SCAD Soft

SCAD Office

CROSS

User manual

2008

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1 The CROSS software

The **CROSS** software calculates the first coefficient of soil reaction (Winkler coefficient) using results of explorations. The software implements a procedure developed by NIIOSP experts (a description of the procedure previously published as the article "Predicting subsidence in foundations of shallow expansion and selecting a subgrade model for slab analysis").

The **CROSS** software finds the subsidence (and thus Winkler's coefficient of soil reaction) allowing for a distributive ability of the foundation. This feature helps use results obtained with the program to find the stress and strain in a structure (using **SCAD** or other software) without specifying the second, Pasternak's, bedding value.

1.1 Coordinate system

A right-oriented Cartesian coordinate system is used (**X**, **Y**, **Z**). The **Z** axis is a longitudinal axis of a structure or a building directed from the plane of the drawing towards the observer. The **Y** axis is vertical and looks upwards on the drawing, and the **X** axis is horizontal with its positive direction to the right.

1.2 Files created by the program

The **CROSS** software creates, reads, and writes its results in files with the extension **.crs**.

1.3 Model and source data

A construction site is under consideration on which the designed structure will be placed together with other objects (buildings either existing or being erected) that affect the main structure in the sense that loads upon the soil caused by those objects may lead to a subsidence of the designed foundation. It is assumed that the spots of the designed object and its adjacent structure can be represented as closed polygons (possibly, with openings). Each of the polygons will transfer a load to the soil, the load being applied at the founding level. Also, it is assumed that there are known results of the site explorations represented as information about properties of the soil in a set of boreholes. The relief of the site's day is assumed to be smooth and specified as a set of marks of the boreholes' mouths. No other exploration data are used. The data are entered using a coordinate grid with its spacing specified by the user. The following sequence is recommended for creating an adequate model:

- specify outer dimensions of the construction site;
- enter parameters of the coordinate grid;
- enter the outline of the foundation slab;
- enter the outlines of existing buildings (if necessary);
- specify openings (if there are any);
- smooth down angles (if necessary);
- specify loads;
- specify founding levels;
- specify locations of boreholes;
- enter soil data;
- specify the boreholes' parameters.

The result of the analysis will include a set of values for the coefficient of soil reaction (Winkler's coefficient) in any point of the foundation slab.

The technique and procedure for this analysis have been developed by V.G. Fedorovsky. Key principles of the technique were presented in the paper by V.G. Fedorovsky, S.G. Bezvolev ""Predicting subsidence in

foundations of shallow expansion and selecting a subgrade model for slab analysis" // Foundations, basements, soil mechanics. 2000. N4. P. 10–18. By courtesy of the authors, this paper is annexed to the present document.

1.4 Controls

1.4.1 Main window of the program

The main window of **CROSS** (Fig. 1.4.1-1) contains a menu, a toolbar, a working area (with scrollbars if necessary), and a status bar.

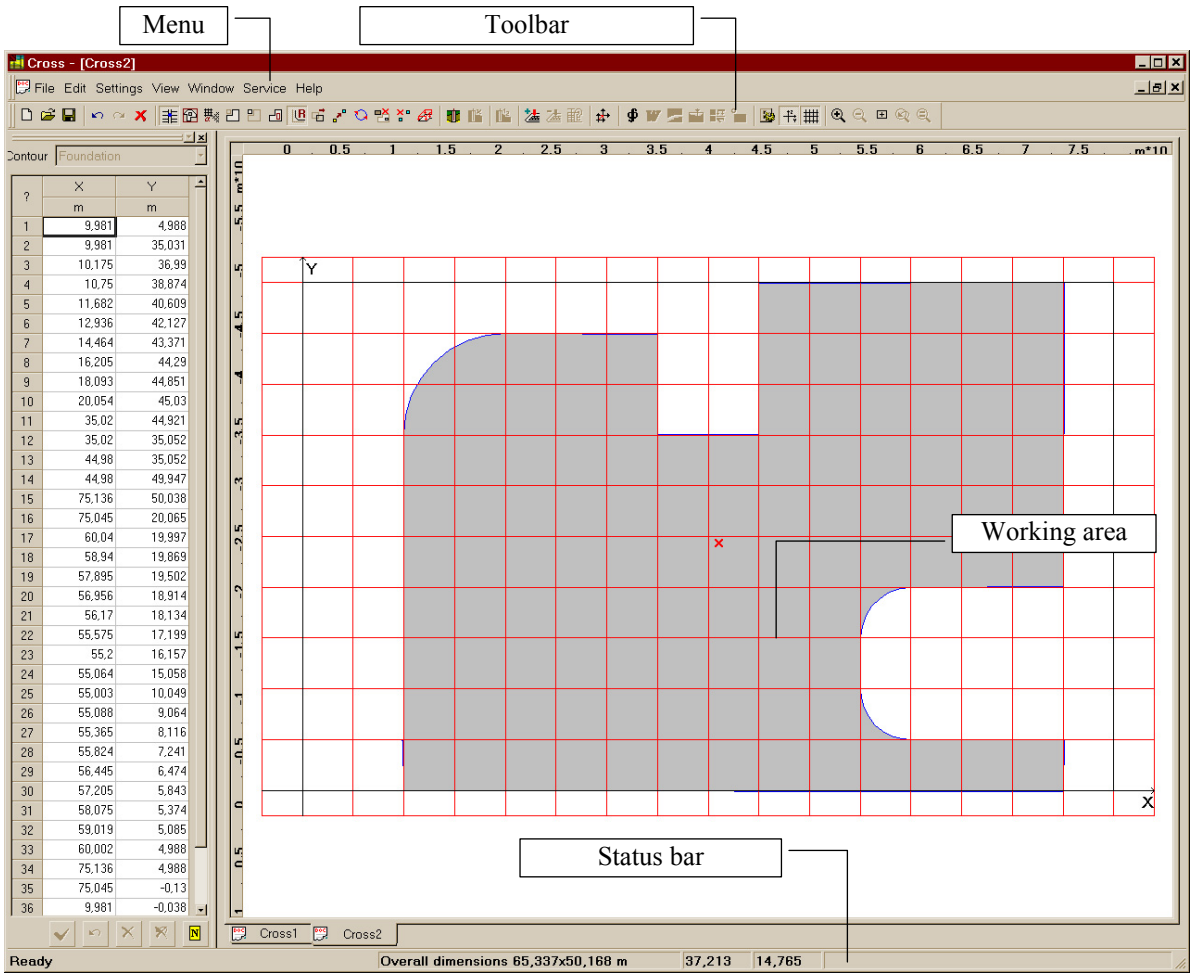


Fig. 1.4.1-1. A general view of the **CROSS** main window

1.4.2 Settings

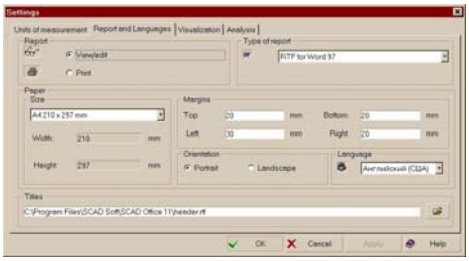


Fig. 1.4.2-1. *The* **Report and Languages** *tab of the* **Settings** *dialog box*

The program can be adjusted to the user's preferences using appropriate settings such as units of measurement for physical values or report generation rules. These adjustments can be made in the **Settings** multi-tab dialog box. The **Settings** dialog is invoked via the **Settings** menu item or by clicking a toolbar button (its name is **Settings** and it looks like). You adjust settings in the same way as described in Section 3.2. The difference is that the following additional operations are included:

- the most recent project can be opened automatically when the program starts;
- the number of points on a full circle can be specified for the purpose of angle rounding;
- the mouse pointer can snap to nodes of the grid;
- nodes can be displayed on a contour.

If the **Open last project by default** option is checked, the program will load the most recent project when starting.

The **Circle** property defines the number of points to be used to approximate an inscribed circle by a polygon. If an angle is to be rounded, the number of points on the rounded arc will be appropriately proportional to the central angle of the arc.

The **Snap to grid** option, when checked, helps associate boreholes and salient points of contours with nodes of the given grid. This feature is used to build contours of foundations and to assign locations of boreholes. A point snaps to the node of the grid nearest to the mouse pointer in its current position.

If the **Show nodes** option is checked, nodes (salient points) will be displayed on contours.

On the **Analysis** tab, you can set the ratio σ_{zp}/σ_{zg} between an additional vertical stress (σ_{zp}) and a vertical stress caused by the soil's dead weight (σ_{zg}). This ratio will determine the boundary of the compressible soil massif. The default value for this ratio is 0.2 which complies with SNiP 2.02.01-83* Foundations of buildings and structures, though you can specify any number from the interval [0.1…0.5] in compliance with requirements of a new draft SNiP document.

This tab also contains the **Save results of analysis** checkbox. If it is enabled, then results of the analysis performed will be saved whenever the model is saved (provide the analysis has been actually performed). Turning this feature on will increase the size of the model's file dramatically. The advantage is that after restarting the program and re-loading the model you don't have to perform the calculations again; instead, you can pass to the reviewing of its results.

1.4.3 Menu

The main menu is located at the top of the window and includes five drop-down menus: **File**, **Edit**, **Properties**, **Tools** and **Help**.

The **File** menu includes this set of actions:

- **New** — create a new site (the hotkey combination is **Ctrl+N**);
- **Open** — load a previously created site (the hotkey combination is **Ctrl+O**);
- **Save** — save the current site to disk (the hotkey combination is **Ctrl+S**);
- **Save As…** — save the site (the model's file) under a new name;
- **Import DXF, DWG ...** — import data about the bedplate's geometry from a file of the DXF or DWG format;
- **Calculate** — calculate the coefficients of the soil reaction;
- **Report** — generate a report;
- **Fields** — display isofields of the soil reaction coefficients.
- **Subsidence ...** — display isofields of distribution of the bedplate's base subsidence;
- **Load field** — visualize isofields of loads if the load upon the bedplate is non-uniform;
- **Save picture** — save the picture currently on the screen in a Windows metafile format.

The **Edit** menu comprises the following actions:

- **Undo** — cancel the latest performed action;
- **Redo** — cancel the latest **Undo** command;
- **Dimensions** — specify overall dimensions of the site on which the designed structure will stand together with other objects that may influence it (this action and all the following ones in this menu duplicate the respective buttons of the toolbar);
- **Foundation** — enter and edit the outline of a foundation slab;
- **Existing building** — enter and edit the outline of a building that stands beside the designed structure and has an effect on the latter;
- **Opening** — enter the outline of an opening;
- **Delete** — delete an existing building and/or opening;
- **Round angle…** — round a selected angle by a circular arc of a specified radius;
- **Move** — move vertices of the contours of the foundation or existing buildings;
- **Vertices** — edit the coordinates of vertices of the foundation or existing buildings;
- **Delete vertices** — delete one or more vertices;
- **Assign foundation** — assign the foundation of an existing building to be the bedplate for the analysis;
- **Load** — specify a load upon the foundation (or an existing building) and the founding level;
- **Create are of extra load** — create an area in the foundation subject to an additional load;
- **Delete area of extra load** — delete an area subject to an additional load;
- **Change load on area** — edit the value of a load applied to an additional area;
- **Add point of extra load** — create a point in which a load is defined;
- **Delete point of extra load** — delete a point where a load is defined;
- **Points of extra load** — edit the coordinates and load values in additional points;
- **Add borehole** — add a borehole to the model;
- **Delete borehole** — delete a previously added borehole;
- **Borehole properties …** — invoke a dialog box to specify soil and borehole properties;
- **Coordinate origin …** — move the coordinate origin to another location;
- **Point to calculate compressible massif** — indicate a point in which the compressible massif's depth is to be found;

The **Properties** menu contains the following actions:

- **Settings** — invoke a dialog box to set up preferences and settings;
- **Grid spacing** — specify a spacing for the coordinate grid;
- **Grid** — display the coordinate grid in the working field;
- **Coordinate axes** — display coordinate axes of the site;
- **Fields in buildings** — choosing this option will visualize the soil reaction coefficient isofields not only under the foundation but under adjacent buildings as well;
- **Additional points** — create points on isofields in which to display markers with values of the soil reaction coefficients;
- **Zoom in** — zoom in the view of the site in the working area;
- **Zoom out** — zoom out the view of the site in the working area (this action is available only after the view has been zoomed in);
- **Zoom to selection** — zoom in to the view of a site's fragment selected by a rectangular rubber frame;
- **Fit** — display the original view of the whole site.

The **Tools** menu helps invoke useful utilities such as the standard Windows calculator, a calculator of formulae, a unit of measurement conversion program.

The **Help** menu suggests the access to helpful reference information.

1.4.4 Status bar

The status bar (Fig. 1.4.4-1) contains two fields: the coordinates of the current mouse pointer's location and the **Distance**. The former displays the pointer's coordinates. The latter is used for displaying the distance between two points of the site in the measurement mode.

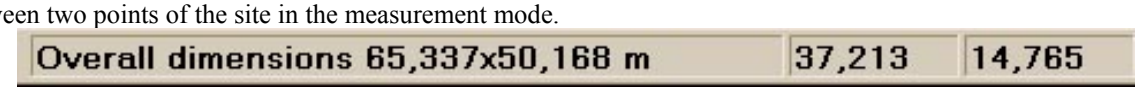


Fig. 1.4.4-1. Status bar

1.4.5 Pointers

All operations in the working field are done using the mouse pointer. As the pointer is moved along the **X** or **Y** directions around the screen or as some commands are invoked, the pointer may change its appearance. For example, it becomes an arrow when you are about to choose a menu item or click a toolbar button; when a command is being processed, the pointer looks like a sand-glass (a wait pointer); when in the working area, the pointer is a crosshair.

Using the pointer, you can find the distance between any two points of the site. To do this, move it to the first point and left-click. Keeping the left key depressed, move the pointer to the second point. The right sector of the status bar will indicate the distance between the points (the accuracy of this indication will depend on the number of decimal digits specified on the **Units of measurement** tab of the **Settings** dialog box). The coordinates of the current pointer's position are displayed in the status bar, too.

1.5 Actions

Placing the pointer onto a button of the toolbar and left-clicking will invoke an action or command. This sequence of operations will be referred to as “clicking a button of the toolbar”.

1.5.1 New

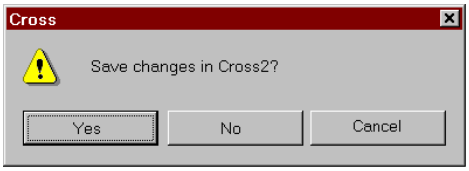


Fig. 1.5.1-1. A message box

This action is used to create a new site. After it is performed, the program’s window returns to its original state. If the current site has been modified but not saved, a message box will appear with a warning and a suggestion to save the file (Fig. 1.5.1-1).

1.5.2 Open

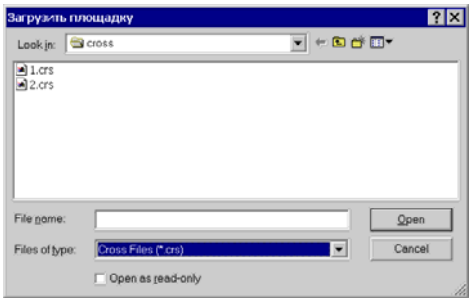


Fig. 1.5.2-1. *The* **Load site** *dialog box*

This action is used to load a previously created site. Invoking this action will open a standard MS Windows dialog with a list of files having the .crs extension (Fig. 1.5.2-1). As in the previous case, a check is performed and a warning/suggestion to save the current site is displayed if necessary (Fig. 1.5.1-1).

1.5.3 Save

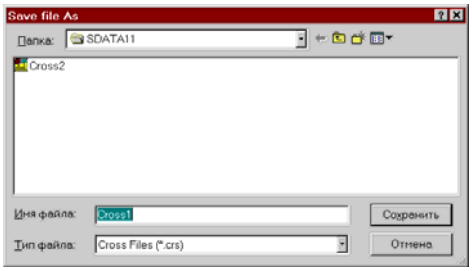


Fig. 1.5.3-1. *The* **Save site** *dialog box*

This action saves data of the current site to its file. If the site has not been saved before, invoking the action will open a standard Windows dialog in which to enter a name for the file (Fig. 1.5.3-1).

1.5.4 Save As...

This action is intended for saving data of the site in a file under a new name. Invoking the action will open a standard Windows dialog in which to enter a new name for the file (see Fig. 1.5.3-1).

1.5.5 DXF, DWG formats

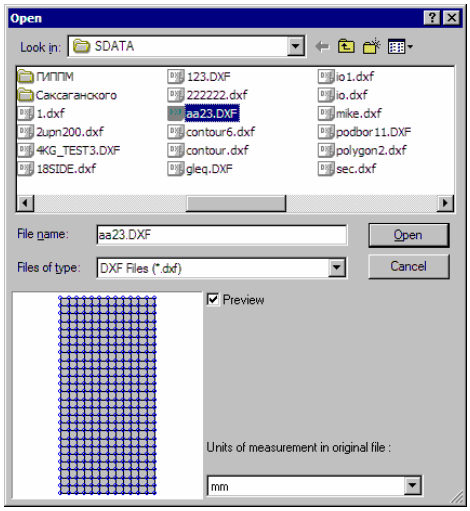


Fig. 1.5.5-1. *The* **Open** *dialog box*

The description of geometry of a foundation can be imported from the AutoCAD environment as a DWG or DXF format file. The following graphic primitive types are recognized:

- 3DFACE
- SOLID
- TRACE
- LINE
- POLYLINE
- LWPOLYLINE
- ELLIPSE
- CIRCLE
- ARC

This mode is invoked by the **Import DXF, DWG** item of the **File** menu. Before the file is loaded, the **Units of measurement in AutoCAD files** dialog box appears (Fig. 1.5.5-1) where you should choose the units of measurement using which the model was created in the AutoCAD environment. The unit is selected from a list.

1.5.6 Calculate

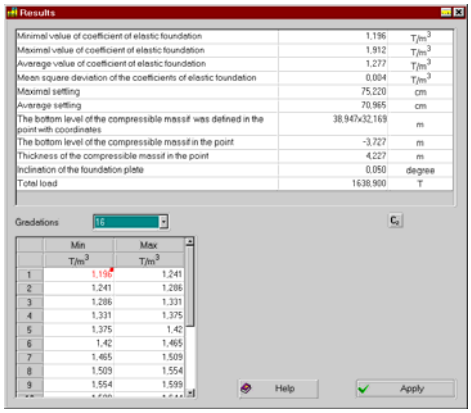


Fig. 1.5.6-1. *The* **Calculation results** *dialog box*

Clicking this button activates the calculation of the soil reaction coefficients. After the calculation is done, the **Calculation results** dialog box appears (Fig. 1.5.6-1) which lists maximum and minimum values of the coefficient, the bottom level of the compressible soil massif, and the thickness of the compressible soil massif at the point it has been determined (if no rock bed is specified), the root-mean-square value of the soil reaction coefficient, the root-mean-square deviation of the soil reaction coefficient, the total load on the foundation, the maximum subsidence, the root-mean-square subsidence, and the tilt of the foundation. Also, in this dialog you can choose the number of color ranges to depict the isofields or change the bounds of intervals if necessary.

The root-mean-square deviation serves for making a decision in each particular case whether the root-mean-square value of the soil reaction coefficient can be used or variable values over the area of the foundation should be specified.

1.5.7 Report

Invoking this action will generate a report containing results of the calculation. The report is an **RTF** file (Rich Text Format). After the report is generated, an application associated with **RTF** files is started automatically (such as MS Word или WordPad). If the MS Word software is used, its version is of importance due to differences in the data formats. The version of the software installed on the computer should be specified among other settings in the **Settings** dialog box, the **Other** tab.

1.5.8 Fields

This action is used to build isofields of the soil reaction coefficients (Fig. 1.5.8-1).

Controls of the color scale are contained in the **Coefficients of soil reaction** dialog box (Fig. 1.5.8-2). They enable you to control the visualization depending on the character of calculated results and available resources of the computer. Each range of results, thus the color too, conforms to a checkbox. Turning it on makes the results included in the respective range visible on the model. By turning a checkbox off, you can choose not to display some of the results in color if those are of little importance for the current analysis.

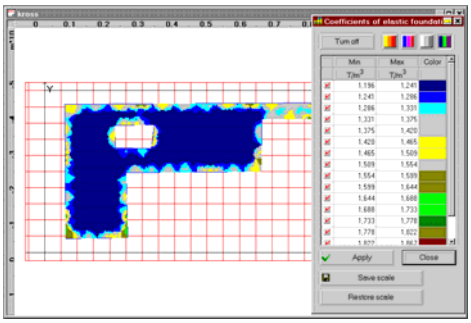


Fig. 1.5.8-1. A foundation with an isofield of the soil reaction coefficients displayed on it

To display the results of the color scale setup on the screen, click the **Apply** button at the bottom of the dialog box.

A row of buttons at the top is used to change the color gamut of the scale. The gamut changes on the screen after the **Apply** button is clicked.

To simultaneously turn on or off all checkboxes of the color scale, use the **On/Off** button. This button is handy in cases when you need to choose only a few values of the whole range. To do it, first, turn the scale off; second, turn on buttons with appropriate values and click the **Apply** button.

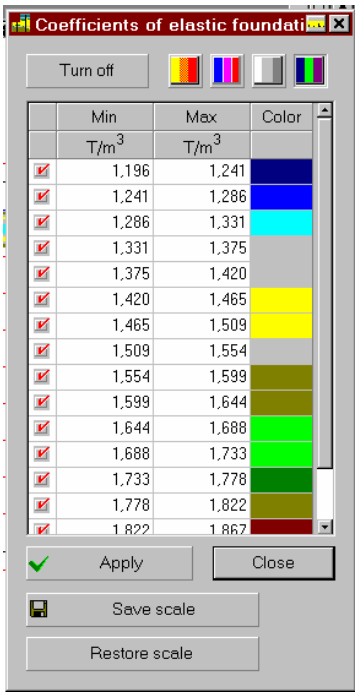


Fig. 1.5.8-2. Setting up the color scale

The color scale dialog box can occupy any position on the screen. It can be closed (by the **Close** button) or moved out of the working area (if the program's window occupies only a part of the screen).

Right-click to change the number of color ranges to be used for depicting the isofields or to change the interval boundaries. This will open the **Color scale setup** dialog box (Fig. 1.5.8-2).

Colors suggested for the scales are not a must. You can change any color in the scale or even the whole gamut, and remember the changes made for subsequent working sessions. To do it, move the pointer to a color box correspondent to the color to be replaced, and double-**left**-click. This will open a standard Windows color setup dialog. After the color is selected, click the **OK** button. The new color will appear in the color scale. To remember the new color gamut, use the **Save** button. After this action, the new color gamut will be always displayed instead of the previous one.

Note that while the pointer is moved inside the foundation's area, the status bar is displaying the soil reaction coefficient at the point the pointer is located right now (Fig. 1.5.8-1).

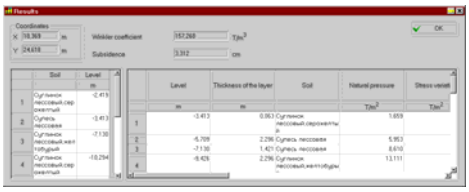


Fig. 1.5.8-3. A dialog with results of calculation in a particular point

Clicking the left mouse button will open the **Calculation results** dialog box (Fig. 1.5.8-3) for the point where the pointer stands at the moment. This dialog displays the coordinates of the point, a table describing the structure of the soil massif, the soil reaction coefficient, the foundation's base subsidence. The subsidence data are given in assumption that the bedplate has a zero stiffness.

1.5.9 Additional points

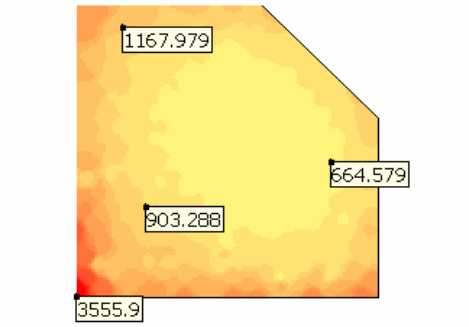


Fig. 1.5.9-1. Isofields with additional markers

If the **Additional points** button is pushed, then left-clicking will not open the dialog box of results (Fig. 1.5.8-3). Instead, values of the soil reaction coefficients will appear on isofields in points indicated by the pointer (Fig. 1.5.9-1). Clicking the right mouse button will open a menu in which one of two actions can be done: remove additional points or invoke the dialog box for setting up the color scale.

1.5.10 Foundation's base subsidence

In this mode, isofields of the subsidence of the foundation's base are displayed. Conventions of output are the same as when the soil reaction coefficient isofields are displayed.

1.5.11 Save picture

This action will save the picture currently on the screen as a Windows metafile (.wmf) which can be used afterwards to create a report document. Clicking the button will open a standard MS Windows dialog box in which a filename for the picture should be specified.

1.5.12 Undo

Clicking the **Undo** button will cancel (undo) the previous action performed. The maximum undo history depth is not limited.

1.5.13 Redo

Clicking the **Redo** button will cancel the latest **Undo** command.

1.5.14 Dimensions

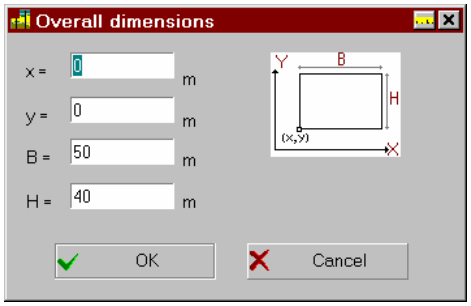


Fig. 1.5.14-1. *The* **Overall dimensions** *dialog box*

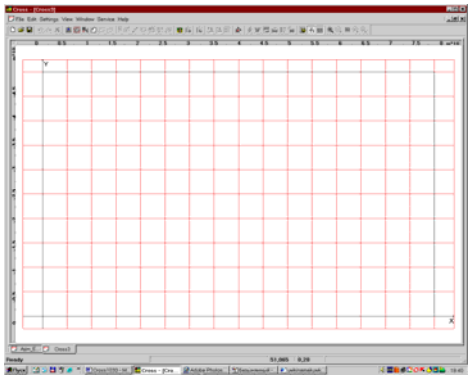


Fig. 1.5.14-2 Displaying site dimensions in the working area

The foundation is entered using a coordinate grid with its sizes limited to the dimensions of the site. The dimensions of the site can be specified via a dialog box (Fig. 1.5.14-1) in units of measurement defined on the **Units of measurement** tab of the **Settings** dialog box.

After the dialog is closed, a rectangle appears in the working area which outlines the exterior contour of the site according to the specified dimensions (Fig. 1.5.14-2).

1.5.15 Foundation

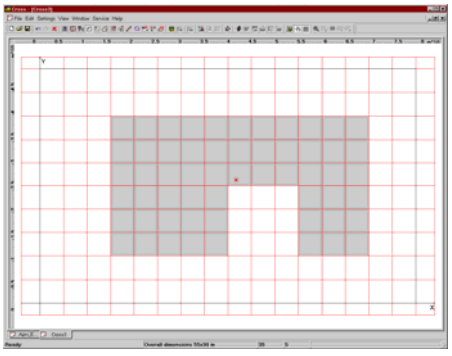


Fig. 1.5.15-1. Displaying a foundation in the working field

The exterior contour of the foundation slab is entered by specifying salient points (vertices) of the polygon that bounds the contour. Each vertex is set by left-clicking. To close up the contour, double-click the left button. The last vertex is joined to the first one, and the screen displays the outline of the foundation (Fig. 1.5.15-1).

The salient points can stand in arbitrary positions or snap to nearest nodes of the grid. The snap mode can be turned on or off on the **Other** tab of the **Settings** dialog box. If the snap mode is off, the second field of the status bat displays the current coordinates of the pointer. If the **Snap to grid** option is on, the status bar displays coordinates of a grid node nearest to the pointer.

1.5.16 Editing the foundation's outline

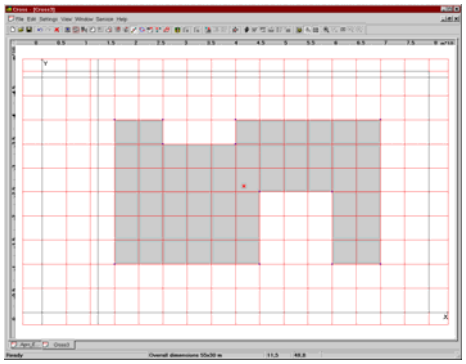


Fig. 1.5.16-1. A foundation after its outline has been edited

If a foundation has been already specified, the second click on the **Foundation** button of the toolbar will activate the outline editing mode. To do it, move the pointer to any point of the contour, wait till the pointer changes its appearance (it'll become a crosshair at any arbitrary point, or a target crosshair at a salient point), left-click and drag the selected point to a new location. To fix the new salient point, double-click the left mouse button. Fig. 1.5.16-1 shows the bedplate after its outline has been edited.

When moving vertices (salient points), you are not allowed to make ribs of the outline cross one another or draw an opening outside the contour.

1.5.17 Existing building

This action lets you enter the contour for an existing building (or buildings). The procedure is just the same as that used to create a foundation's contour.

1.5.18 Opening

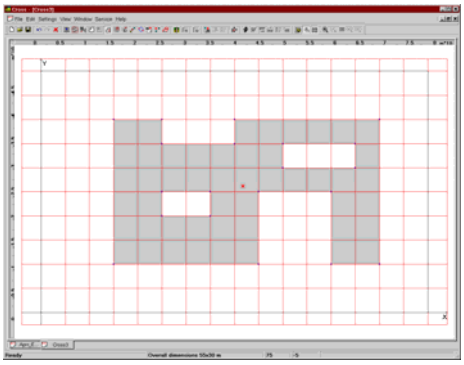


Fig. 1.5.18-1. An example of a foundation with an opening

This action lets you enter an opening in a foundation slab or an existing building. The opening is specified as a closed polygon. The procedure of entering and editing an opening is the same as that of entering/editing the outline of a foundation.

Fig. 1.5.18-1 shows an example of a foundation with an opening.

A polygonal opening is not allowed to cross the outline of the foundation or another opening.

1.5.19 Assign foundation

In some cases one has to design a few buildings standing together at the same time (for example, a block in the city). It is quite possible that one does not know which building will be erected first. Accordingly, during the creation of a model it is not clear which building (in terms of the **CROSS** software) should be treated as a foundation and which one as an existing structure. This action lets you re-assign a foundation, that is, by invoking the action and pointing at an existing building you can assign the selected one to be the new foundation. The previous foundation will become an "existing building".

1.5.20 Delete

This action deletes an opening (either in a foundation or in an existing building) or even an existing building. To invoke the action, point at an object with the mouse pointer and left click.

1.5.21 Round angle

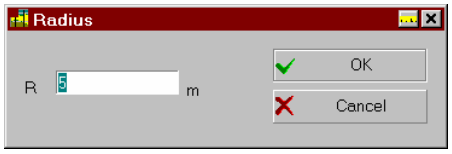


Fig. 1.5.21-1. *The* **Rounding radius** *dialog box*

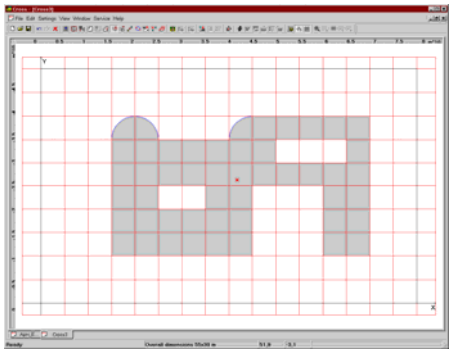


Fig. 1.5.21-2. An example of a rounded foundation

An angle is rounded by inscribing a circle of a given radius in it. After you invoke the action, point at the contour's vertex (it may belong to either the foundation's exterior contour or that of an opening), wait till the pointer becomes a crosshair, and left-click. In the **Rounding radius** dialog box that opens (Fig. 1.5.21-1) specify the radius and click **OK**. Fig. 1.5.21-2 shows a foundation with one of its angles rounded.

The number of points (nodes) on the arc must be specified on the **Other** tab of the **Settings** dialog box. The number of nodes on the full circle (including any interior opening) should not be less than 8.

1.5.22 Move

This action helps move a group of vertices selected by the frame. Do the following:

- invoke the action;
- grab vertices to be moved by a rectangular (or polygonal) selection frame;
- move the pointer inside the frame, wait till the pointer changes its appearance, and move the frame together with the grabbed vertices to a new position.
  Left-click to fix the new position.

When moving vertices, you are not allowed to make ribs of the foundation's outline cross one another or draw a polygonal opening outside the contour.

1.5.23 Vertices

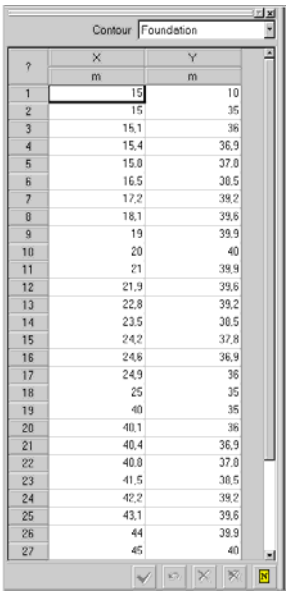


Fig. 1.5.23-1. *The* **Coordinates of vertices** *dialog box*

The positions of vertices of a foundation's contour can be adjusted by changing their coordinates. To do it, use the **Vertices** item of the **Edit** menu. Clicking this item will display the **Coordinates of vertices** dialog box (Fig. 1.5.23-1) that includes a list of contours in the order of their creation and a table of coordinates of vertices belonging to a selected contour (a foundation, an opening, or an existing building).

To adjust a vertex's position, do the following:

- select a contour in the list (vertices of the selected contour will be numbered in the section);
- change the coordinates of the vertex in the coordinate table;
- click the **Apply** or **OK** button.

When moving vertices, you are not allowed to make ribs of the foundation's outline cross one another or draw an opening outside the bedplate's contour.

1.5.24 Delete vertices

This action is used to delete one or more groups of selected vertices. To do it, follow this procedure:

- invoke the action;
- use the rectangular or polygonal selection frame to grab the vertices to be deleted;
- left-click the mouse.

1.5.25 Load

This action is used to specify a load applied at the founding level, and the founding level itself. Do the following:

- invoke the action;
- point at an object (a foundation or an adjacent existing building) to which to apply the load, and then left-click;
- specify the magnitude of the load and the founding level in the **Load** dialog box that opens (Fig. 1.5.25-1). The subsidence of the soil bed *W* (see Fig. 1.5.25-2) depends on the applied load *P* nonlinearly, therefore, generally, the coefficient of the soil reaction should be a variable.

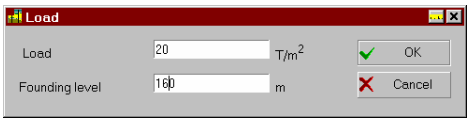


Fig. 1.5.25-1. *The* **Load** *dialog box*

In the engineering practice, the nonlinear relationship OBA is usually replaced by the linear dependence OB (a "chord modulus" analysis). Tangent of this linear plot's inclination is exactly the coefficient of soil reaction.

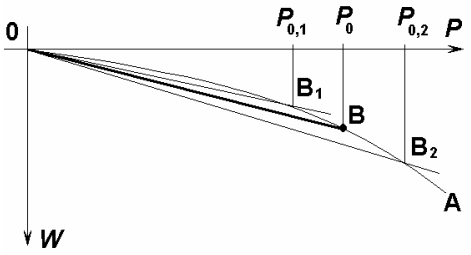


Рис. 1.5.25-2.

Therefore the applied load P_0 should have a most probable expected value (such as the dead weight load plus sustained load plus a sustained part of short-term loads). The actual structure may be subject to other loads too, but if the main part of the load has been taken into consideration then small variations between $P_{0,1}$ and $P_{0,2}$ will affect the coefficient of the soil reaction very little (the inclination of the OB_1 and OB_2 lines is hardly different from that of OB).

1.5.26 Create area of extra load

A non-uniform load upon the foundation is simulated by introducing an area or a point subject to an additional load. After this action is invoked, use the mouse pointer to enter any desired polygonal shape for the area of additional load. To finish the entering, double-click the mouse, and this will open the **Load** dialog box where you should specify a value for the load.

An area of additional load can be created by this action via the main menu or via the respective button of the toolbar. After that, use the mouse pointer to draw a polygonal area. Double-click to finish entering the loaded area. Then, enter a value for the load in the dialog box that opens. The entered load value will be added to the uniform load upon the foundation specified earlier using the **Load** action.

1.5.27 Delete area of extra load

To delete an area subject to an additional load, invoke the action **Delete area of additional load**, point at an area to be deleted, and left-click.

1.5.28 Change load on area

A load applied to an area can be modified. To do it, invoke the action, point at the desired area, left-click, and specify a new value for the load in the dialog box that opens.

1.5.29 Add point of extra load

In cases when a load in a certain convex area changes according to a linear law, you can enter only points that bound this loaded area. The load at points inside the area will be calculated by linear interpolation of the load values entered for the bounding points and added to any load specified earlier. These points (three at least) are entered using the **Create point of extra load** action from the **Edit** menu. After each point is entered, you are asked to specify a load value for it.

Note that the load in additional points must be specified in *units of pressure* — please do not confuse these points with those subject to concentrated forces.

1.5.30 Delete point of extra load

Points of extra load can be deleted using the appropriate item from the **Edit** menu.

1.5.31 Points of extra load

The **Change load values in points** function enables you to make changes to load values or coordinates of points in a table.

1.5.32 Load field

To verify that the loads on the foundation have been specified correctly, you can use the **Load field** action and get a picture of load isofields.

1.5.33 Add borehole

This action is used to assign a location for a borehole on the construction site. To enter a new borehole, point at its location with the mouse and fix it by left-clicking. The working area will display a label with No. of this hole (or its name if any has been specified). If the snap-to-grid mode is enabled, then the borehole will be added at nodes of the grid nearest to the position of the pointer. You can modify the coordinates of a borehole in the borehole properties setup mode.

1.5.34 Delete borehole

To delete a borehole, point at it with the mouse pointer and left-click.

1.5.35 Borehole properties

Invoking this action opens the **Borehole properties** dialog box (Fig. 1.5.35-1) in which the following information should be specified for each hole:

- coordinates of the hole (they were specified when the hole was added, but changes can be made to them in this dialog);
- name (entitlement) for the hole;
- soil information;
- levels of soils (top) for every borehole.

If there is a rock bed under the soil layers, enable the respective checkbox. The calculation of the subsidence will be limited by the level of the deepest soil layer. The latter's name in the table will be replaced by "rock". Otherwise, the program will determine the depth of the compressible soil massif on the basis of the assumption that the deepest layer is infinitely deep.

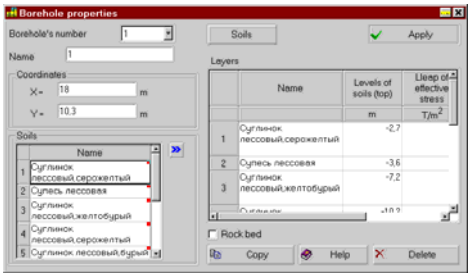


Fig. 1.5.35-1. *The* **Borehole properties** *dialog box*

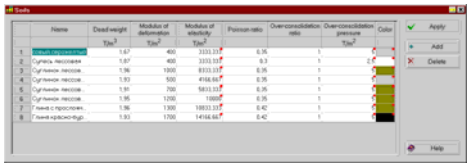


Fig. 1.5.35-2. *The* **Soils** *dialog box*

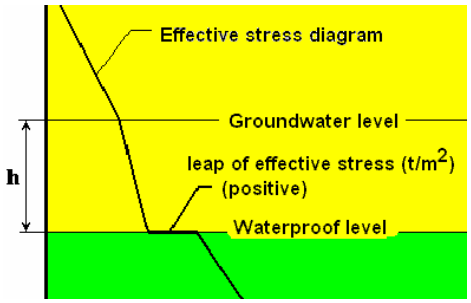


Fig. 1.5.35-3. Determining the effective stress leap

The specification of the borehole properties must be preceded by a description of all soil characteristics. These characteristics are specified in the **Soils** dialog box (рис. 1.5.35-2). Before entering the properties of a soil, click the **Add** button. This is what must be specified in the new line of the soil table:

- name of the soil;
- specific weight;
- modulus of deformation;
- modulus of elasticity (if this property is set to zero, it will be calculated automatically as D/0.12 where D is the modulus of deformation);
- Poisson ratio;
- over-consolidation ratio;
- over-consolidation pressure.

In the last column you can assign a color to designate the soil in sections.

The leap of effective stress is caused by buoyancy which lessens the volume weight of soil by 1 t/m^3 beginning from the phreatic surface and ending at the aquiclude. This effect disappears on the aquiclude, and thus the leap of the effective stress arises (Fig. 1.5.35-3).

If saturated soil is located *under* waterproof one, then the buoyancy creates a negative leap of the effective stress.

One of key properties that describe the soil behavior is the structural strength p_c. The p_c value can be represented as

$$p_c = R\sigma + \Delta p_c ,$$

where R is the over-consolidation ratio (related to the age of the soil massif), Δp_c is the over-consolidation pressure (related to maximum pressures that affected the soil in the whole history of its formation), σ is the natural pressure. The over-consolidation ratio and the over-consolidation pressure are constant, and they can be treated as soil properties.

If there are no experimental field data about the values of R and Δp_c, you are recommended to use the over-consolidation coefficient of 1.0, and the over-consolidation pressure of:

5 t/m^2 — for clayey soil;

2.5 t/m^2 — for sandy clay;
0 t/m^2 — for sand.

If any of the soils needs to be deleted, select the respective line with the mouse pointer and click the **Delete** button.

Having finished entering the soil properties, click the **OK** button to close the **Soils** dialog box and return control to the **Borehole properties** dialog.

To describe the sequence of layers in a borehole, do the following:

- choose No. of the borehole from the **No. of borehole** list;
- select the line with properties of the layer's soil in the **Soils** table (Fig. 1.5.35-1) and click the >> button to move it to the **Layers** table;
- specify the layer's properties (soil of the same type can occur in a few different layers).

The properties of a layer include: the level mark and (if necessary) the effective stress leap that can be caused, for example, by water saturation of the layer. Note that the level marks can refer to any basic reference point (such as the rock bed or the day).

The entering of the borehole properties can be facilitated in this way: enter only one borehole and edit its properties, then start entering the rest of the boreholes. Their properties will be copied from the first one by default, so you will need only to edit them. Also, clicking the **Copy** button will open the **Copy borehole** dialog box in which you can choose a "counterpart" borehole and copy its level marks from there.

1.5.36 Point to calculate compressible massif

If no rock bed is specified for the model, then the bottom level of the compressible massif will be calculated at the central point of the foundation slab. Using the **Edit** menu, you can invoke the action **Point to calculate compressible massif**, and use your pointer to indicate a different location for this purpose (it will be indicated by a red cross on the model's view).

If the foundation has a nearly rectangular shape, then the recommended point for calculating the compressible massif depth will be the middle of a line that connects one of the rectangle's vertices with its diagonals' intersection point.

1.5.37 Cancel

Clicking this button will cancel the currently invoked action, and you can use such functions as the distance measurement, construction of sections etc.

1.5.38 Section

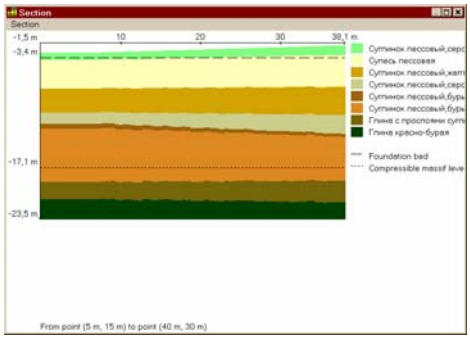


Fig. 1.5.38-1. A dialog box that shows a section

To validate given properties of boreholes, you can use the geological section mode (Fig. 1.5.38-1). The section is generated along a linear segment located in any place of the site. To construct a section, do the following:

- use the **Cancel** button to disable the current action;
- place the pointer onto the beginning of the segment;
- press the **Ctrl** key and, at the same time, click and hold the left mouse button;
- holding both the mouse button and the key, drag the mouse to the second node of the segment.

A dialog box will appear with a geologic section along the specified direction. A hachure line will denote the founding level, and a dot line will indicate the boundary of the compressible soil massif. The boundary will be visible only in the case it is not deeper than 10 meters below the top level of the last soil layer.

Use the **Save** menu item to save the picture as a Windows metafile, if desired.

The following algorithm is used to build a section:

A convex envelope is constructed for all points at which the boreholes are specified. This convex envelope is triangulated. Further, one of three options is possible for every point inside the construction site:

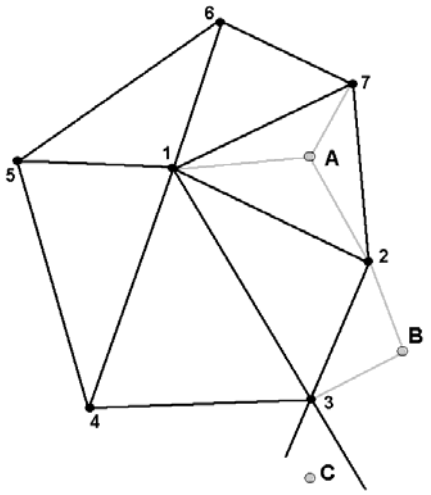


Fig. 1.5.38-2.

A the point lies inside one of triangles (an example is the **A** point in Fig. 1.5.38-2);

B the point is outside the convex envelope, and the distance from this point to the convex envelope is equal to the length of a normal dropped on the nearest side of the envelope (an example is the B point in Fig. 1.5.38-2);

C the point is outside the convex envelope, and the distance from this point to the nearest side of the convex envelope is equal to the distance to one of the vertices (an example is the **C** point in Fig. 1.5.38-2);

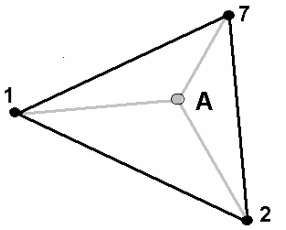


Fig. 1.5.38-3.

In case **A**, the thickness of each soil layer is calculated by linear interpolation between the vertices of the triangle, proportionally to the areas of the triangles opposite to their respective vertices (Fig. 1.5.38-3).

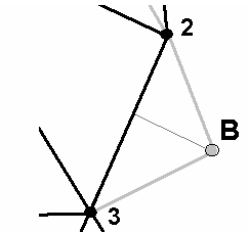


Fig. 1.5.38-4.

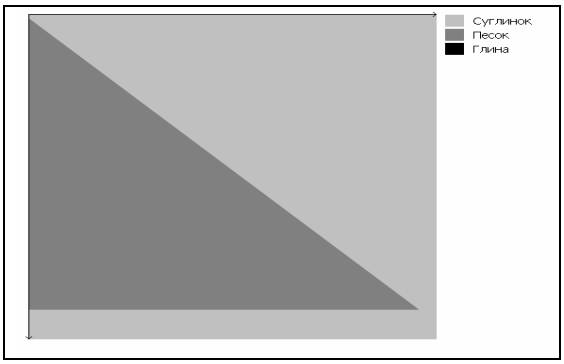
In case **B**, the thickness of each soil layer is calculated by linear interpolation of the lengths of segments into which the side is divided by the normal dropped from the **B** point (Fig. 1.5.38-4).

In case **C**, we assume that the structure of the soil massif in the current point is the same as that in the nearest borehole (it is borehole 3 in Fig. 1.5.38-2).

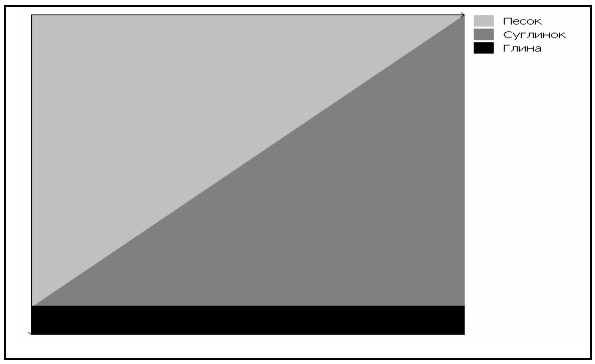
Note the impossibility to restore the structure of a soil massif only by information about the structure of boreholes. This can be seen from the following simple example. Suppose there are two boreholes of the following structure:

Borehole 1		Borehole 2	
Soil	**Top level**	**Soil**	**Top level**
Clayey	0	Sand	0
Clay	-10	Clayey	-10

The axial geologic section can be like that:



Or



The ambiguity of this kind can be eliminated by specifying the same package of soils for every borehole. That is, in each borehole the set of soils and their order should be the same (only their top levels are different), while the lack of a soil (say, i^{th}) in a certain borehole should be specified as equal top levels for i^{th} and $(i+1)^{th}$ soils. In the example above, the structure of the boreholes should be described as follows (suppose the second section is the correct one).

Borehole 1		Borehole 2	
Soil type	**Top level**	**Soil type**	**Top level**
Песок	0	Sand	0
Clayey	0	Clayey	-10
Clay	-10	Clay	-10

1.5.39 Measuring distances

Using the mouse pointer, you can determine the distance between any two points of the site. To do it, move the pointer onto the first point, click and hold the left mouse button, and move the pointer onto the second point. The right sector of the status bar will indicate the distance between points (the accuracy of this indication will depend on the number of decimal digits specified on the **Units of measurement** tab of the **Settings** dialog box). The coordinates of the current pointer position will be displayed in the middle of the status bar.

Note that, in order to be able to perform this action, you should turn off all edit modes.

1.5.40 Coordinate origin

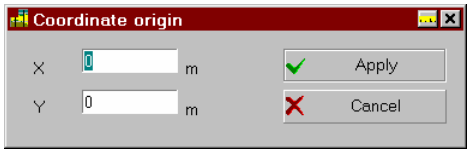


Fig. 1.5.40-1. *The* **Coordinate origin** *dialog box*

This action is invoked from the **Edit** drop-down menu and lets the user move the coordinate origin to a point with specified coordinates (Fig. 1.5.40-1).

The grid is turned around the coordinate origin, therefore moving it can be useful when specifying a contour.

1.5.41 Grid spacing

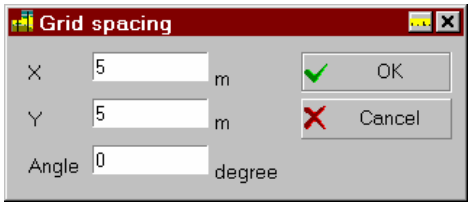


Fig. 1.5.41-1. *The* **Grid settings** *dialog box*

Properties of the coordinate grid are set up in the **Grid settings** dialog box (Fig. 1.5.41-1) that opens by invoking the appropriate action. Edit fields of this dialog lets you specify the horizontal grid spacing (by **X**) and the vertical one (by **Y**), together with an inclination of the grid with respect to the horizontal axis expressed in degrees. The grid is rotated around the coordinate origin.

Note that the grid spacing and its inclination angle can be altered as many times as needed in the course of contour specification. That's how you can adjust the grid to the sizes or orientation of the contour being entered.

The grid appears on the screen after all its settings are specified (Fig. 1.5.41-2).

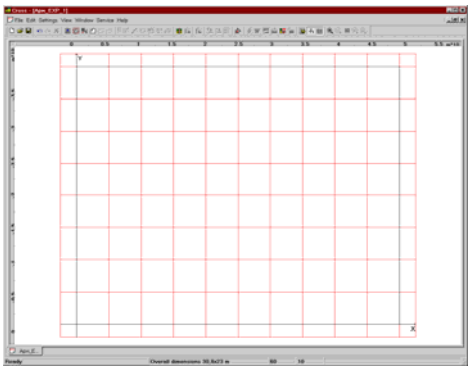


Fig. 1.5.41-2. A grid displayed in the working area

1.5.42 Grid

This will turn on or off the displaying of the dimension grid in the working area. The spacing of the grid is assigned by the **Grid spacing** property in **Settings** or by clicking the  button on the toolbar.

1.5.43 Fields in buildings

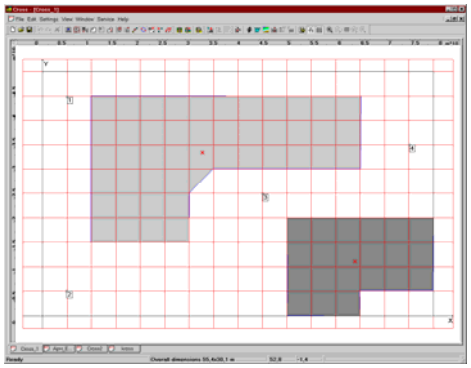


Fig. 1.5.43-1. A foundation model together with an adjacent building

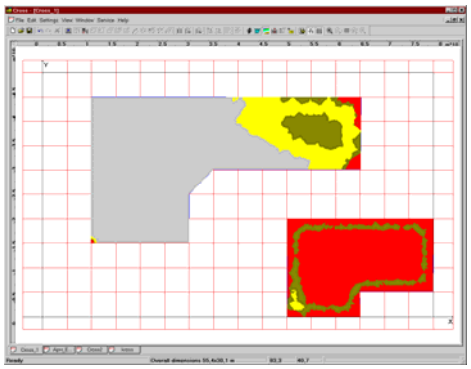


Fig. 1.5.43-2. A soil reaction coefficient field in the foundation and its adjacent building

The program can give out fields of coefficients for existing buildings, too, if the respective option has been enabled in **Settings**. As a rule, such information about the distribution of soil reaction coefficients under existing buildings is not of much importance for the design procedure. Nonetheless, there may be cases when this data is useful.

If the **Fields in buildings** action is invoked, a full picture of the soil reaction coefficient distribution under all buildings will be generated (Fig. 1.5.43-2).

1.5.44 Zoom in and out

The picture of the site can be zoomed in. Each click on the  button — **Zoom in** — will increase the linear scale by 10%. The maximum possible scale is 2:1 comparing to the original size. If the picture has been zoomed in, scrollbars appear along the right and bottom borders of the working area. The scrollbars can be used to move the picture around in the working area. For zooming out, use the  button — **Zoom out** — to decrease the scale by 10% with each click down to the original size of the model fitting the window.

1.5.45 Zoom to selection

After invoking this action, use a rectangular selection frame to select a part of the model. After the right mouse button is clicked, this selection will be zoomed in.

1.5.46 Fit

This action will return the picture of the site to its original size that fits the window.

1.5.47 Help

Clicking the **Help** button will invoke a standard MS Windows function for getting reference help information from a database created by the program's developers.

1.5.48 About

Fig. 1.5.48-1. *The* **About** *message box*

Clicking this button will open the **About** message box (Fig. 1.5.48-1) that displays the version number and the developer of the program.