Siren

Version 8.0.0.1

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Oasys Siren

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This document has been created to provide a guide for the use of the software. It does not provide engineering advice, nor is it a substitute for the use of standard references. The user is deemed to be conversant with standard engineering terms and codes of practice. It is the users responsibility to validate the program for the proposed design use and to select suitable input data.

Printed: July 2006

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Foreword

This is just another title page
placed between table of contents
and topics

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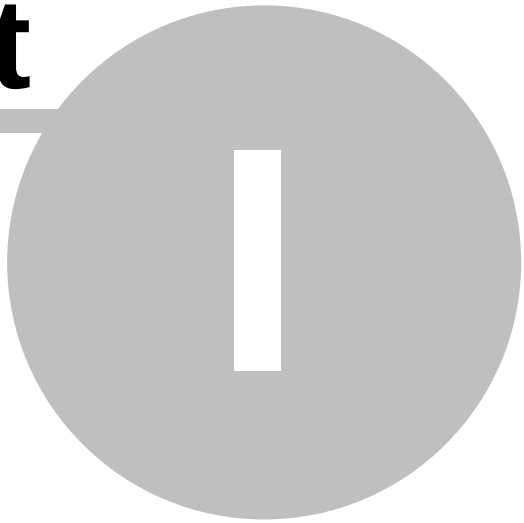
About Siren

Part



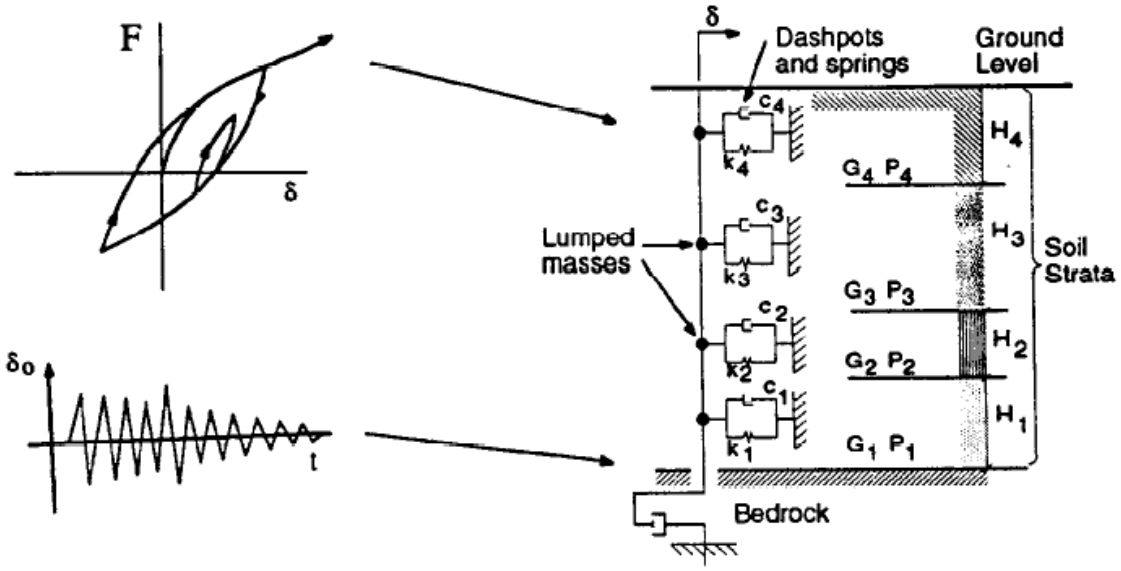
1 About Siren

Siren analyses the response of a one-dimensional soil column to an earthquake motion input at its base, according to Heiderbrecht et al (1990).

More:
General Description

1.1 General Description

The soil column is specified as a series of layers each with its own material properties, characterised by a stress-strain relationship and a bulk density. The program operates in the time domain enablng it to model non-linear soil properties with hysteretic damping as shown below.



Diagrammatic Representation of Siren Analogy

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Step By Step Guide

Part II

2 Step By Step Guide

To analyze a soil column in **Siren**, follow the steps listed below.

- Create a new document by selecting 'File | New' from the main menu, or by clicking the 'New' button of the Standard toolbar.
- Enter Bedrock data by selecting 'Data | Bedrock' menu command
- Define materials for different soil layers.
- Define the soil elements.
- Input time history data or import it using 'File | Import' menu command.
- Enter the analysis control specifications.
- Check the validity of the input data by selecting 'Analyse | Check data' from the main menu.
- If the data is valid, analyse the model.
- Review the results in the Output View by double-clicking the 'Text Output' in the Output tab in the Gateway or by selecting 'View | Results' option from the main menu. To view results graphically, select 'View | graphics' from the main menu.
- To modify the data after analysis, the results must be deleted by selecting the 'Analyse | Delete Results' option of the main menu.

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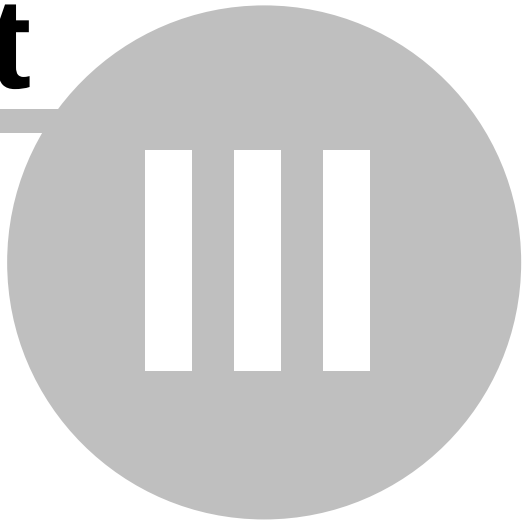
Working with Siren

Part



3 Working with Siren

3.1 Some Basic Concepts

3.1.1 Welcome to Siren

The Welcome to Siren dialog is displayed on entry to Siren and is designed to assist the user to get started quickly. In addition to allowing the user to select what he wants to do the dialog displays a `Did you know…´ tip.

Create a new data file

This option creates a new data file.

Work on your own

This allows the user to exit from the dialog and work on his own. This is the same as selecting `Cancel´.

Open an existing file

This activates the `File Open´ dialog, allowing the user to select a file to open

Select recent file

This allows the user to open a file that has recently been opened in Siren. The selection is made from the list of files shown.

Show this dialog on Startup

The `Welcome to Siren' dialog can be disabled if required.

3.1.2 Preferences

In many cases the user will want to be able to have preferred settings. These settings or `Preferences´ are stored between one session of Siren and the next. The settings include numeric format, current version checking on startup, show tips on startup, print parameters and company information.

Preferences are set in the 'Preferences' dialog available from the `Tools | Preferences´ (Ctrl+F7) menu command.

Numeric Format

The numeric format governs the way that numbers are output.

The options are:

- **Engineering** —numbers are output to the specified number of significant figures with exponents

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which are multiples of 3;
- **Decimal** —a number of decimal places is specified; and
- **Scientific** —numbers are output to the specified number of significant figures in exponent form.

Check for current version on startup

This will check to see if the current version of the program is being run. This can be disabled where there is a slow network connection.

Show welcome to Siren

The `Welcome to Siren´ dialog can be enabled/disabled if required.

Company Info

Opens the Company Information dialog to set up your company name and logo that appear on printed output.

Page Setup

Opens the Page Setup dialog allowing the style of output for printed text and graphics to be selected.

If `Calculation Sheet Layout´ is selected the page is formatted as a calculation sheet with details inserted in the page header. If `Logo´ is selected the company logo is inserted in the top left corner of the page. If `Border´ is selected this gives a border but no header information. If `Clipped´ is selected the output is clipped leaving a space for the logo. This has no effect on text output.

3.1.3 Toolbars

Many of the commonly used commands are available on toolbars. All toolbars can be either docked (attached to the main frame) or floating. The toolbars can be switched on and off from the `View | Toolbars´ menu command. Hovering the mouse over a toolbar button will display a small window (tool tip) with the name of the command.

Toolbars are covered in detail in the Toolbars and Keyboard Accelerators section.

3.1.4 File Formats

Siren supports the 'srn' file type. The data in other formats (GFD, TXT, CUR files) can be imported using 'File | Import' menu command.

There are options to save the data, both graphical and tabular, to other file formats. These are described in detail in the Interaction with Other Software section.

3.2 Working with the Gateway

The Gateway gives access to the input data and to the output views available.

The Gateway behaves like a toolbar in that it can be displayed or hidden and, when displayed, can be docked onto an edge of the Siren window or floating anywhere on the screen. When floating it is displayed on top of any other view. When docked the part of the screen that is available for other views excludes that occupied by the Gateway. The content of the Gateway always relates to the current model. There is never more than one Gateway displayed even if there is more than one model open.

The Gateway can be opened and closed using the `View | Gateway´ (Alt+0) menu command. `Gateway´ is also available on the Data toolbar.

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The Gateway has two tabs: `Tables which gives access to the input data editing and viewing, `Output´ for viewing graphical data and tabulated data.

Double clicking on an item will open the appropriate table view or dialog for data input.

More:
Right-click menu
Tables Tab
Output Tab

3.2.1 Right-click menu

Clicking the right mouse button when the cursor is pointing at an item in the Gateway displays a floating menu that relates to that item.

3.2.2 Tables Tab

The Tables tab in the Gateway provides access to the input data tables and dialog.

Double-clicking the item opens the related data view.

3.2.3 Output Tab

The Output tab in the Gateway gives access to:

- Text Output - Text Output opens Output Settings' dialog where the user can select the data to be displayed.
- Graphic Output - Graphic Output provides the option to view analysis results graphically.

3.3 Working with Graphic View

Graphic View allows the user view the analysis results graphically.

Graphic View may be opened using the `View | Graphics' menu command or double-clicking 'Graphic Output' in the Gateway. Graphic View provides a control at the top of the window to select the data to be plotted. The graph data can be exported to Oasys Sigraph by selecting the option from the context menu in the Graphic View.

More:
Zooming and Panning
Printing from Graphic View

3.3.1 Zooming and Panning

Zooming and panning affect the scale and the mid-point of the diagram displayed in the Graphic View.

Zooming:

- **Dragging a rectangle** in the window causes the image to be zoomed and panned to result in that rectangle filling the Window. Only when the aspect ratios of the rectangle and window are identical will this be exact; otherwise the scale is such that **at least** all of the rectangle remains visible.
- **Shft+Click** pans. The image is panned to result in the point clicked on being at the mid-point of the view.

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Dragging:

- **Ctrl+Drag** up and down zooms in and out respectively.
- **Shft+Drag** pans the image.

Intellimouse wheel:

- **Rolling the mouse wheel** forwards and backwards zooms in and out respectively.
- **Drag with the mouse wheel** (or middle button) held down pans the image.
- **Ctrl+Drag with the mouse wheel** (or middle button) held down operates as Ctrl+Drag.

3.3.2 Printing from Graphic View

The graphic image may be printed by giving the `File | Print´ (Ctrl+P) menu command. The printed image may be previewed by giving the `File | Print Preview´ menu command. `Print´ button is also available on the Standard toolbar.

The underlying graphics code used for printing and print previewing is different to that used for display to the screen. This may occasionally cause subtle differences between the screen image and the printed image.

When printing to a monochrome device, lines, text and symbols are automatically output in black and in-fill is converted to a shade of grey by the program. (The various printers and printer drivers interpret colours differently, sometimes even to the extent of ignoring some colours.)

3.4 Working with Table View

Some input data required by Siren is to be entered in tables. The details of the data entered in each table are covered in the Program Data section. Tables in Siren are similar to spreadsheets.

Note that in general, data cannot be entered or edited if results exist.

See Also:
Table View Import/Export Options

3.5 Working with Output View

Output View may be used to view input data and results in tabular format.

'Output View' may be opened using the `View | Results´ menu command. It can also be opened by selecting 'Text Output' from the Output tab in the Gateway.
This first displays the Output Settings Dialog. `OK´ opens an Output View containing the selected output; `Cancel´ exits the dialog box without opening an Output View.

The units in which data is output are the units.

The numeric format in which data is output is as set in the user preferences.

See Also:
Output View Export Options

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Program Data

Part IV

4 Program Data

This section describes the different types of data that is required for each analysis. The data is organised in modules and displayed for input and editing in dialogs or tables. All the tables can be accessed from the Data pull down menu, or from the Tables tab in the Gateway. These can also be accessed from the Data toolbar.

More:
Titles
Units
Bedrock
Soil Materials
Soil Elements
Time History
Analysis Control

4.1 Titles

The Titles window allows the user to enter the job details. By default the job details of the previous job are used.

Job Number

This is the job number, which can be any alphanumeric string.

Initials

The initials of the user used on printed output.

Last Edit Date

Today for new input; when last edited for retrieved files.

Job Title

The title of the job.

Subtitle

The subtitle that this model relates to.

Calc Heading

Specific to this model.

The above items are reproduced in the title block at the head of all printed information for the calculations. The fields should therefore be used to provide as many details as possible to identify the individual calculation runs.

An additional field for Notes has also been included to allow the entry of a detailed description of the calculation.

More:
Titles window – Bitmaps

4.1.1 Titles Window - Bitmaps

The box to the right of the Titles window can be used to display a picture beside the file titles.

To add a picture, place an image on to the clipboard. This must be in a RGB (Red / Green / Blue) Bitmap format.

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Select the `Paste´ button to place the image in the box. The image is purely for use as a prompt on the screen and cannot be copied into the output data. Care should be taken not to use large bitmaps, which can dramatically increase the size of the file.

Select the 'Copy' button to copy the image to the clipboard for pasting elsewhere.

To remove a bitmap select the `Remove´ button.

4.2 Units

This dialog allows the user to specify the units in which data is to be entered and results are to be reported.

The dialog is accessible from the Gateway or from the main menu via 'Data | Units...'.

4.3 Bedrock

Allows input of the physical properties and location of the bedrock. The user can specify bedrock level, density, shear wave velocity and whether the base boundary is considered as "transmitting".

4.4 Soil Materials

Allows input of the strain degradation curve for different soil types. The curve represents the degradation of shear modulus with increasing strain levels. For sands, the G/G_o vs γ curves proposed by Seed et al (1984) and for clays the relationships given by Sun et al (1988) may be used.

The values of shear strain and the product of shear strain and shear modulus should be increasing.

The shear stress and Damping ratio are calculated from the strain degradation curve by the program and cannot be edited by the user.

4.5 Soil Elements

Allows input of the location and material property number of each soil layer. Each soil element is located by its top level and assigned a soil material number, bulk density (ρ) and yield factor. The data should be such that the natural frequency of each layer within the site is approximately equal (say $\pm$ 10 Hz). This can be achieved by assuming a natural frequency for a layer and then calculating its height.

Viscous damping can be added into the system in addition to hysteretic damping. For normal situations this can be set to zero; however, they may be appropriate for modelling a simple structure on the soil surface.

4.6 Time History

This represents the expected bedrock motion expected for the site. This can be scaled to achieve the appropriate magnitude of motion. Scaling can be done by using the 'Wizard' button on the Tables toolbar.

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4.7 Analysis Control

Allows specification of the method and location of the excitation motion, together with several analysis parameters. The excitation can be specified at bedrock level or as nodal force at any node. For output results, specify the calculation time step (seconds) and the finish time (seconds). The number of time steps between output are used for the calculations between those whose results are stored for producing the detailed output. Linear interpolation is used for intermediate values in the time-history input.

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Toolbars and Keyboard Accelerators

Part V

5 Toolbars and Keyboard Accelerators

5.1 Toolbars

5.1.1 Standard Toolbar

The standard toolbar handles the common Windows options:

New - create a new document

Open - open an existing file

Save - save the data to file

Cut - cut the data and place on clipboard

Copy - copy the data and place on the clipboard

Paste - paste the data from the clipboard into the model

Print - print the current view

About - open a dialog providing version information about Siren's components

5.1.2 Siren Toolbar

The Siren toolbar provides access to the main Siren options:

Gateway - show or hide the Gateway

Titles - open Graphic view

Units - open table view

Results - provide options to edit data type, units and labels of curve. Enabled only in table view.

Bedrock - open the Bedrock dialog

Soil Materials - open the Material Degradation table

Soil Elements - open the Elements table

Time History - open the Excitation Time History table

Analysis Control - open the Analysis Control dialog

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Check Data - check the consistency and completeness of the model's data

Analyse - analyse the model

Delete Results - delete all the results (enables input data to be edited)

Results - view text output

Graphics - view graphic output

5.1.3 Data Toolbar

The Data toolbar gives access to various methods for modify the way data can be viewed or edited:

Wizard - access the data wizard in Time History table view

Plot Data - plot the data from the active table view

Find - search data for particular value

Replace - search and replace values

Modify - modify the values in tables

Go To - go to a particular record in table

Import - import data from other files

Export - export data to other files

5.2 Keyboard Accelerators

Key	Action
Alt+0	Gateway
Ctrl+A	Select All
Ctrl+C	Copy
Ctrl+V	Paste
Ctrl+N	New
Ctrl+O	Open
Ctrl+P	Print
Ctrl+S	Save
Ctrl+W	Wizard
Ctrl+X	Cut
F1	Help
Ctrl+F7	Preferences
Esc	Quit
Tab	Next Cell
Return	Next Cell
Delete	Delete

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Output Options

6 Output Options

The program calculates:

- the displacement, velocity and acceleration, time history for any node
- the shear strain and shear stress time histories for any element in the soil profile
- the maximum acceleration, velocity and displacement for each node and the time of occurence
- the maximum shear strain and shear stress for each element, together with the associated time of occurence.

More:
Text Output
Graphical Output

6.1 Text Output

The text output can be viewed by selecting 'View | Results' command from the main menu or by double-clicking 'Text output' in the Output tab in the Gateway. The output settings dialog appears that allows the user to select the data to be displayed. Node lists and element lists can be specified for detailed output. The data from output view can be exported to various other file formats:

See Also:
Output View Export Options

6.2 Graphical Output

Graphical output allows the following to be displayed graphically:

- Input time history
- Displacement, velocity and acceleration time response for any node
- Stress-Strain curve for any element in the soil profile
- Relative displacement at various elevations at any time
- Base response spectrum and surface response spectrum
- Spectral ratio (surface/bedrock)

The results from the graphic view can be directly exported to Sigraph (csv file) by right-clicking on the graphic view and selecting 'Export to Sigraph' or by clicking 'Export' button at the top of Graphic view. This exports the data corresponding to the current graphic view.

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Method of Solution

Part VII

7 Method of Solution

The soil coulmn is represented as a series of lumped masses, one at each layer boundary. At each time step, t_i, the shear stress acting in each soil layer is calculated from the shear strain existing in that layer at that time. The net force on each lumped mass is calculated as the difference of the shear stress above and below the mass.

The acceleration, a_i, is then calculated as the net force divided by the mass.

The displacement, d_{i+1}, of the mass at the end of the next time increment, t_{i+1}. is calculated as

$$d_{i+1} = a_i \Delta t^2 + 2d_i - d_{i-1}$$

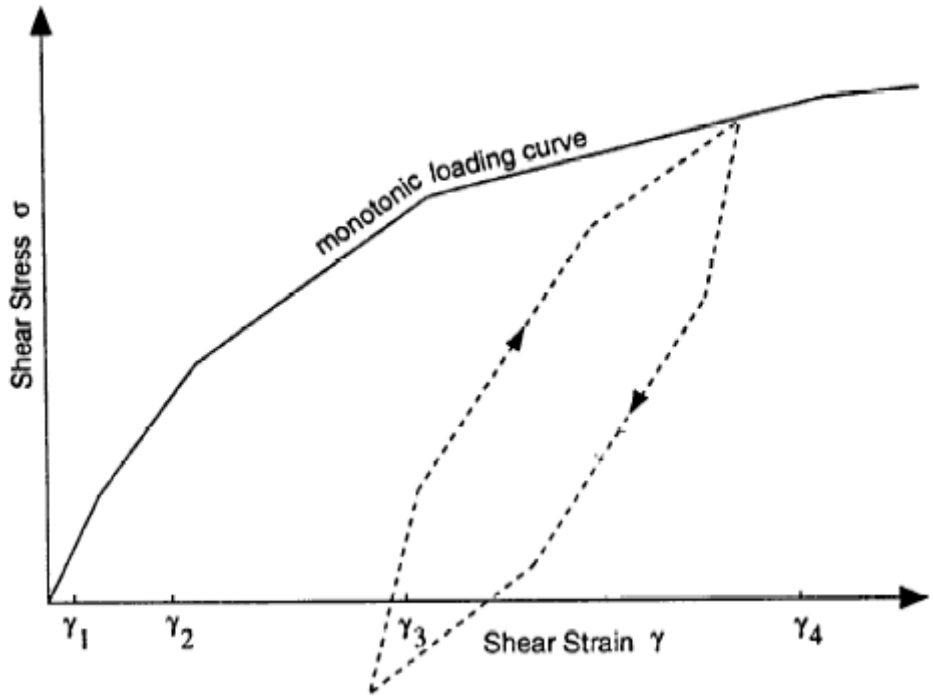
where $\triangle$t is the calculation time step.

The velocity v_i is given by

$$v_i = \frac{(d_{i+1} - d_{i-1})}{2\Delta t}$$

Having calculated the displacement of the masses, the shear strain and consequently the shear stress at the next time step, t i+1, for each layer can be determined and the process is repeated until teh total specified time is achieved.

To calculate the shear stress in the soil, the program represents each soil material type as an elastic-plastic behaviour spring as shown below. The elastic-plastic behaviour is represented by a mechanical soils-layer model.



The spring is set up in such a way that if it is unloaded monotonically the overall response will be the same as that specified. Upon unloading and reloading, the spring exhibits hysteresis in accordance with the Masing principles, as illustrated. Once the shear stress is determined for each soil layer, the shear stress is calculated from the shear stress and shear strain history.

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The program can model the partial transmission of waves into the rock underlying teh soil deposit using teh principal proposed by Papastamatiou (1973). In this method the input base velocity is modified as

$$v_b = v_s + \frac{\tau}{v_r \rho_r}$$

in which v_b is the input base velocity, v_s is the specified input velocity, τ is the shear stress in the lowest soil element, v_r is the shear wave velocity of the base rock and ρ_r is the base rock density. This method is used if the bedrock mothion is selected to be 'transmitting'. If 'non-transmitting' is selected, v_b is equal to v_s. For conventional calculation where an outcrop rock acceleration time history is to be used for the input motion, 'transmitting' should be selected. For the unusual situation where a ground motion is known at depth (ie by way of a borehole measurement or from deconvolution by another progrm), 'non-transmitting' should be selected.

The input excitation can be specified as a base motion or a force excitation.

The base motion can be specified as an acceleration, velocity, or displacement time history with either a constant or varying time step. If the calculation time step, $\triangle t$, is smaller than the input time step, the program converts the input to acceleration and uses either linerar interpolation to determine the value at each calculation time step.

The excitation force is applied as a nodal force time history at a node specified by the user.

A disadvantage with the program is that the upper one or two masses can set up a resonant oscillation which is a function of the discretisation and is not a feature of the soil deposit.

The natural period of each layer is

$$\tau = \frac{\pi h}{\sqrt{G/\rho}}$$

where G, h and ρ are the layer shear modulus, thickness and density respectively. For numercal stability, it is necessary that the time step be less than $0.3T_{min}$, where T_{min} is the minimum period of the layers.

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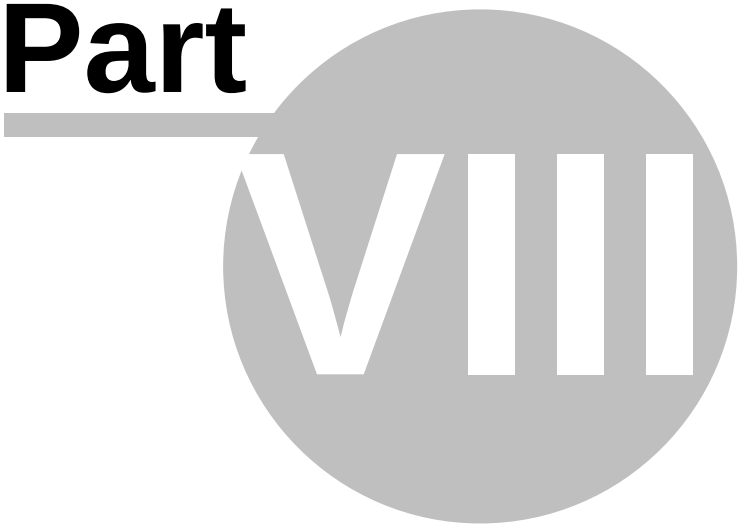
Interaction with Other Software



8 Interaction with Other Software

8.1 Export to Oasys Sigraph

This option is effected by selecting 'File | Export | Sigraph (CSV file)' from the main menu.

The data are are exported to a Sigraph text file with the default file extension 'csv'. The following data can be exported to Sigraph:

- Input time history
- Displacement, velocity and acceleration time response for any node
- Stress-Strain data for any element

The data can also be exported to Sigraph using the right-click menu in the graphic view.

See Also:
Graphical Output

8.2 Export to Siren Text File

The input data can be exported to a text file. This can be done by selecting 'File | Export | Siren Text File' from the main menu.

8.3 Table View Import/Export Options

The input time history and the material degradation curves from the table view can be exported to other file formats (txt, csv, html, cur). This can be done by selecting 'File | Export | Table' from the main menu. The option is enabled only in the table view.

The 'File | Import' option in table view allows the user to import data from txt, csv, cur, and gfd file formats.

8.4 Output View Export Options

Text output is available from Output views. The following file formats are supported for text output.

- TXT - tab delimited file
- CSV - comma delimited file
- HTML - web pages for display in browsers
- RTF - Rich text format

These output the data displayed in the current view in the selected file format.

The option to export from output view is effected by selecting 'File | Export | Output' from the main menu.

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