "**maximum**") is defined by the "**No. of subdivisions**". The program begins the analysis with the first entered minimum slip surface angle. The next ***intermediate angle*** is then investigated.

In the lower group box you select the type of lateral pressure increase. There are three possible options (see also Section 5.4):

- bilinear after DIN 4126
- sublinear after Terzaghi
- sublinear after Terzaghi, but with the limitation that the bilinear approach after DIN 4126 using the bending point defined by the depth z = trench width is not exceeded.

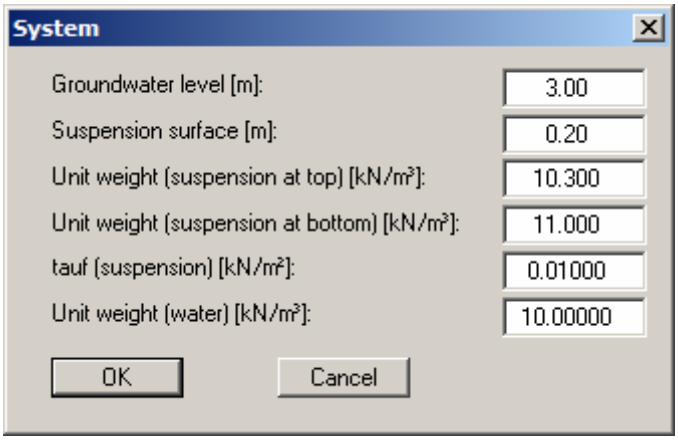
When computing the lateral pressure increase after Terzaghi the lateral pressures increase following an exponential function. In order to model the curve precisely enough in the program, it is possible to control the model points at which the lateral pressures after Terzaghi are computed using the "**Delta depth (Terzaghi)**" value.

In the lower group box, any ground inclination and the value of the distributed load are defined.

> In contrast to line loads, the distributed load is always taken into consideration when determining the friction forces acting on the wedge flanks.

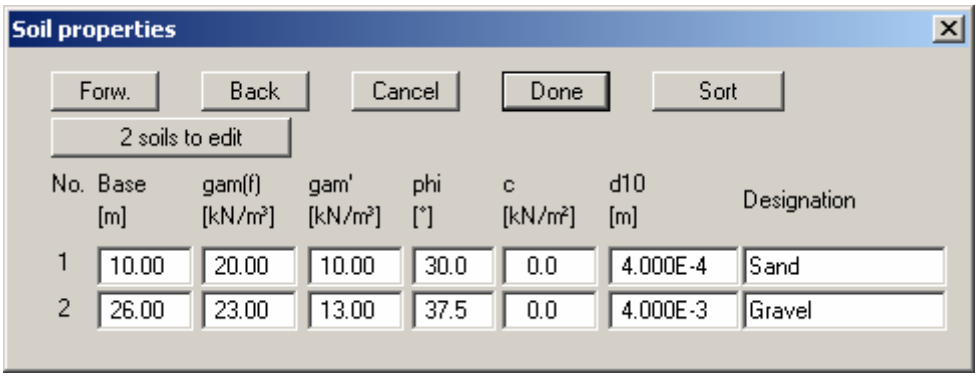
6.2.4 "Suspension + GW" menu item

Using this menu item, information is entered on the unit weight of the suspension, the suspension surface level, the liquid limit of the slurry fluid (tauf) and the groundwater level.



6.2.5 "Soils" menu item

The layering of the ground is described using this menu item. After clicking on this menu item the following dialog box opens:



By clicking the "**x soils to edit**" button a further dialog box opens in which you can enter the number of soils. If more than eight soils are present they can be viewed by navigating through the soil table using the "**Forw.**" and "**Back**" buttons.

The properties for each soil are entered into the corresponding input boxes. These are:

- **Base** = base of respective layer [m];
- **gam(f)** = unit weight of wet soil [kN/m³];
- **gam'** = buoyant unit weight of soil [kN/m³];
- **phi** = friction angle of soil [°]
- **c** = cohesion of soil [kN/m²]
- **d10** = grain size of soil for 10 % mass component [m]

If you have activated the "**Use absolute heights**" check box, the layer depths ("**Base**") are positive upwards, i.e. the layer depths must be entered in mAD.

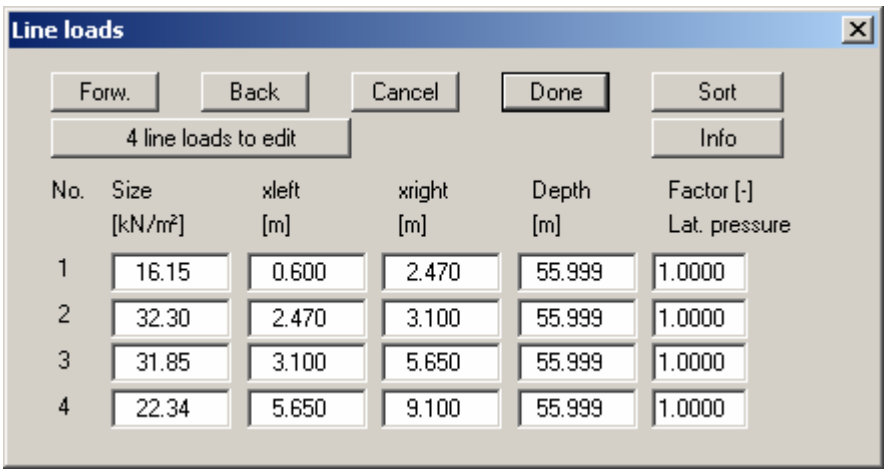
The soils are sorted according to depth by pressing the "**Sort**" button. This is always done automatically after leaving the dialog box.

> You can also use this function to eliminate a soil from the table.
>
> Simply assign the soil to be eliminated a greater layer depth and then click the "**Sort**" button. The corresponding soil is now the last soil in the table and can be ***deleted*** by reducing the number of soils.

Any groundwater present does not need to be entered as a layer boundary, the program does this automatically.

6.2.6 "Line loads" menu item

You will see the following dialog box:



By clicking the "**x line loads to edit**" button a further dialog box opens in which you can enter the number of line loads (max. 20). If more than eight line loads are entered they can be viewed by navigating through the line load table using "**Forw.**" and "**Back**".

The values corresponding to the respective line loads are entered into the appropriate fields in the dialog box. These are:

- **Size** = the size of the line load [kN/m²]
- **xleft** = the distance of the left line load boundary from the diaphragm wall [m]
- **xright** = the distance of the right line load boundary from the diaphragm wall [m]
- **Depth** = the depth at which the line load acts [m], from the top of the diaphragm wall
- **Factor Lateral pressure** = the amount by which the line load contributes to an increase in the lateral pressure (0.0 => no contribution)

The line loads are sorted according to acting depth by pressing the "**Sort**" button.

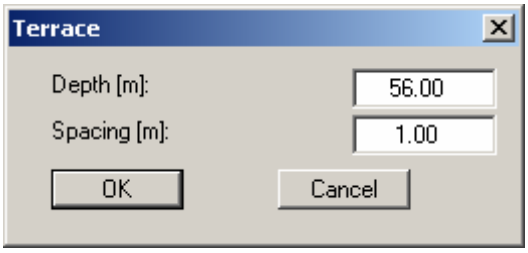
You can also use this function to eliminate a line load from the table.

Simply assign the line load to be eliminated a greater acting depth and then click the "**Sort**" button. The corresponding line load is now the last line load in the table and is be ***deleted*** by reducing the number of line loads.

If line loads possess a factor for the lateral pressure > 0.0, the corresponding value will be displayed in brackets in the system graphics, following the value for the line load.

6.2.7 "Terrace" menu item

Using this menu item you can take the influence of a terrace beside the diaphragm wall into consideration.



The "**Depth**" value designated the depth of the terrace below ground level. The "**Spacing**" value designates the distance of the terrace from the guide wall.

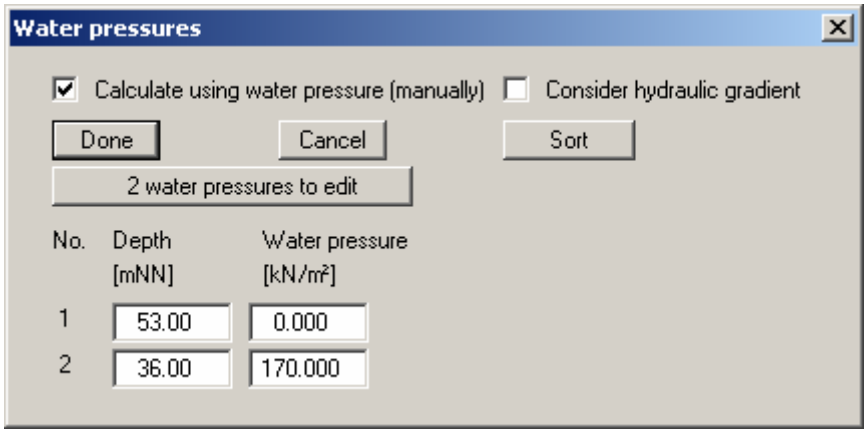
The current version of the program only allows for terraces **> 0.0**.

Terraces < 0.0 can be taken into consideration approximately by using negative line loads.

Below the terrace, a correspondingly reduced lateral pressure is assumed on both flanks, which leads to a lower friction force on the flanks. In addition, the cohesion component on the slip surface is correspondingly reduced.

6.2.8 "Water pressure (manually)" menu item

Normally, the water pressure is calculated using the user-defined groundwater level. If you want to take a different water pressure distribution into consideration, you can use a polygon course to define almost any distribution using this menu item.

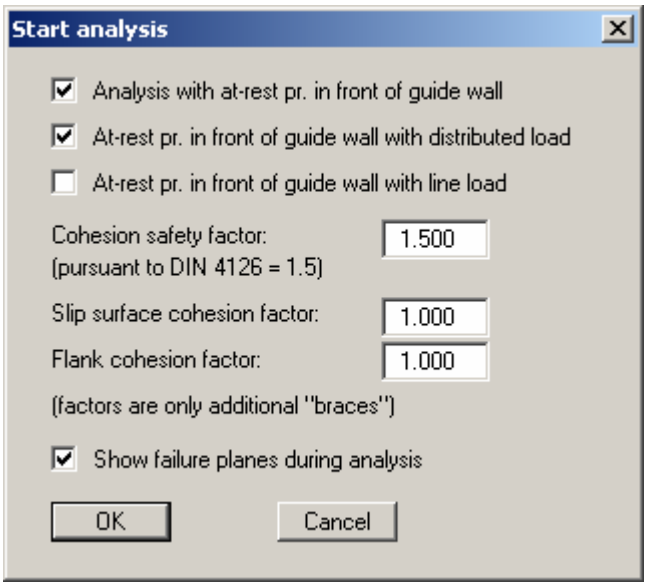


To enter your water pressure distribution, first activate the "**Calculate using water pressure (manually)**" check box and then define the number of polygon model points after clicking the button marked "**x water pressures to edit**". Then enter your data.

Upwardly or downwardly directed gradients i may result as a consequence of user-defined water pressure distributions, thereby increasing or decreasing the unit weight of the soil. The change in unit weight is equal to i * γ_w and can be taken into consideration by activating the check box.

6.3.1 "Analyse" menu item

You see the following dialog box, in which you can define further preferences for the type of analysis:



- "**Analysis with at-rest pr. in front of guide wall**"
  If this check box is activated the guide wall is analysed with at-rest pressure. If the check box is not activated the force from the suspension is adopted.
- "**At-rest pr. in front of wall with distributed load**"
  If this check box is activated any distributed loads are taken into consideration for computation of the at-rest pressure.
- "**At-rest pr. in front of wall with line load**"
  If this check box is activated any line loads are taken into consideration for computation of the at-rest pressure.

If you activate the line load check box, but have entered the line loads with a factor for the lateral pressure of **0.0**, the check box has no affect. A corresponding message will be displayed before analysis commences.

- "**Cohesion safety factor**"
  Enter the cohesion safety factor here. In accordance with DIN 4126 (9.1.4.1) and DIN 4126-100 (7.4.3), the cohesion may only be adopted with the reduced value of

  red c = cal c / eta(c),

  whereby a value for eta(c) of 1.5 is given.

If higher safety is required the cohesion in the region of the slip surface and the flanks can be further reduced. You must then enter a value **< 1.0** for "**Slip surface cohesion factor**" and "**Flank cohesion factor**".
The cohesion values reduced by eta(c) are multiplied by this factor.

- "**Slip surface cohesion factor**"
  You can enter a factor < 1.0 to further reduce the cohesion values.
- "**Flank cohesion factor**"
  You can enter a factor < 1.0 to further reduce the cohesion values.
- "**Show failure planes during analysis**"
  If you activate this checkbox the failure planes for the current analysis are displayed on the screen. Interesting to look at; however, this does cost more time.
- "**OK**"
  After clicking this button you will see a message box with information on the current preferences. You can deactivate these messages. The system will then be analysed.

Once this has been done you will be presented with information on the principal analysis results in an info box. After closing the info box, detailed analysis results are presented graphically on the screen in a legend (see Section 6.4.8). Even more detailed analysis results can be displayed using the menu item "**File/Print output table**" (see Section 6.1.5).

6.3.2 "Minimum safety factors" menu item

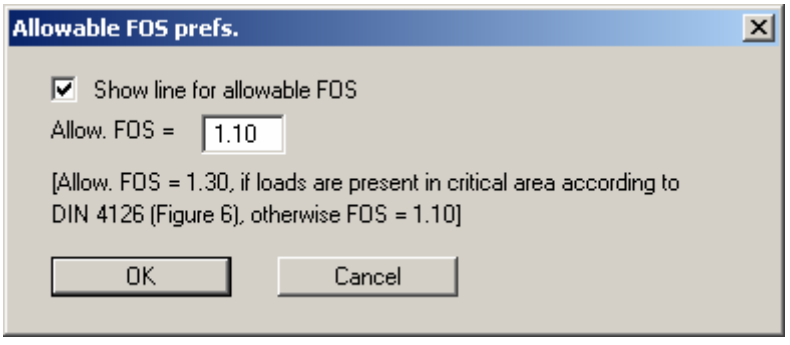
After an analysis performed using the old ***global safety factor concept*** you can view the minimum safety factors computed in a message box, without having to reanalyse the system. The same message box opens; the dialog box is the same as that displayed upon completion of analysis (see Section 6.3.1).

6.3.3 "Maximum utilisation factors" menu item

After an analysis performed using the new ***partial safety factor concept*** you can view the maximum utilisation factors computed in a message box, without having to reanalyse the system. The same message box opens; the dialog box is the same as that displayed upon completion of analysis (see Section 6.3.1).

6.3.4 "Allowable FOS preferences" menu item

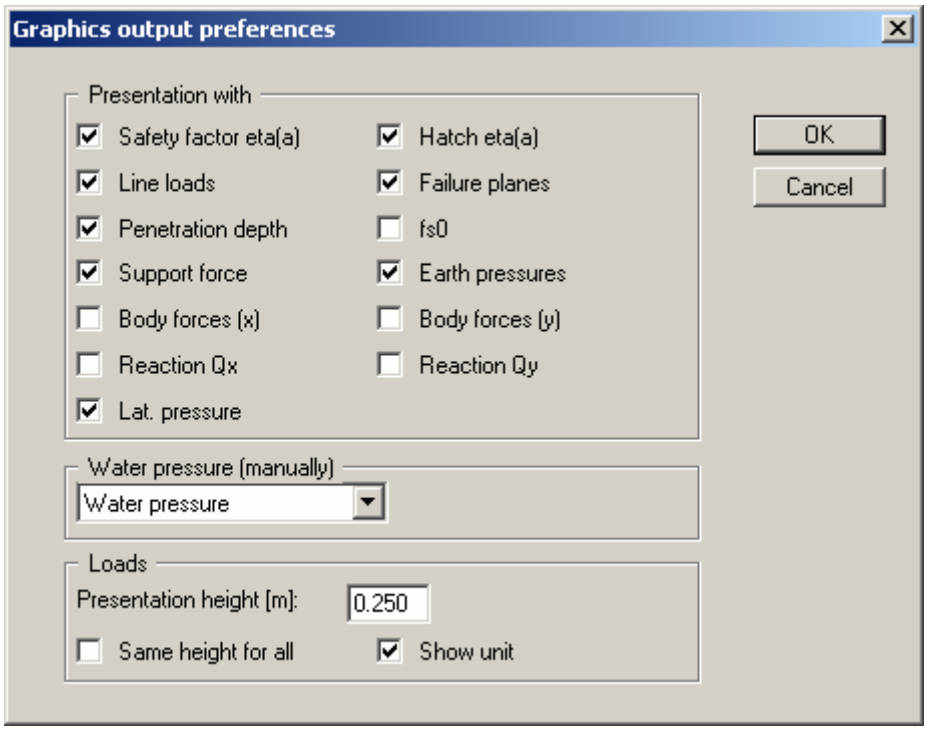
DIN 4126 demands a FOS of 1.1 or 1.3 (if loads from structures act in the critical area). If you are analysing using the ***global safety factor concept***, you can have the user-defined safety factor entered as a horizontal boundary line into the safety factor distribution diagram. Use this menu item to do this.



Just activate the line representation check box and enter the desired safety factor.

6.3.5 "Graphics output preferences" menu item

Among other things, the screen graphics consist of several diagrams, presenting depth-oriented results. The represented variables can be specified in the dialog box for this menu item.



Depending on the verification concept selected, the "**Safety factor eta(a)**" or the "**Utilisation factor µ(a)**" is displayed and hatched where specified. Body forces refers to the loads from line loads, soil self-weight, friction forces resulting from both cohesion and the friction angle on both flanks, and the cohesion force on the front of the wall. The reaction force Q is the force resulting from the friction angle on the front of the wall. The lateral pressure is represented without a component from any line loads present with a factor for the lateral pressure of > 0.0.

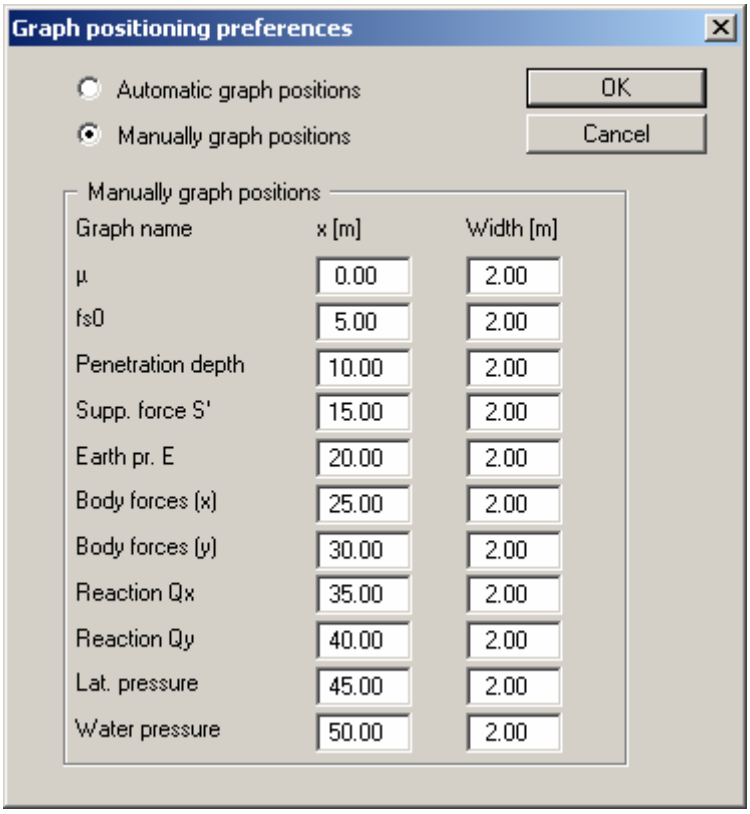
If you analysed using a user-defined water pressure (see Section 6.2.8), the screen graphics will display a diagram with the water pressure distribution. In the combo box you are given the option of displaying the potential or the gradient, instead of the water pressure.

Line loads and distributed loads are shown in the graphics at the height specified in the "**Presentation height (loads)**" field. If you deactivate the "**Same height for all**" check box, the largest load is displayed with the specified value and the remaining smaller loads displayed in proportion to this. The unit can also be displayed by activating the "**Show unit**" check box.

> The program automatically scales the graph width to fit.
>
> If the system coordinates are modified, e.g. using "**Page size + margins/Manual resize (editor)**" (Section 6.5.3), or by adding further graphics, all graphs are rearranged uniformly within the available space.

6.3.6 "Graph positioning preferences" menu item

If you are not happy with the automatic graph arrangement you can arrange them to suit your needs using the dialog box for this menu item. First, activate the "**Manually graph positions**" check box

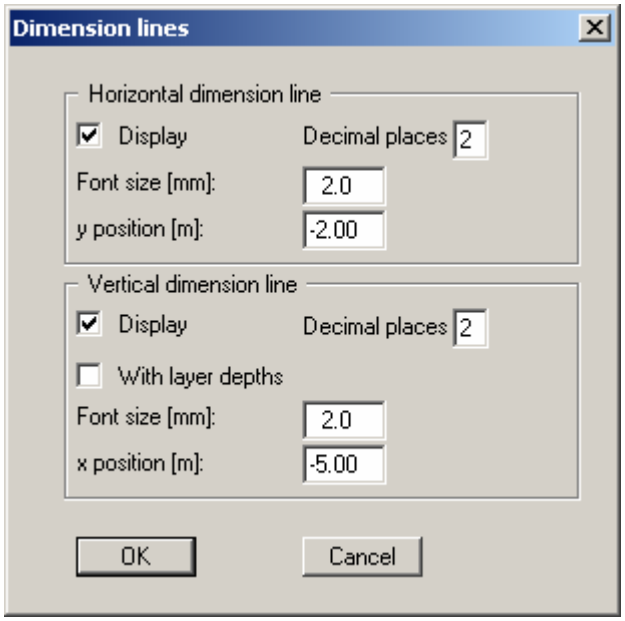


The graphs will be shown central at position "**x**" with the specified "**Width**". Depending on the verification concept selected, the graph for the safety factor "**eta**" or the utilisation factor "**μ**" can be modified.

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

6.3.7 "Dimension lines" menu item

You can define a vertical and/or horizontal dimension line for the graphics in order to emphasise and clarify the system dimensions. If the dimension lines are displayed on the screen you can also open the following dialog box directly by double-clicking on the dimension line.



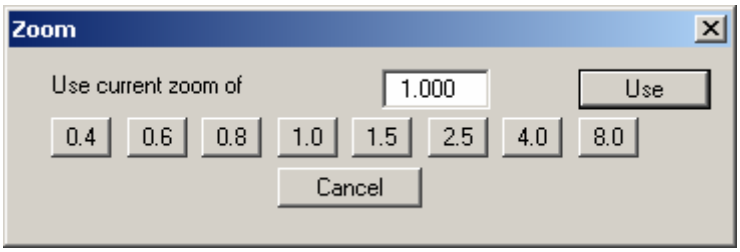
The distance to the diaphragm wall is defined by means of the "**y position**" for the horizontal dimension line and "**x position**" for the vertical dimension line. All values are in metres in the scale selected (see the menu item "**Page size + margins/Manual resize (editor)**" in Section 6.5.3).

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

6.4.1 "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.

6.4.2 "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.

6.4.3 "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.

6.4.4 "Pen colour and width" menu item

In order to enhance the clarity of the graphics you can edit the pen settings for various graphic elements (e.g. loads, groundwater, etc.). 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.

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.

6.4.5 "Mini-CAD toolbar" and "Header toolbar" menu items

Using these two menu items 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.). The same pop-up menu opens for both menu items, the icons and functions used are described in more detail in the **Mini-CAD** manual provided. The differences between the Mini-CAD and Header CAD are as follows:

- Objects created with **Mini-CAD** are based on the coordinate system (generally in metres), in which the drawing is produced, and are shown accordingly. You should use the "**Mini-CAD toolbar**" when you wish to add information to the system (for example, labelling of slope inclinations or the location of any foundations).
- Objects created with the **Header CAD** 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 "**Header 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.

6.4.6 "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.

6.4.7 "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-TRENCH.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.

"**Next page**"/"**Previous page**"
Using this icon, you can navigate between the individual pages in the ***tabular representation***.

"**Select page**"
If you are in the ***tabular representation***, you can use this icon to jump to a specific page or to return to the ***normal representation***, that is, to the graphics.

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

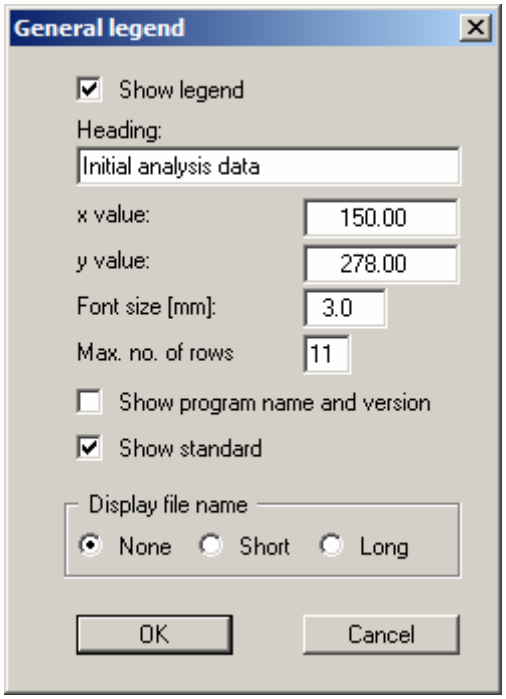
"**Zoom (-)**"/"**Zoom (+)**"
With the zoom functions you can zoom in or out of parts of the image, by clicking the left mouse button.

"**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 7.3).

"**Colour on/off**"
If you need to remove the colour from the system presentation, to create a black and white print-out, for example, use this on/off switch.

6.4.8 "General legend" menu item

A legend with general properties will be displayed on your output sheet if you have activated the "**Show legend**" check box. Using this menu item you can alter the type of presentation.



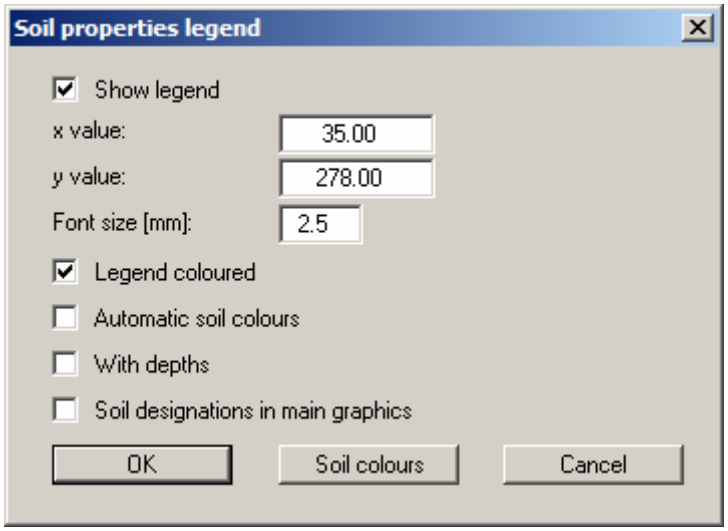
If wanted a given heading can be used. You can define and edit the position of the legend using the values "**x value**" and "**y value**". You control the size of the legend using "**Font size**" and "**Max. no. of rows**"; where necessary, several columns are used.

> 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.

In the ***General legend*** you can, if wished, display information on the program (name and version) and on the adopted standard. Any project identification entered using the menu items "**File/New**" or "**Edit/Project identification**" will be shown in the general legend. The file name can be switched off ("**None**" option button) or be displayed automatically with or without the path by selecting the appropriate "**Short**" or "**Long**" option button.

6.4.9 "Soil properties legend" menu item

A legend with the soil properties, s 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 type of presentation or turn off the legend completely.



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

- "**Legend coloured**"
  The soil colours are displayed in the legend. Otherwise, they will be numbered
- "**Automatic soil colours**"
  The soils are assigned soils colours automatically by the program. If the check box is not selected, the soil colours individually defined using the "**Soil colours**" button will be adopted.
- "**With depths**"
  The depths of the individual soil layers will be shown in the soil properties legend.
- "**Soil designations in main graphics**"
  The designations entered for the individual ground layers are displayed in the system graphics adjacent to the layer depths.
- "**Soil colours**"
  You will see a dialog box, in which you can define your preferences. After clicking the button with the desired number you can assign each soil layer a new number or reorganise using the "**Soil colours/Reorganise**" command button. You can save your colour preferences to a file with "**Soil colours/Save**" and use them for different systems by means of the "**Soil colours/Load**" command button. In the lower group box you can also transfer the colour preferences to the Windows colour management dialog box, or vice versa, as user-defined colour preferences for example. You can read a further description by pressing the "**Info**" button.

6.4.10 "Move objects" menu item

Select this menu item in order to position legends, diagrams or other graphical elements at the desired position on the output sheet. You can also move objects by pressing [**F11**] and then positioning the legend box with the left mouse button pressed. In that case an info-box appears no more.

6.4.11 "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-TRENCH.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.

6.4.12 "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.

6.5 Page menu

6.5.1 "Auto-resize" menu item

This menu item provides a to-scale visualisation, in both x and y coordinates, of the system and result graphics. If you have previously altered the image coordinates graphically or via editor, you can quickly achieve a complete view using this menu item. This function can also be accessed using the [**F9**] function key.

6.5.2 "Manual resize (mouse)" menu item

You can use the coordinates of a section of the visualisation as the new image coordinates by marking the desired area with the mouse, pressing the left mouse button and holding the [**Ctrl**] and [**Shift**] keys. The scales of the x- and y-axes are adjusted accordingly. If the previous proportions (scale x-direction/scale y-direction) need to be retained, the "**Proportional section**" check box must be activated.

Alternatively, you can simply "**Redefine origin**" of the visualisation. The previous scale preferences are not affected by this.

6.5.3 "Manual resize (editor)" menu item

You can alter the image coordinates by direct numerical input in a dialog box. This allows precise scale input. The coordinates refer to the ***drawing area***. This can be defined in the "**Page size and margins**" menu item by means of the plot margins (see Section 6.5.5).

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

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

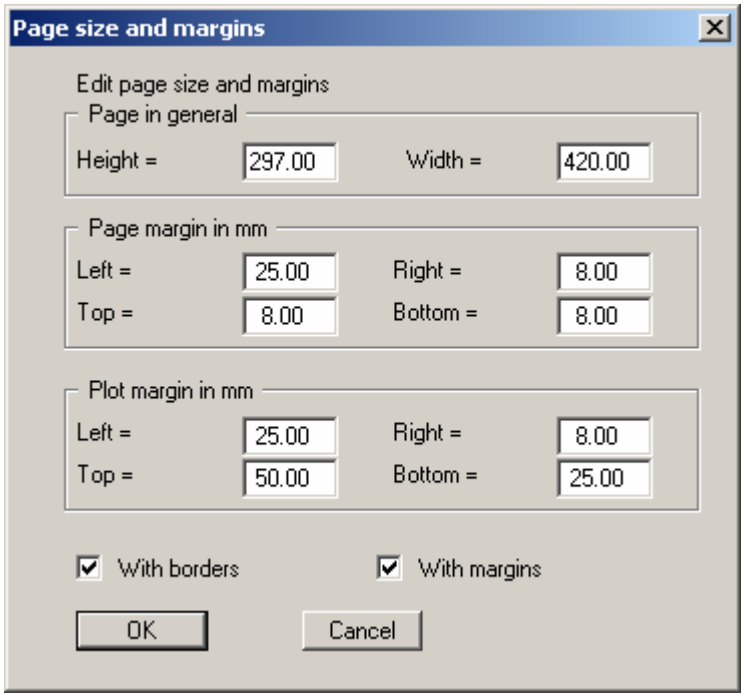
6.5.4 "Font size selection" menu item

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

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

6.5.5 "Page size and margins" menu item

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



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

6.6.1 "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-TRENCH**.

6.6.2 "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.

6.6.3 "GGU support" menu item

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

6.6.4 "Maxima" menu item

Here you can check the defaults for maximum values.

6.6.5 "Help" menu item

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

6.6.6 "What's new?" menu item

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

6.6.7 "Language preferences" menu item

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

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

7 Tips and tricks

7.1 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. Use the mouse wheel to zoom in or out of the screen view or to pan.

In addition, scale and coordinates of the system graphics (drawing area within the plotting margins) can be altered directly using the mouse wheel. The following mouse wheel functions are available

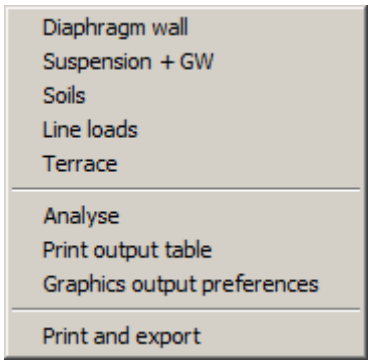
Change system graphics (new values can be checked in "Page size + margins/Manual resize (editor)"):

- [**Ctrl**] + mouse wheel up = enlarge system graphics (change of scale)
- [**Ctrl**] + mouse wheel down = shrink system graphics (change of scale)
- [**Shift**] + mouse wheel up = move system graphics up (change in system coordinates)
- [**Shift**] + mouse wheel down = move system graphics down (change in system coordinates)
- [**Shift**] + [**Ctrl**] + mouse wheel up = move system graphics right (change in system coordinates)
- [**Shift**] + [**Ctrl**] + mouse wheel down = move system graphics left (change in system coordinates)

Change screen coordinates:

- Mouse wheel up = move screen image up
- Mouse wheel down = move screen image down
- [**Alt**] + [**Ctrl**] + mouse wheel up = enlarge screen image (zoom in)
- [**Alt**] + [**Ctrl**] + mouse wheel down = shrink screen image (zoom out)
- [**Alt**] + [**Shift**] + mouse wheel up = move screen image right
- [**Alt**] + [**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, dimension lines or **Mini-CAD** objects, the editor for the selected object immediately opens, allowing it to be edited.

If you double-click in the system graphics with the left mouse button you will see a result box with the results at the selected depth. This gives you a quick overview of the results for any desired depth.

7.2 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 format. 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.
- [**F5**] opens the menu item "**System/Analyse**".
- [**F6**] opens the menu item "**System/Minimum safety factors**" when using ***global safety factor concept***.
- [**F6**] opens the menu item "**System/Maximum utilisation factors**" when using ***partial safety factor concept***.
- [**F9**] opens the menu item "**Page size + margins/Auto-resize**".
- [**F11**] activates the menu item "**Graphics preferences/Move objects**".

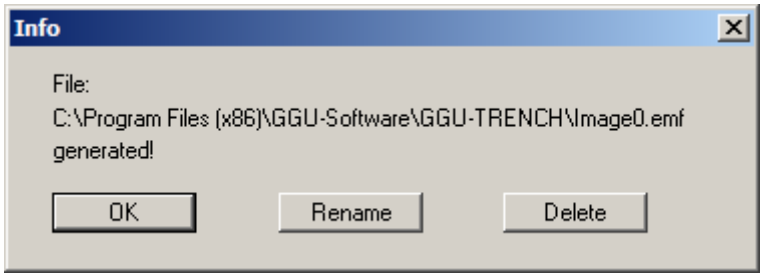
7.3 "Copy/print area" icon

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.

8 Index

A

Absolute heights, use ... 10
Allowable FOS, display as boundary line ... 26
Analysis results, display for selected depth ... 39
Analysis results, save in file ... 11
At-rest earth pressure, as maximum pressure ... 9
At-rest pressure on guide wall, determine ... 9
At-rest pressure, activate for analysis ... 25

B

Body forces, display in result graphics ... 27
Bracing of guide wall, consider ... 9
Buoyant unit weight of soil, adoption for γ" ... 7
Buoyant unit weight of soil, define ... 21

C

Clipboard ... 16
CodeMeter stick ... 4
Cohesion, define as soil property ... 21
Cohesion, enter reduction factor ... 25
Cohesion, enter safety factor ... 25
Cohesion, reduction to DIN 4126 old ... 9
Colour, switch on/off ... 32
Colour/pens, define for graphical elements ... 30
Colours, soils ... 34
Company letterhead, add via Mini-CAD ... 31
Context menu, open ... 39
Coordinates, alter using an editor ... 35
Coordinates, alter with mouse ... 35
Coordinates, optimise/reset ... 35
Coordinates, save/load ... 35
Copy/print area ... 16, 32, 40
Cutting borders, switch on/off ... 31, 36

D

d_{10}, define ... 21
d_{10}, select unit ... 10
Dataset description, display ... 33
Dataset description, enter ... 18
Delete, line loads ... 23
Delete, soil layer ... 22
Delta depth (Terzaghi) ... 20
Depth distribution, lateral pressure stress ... 7
Diaphragm wall, define ... 19
Dimension lines, define ... 29
DIN 4126 old/Aug. 2004, verifications ... 6
DIN 4126-100, select for analysis ... 10, 18
Distributed loads, consider ... 8
Distributed loads, define ... 20
Drawing area ... 35
Drawing area, define ... 36
DXF file, export ... 16
DXF file, import ... 4

E

Earth pressure wedge ... 7
Earth pressure, approach instead of suspension pressure ... 9
Earth pressure, display in result graphics ... 27
Earth pressure, in calculation formula ... 7
Editor window, output table ... 14
Effective support force, calculation ... 8
EMF format ... 16
Equivalent distributed loads, for consideration of line loads ... 8

F

Failure planes, display in result graphics ... 27
Failure planes, show during analysis ... 26
File name, display in legend ... 33
File, load/save ... 11
Font selection ... 30
Font size, dimension lines ... 29
Font size, edit for graphical elements ... 36
Font size, general legend ... 33
Font size, soil properties legend ... 34
Footer, output table ... 12
Footings, consider ... 8
FOS, cohesion ... 25
FOS, Define/display allowable ... 26
FOS, groundwater eta(w) ... 6
Friction angle, define ... 21
Friction forces, consider ... 7
Function keys ... 39

G

General page information, add via Mini-CAD ... 31
GGUCAD file, export ... 16
GGUMiniCAD file, export ... 17
Global safety factor concept, verifications ... 6
Gradient, display in result graphics ... 27
Graphics, add via Mini-CAD ... 31
Graphs, arrange manually ... 28
Graphs, scale width automatically ... 27
Ground inclination, define ... 20
Groundwater level, define ... 21
Groundwater, consider as layer boundary ... 22
Groundwater, define colour ... 30
Guide wall, consider in analysis ... 9
Guide wall, define ... 19

H

Header CAD, use ... 31
Header, output table ... 12
Hydraulic gradients, activate consideration ... 24

I

Installation 4
Intermediate angle, define quantity 20

K

Knowledge Base 37

L

Language preferences 5, 37
Lateral pressure increase, select type 20
Lateral pressure stress, consider 7
Lateral pressure stress, increase from line loads 8
Lateral pressure, display in result graphics 27
Layer depths, define 22
Layout, output sheet 36
Layout, output table 12
Legend, soil properties 34
Legend, system properties 33
Licence protection 4
Limit gradients, consider 8
Line loads, consider 8
Line loads, define negative 23
Line loads, define/delete 22
Liquid limit of slurry fluid, define 21
Loads, activate unit display 27
Loads, define presentation height 27

M

Manual, open as PDF file 37
Maximum values, display for system 37
Metafile, export 16
Mini-CAD file, export 17
Mini-CAD, use 31
Mouse click functions 39
Mouse wheel functions 38

N

Navigation, output table 31

O

Output table, as ASCII 14
Output table, as graphics 12
Output table, navigation 13
Output table, select the output format 11
Output table, switch to system graphics 31

P

Page format/margins, define 36
Page margins, switch on/off 31, 36
Page section, copy/print 32, 40
Pagination, automatic 13, 14
Partial safety factors, define 18
Partial safety factors, DIN infos 18
Partial safety factors, verifications 6
Pen preferences, edit for graphical elements 30
Plot margins, define 36
Point loads, consider 8
Potential, display in result graphics 27
Preferences, program 35
Pressure gradient 8
Print, graphics 15
Print, output table 16
Print, section 16, 32, 40
Print, several files 17
Printer preferences 14, 15
Program, display name in legend 33
Program, show improvements 37
Program, show information 37
Project data, add via Mini-CAD 31
Project identification, display 33
Project identification, enter 18

R

Reaction forces, display in result graphics 27
Reduction, cohesion 9
Reduction, support force in suspension 8

S

Safety concept, select 10
Safety factor concept, change 18
Scale, alter with mouse 35
Scale, define using an editor 35
Scale, determine automatically 35
Scroll the screen 38
Shoulder theory 7
Silo theory 7
Slip surface angle, define range of variation 20
Slip surface angle, influence in ep calculation 9
Smart icons, for menu items 31
Soil designations, activate presentation in system graphics 34
Soil layer, define/delete 22
Soil properties, define 21
Soil, colours/numbers 34
Stability, external 7
Stability, inner 7
Stability, trench 6
Standard, display in legend 33
Status bar main program, activate 31
Support force in suspension, reduce 8
Support force, determination 9
Suspension, define 21
Suspension, membrane effect 8
System, show information 37

T

Terrace, define 23
Terzaghi, consider 7
Terzaghi, select for lateral pressure increase 20
Toolbar, edit for menu items 31
Translation, activate 37
True-type font 30

U

Unit weight of suspension, define 21
Unit weight of wet soil, define 21

Unit, display for loads 27
Unit, select for d_{10} 10
Utilisation factor, definition 9

V

Verification concept, change 18
Verification concept, select 10
Version number, display in a message box 37
Version number, display in legend 33

W

Water pressure distribution, define individually 24
Water pressure distribution, display in result graphics 27
Water pressure, consider 7
What you see is what you get 30

Z

Zoom factor, define for full-screen display 30
Zoom function, activate 30, 32, 38