

User Guide for xsec

At a glance:

This user guide applies to:

- xsec for Apple OS-X referred to as “Mac”.
- xsec for Microsoft Windows referred to as “PC”
- xsec for Apple iPhone referred to as “iPhone”
- xsec for Apple iPad referred to as “iPad”;
- xsec for Android phone referred to as “Android phone”

There are three volumes:

General volume applies to all versions and gives the meaning of words, descriptions of processes and the definition of some terms.

Mac & PC volume sets out “how to” suggestions and instructions specific to the use on an Apple OS-X computer or a Microsoft Windows computer.

Android phone, iPhone & iPad volume sets out “how to” suggestions and instructions specific to the use on an Android phone or an Apple iPhone or iPad

User Guide for xsec – Android phone, iPhone & iPad

At a glance: This volume of the user guide is specific to the Android phone, iPhone and iPad. There is a **General** volume that also applies to the Android phone, iPhone and iPad but applies to the Mac & PC as well. The various sections of this volume are:

Introduction explains the five tabs on the main display panel, and the various data input facilities.

Other sections explain each of the five tabs.

- **Files**
- **Materials**
- **Components**
- **Load cases**
- **Time affect sets**

Chronological sequences explain composite construction, staged construction and prestressing.

Android phone, iPhone & iPad

Introduction

At a glance: This describes the use of the application on an Android phone, iPhone or iPad. See the General – Introduction for the meanings and definitions of some of the words used here.

The expressions ‘phone’, ‘back button’ and ‘next button’

This volume of the xsec user guide covers the Android phone, the Apple iPhone and the Apple iPad. These devices have a range of display size; 4 inches up to 12.9 inches.

Herein the word ‘**phone**’ means either an Android phone or iPhone; the devices with the smaller display sizes.

The application on these smaller devices often has a left pointing arrow button in the top left corner of the display and a right pointing arrow button in the top right corner.

The application on the iPad does not have such buttons. However, it does have buttons with captions ‘Back’ and ‘Next’ that have a purpose similar to those buttons on the smaller devices.

Herein the expressions ‘**back button**’ and ‘**next button**’ mean those arrow buttons on the smaller devices and also mean those ‘Back’ and ‘Next’ buttons on an iPad

The display at startup

The display that appears at startup has a panel headed “Files” and in the body of that panel is a list of file names. On a phone this panel occupies the whole display. On an iPad the panel is top center; the remainder of the display being black.

The main tab buttons labeled F, M, C, L and T are at the top of this panel on an Android phone and at the bottom on an iPhone or iPad. Only the F button is enabled however.

For the iPhone and iPad the installation package contains a number of example files that appear in the list.

For the Android phone the installation package contains no example files. However, the application can automatically generate an example file for each of the measurement unit systems. (See **Files - New file.**)

A tap on a file name in the list will open that file. Alternatively a tap on the “+” button in the top right corner of the panel will invoke facilities that create a new opened file. With an opened file the main tab buttons are enabled allowing access to the content of the file.

Also on an iPad the display outside the panel becomes white with an image of the cross-section described in the file shown in black.

The main tab button labels; F, M, C, L and T stand for: Files, Materials, Components, Load cases and Time affect sets.

Lists of entities

The body of each tab contains a list of entity names

Other than files there are four kinds of entity:

Material: A material entity describes a material such as concrete, or mild steel.

Component: A component entity describes a part of the cross-section. Each component is either a **shape** component or a **point** component. Typically concrete is a shape component and an arrangement of steel bars is a point component.

Load-case: A Load-case entity describes a state of the cross-section that is of interest. For example the ultimate strength or the first yield of a mild steel bar.

Time affect set: A Time affect set has provision for a shrinkage value and a creep coefficient for each component and the name of the load case that causes the creep.

Features common to all the entity lists are:

- A tap on an entity name will open that entity in the appropriate editor.
- A swipe either to the left or the right on an entity name will cause a red delete button to appear that will delete that entity if tapped.
- In the top right corner of the panel is a “+” button. A tap on this will invoke facilities for adding an entity to the list. These facilities vary dependent on the entity kind, but they all require a name. The name facility is described under **Entity names.**

- Below the list are various buttons. Generally these buttons have captions that indicate the purpose.

Entity names

In the top right corner of the entity list panel is a “+” button. When this is tapped facilities to add an entity are invoked that culminate in a prompt “Enter the name of ...” appearing at the top of the list in grey text on a white background. Also an “Ok” button will appear to the right of that prompt text. A tap on that prompt will cause a virtual keyboard to appear at the bottom of the display. Names can be up to twenty characters including spaces between words. (File names have different requirements.) Automatic facilities ensure each name is unique within each entity kind.

Not all the characters on the virtual key board are acceptable. A tap on an unacceptable key is ignored by the application.

This keyboard, like most keyboards, has a particular key in the bottom right corner often called the “return key”. On some devices this key is not labelled “Return” being labelled “Done”, “Go”, “Next” or whatever. Nevertheless in this user guide it is referred to as the “return key”.

A tap on the return key will cause the virtual keyboard to disappear. A further tap on the prompt text or text that has replaced the prompt will cause the virtual keyboard to reappear.

A tap on the “Ok” button will invoke a check on the validity of the name and also cause the virtual keyboard to disappear. If the name is valid the name and the “Ok” button will disappear and the name will reappear in the list as an entity name. If, on the other hand it is not valid an error dialog will appear with a further “Ok” button. A tap on that “Ok” will return the application to the state before the “+” button was tapped.

However with some entity kinds, if the “+” button is tapped again the line for the new name will still contain that invalid name rather than the grey prompt text. A tap on that invalid name will cause the virtual keyboard to reappear so that the name can be corrected.

Entity edit facilities

Features common to all the various entity edit facilities are:

The editing facilities are presented on a sequence of panels.

On a phone each of these panels occupies the whole display. In the top right corner is a right pointing arrow button, and in the top left corner is left pointing button. These are next and back buttons. The idea is that the various panel contents are to be read like the pages of a book.

On an iPad the panels are shown one at a time and there are buttons with self explanatory captions in the panels that change the displayed panel.

In the top centre of each panel is the name of the entity in bold characters and under that in small characters is a label indicating the entity kind and the name of the file.

Generally information in a panel is black text on a light gray background.

Selection Boxes

There are selection boxes for names or short phrases that can be changed by selection from a list of alternatives. Generally these are preceded by a label ending “=”.

On an iPhone or iPad these have black text of slightly smaller font on a white background. A tap on such text will reveal a list of alternatives. Scroll the list up or down to highlight the desired selection then tap the associated “Done” button. On an iPhone these lists are near the bottom of the panel. On an iPad these lists are near the selection box, but not confined to inside the panel.

On an Android phone there is a shadow line at the bottom of the box and a down pointing triangle in the right hand end. A tap on the box will reveal a list of alternatives each item having a radio button to the left. The radio buttons indicate the previous selection. A tap on an item will select that item and the list will disappear.

Other controls

There are specific purpose buttons on various of the panels. These are generally near the bottom of the panel. A caption on the button indicates the purpose.

There are also switches and segmented controls; more-or-less Android phone, iPhone and iPad standard features. Generally there is captions and labels that indicate the purpose.

Number input facilities

Black text that has a blue glow indicates a number that can be edited. A tap on such a number will change the glow from blue to green and a virtual keyboard will appear in the lower part of the display. Generally the keys affect the right hand end of the number except the “+/-“ key which toggles a minus sign on and off at the left hand end. If a positive number is required the “+/-“ key is not visible. If the number contains a decimal point the decimal point key is not visible. This ensures that the number has only one decimal point.

A red glow indicates a number that is not valid. A tap on the return key will make an error message dialog appear. A tap on any other feature on the display will take focus away from that number and the number will return to a previous value; the editing being ignored.

Some numbers have an exponent part. Usually these are represented by simple characters. For example ‘x10-3’ is intended to mean $x10^{-3}$ or ‘multiply by ten to the power of minus three’. Superscripts are not used.

Numbers where the exponent part is editable are represented in the E format. That is the exponent is represented by the character ‘E’ followed by an integer number being the power of ten. For example E-3 means $x10^{-3}$.

A tap on such an exponent part will cause a keyboard to appear that has keys representing alternative exponents. Note that only exponents that are a multiple of three are offered. An exponent of zero is also offered. This is represented by a blank space.

When the metric system is in use the standard metric prefixes to the measurement units are used. Note there is potential confusion from the used of both the lowercase and

uppercase ‘M’: The lowercase ‘m’ stands for ‘milli’ and means $\times 10^{-3}$ where as the uppercase ‘M’ stands for ‘mega’ and means $\times 10^6$.

Graphical information

The cross-section, both shape components and point components as well as the stress/strain relationship of each material can be represented graphically.

On a phone these images is presented on one of the panels which occupy the whole display. On an iPad each image occupies the whole display but data panels overlay it.

During editing there is a little red circle that acts as a cursor indicating a particular object that is the subject. Also on a cross-section image a subject component is highlighted: the other components are dimmed.

Here the word ‘object’ means either a corner of a shape component, a point in a point component or a stress/strain in the description of a material. These objects are in a sequence and are numbered; 0, 1, 2,

Also, in the case of a shape component or a stress/strain relationship the line between the subject object and the next object is red. This is intended to indicate where an added new object would appear.

Graphic edit panels

On a phone the graphic’s editable numbers are on the next panel and the back button on that panel allows a return to the graphic panel so that the affect of the editing can be seen. On an iPad the graphic’s editable numbers are on a similar panel but it overlays the graphic image and can be located so that the affect of the editing can immediately be seen.

These graphic edit panels have two ‘back - next’ tool bars. The top such tool bar serves the same purpose as the tool bar at the top in other panels. On an iPad it has only the “+” button.

The lower tool bar allows the user for move forward and backward through the sequence of objects.

Some graphic edit panels also have a selection box labeled “Component=” between the two toolbars; the alternatives offered being the names of the components that have been described.

In the centre of the lower tool bar is a label in bold characters indicating the kind of object; corner, point or stress/strain, followed by the number in the sequence.

The ‘+’ button in the top tool bar invokes facilities to add an object to the sequence. The added object appears in the sequence immediately after the object displayed at the time the ‘+’ button is tapped and the data displayed changes to the new object.

A tap on the label indicating the kind of object will cause a red delete button to appear and a tap on that will delete that particular object from the sequence.

With both the deletion and addition operations sequence numbers are reassigned to all the objects in the sequence after the deleted or added object.

It is not possible to delete the object with number zero, nor is it possible to add an object before that object.

On a phone a new object has 0.0, 0.0 as the co-ordinate parameters values. That is X, Y values or stress/strain values. These can then be changed to whatever is required.

On an iPad if the subject object is not the last the new object will have values that are half way between that subject object and the next object. Those new values can then be changed to whatever is required. If, on the other hand, that subject object was the last the new object values are copied from that subject object. Although those new values can still be changed to whatever is required the new object is not obvious on the graphic image. In a point component such lost objects make the computations erroneous. The automatic geometry check that happens when a load case is opened should pick up such lost points. The error message is ‘Point components clash at ...’.

When the first component is added to a file or a material description is created from scratch the image will be blank white until there are objects with more than one value for both of the co-ordinate parameter. That is more than one value of both X and Y or more than one value of both stress and strain.

Moveable panels on an iPad

On an iPad information that pertains to a particular object is presented on a panel that can be moved so that always that object can be seen. ‘Drag and drop’ is not provided, rather near each corner of these panels is a small button labeled ‘TL’, ‘TR’ ... etc. A tap on these buttons will move the panel.

TL = Top left corner of the display

TR = Top right corner of the display

BR = Bottom right corner of the display

BC = Bottom centre of the display

BL = Bottom left corner of the display

C = Centre of the display

The virtual alpha numeric keyboard for entity names occupies the bottom of the display. The place for the new entity name is always near the top.

The virtual numeric keyboard is always at the bottom of the display. When the number to be edited is on a moveable panel the keyboard has move buttons each side. It can be moved from side to side across the bottom so that always the object being edited can be seen.

Abbreviations

The various panels are formatted to fit on a four inch screen. To achieve this various headings and labels are abbreviated. The meaning of the abbreviations are:

Ax. load error Axial load error – The error in the result axial load value.

Bending mom.	Bending moment.
Cur. Dev.	Curvature deviation.
Cur. Deviation	Curvature deviation.
Cur. other ax.	Curvature other axis– The component of the curvature about the other axis.
Cur. ref. ax.	Curvature reference axis– The component of the curvature about the reference axis.
Mom. error	Moment error – The error in the result bending moment value.
Mom. magnitude	Moment magnitude – The magnitude of the bending moment.
Mom. orientation	Moment orientation – The orientation of the axis of the bending moment.
Mom. other ax.	Moment other axis – The component of the bending moment about the other axis.
Mom. ref. ax.	Moment reference axis - The component of the bending moment about the reference axis.
Other ax. cur.	Other axis curvature – The component of the curvature about the other axis.
Ref. angle	Reference axis angle
Ref. ax. cur.	Reference axis curvature – The component of the curvature about the reference axis.
Ref. X	Reference axes origin X value

The hardware “back key” (Android phone only)

Android phone devices have a key below the bottom right corner of the display outside of the display known as the “back key”. The function of this key varies from device to device. However with some devices such as the Samsung Galaxy it has a standard behavior with this application. That behavior is described as follows. It is referred to as the “hardware back key” to avoid confusion with the virtual keys and buttons on the display. :

The affect of this key is:

- If the tab item buttons “F”, “M”, “C”, “L” and “T” are visible and no virtual keyboard is visible –
 - a tap on the hardware back key will close the application. Note that the current job is not automatically saved. The user can use the “Save” or “Save as” buttons on the “F” tab before tapping the hardware back key.
- If the virtual keyboard for names is visible -
 - a tap on the hardware back key has the same affect as the “Ok” button adjacent to the name input.

- If the tab item buttons “F”, “M”, “C”, “L” and “T” are not visible –
A tap on the hardware back key will cause a change to a display where those tab item buttons are visible.

Tap and hold of the hardware back key has the same affect as a tap; the affect not happening until the key is released.

Android phone, iPhone & iPad

Files

At a glance: This describes the files on an Android phone, iPhone or iPad.

The XSF file

The application reads and writes one kind of file; referred to as XSF files. Such a file contains all the information the application has at the time it was written. The application works on only one cross-section at a time: there is only one cross-section per file.

These XSF files are compatible with the xsec application on other platforms; specifically Apple OS-X and Microsoft Windows. Nevertheless this Android phone xsec or iPhone xsec or iPad xsec can be completely stand-alone: its use does not require a computer with or without xsec.

TXT files

The application also writes various text files that present various reports, not intended to be read by the application. These can be viewed and manipulated by any text editor application such as Apple Pages or Microsoft Word.

File structure

The XSF files and the TXT files are text files limited to ASCII characters 10, 13 and 32 to 126 (decimal representation). The file name extension is “xsf” and “txt” respectfully.

The XSF files are intended to be read only by this application, although being text files they can be inspected, and possibly changed in any text editor application. There is one item of information on each line and lines are separated by characters 10 and 13.

New File

A tap on the ‘+’ button in the top right corner of the main files tab leads to a panel that sets out the measurement system alternatives. This also has a segmented control offering either “Create example” or “Create blank”. This should be set before a measurement system is selected.

A tap on a measurement system selects that system and the panel changes back to the file list with provision for a new file name at the top. At the same time, if the segmented control is set to “Create example” the newly created file is populated with a simple example.

The alternatives measurement systems are:

- The inch pound system sometimes also called customary units. The maximum dimension is 320 inches or 26’ 8” and the resolution is 0.01 inch.
- Metric units with large dimensions. The maximum dimension is 32 metres and the resolution is 1 mm.

- Metric units with small dimensions. The maximum dimension is 3.200 metres and the resolution is 0.1 mm.

At any particular time the application works wholly with one system and there are no facilities for converting data from one system to another.

The need for these alternatives is explained in the General section under “Geometric data measurement systems”.

At the top of the file list that reappears when a measurement system is selected is a prompt “Enter the new file name” in grey text on a white background. Also an “Ok” button appears to the right of that prompt. A tap on that grey text will cause a virtual keyboard to appear at the bottom of the display. A name is required as described under **File names**.

File names

The XSF files names created in this application are limited to six characters and only uppercase letters and numerical digits. A standard virtual keyboard appears when such a name is required. Keys for invalid characters are ignored, lowercase letters appear as uppercase and only six characters are accepted.

The name of an XSF file imported from a computer is not subject to these restrictions. However files with names that do not conform cannot be saved. There is a “save as” facility to save the content with a name that does conform.

Each TXT file is automatically assigned a name. It is the XSF file name followed by the underline character, a letter and one or more numerical digits. The letter indicates which part of the application wrote the file and the numerical digits ensure each file has a unique name. The letters are:

- M a material description.
- S a shape component description.
- P a point component description.
- L a load case description, usually including a computation result.
- T a time affect set.
- G errors found in a geometry check.
- R the transformed section properties.

The Files main tab

The files are listed on the Files tab; one of the main tabs described in the Android phone, iPhone & iPad - Introduction under **Lists of Entities**.

Unlike the other list of entities tabs this has a back button in the top left corner that leads to an “About xsec” panel.

Below the list of file names are buttons labeled “Save” and “Save as” and provision for a note indicating which file is open.

The Save button can have a purpose when the open XSF file is to be copied to a computer or when the application is to be closed.

The Save as button saves the open XSF file under a different name. This does not provide facilities for choosing a directory or a folder. Only one directory or folder is available.

Other files

The other files facilities allow individual materials and components to be copied into the open file from another XSF file. These facilities are not on the main files tab: there is a button on the Materials tab and a button on the Components tab. Each of these invokes a panel that has a list of files similar to the list on the main Files tab but headed ‘Import source’.

A tap on a file name will select that file.

On a phone a note saying it is selected will appear below the list and a next button will appear in the top right corner. That next button leads to a list of materials that can be overwritten or a lists of components that can be imported. In the case of the list of materials that can be overwritten there is next button in the top right corner that leads to a list of materials that can be imported.

On an iPad the list of files is replaced by a list of materials that can be overwritten or a list of components that can be imported. Also below the list is a note naming the selected file and various buttons with self explanatory captions. In the case of materials there is a ‘Show materials to import’ button that changes the list to materials that can be imported.

With the lists of materials that can be overwritten there is an ‘Overwrite all materials’ button. A use for this is explained under *Android phone, iPhone & iPad - Chronological Sequence*.

A material can be written over an existing material of the same name.

With a written-over material any existing associations with components are maintained.

Other materials can be imported only if there is room for them. The number of materials is limited to ten.

A component can not be overwritten. There is only one list of components being those that can be imported.

A component can be imported only if:

- There is not already a component of the same name.
- There is room for that component. The number of components is limited to ten.

If a component to be imported has an associated material then:

- If that material has the same name as a existing material then that imported component is associated with that existing material.
- If, on the other hand, there is no existing material of the same name that material is also imported. The number of materials is limited to ten. If there is no room for that material then the components is not imported.

Note that the stage distortion and other distortion data of a component is included with the imported information.

Android phone, iPhone & iPad

Connection to a computer

At a glance: The ability to transfer XSF and TXT files between a phone or iPad and a Apple Mac or PC computer is described.

Introduction

The transfer of files between the phone or iPad and a computer:

- Allows the xsf files of worked examples to be transmitted to the phone or iPad
- Allows the reports in the txt files written by the application to be transmitted to a computer where they can be included with other documents.
- Allows the advantages of the compatibility of the xsf files with the xsec application on other devices.

There are differences between an Android phone and an iPhone or iPad in this transfer of files.

Android phone connection (Android phone only)

With some Android phone devices it is not possible to transfer files to and from a computer. However with some it is possible.

Described here is the connection between a Samsung Galaxy J250G and a Microsoft Windows 10 computer.

The cable used to charge the battery of the phone has a USB connector. This is used to connect the phone to a USB connector on the computer. If the computer is running at the time this connection is made a Files Explorer window for the phone device will appear on the computer screen. Also at the same time a dialog will appear on the phone posing the question “Allow access to phone data?” with “Deny” and “Allow” buttons.

A tap on the “Allow” button will cause the dialog to disappear and a sub-folder labelled “Phone” to appear on the computer.

On the computer navigate: Phone > Android > data > com.xsec > files This should lead to a Files Explorer display of the files that appear on the application’s files list. The various Windows Files Explorer facilities can then be used to copy files into and out of that list.

Apple iPhone or iPad connection (iPhone and iPad only)

The sandbox (iPhone and iPad only)

The files used by the application whose names are displayed in the file list are in what is referred to as the “xsec home documents directory”. This is not accessible to any other applications on the device. In Apple parlance it is in a sandbox.

However files can be copied to or from a computer that is running iTunes. iTunes, an Apple product is available for both Apple OS-X and Microsoft Windows computers.

These transfers into and out of the iPhone xsec sandbox or iPad xsec sandbox do not require xsec on the computer.

To transfer files to and from a computer (iPhone and iPad only)

iTunes is available to download for free from an Apple web site. The iTunes main menu Help includes items ‘iPhone user guide’ and ‘iPad user guide’ that have links to definitive descriptions of this process.

Nevertheless a brief description of the process is:

1. Download and install iTunes on the computer; either an Apple MacOS or a Microsoft Windows computer.
2. Connect the iPhone or iPad to the computer. The cable for recharging the battery can be used. This cable is usually connected to a transformer/wall- outlet plug by a standard USB connector. Unplug this from the transformer/wall-outlet plug and plug it into a USB connector on the computer.
3. On the computer launch iTunes by clicking on the appropriate icon. The iTunes window should appear. In the top left corner of the main part of this window there should be an icon representing the iPhone or iPad. This is in the form of a small image of the iPhone or iPad.
4. Click on that icon.
The display should change to information about the iPhone or iPad.
5. On a sidebar to the left under a heading “Settings” is an item “Apps”. Click on that item.
The main body of the display should change to information about the Apps on the iPhone or iPad.
6. Scroll to the File Sharing section at the bottom of the page. An icon for the xsec application should appear in the left hand part of this display.
7. Click on that xsec icon.
A list of documents should appear in the right hand part. Although this list is headed “Documents” it should include the XSF files. Files can be dragged to and from this list from and to the directories or folders on the computer.

Android phone, iPhone & iPad

Materials

At a glance: Materials on an Android phone or an iPhone or iPad are described here. The General – Materials section describes aspects of the materials edit facilities that are common to all the hardware platforms.

The main Materials tab

Material names are listed on the Materials tab; one of the main tabs described in the Android phone, iPhone & iPad - Introduction under **Lists of Entities**.

The Material edit facilities are **Entity edit facilities** as described in the Android phone, iPhone & iPad - Introduction. Here is an elaboration on that description.

Button – “**Import material from another XSF file**” on this Materials tab is described in Android phone, iPhone & iPad – Files under **Other files**.

Material edit facilities

A tap on a material name in the list of materials will open the editor for that material.

On a phone the first of four panels will appear in the display. The first two of these panels contain choices and parameter values that define the material while the third contains a graphic image of the stress/strain relationship and the fourth the numbers represented in that image.

On an iPad a graphic image of the stress/strain relationship occupies the whole display and there is a panel that overlays that image top centre and contains both those first two panels as well as various buttons with self explanatory captions.

First two panels – First panel

At the top of the first panel is a label “Code=” with a selection box. The alternatives offered are the names of various standard code documents that describe a material and also the alternative “Properties as described”.

The alternative “Properties as described” leads to the general material description facilities. This first panel is mostly blank but the information on the other material description panels is all editable. This is very universal so that practically any design code can be accommodated. It is envisaged that the usual materials used at any particular locale will be described with this facility and kept in a xsf file. Once described the materials can be copied into each new job using the “Import material from another xsf file” button on the main materials tab.

With the other alternatives the various parameters defined in the selected code document appear on this first panel in an editable form: the numbers indicating the values having a blue glow. However no other information is editable.

With some of these alternatives in the “code” selection box a second selection box appears with a label “Clause=”. The alternatives offered are references to various parts of the document identified as the “code”.

The alternatives offered are described in General – Materials.

On a phone there is a “Write to text file” button on this first panel.

Button – “Write to text file” near the bottom on this first panel will cause a description of the material to be written to a text file as described in Android phone & iPhone – Introduction, Files, **Text Files**.

There is also a next button in the top right corner that will reveal the second panel.

First two panels – Second panel

At the top of the second panel is a label “Material kind=” with a selection box. The alternatives offered are material kinds. Under that is a line indicating a strain parameter depending on the material kind selected.

This is not able to be changed or edited unless the code selection is either “Properties as described” or “Linear elastic”. The alternative material kinds and their strain parameters are:

- “Concrete” the parameter being “ultimate strain”,
- “Steel that yields” the parameter being “yield strain”,
- “Other” does not have a parameter.

If the code and clause selected imply a curved stress/strain relationship a sequence of straight lines approximates the curve. In these cases a heading “**Tolerance on curves**” appears on this second panel with **above** and **below** tolerance values. This is described further in General – Materials, **Tolerance on curve, above and below**.

Also described in General – Materials is a procedure to describe a material similar to a code material but fully editable. The code material is changed to “Properties as described”.

On a phone this second panel has a next button in the top right corner that will reveal the third panel which presents a graphic image of the stress/strain relationship.

On an iPad the panel containing these first two panels has the following buttons:

Button – “Edit stress/strain” or “Inspect stress/strain” depending on whether or not the information is editable. This will cause the panel containing the first two panels to be hidden and a moveable panel to appear that presents the numbers represented in the graphic image. This is a graphic edit panel as described in the introduction of this volume.

Button – “Write to text file” will cause a description of the material to be written to a text file as described in Android phone & iPhone – Introduction, Files, **Text Files**.

Button – “Close material editor” will cause the material editor to be closed. The panel containing the first two panels will disappear and the panel with the main tab buttons will reappear with the materials tab selected.

Stress/Strain relationship graphic image

The stress/strain relationship graphic image includes a grid in green and a blue line to indicate the nominated yield strain or the ultimate compressive strain.

On a phone the image is presented on the third of the four panels. If the information is editable the numbers that are represented on that image are presented on the fourth of the four panels. This is a graphic edit panel as described in the introduction to this volume.

On an iPad the image occupies the whole display. The numbers that are represented are presented on a moveable panel that overlays the image and is a graphic edit panel as described in the introduction to this volume..

If the code selection is “Properties as described” this is editable: the top toolbar has a ‘+’ button and the stress and the strain value have a blue glow.

This data input is completely general so that practically any standard design code can be accommodate.

There are the requirements that the strain values must be in increasing order and if there are both negative and positive strain values zero strain must be included.

Android phone, iPhone & iPad

Components

At a glance: Components on an Android phone or iPhone or iPad are described here. The General – Components section describes aspects of the components edit facilities that are common to all the hardware platforms.

The main Components tab

Component names are listed on the Components tab; one of the main tabs described in the Android phone, iPhone & iPad - Introduction under **Lists of Entities**.

The Component edit facilities are **Entity edit facilities** as described in the Android phone, iPhone & iPad - Introduction. Here is an elaboration on that description.

Button – “**Import component from another XSF file**” on this Components tab is described in Android phone & iPhone – Files under **Other files**.

Button – “**Write transformed section properties**” on this Components tab writes a text file of the transformed section properties of the cross-section. This is a text file as described in Android phone & iPhone – Files under **Text files**. For each component it gives:

- The total area
- The centroid of that area in terms of the X, Y axes.
- The second moments of area about the X and Y axes.

Finally it gives the same information for the whole cross-section using modula ratios stipulated for each component.

None of this information is used in the main computations described under Load cases.

“+” **button** in the top right corner of the panel invokes facilities for adding a component to the list. A tap on this causes a change to a panel offering:

- **Shape**, typically of concrete.
- **Point**, typically an arrangement of steel bars.
- **Cancel**

A tap on a choice will cause the component list to reappear. If the choice was not “cancel” at the top of the list is a prompt “Enter a – component name” in grey text on a white background. A tap on that grey text will cause a virtual keyboard to appear at the bottom of the display so that a name can be entered.

The requirements of the name are described in Android phone, iPhone & iPad – Introduction, **Entity names**.

A **tap on a component name** in the list will open the component editor for that component. The panel will change to the first panel of that editor and on an iPad the cross section image in the background will change in that all the components except the subject component will be dimmed so that the subject component is highlighted.

The details of that editor panel depend on whether the component is a shape component or a point component.

Shape component edit facility

The shape component edit facility has two parts:

- for the overall description of the component. This occupies two panels on a phone but only one on an iPad,
- for the corners that define the shape. This is graphical information as described in *Android phone, iPhone & iPad* Introduction, **Graphical Information**.

When the edit facilities for a shape component are invoked an overall description panel will appear. On a phone this will be the first of the two panels. The back button on this panel will close the edit facility and the list of entities panel with the main tab buttons will reappear. On an iPad there is a ‘Close component editor’ button.

At the top of the first panel is a label “**Modula ratio=**” and a number with a blue glow indicating it is editable. This is used for the transformed section properties but not in the computations described under Load Cases.

Under that is a label “**Material=**” with a selection box. The alternatives offered are the names of the materials that have been described.

Under that is a label “Shape described” and a segmented control offering **Anti-clockwise** and **Clockwise**. The corners that define the shape are objects in terms of the Graphical Information description and have an order. That order must be consistent with this control.

Button – “Write to text file” writes a description of the component to a text file as described in *Android phone, iPhone & iPad* – Introduction, Files, **Text Files**.

There is a heading **Stage and Other distortions**.

Under this heading is a label “**In terms of reference axes**” and under this is a selection box. The alternatives offered are the names of the load cases that have been described and also “Global”. Each load case has reference axes and “Global” means the X, Y axes. Under that the selected axes are described; the X and Y of the origin and the angle of the reference axis in terms of the X, Y axes.

Also under that ‘Stage and Other distortions’ heading are two parts headed by labels “**Stage distortion**” and “**Other distortion**” respectively.

Each part has three lines labeled

- “Axial strain=” .
- “Ref. ax. cur.=” that means “Reference axis curvature =”.
- “Other ax. cur.=” that means “Other axis curvature =”.

and each line has a number with a blue glow indicating it is editable.

If the user does not intend to use the stage distortion and other distortion facilities in the application all these number should be set to zero.

The application includes facilities that automatically give values to these number: the “Adopt this load case as at a stage” button on a load case edit panel sets the stage distortion, and the “Apply this set” button on the time affect set edit panel makes contributions to the Other distortion.

Where these facilities suffice there is no need to edit these number. The need to edit these numbers is discussed in General – Components.

On a phone the **next** button causes a change to a panel that presents an image of the cross section. This has the subject component highlighted the same as the background image on an iPad. It also has a **next** button.

On an iPad there is a an ‘**Edit shape**’ button.

Both these buttons invoke a graphic edit facility. On a phone the next button now leads to a graphics edit panel. On an iPad the overall description panel is hidden and a moveable panel that is a graphics edit panel appears.

Both these graphic edit panel are as described in Android phone, iPhone & iPad – Introduction, **Graphical information, Graphic edit panel.**

Point component edit facility

The point component edit facility has two parts:

- for the overall description of the component. This occupies one panels.
- for each individual point. This is graphical information as described in *Android phone, iPhone & iPad* Introduction, **Graphical Information.**

When the edit facilities for a point component are invoked the overall description panel will appear. On a phone the back button on this panel will close the edit facility and the list of entities panel with the main tab buttons will reappear. On an iPad there is a ‘Close component editor’ button.

At the top of the overall description panel is a label “**Modula ratio=**” and a number with a blue glow indicating it is editable. This is used for the transformed section properties but not in the computations described under Load Cases.

Under that is a label “**Material=**” with a selection box. The alternatives offered are the names of the materials that have been described.

Under that is a label “**Section area =**” with a number having a blue glow indicating it is editable. That number is the cross-sectional area associated with one point, usually the cross-section area of one steel reinforcing bar. This is used in the computations; both described under load cases and also the transformed section properties.

Further down is a label “**Bar diameter =**” with a number having a blue glow indicating it is editable. This is ignored by the computation described under load cases and also the transformed section properties. It is used with two buttons on the panel.

Button – “Compute from diam.” Computes a cross-sectional area from the given bar diameter and puts the result in the number adjacent to the “Section area =” label.

Button – “Compute from area” Computes a diameter from the given sectional area and puts the result in the number adjacent to the “Bar diameter =” label.

Button – “Write to text file” near the bottom of this panel writes a description of the component to a text file as described in Android phone, iPhone & iPad – Introduction, Files, **Text Files**.

On a phone the **next** button causes a change to a panel that presents an image of the cross section. This has the subject component highlighted the same as the background image on an iPad.

On an iPad there is a an ‘**Edit points**’ button.

Both these buttons invoke a graphic edit facility. On a phone the next button now leads to a graphics edit panel. On an iPad the overall description panel is hidden and a moveable panel that is a graphics edit panel appears.

Both these graphic edit panel are as described in Android phone, iPhone & iPad – Introduction, **Graphical information, Graphic edit panel**. These graphic edit panels have data in addition to the co-ordinate paraments.

For the subject point the panel presents:

- the X value
- the Y value
- the other distortion strain value
- the stage distortion strain value

All these numbers have a blue glow indicating they are editable.

If the user does not intend to use the stage distortion and other distortion facilities in the application these “other distortion strain” and “stage distortion strain” values should be set to zero.

The application includes facilities that automatically give values to these number: the “Adopt this load case as at a stage” button on the load case edit panel sets this stage strain, and the “Apply this set” button on the time affect set edit panel makes contributions to this other strain.

Where these facilities suffice there is no need to edit these number. The need to edit these numbers is discussed in General – Components.

Android phone, iPhone & iPad

Load Cases

At a glance: Load cases on an Android phone, iPhone or iPad are described here. The General – Load Cases section gives an in-depth description of the processes mentioned here.

What is a load case

The main computation facilities are provided in an entity called a “load case”. Each cross-section can have several load cases associated with it. Each load case is intended to represent a particular situation in the life of the structural member that is of interest. Such matters of interest might be the ultimate strength, or the distortion under a known loading.

The main Load cases tab

The load cases are listed on the Load cases tab; one of the main tabs described in the Android phone, iPhone & iPad - Introduction under **Lists of Entities**.

The Load case edit facilities are **Entity edit facilities** as described in the Android phone, iPhone & iPad - Introduction. Here is an elaboration on that description.

Button – “Zero all stage distortion” on this Load Cases tab is described in **Chronological sequence**.

The input information

The kind of information to be input to a load case depends on the nature of the investigation. Nevertheless the information on the first panel that appears when the load case edit facility is invoked is the same for all load cases.

Reference axes: Associated with each load case is a set of reference axes that are part of the description of what is of interest. The orthogonal axes in the plane of the cross-section used to describe the cross-section are referred to as "the x, y axes". The axis of interest in a particular analysis may be anywhere on the plane. To accommodate this a second set of orthogonal axes is used. The axis of interest is referred to as the "**reference axis**" and the axis at right angles to that axis as the "**other axis**".

The x and y of the origin and the orientation angle of the references axis are input and edited on this first panel.

Switch – “Concrete displaced by bars”: If this is on the computations take into account that part of the concrete is displace by the reinforcing. It is intended that this will normally be on. This can be set to off to obtain results for comparison with results from other computation facilities that do not account for the concrete displaced by the reinforcing.

Switch – “Restrained about other axis”: This relates to the circumstances of the structural member. If this is on the member is restrained and the curvature about the other axis is zero. Otherwise the bending moment about the other axis is zero.

This can be important in computations involving trial and adjustment. Setting this to off adds a degree of freedom to the trial and adjustment process. Usually the expression “biaxial analysis” refers to an unrestrained case.

Maximum iterations: An integer number. Although this is on a specific load case it applies to all load-cases and all methods that use trial and adjustment. It is intended that this should normally not affect the computation. It is intended it should come into effect only when something is wrong. It is a limit on the total number of iterations as represented by the “It. Count” on the computation progress dialog. When this number is reached the computations stop and the buttons that change to another panel are enabled. (next and back buttons on a phone or the ‘Next’ and ‘Load case home’ buttons on an iPad are enabled.)

There is a separate iteration count limit that applies only to the trial and adjustment on the curvature. This is in the inner most loop of the nested trial and adjustment routines used for two and three degrees of freedom. The count is reset to one each time that inner-most loop is invoked. The limit is set at 150 and cannot be changed by the user. Experience so far is that whenever this limit is reached something is wrong.

A suggested value for the overall maximum iterations is 2000. However this may not be appropriate in all situations.

Iteration wait: An integer number. Although this is on a specific load case it applies to all load-cases and all methods that use trial and adjustment. However, it applies only when the “Show progress display” switch is On. The iteration wait controls the speed of the computation. It is approximately the wait between iterations in milli seconds. To slow down the progress increase this wait time. To speed up the progress decrease this wait time. However, if the wait time is too short the Stop, Step and Escape buttons will not work. In this regard the minimum wait time varies from device to device. The default value, 150 is intended to be above that minimum on most devices.

Method = : A selection box; the alternative offered being the names of methods. Several different computation facilities are provided each of which is called a “method” and each method has a name.

Only one method can be current in a load case. However the current method can be changed at any time so that a combination of the methods can be used.

The various methods are:

Ultimate bending moments. The input is the axial load and the main output is the ultimate strength bending moment about the reference axis. In the result:

- At least one corner of a concrete component is at the ultimate compressive strain nominated for the material of that component.

- No corner of a concrete component is at a strain more compressive than its ultimate compressive strain.

Yield bending moments. The input is the axial load and the choice of a reinforcing bar of steel that yields. The main output is the bending moment about the reference axis when that bar starts to yield. In the result the chosen reinforcing bar is at the strain nominated as the yield strain in the material description.:

Utility:-Curvatures and one strain. The input is the curvature about the reference axis, the curvature about the other axis and the strain at the reference point. The output is the bending moment about the reference axis, the bending moment about the other axis and the axial load at the reference point.

Utility:-Strain at three points. The input is the choice of three locations on the cross-section and the strain at each of those locations. The output is the bending moment about the reference axis, the bending moment about the other axis and the axial load at the reference point

Given bending moment. The input is the axial load at the reference point and the bending moment about the reference axis. The output is the curvature about the reference axis, the curvature about the other axis and the strain at the reference point. This has been implemented for the unrestrained case but not yet for the restrained case. Thus in the result the bending moment about the other axis is zero.

Utility:-Curvatures and Axial load. The input is the axial load at the reference point, the curvature about the reference axis and the curvature about the other axis. The output is the strain at the reference point, the bending moment about the reference axis and the bending moment about the other axis.

On this first panel of the load case edit facility are various buttons.

Button – Next: This changes to a panel specific to the selection method.

Button – “Adopt this load case as at a stage”: This is intended for use after the computations. It sets the stage distortion of all the components to the total distortion of this load case. It requires that the current result is valid but it makes all the results invalid. The use of this is explained further under **Chronological Sequence**.

Button – “Write result to a text file”: In response to this a description of the load case is written to a text file. Such text files are explained in the Android phone & iPhone - Introduction, Files, **Text Files**.

Button – “Display result” on an iPad only: This changes to the general result panel. If the result is not valid this is dimmed and not enabled.

Button – “Close load case” on an iPad and the **Back button on a phone:** This closes the load case changing the panel back to the entity list panel with the main tab buttons.

Methods that do not provide automatic trial and adjustment.

The “Utility:-Curvatures and one strain” and “Utility:-Strain at three points” methods simply invoke the explicit algorithm.

With these methods the **next** button on the **first panel** leads to a panel that has provision for the input variables, a “Compute loading” button and below that provision for the resulting three loading variable.

The **next** button on this panel leads to the general result panel described under **General Result Panel**.

Utility: Curvatures and axial strain: input is values for the three distortion variables and the output is the three loading variables.

Button - “Set input to current case” has a purpose when other methods are used in combination. The methods that provide automatic trial and adjustment have some of the loading variables in the input and some of the distortion variables are in the output. To accommodate this there are two sets of memory locations for the six variables; one set of six for the input and another set of six for the output. This button copies the three distortion variables from the output set to the input set.

Utility: Strain at three points: input is the location of three points and values for the strain at those three points.

It is required that the three points are not in a straight line. The application automatically checks for this and can give an error message. An example of three points that are not in a straight line are the two concrete corners on the top of a rectangular beam and the centre of a reinforcing bar near the bottom.

It is not necessary each point is a corner of the concrete or the centre of a bar. Nevertheless there is a facility for choosing a point if it is to be a corner of the concrete or the centre of a bar.

Button - “Choose a point or corner” A graphic edit panel that has a component selection box appears. Any point or corner can be selected.

When the back button on a phone or the “Choose” button on an iPad is tapped the graphic edit panel disappears and the X, Y and load case strain displayed appear on the main input panel.

If the strain at a particular point is to be related to the stress/strain relationship of the material then the “other” distortions and the “stage” distortion need to be taken into account. Examples to illustrate this requirement are:

- where the concrete is to be at the ultimate strain
- where a steel bar is to be at the first yield strain.

There are facilities for this computation. If the material is of kind “concrete” or of kind “steel that yields” then the recorded ultimate strain or yield strain can be used.

Switch – “Use current strain values”. When this is on the current strain values are used. Note it is the load case strain that will be used. This has a purpose when the result from another method is to be investigated further.

When this switch is off the stress-strain can be manipulated although it will be the corresponding load case strain that is used. If the material of the selected component is “concrete” or “steel that yields” a second switch appears; “Use specified strain”.

If the material is not “concrete” and not “steel that yields” or this second switch is off then the number for the stress- strain has a blue glow indicating it can be edited.

Switch – “Use specified strain”. When this switch is on the stress-strain is set to the ultimate strain or yield strain of the material and the corresponding load case strain is used.

When this switch is off the the number for the stress- strain has a blue glow indicating it can be edited.

Note: At this stage in the development the application does not record the details of this computation in the XSF file. Only the resulting location and load case strain at that location are recorded.

Methods that provide automatic trial and adjustment.

With methods that provide automatic trial and adjustment the **next** button on the **first panel** leads to a sequence of panels specific to the selected method. There is one or more panels that present the data input facilities, a panel that presents a computation progress dialog and the last, a panel that presents the computation result. A button on that result panel leads to the general result panel described under ‘General Result Panel’.

A button on the last data input panel starts the computations and changes the panel to the computation progress panel. On a phone this is the next button and on an iPad there is a ‘Compute’ button.

That last data input panel also has a ‘Show progress display’ switch. When this is off the progress panel is blank and there is an automatic change to the result panel when the computations finish . Also the computation are faster; so fast that often it appears that the progress panel is not shown at all.

Axial load and a tolerance on that axial load is a required input for all these methods.

Curvature deviation first estimate and a curvature deviation increment is also required for the unrestrained case. A first estimate of zero usually works. Other values can reduce the computation time. An increment of five degrees is suggested.

A subject location

Each method has a subject location. This is usually a corner of a shape component, or at a point in a point component although it may be anywhere on the cross section. The computation progress panel displays the subject location.

The ‘Ultimate bending moments’ method determines it automatically. The ‘Given bending moment’ method with the ‘Ignore first estimate’ switch on also determines it automatically.

In other circumstances it is determined by the user.

Several of the methods have input facilities for a strain value ‘at’ and an X and a Y value. That X, Y is a subject location. Where all this is under a heading ‘**First estimate**’ it is only the strain value that is variable in the automatic trial and adjustment: the subject location is constant.

The other input requirements for each method are:

Ultimate bending moments method requires no other input.

Yield bending moments method requires the load case strain at the yielding reinforcing and the location of that reinforcing. There is a facility to choose a bar.

Button – “Choose a bar” A graphic edit panel with a component selection box appears. Any point in any component of steel that yields can be selected.

When the back button on a phone or the “Choose” button on an iPad is tapped the graphic edit panel disappears and the X, Y and load case strain displayed appear on the main input panel.

The yield strain nominated in the material description is a stress-strain so the “other” strain and the “stage” strain need to be taken into account. This can be automatic.

Switch – “Use specified strain” If this is on the strain stipulated in the material description is used. If this switch is off the stress-strain has a blue glow indicating it can be edited.

In either case it is the corresponding load case strain that appears in the main input panel.

Note: At this stage in the development the application does not record the details of this computation in the XSF file. Only the resulting point location and load case strain at that point are recorded.

Given bending moment method requires a bending moment and a tolerance on that bending moment. The first estimate facilities include a strain at a subject location. Also there is a switch to ignore the first estimates and a button to automatically determine first estimates.

Switch – “Ignore first estimates”: When this switch is on the ultimate bending moment method is invoked at the start to determine a subject location and the strain at that location. Then, that strain is adjusted with the objective of the computed bending moment being of the stipulated value.

At a successful result the first estimates are automatically set to the values in the result. Those first estimates might be good for a subsequent computation with different but similar input information. Thus setting this switch off might save computation time.

Button – “Set first estimates to current case”: Another reason for setting the “Ignore first estimates” switch off is when the ultimate bending moment method will not work. Other methods can be used to determine starting values for the strain adjustments with the bending moment objective.

This button leads to facilities where any corner or point of any component can be chosen as the subject location and the strain at that corner or point is set as the first estimate. It is envisaged computations with another method were done before the method was changed to Given bending moment and this facility used.

Utility:- Curvatures and axial load requires a value for the curvature about the reference axis and the curvature about the other axis. This does not have facilities for a curvature deviation first estimate: curvature deviation is irrelevant. It does have facilities for a first estimate strain at a subject location and also an “Ignore first estimate” switch. When this is on the first estimate strain is zero.

This last input panel has a switch:

Switch – “Show progress display”: If this is on data indicating the computation progress will be displayed on the progress panel. The progress panel has buttons that control the progress. If this switch is off the progress panel will be blank, the computations will be faster and the trial and adjustment result panel will appear automatically.

If the “Show progress display” switch is on a second switch is visible:

Switch – “Auto start computations”: If this switch is off the Step or Go buttons on the progress panel will be required to start the computations.

On a phone the next > button on the last input panel invokes the computations and on an iPad there is a ‘Compute’ button on the last input panel..

Nested one-dimensional routines

The application uses one-dimensional trial and adjustment routines nested one within another to achieve two and three dimensional trial and adjustment.

Inner-most loop: The Ultimate bending moment method, Yield bending moment method and Given bending moment methods do adjustments of the reference axis curvature magnitude with the objective of the axial load having a stipulated value. This is the inner most loop. It is an adaptation of a well established computation procedure described in most standards texts. Trial and adjustment on the depth of the neutral axis described in the texts is tantamount to adjustments of the curvature magnitude with the objective of the axial load having a particular value.

Middle loop: In the unrestrained case this inner most loop is within a routine that adjusts the curvature deviation angle with the objective of there being zero bending moment about the other axis.

Outer-most loop: For the Given Bending Moment method this middle loop is within a routine that adjusts the strain at the subject location with the objective of the bending moment having a stipulated value.

The computation progress panel

Process control

While a computation involving trial and adjustment is in progress a progress panel is visible and the next, back and ‘Load case home’ buttons are disabled.

If the “Show progress display” switch is On information indicating the progress is displayed and there are buttons labeled ‘Stop’, ‘Step’, ‘Go’ and ‘Escape’:

Escape: The escape button will cause the computations to be abandoned and the next, back and ‘Load case home’ buttons to be enabled.

Stop: The stop button will interrupt the computation so the various numbers displayed can be inspected.

Step: Step will cause one cycle of the computations.

Go: Go will cause the automatic trial and adjustment to resume.

If a solution is found, a problem is encountered or the Escape button is tapped: the computations stop, a note appears above these buttons indicating why, these buttons are disabled and on an phone the next and back buttons are enabled and on an iPad the ‘Next’ and ‘Load case home’ buttons are enabled.

The next button leads to a panel that displays the trial and adjustments result.

Progress display

The top four lines of the progress display identify a subject. The meaning of this depends on the method that invoked the display. Generally a particular location on the cross-section is identified that is the subject location.

Under that is the heading ‘It. Count=’ where the number of cycles of the computations is displayed.

Below that are three parts separated by spaces that correspond to the three degrees of freedom in the trial and adjustment. These are not all visible all the time: they don’t have meaning all the time.

The inner-most loop is represented by lines labeled “**Curvature=**” and “**Ax. load error=**”. These show a curvature value and the corresponding error in the computed axial load. Immediately above those lines there may be lines labeled “Cur. Dev.=” and “Subject strain=” that show the curvature deviation and the strain at the subject location used in the computation of that axial load error.

The middle loop is represented on lines labeled “**Cur. dev.=**” and “**Mom. Other Ax=**” that display a curvature deviation and an other axis bending moment result. These result from the last cycle of the inner-most loop in which the axial load error was within tolerance.

The outer-most loop is represented on two lines labeled “**Subject strain=**” and “**Mom. Error=**” that display a strain at the subject location and the resulting error in the reference axis bending moment. These result from the last cycle of the middle loop in

which the other axis bending moment was within tolerance. (The other axis bending moment tolerance is one thousandth of the reference axis bending moment magnitude.)

Trial and adjustment result panel

The trial and adjustment result panel sets out the values for the six variable in terms of the reference axes and also possibly a comment on the trial and adjustment process. The distortion represents only the Load-case distortion.

Sometimes two set of values for the six variables are displayed. This can occur only when the automatic trial and adjustment process fails. It is envisaged that possibly one of these result sets is useful in that the loading variables are close to known values that are of interest.

A segmented control allows the user to choose between the two and the chosen result is displayed on the General result panel and result detail facilities.

On a phone the next button leads to the general result display. On an iPad there is a 'Display result' button.

General result panel

The general result panel is available for all the computation facilities whether or not trial and adjustment is involved.

The overall result

The first panel sets out the overall result in various forms.

In this the distortion values represent only the Load-case distortion.

The first two lines describe the reference axes and the next six lines display the six variable in terms of those reference axes.

This is followed by the bending moment expressed in polar co-ordinates. This is the bending moment with the axial load at the origin of the references axes although the orientation angle is in terms of the global X, Y axes.

Then, if there is an axial load the cartesian co-ordinates of the axial load in terms of the global X, Y axes.

At the bottom is an account for the axial force in the various kinds of materials. Here the expression "mild steel" means "steel that yields".

On a phone the next button leads to panels that give details of each corner and each point. On an iPad there is a 'Inspect result details' button.

Result details at each corner and point

Each panel for the result details gives information pertaining to one object; corner or point. They are graphic edit panels with a component selection box as described in Android phone, iPhone & iPad – Introduction, **Graphical information, Graphic edit panels.**

Each panel sets out the X and Y values of the object location. Then, details of the strain at that location in the selected component. This includes:

1. The Load case strain computed from the Load case distortion,
2. The Stage strain computed from the Stage distortion of the component,
3. The total strain which is the sum of the Load case strain and the Stage strain,
4. The Other strain computed from the Other distortion of the component,
5. The Stress-strain which is the total strain minus the Other strain.

Below this is a line displaying the stress computed from this Stress-strain and the Stress/Strain relationship of the material.

Note that if the Stress-strain is at a discontinuity in the Stress/Strain relationship of the material the stress displayed may be either side of that discontinuity; the choice being more-or-less random. This can occur when the rectangular stress block is used in an ultimate strength computation. At least one corner of the concrete has a strain that coincides with the discontinuity at the side of the stress block. Thus the stress displayed might be zero rather than the maximum stress. In the model the stress very close to such a corner is the maximum stress. Such a displayed zero stress does not indicate an error in the overall computation.

Load case graphics on an iPad

On an iPad the background to the various load case data panels is an image of the cross-section.

As with the graphics on a phone the reference point is indicated by a little blue circle and the reference axis is also shown in blue.

Also as with a phone there is a little red circle that acts as a cursor indicating a corner or point that is the subject.

With the load case facilities on an iPad there are also circles of a dark cyan color that indicate what is of interest. These circles are slightly larger than the red cursor circle.

Two concentric circles indicate the subject of a yield computation.

Two concentric circles also indicate the point with the focus in the three point method, while the other two points are indicated by single circles.

With a computation result three concentric circles indicate the location of the axial load (if there is an axial load). If this is outside the area that displays the cross-section the scale of the image is reduced so that it is accommodated. The axial load can possibly be some distance from the cross section so that the reduction in scale affects the readability of the cross section image. There is a button to hide the axial load location that overcomes this problem.

A note on steel that has a strain limit

It has been common to assume that reinforcing steel sustains a load regardless of how large the strain. Many standard codes of practice included this assumption. Examples are ACI318:14 clause 20.2.2.1 and Eurocode 2: (BS EN 1992-1-1:2004) clause 3.2.7 (2) b).

A steel stress/strain relationship that has a strain limit and stipulates that beyond that limit there is no stress reflects reality. However, this can cause a problem with the **Ultimate Bending Moment** method particularly if that breaking strain limits the strength of the cross-section. Eurocode 2: (BS EN 1992-1-1:2004) clause 3.2.7 (2) a) describes such a stress/strain relationship.

The existence of such a strain limit should be apparent on the graphic image of a material. Zero stress at the strain extremity of the graph indicates such a limit.

In such cases the **Yield bending moments** “method” might help.

Use the Yield bending moments “method” and increased the strain in the critical bar from the yield strain to a strain slightly less than the strain limit. This can be done on the “choose a bar” panel. Set the “Use specified yield strain” switch to off then change the stress-strain.

The result would be the bending moment at a tension failure. This result could be used as the first estimate for the **Given bending moment** method. Change the selected method to Given bending moment and then tap the “Set first estimate to current case” button and select that critical bar. Also set the “Ignore first estimates” switch to off.

Android phone, iPhone & iPad

Time affect sets

At a glance: Time affect sets on an Android phone, an iPhone or an iPad are described here. The General – Time affect sets section describes aspects of the Time affect sets edit facilities that are common to all the hardware platforms.

The main Time affect sets tab

Time affect sets names are listed on the Time affect sets tab; one of the main tabs described in the Android phone, iPhone & iPad - Introduction under **Lists of Entities**.

The Time affect set edit facilities are **Entity edit facilities** as described in that Introduction. Here is an elaboration on that description.

Button – “Zero all other distortions” on this Time affect sets tab makes all the Other Distortion values of all the component zero.

Time affect set edit facility

A tap on the name of a Time affect set in the list will cause the panel to change to the Time affect set edit panel.

At the top of the panel is a label “**Creep load =**” with a selection box. The alternatives offered are the names of the Load cases that have been described and also “No affect”.

The time affect set can not be applied unless the selected load case has a valid result. The selection “No affect” means that no creep will be included when the set is applied. It also means that there is no need for a load case to have a valid result.

Under that is a label “**Component =**” with a selection box. Any component can be selected. On an iPad the selected component is highlighted in the cross section image: all the other components are dimmed.

Under that is:

- “**Creep coefficient =**” label and a number being the creep coefficient.
- “**Shrinkage =**” label and a number being the shrinkage value.

Shrinkage represented here by a positive value is a slight decrease in a dimension of the component. When the set is applied it is a negative contribution to the strain in the “other” distortion of the component.

Also when the set is applied the creep contribution to the “other” distortion of the component is the stress distortion of the component in the nominated load case multiplied by the creep coefficient.

Button – “Apply this set” in the lower part of the panel causes the shrinkage and creep contributions in all the components. However, if the creep load is not “No affect” and the nominated load case does not have a valid result no contributions are made and an error dialog appears.

Button – “**Write set to a text file**” near the bottom on the panel will cause a description of the Time affect set to be written to a text file as described in Android phone, iPhone & iPad – Introduction, Files, **Text Files**.

Android phone, iPhone & iPad

Chronological Sequence

At a glance: The use of the application to follow a chronological sequence of events is described in the user guide General - Chronological Sequence. A procedure for adopting a stage load and setting up an initial state specific to the Android phone, iPhone & iPad is described here.

The chronological sequence

A sequence of computations that follows the chronological sequence of events in the life of a structural member is envisaged. It is also envisaged that such a sequence will be repeated many times as a design progresses from an initial concept to a final perfected design.

Time affects

For the steps to apply a Time Affect Set that includes creep computation see General - Time Affect Sets, **Applying a Time Affect Set**.

Adopting a stage load

The **initial state** and **stage distortion** facilities have a purpose illustrated by two parallel structural members in close association but structurally independent; each having a loading and corresponding distortions. At a particular instant in the construction process these two members are joined so they act as one structural member. Immediately after that instant the resulting member has a loading that is the combined affect of the two loadings before and each component has the same distortion as before that instant.

The procedure described here uses three XSF files; one for each of the contributing members cross-sections, and one for the resulting member cross-section.

The procedure is:

1. For each of the contributing members set up the XSF file with load cases and Time Affect Sets for the chronological sequence before the members are joined.
2. With each of the contributing member XSF files add a Load-case and set it up with the envisaged loading at the instant the members are joined.
3. With each of the contributing members XSF files:
 - 1) Do the computation for the chronological sequence before the members are joined
 - 2) Compute the load case for the instant the members are joined
 - 3) With the load case for the instant the members are joined open in the load case editor tap the button “Adopt this load case as at a stage”. This button is on the first panel of the editor. Tap yes on the confirm dialog.

- 4) When changing the open file tap yes on the dialog to confirm that the previous open file is to be saved.
4. Open the file for the resulting member cross-section.
5. Delete all the components and all the materials that remain from a previous cycle of the design process.
6. Use the “Import component from another XSF file” button on the component list panel to import all the components in both the contributing members. This is described in Android phone, iPhone & iPad – **Introduction, Files, Other Files**.

This procedure sets up the initial state of the resulting member.

A further step is a check and also illustrates the meaning of this. On the resulting member file use a load case to do a computation with the “Utility: Curvatures and one strain” method and all three distortion variables set to zero. This should result in a loading that is the combined affect of the loadings on the contributing members.

Facilities to zero the stage and other distortions

If the chronological sequence starts before any concrete is cast or pretension tendons are tensioned all the stage distortions and other distortions should be set to zero at the beginning of each cycle.

The main Load cases tab display has a button “Zero all stage distortions” and the main Time affects set tab display has a button “Zero all other distortions” intended for this.

The aging of concrete

The stress/strain relationship of concrete changes as the concrete ages. A sequence of xsf files could be set up that each have a set of material descriptions appropriate to different points in the chronology.

The main Materials tab has a button “Import material from another XSF file” that leads to a panel headed “Import Source” with a list of files.

On a phone when a file is selected that panel has a button “Overwrite all materials” intended for this purpose.

On an iPad the selection of a file from that list causes a change to a panel headed “Materials to overwrite” and that panel has a “Overwrite all materials” button intended for this purpose.