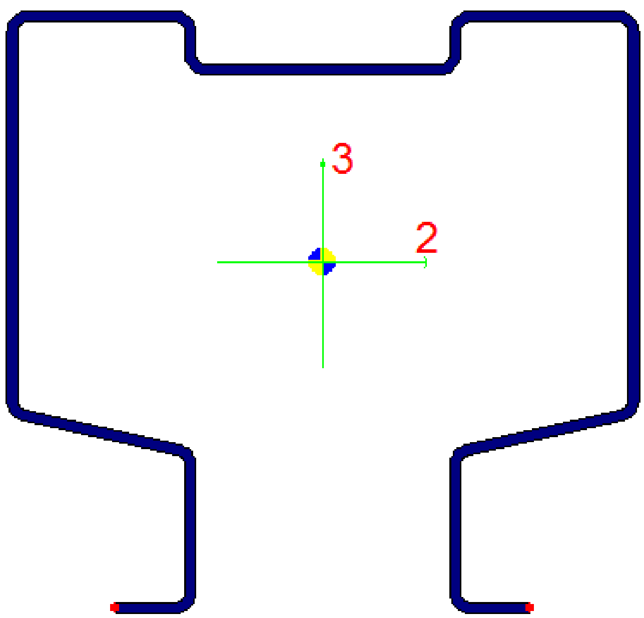
Samba - Help

Version 3.50



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SAMBA help

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Summary

Part I

1 Introduction

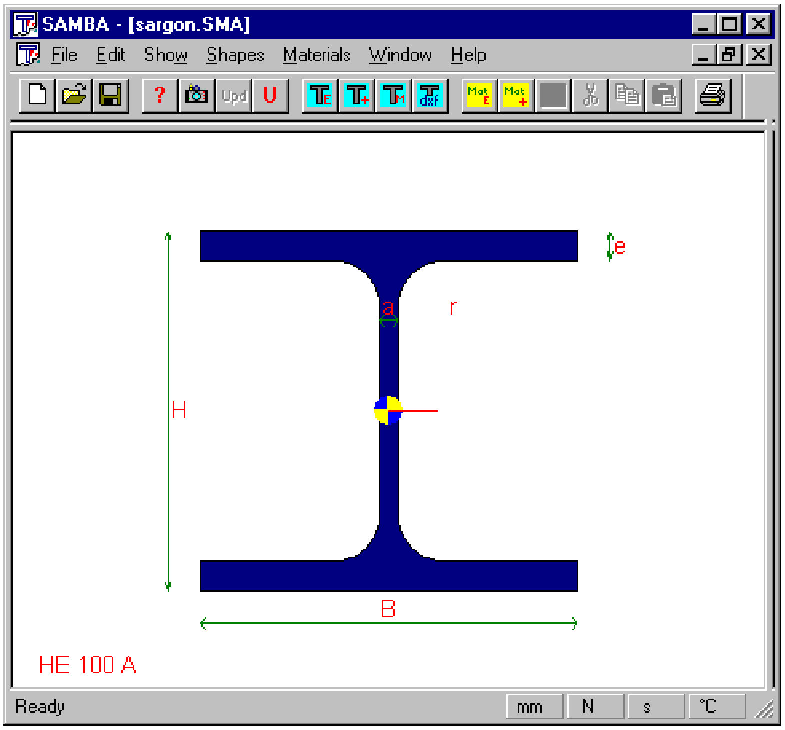
Introduction

The guide of SAMBA (Shape And Material Brisk Archive) is divided into four parts. The first three parts help in understanding the use of the program starting form a general introduction and arriving to single commands and dialog boxes explanation, passing through work steps description. The last part is an article about elastic and plastic properties of generic cross-sections. The four parts of the guide are:

Part 1 includes the following arguments:

1.1 Samba: what does it do? Who is it for?

SAMBA: WHAT DOES IT DO? WHO IS IT FOR?



Shape And Material Brisk Archive (S.A.M.B.A.) is a program made by Castalia s.r.l. on the basis of designers' and shape industry requirements, in an international context.

SAMBA can be seen as a shape study environment and as a clever database dealing with shape and material properties. Using SAMBA you can treat thousands of shapes and materials in only one environment, especially made for this goal.

But SAMBA is not only this.

Using SAMBA you can create archives and sub-archives, as well as reunions of different archives. It supports classic *copy*, *cut* and *paste* operations, as well as *drag and drop* from a window to another, making it easier the transferring operations. It allows the addition of new shapes and materials to the archive (Maintain the archives 27), evaluating automatically every section property. Shapes can be added in a tutorial way or can be read from a file, in the preferred unit of measure. In this way you can add hundreds of shapes with just one operation.

SAMBA lets you choose among thousands of shapes those satisfying a set of design criteria, including shape kind, shape data and deformability or stability (How to design using SAMBA 36).

SAMBA lets you print shape catalogues, listing not only available sections (more than 5,000) but sections added by the user as well.

Born to be international, SAMBA converts automatically each data into the units you wish to use: you can have data into SI system of units and convert them into US system, or vice versa. (Change units 25).

SAMBA lets you study which are the best sizes for a shape, since it gives information real time about main design data change (second moments of area, section moduli, etc.) (Study new shapes 37). Besides SAMBA lets you design composed shapes of any kind, thanks to its specific working environment. Real time you'll shift and rotate the shapes gaining all relevant data, including elastic and plastic moduli, as well as principal axes position and shape center.

SAMBA is furnished with an initial set of more than 5,000 shapes, among which welded, rolled, composed, European or American shapes.

SAMBA is written using MDI architecture (Multiple Document Interface), so that you can open more that one archive at a time, and more windows of the same archive.

SAMBA is fully interfaced with code SARGON, developed by Castalia s.r.l., being one of its components, but it is also sold as a standalone application.

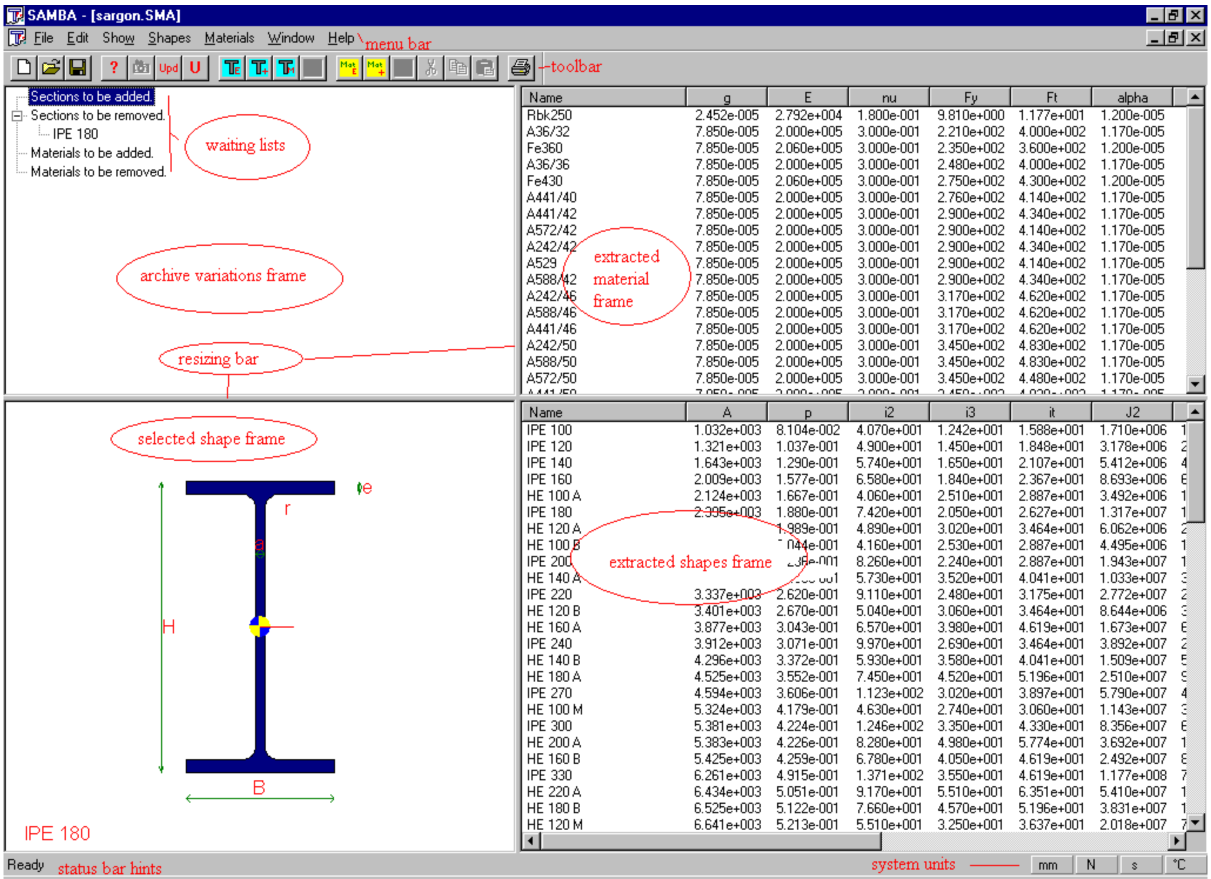
Printing and print-preview capabilities let you easily obtain clear tables you can add to your design or use for any purpose. You can print the one-shape portrait or the multiple-shapes tables, so any need is covered.

A list of the main SAMBA uses is the following:

* Computerized and "clever" shape and material database.
* Environment specialized in the study of new sections, arbitrary complex.
* Guide to the choice of the best section for a given design requirement, among the most frequent.
* Catalogue or single-section printing environment

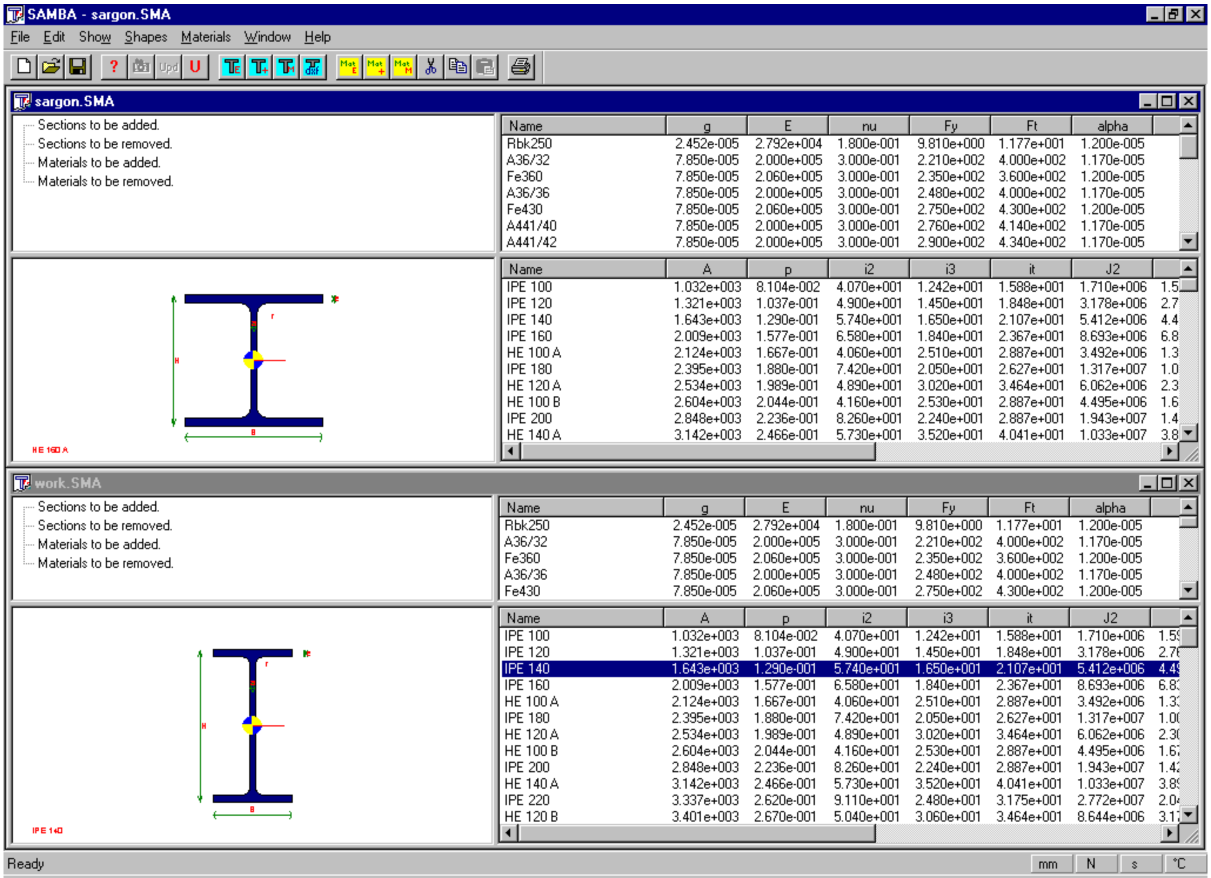
1.2 Graphic interface

GRAPHIC INTERFACE



SAMBA interface

SAMBA graphic interface is very evolute, and its description very complex. In the figure above a typical SAMBA window is shown, with all the necessary explanations to show the main interface components.



Multiple windows

The program main window can contain one ore more windows referring to one or more archives. It is both possible to have windows of the same archive and of different archives.

Besides command menu a toolbar button is available, with main commands. The toolbar can be moved freely in the screen.

Main window, besides, has a status bar where all messages useful to the user are written, and where active units of active archive are listed (Change units 25).

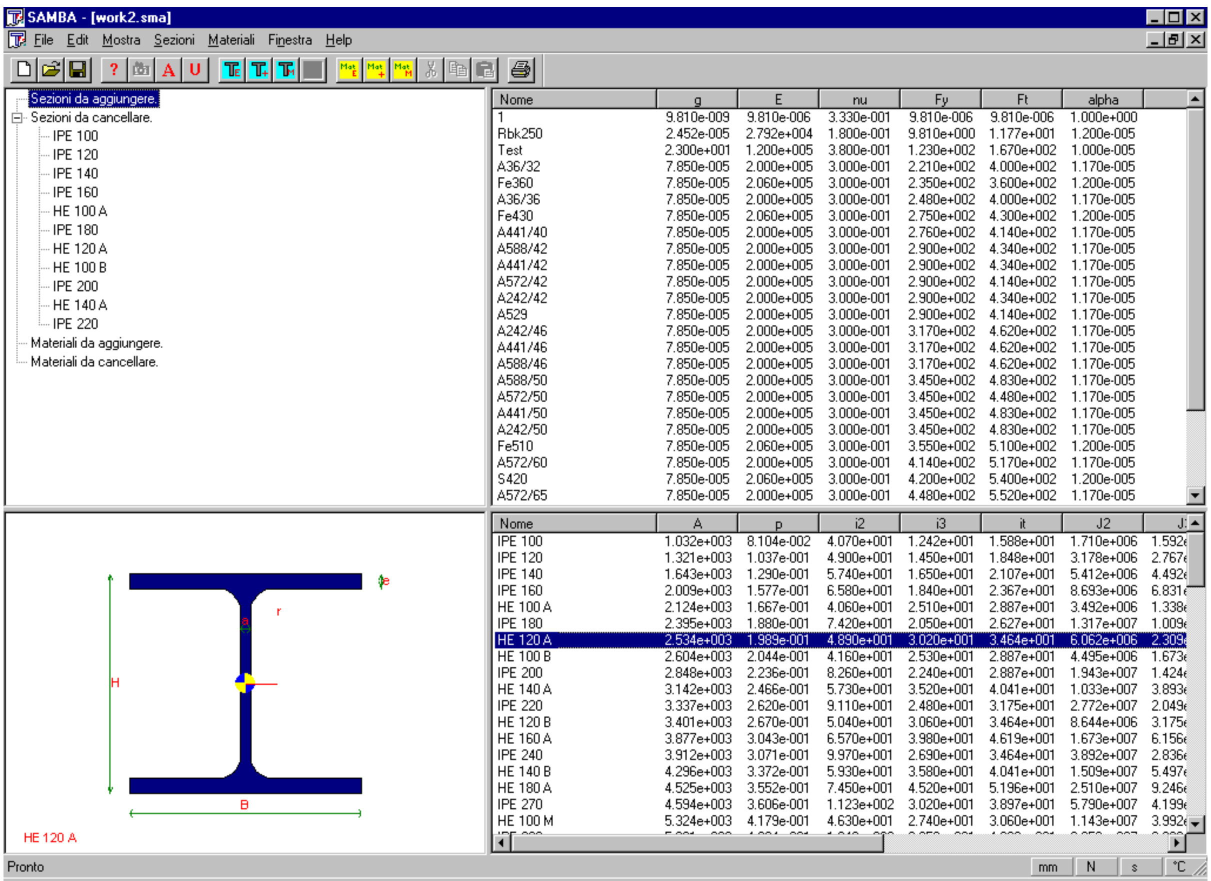
The ways to get help are many. There are tooltips and context sensitive help (Get help 24).

Each open window relative to the archive is a "view" of the archive. Each view is divided into four subviews or frames, with a different goal.

Top left frame is used to show waiting lists content, that is materials in to be added or removed.

Top right frame lists all the materials extracted from the archive. The list is made up by a number of rows, one for each material, and a by a number of columns, one for each relevant data. Column width can be changed at any time. Column meaning is the following:

Name	name of the material (max 15 carachters)
g	weight per unit volume
E	Young's modulus
Nu	Poisson's coefficient
Fy	yield stress or elastic limit
Ft	ultimate or failure stress
Alpha	thermal expansion coefficient

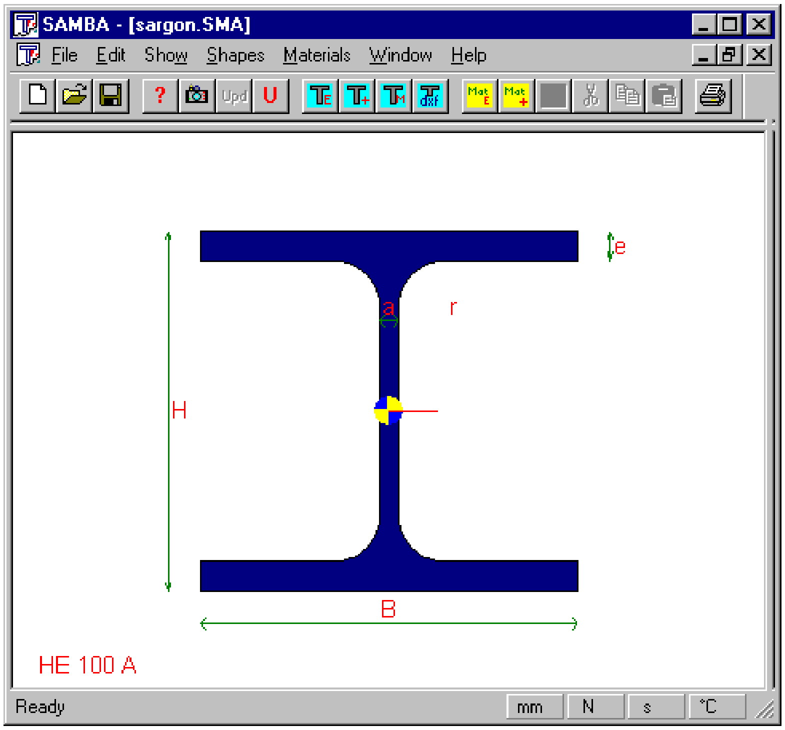


The frames

The bottom right frame lists all the shapes extracted from the archive. The list is made by a number of rows, one for each shape, and by a number of columns, one for each relevant data. The column width can be changed at any time. Le column meaning is the following:

Name	name of the shape (max 20 carachters)	
A	shape area	$[L^2]$
p	weight of the shape per unit length (steel made)	[F/L]
i2	axis 2 inertia radius	[L]
i3	axis 3 inertia radius	[L]
it	torsional inertia radius	$[L^4]$
J2	second area moment, axis 2	$[L^4]$
J3	second area moment, axis 3	$[L^4]$
Jt	torsional constant	$[L^4]$
W2	axis 2 section modulus	$[L^3]$
W3	axis 3 section modulus	$[L^3]$
Wpl2	axis 2 plastic modulus	$[L^3]$
Wpl3	axis 3 plastic modulus	$[L^3]$
U	external painting surface per unit length	[L]

Bottom left frame is the current section drawing, that is the drawing of the section currently selected in the previous frame.



Current shape frame maximization

All the frames are resizable, so that it is possible to maximize one frame dimensions so as to cover the whole available space. To do that you have to move the two subdivision bars which split the window in four subwindows.

It must be underlined that the two right frames do not list all the materials and the shapes in the archive, but just a subset, chosen by the user (Browse archives 26). Obviously you can do so that the subset gets equal to the whole set, anyhow due to the relevant database size this is neither the best, nor it is necessary.

1.3 The sections

THE SHAPES

As "shape" we here mean the normal section of a prism used to realize beams which follow elastic theory and De Saint Venant's hypotheses. The shapes belong to the following types:

Composed by polygons (full and empty) 126

Generic 142

Each shape is referred to its principal axes, that generally are not horizontal and vertical. Principal axes are named "2" and "3", by definition. Often, anyhow, due to shape simmetry, principal axes are horizontal and vertical.

Data computed by the program always refer to principal axes, and that is why they use indexes "2" and "3", depending on the relevant axis.

Usually axis 2 is the strong axis of the section, even if particular choices of the sizes can reverse this statement. The choice of which is axis 2 and axis 3 is done on the basis of what is the normal behaviour of the sections belonging to a given type. For instance, H shapes axis 2 is always the axis perpendicular to the web, even if widening the flanges you can have this axis as the weak one. For particularly complex shapes, like Composed generic 140 and Cold formed (generic) 98 the choice of axis 2 is made by governing equations, there is not a specific convention.

Sometimes the sizes must be specified respecting some coherence and regularity conditions, with respect to the chosen shape kind.

The exact meaning of some data (like torsional constant) can change from shape to shape, depending on simplified theories used to compute its value.

1.4 Materials

THE MATERIALS

As "material" it is here meant linear elastic homogeneous, isotropic material, so that it can be set by the following parameters:

g	weight for unit volume	$[F/L^3]$
E	Young's modulus	$[F/L^2]$

nu	Poisson's coefficient	
fy	yield stress or elastic limit	$[F/L^2]$
ft	ultimate stress or failure stress	$[F/L^2]$
Alpha	thermal expansion coefficient	[1/°C]

The yield and ultimate stresses are widely used by standards in order to set rules to determine material exploitation. Namely, CNR standards for sted structures fix an allowable ideal stress comprised between Fy/1.5 and Fy/1.3333. AISC standards (USA) use different allowable stresses depending on section internal forces (flexure,shear, axial force, …).

Part II

2 How to...

How to...

2.1 How to get help

HOW TO GET HELP

In Samba help is available by command Index 192 of menu Help 192. Anyhow there are more help features:

1) Tooltip

Moving the mouse near a button a small hint-window appears.

2) Status bar

Selecting a command (both from menu or from toolbars) an explicit explaination appears in main window status bar.

3) Context sensitive help

Pressing F1 key when a dialog box window is open will get information about dialog box meaning and content (this is recommended to have detailed explainations).

Selecting a command from menu and pressing F1 you have information about that command.

Clicking on

and afterwards over a button or a menu command you will get information about that command.

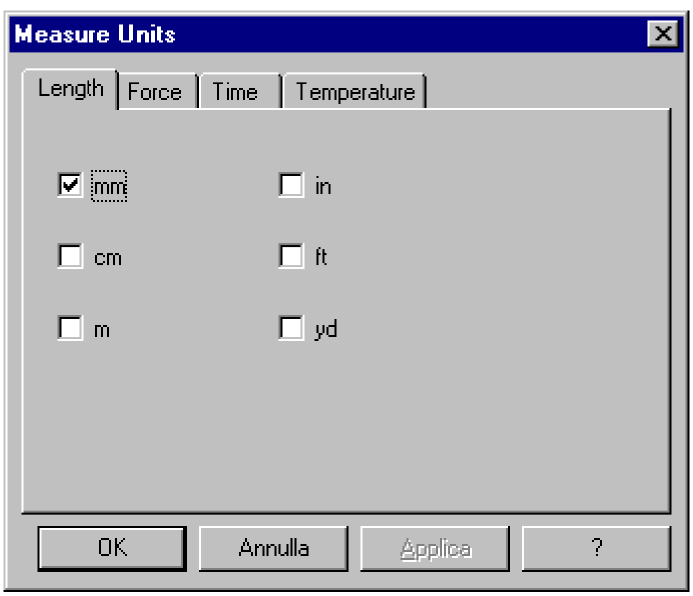
2.2 How exit from SAMBA

HOW TO EXIT FROM SAMBA

To exit from SAMBA you must choose the command Exit 49 in menu file. If open archives have been modified a save prompt will appear.

2.3 How change unit

HOW TO CHANGE UNITS



The proper command is Units... 55 in menu Edit.

Changing units is often strongly recommended: in fact, we usually adopt different units in referring to different things. For instance, mm are fine describing a steel-shape sizes, but they are unconfortable when writing an inertia value, or a load per unit length.

You can change current units at any time: automatically the program updates data listed or enquired. From that moment each data input or output will use the new current units.

Remember that data input must be coherent with current units, if you prefer others change them.

Units choice is common to all active views of open document.

Every document has its own current units.

2.4 How to browse archives

HOW TO BROWSE ARCHIVES

In SAMBA browsing of the archives is done through two frames (Graphic Interface 15), one concerning shapes and one concerning materials.

Within each frame, data are organized in rows, which can be scrolled horizontally and vertically. You can use Page Up, Page Dn and the arrow keys to navigate.

Due to the high number of shapes and materials, data listed in frames **are not usually the whole archive content. They are a subset of the archive content** chosen thanks to some data filters. The subset, if wished, may be set equal to the whole archive content, just not specifying filters at all.

It is therefore of the greatest importance to fix filter criteria, in order to subset the archive. The element listed in frames are those satisfying each filter, none excluded.

The command used to establish filter criteria, setting new subset, is called "Extract" both for shapes (Extract 57) and materials (Extract 186).

SAMBA gives to the user the chance of setting filters based upon kind (Shape Archive Access 58), geographical origin (Material Archive Access 187), numeric intervals to respect (Data Filters 62) or design criteria to accomplish to (Choice of design Criteria 63).

2.5 How to maintain archives

HOW TO MAINTAIN ARCHIVES

As "archive maintenance" we mean all the actions that is necessary to perform in order to manage dinamically an archive of shapes and materials. Therefore addition, deletion, move, splitting and merging, as applicable to sets.

From operating standpoint this means that in SAMBA not only it's possible addition and deletion of shapes and materials, but it's also possible to merge two different archives as well as to create a new archive from a subset.

How to add shapes 28
How to delete shapes 34
How to modify existing shapes 34

How to add materials 35
How to delete materials 35
How to modify existing materials 35

How to create a sub-archive 36

How to merge two archives 36

How to enquire the number of shapes and materials 36

Addition and deletion in SAMBA is not done at once, but it's done with a two step procedure: at first shapes and materials to be added or deleted are input, with all their data, in a waiting list; then this waiting list is processed performing the operations required (additions and deletions). The archive can be updated at any time: you just have to execute command Update 54.

To check waiting list content you can just watch at the top left frame content (Graphic Interface 15).

2.5.1 How to add shapes

HOW TO ADD SHAPES

Adding of shapes in SAMBA can be done in different ways. Shapes can be added in an interactive way, by a number of proper dialog boxes, or they can be added reading a file properly written: the command for both ways is Add 66. This command only adds shapes to waiting list.

Adding shapes one by one in an interactive way 29
Adding shapes read in a file 31.
Deleting a shape or a material from waiting list 33.

Once added to waiting list the shapes are ready to be effectivaly added to the archive, thanks to command Update 54, or automatically if the file is saved.

If shapes to be added are part of an existing archive, and this is available, they can be added by the Copy-Paste or drag and drop method. (You have to drop them in the bottom right frame).

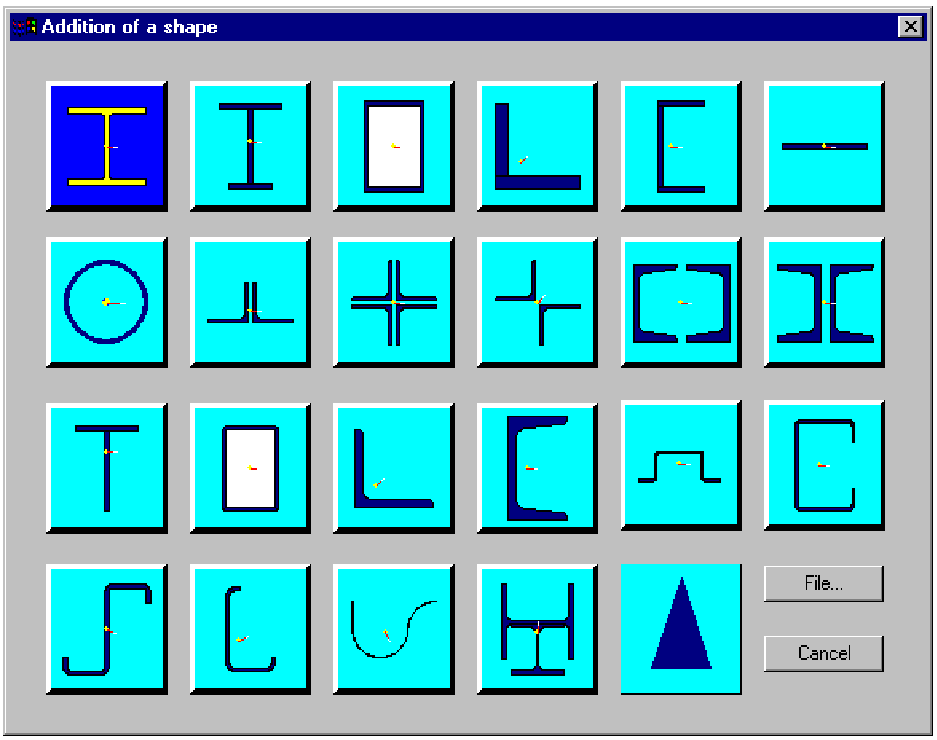
2.5.1.1 How to add shapes one by one in an interactive way

HOW TO ADD SHAPES ONE BY ONE IN AN INTERACTIVE WAY

The addition of shapes in an interactive way is done through a first dialog box (obtained thanks to command Add 66) which lets you choose the kind of the shape in for being added.

After this first dialog box a second dialog box appears, depending on the kind chosen.

The first dialog box is the following



Pressing one of the bitmapped buttons, that referring to the chosen kind, opens immediately the proper dialog box.

Possible dialog boxes refer to these possible shape kind (The shapes 19):

Rolled H shapes (IPE, HE, W, DIL, HLS...) 68

Rolled I shapes with tapered flanges (IPN, ISMB) 81

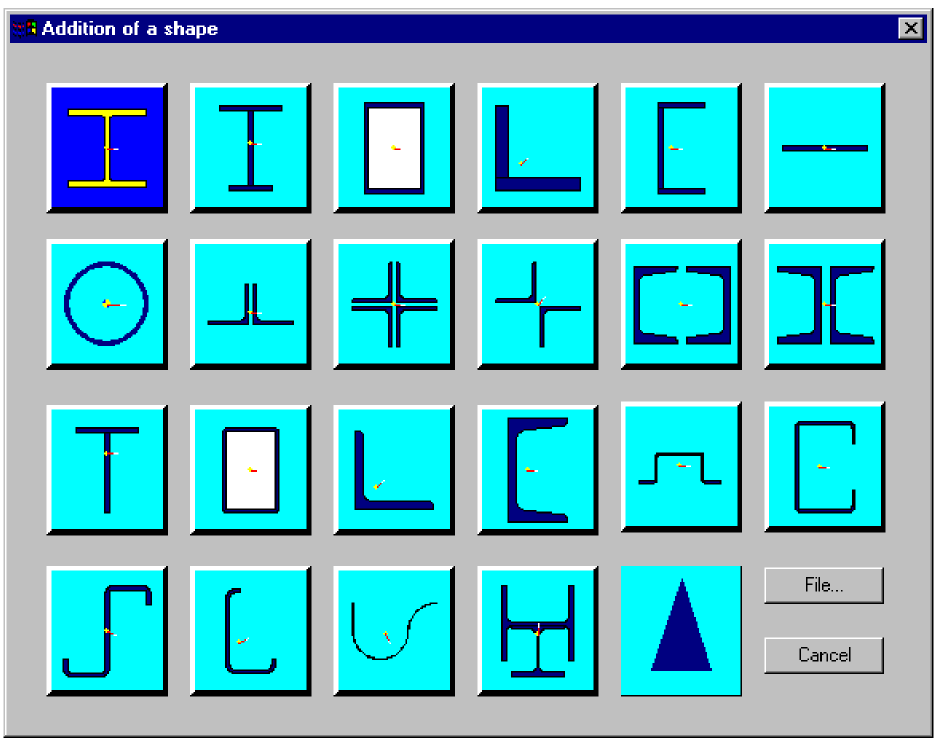
If it's necessary to study the best sizes for a given shape, there is no doubt that this way of adding is the best, since it is possible to use the Upgrade capability (Study New Shapes 37).

2.5.1.2 How to add shapes read in a file

HOW TO ADD SHAPES READ IN A FILE

Adding of a shape can sometimes be asked on the basis of existing catalogues. Adding shapes one by one would be long and boring. SAMBA can add many shapes at a tine, just reading data from a file.

To do so it’s necessary to execute the command Add 66 which opens the following dialog box:



where you must choose "File...". Afterwards you will be asked to specify a file, which must be an ASCII file (not necessarily with “*.txt*” extension).

```
///

_LSH    LSH200x200x10    200.    200.    10.    10.
```

```
_OSH     OSH200x400x20x10     200.   400.  20.   10.
_TSH     TSH1                 200.   200.   5.    10.
_USH     USH1                 400.   300.   5.     10.
_OOO     O100x1               100.   1.
_RHS     RHS300x300x10x20     300.  300.  10. 20.
_HSM     IPROVA               300.  200.  10. 20. 15.
_LSM     L?100x10             100.  100.  10. 12. 6.
_UNITS     cm
_PSH     40x40                40.   40.
```

The rows listed in the frame are from a file used to add some sections. The file is read according to the following rules:

* Each row not beginning with "_" is a comment and will be discarded.
* Each row beginning with "_" is a command, on the basis of a proper keyword.
* The character “?” is decoded as “ “ (blank). Therefore, if a “?” is encountered in the name field then it will be replaced by a blank. If, on the other hand, a blank is required, it must be replaced by “?”.

Possible identifier (keywords) are the following:

_UNITS 161	_HEA 162	_HAA 163	_HEB 163
_HEM 164	_HSM 164	_IPE 165	_IPE* 165
_IPN 166	_THSM 166	_USM 167	_RHS 167
_LSM 168	_PSH 168	_HSH 169	_USH 169
_TSH 169	_LSH 170	_OSH 170	_OOO 171
_UCF 171	_LCF 172	_ZCF 172	_OMCF 172
_COLD 173	_L2T 175	_L2CR 175	_L4CR 176

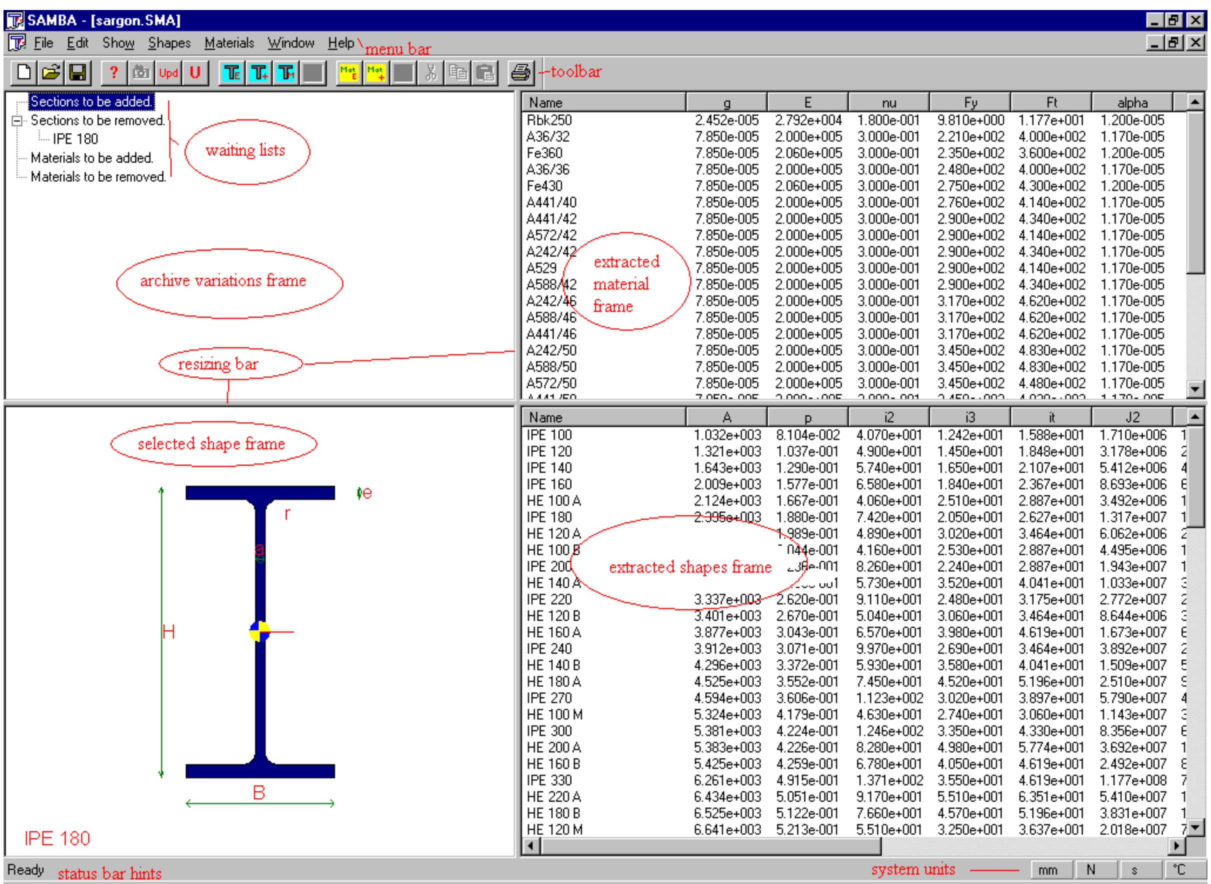
_U_O 177 _U_H 177 _UHCF 178 _POLI 179

_COMP 180

Generally each row adds a new shape, except the command _UNITS, which is used to change, from that row forward, the units used to decode data.

2.5.1.3 How to delete a section or a material from waiting list

DELETING A SHAPE OR A MATERIAL FROM WAITING LIST



After a section or a material has been added to one of the waiting lists, in order to be added or removed, you can change idea.

To modify a waiting list to delete sections or materials from the list (addition or removal list) you can just select it in the list and press the "delete" button.

Keep in mind that while removing a section or a material from the *in-for-being-deleted* waiting list does not imply a data loss, deletion of a section or of a material from *in-for-being-added* list implies the loss of the previously added data (and not yet written onto disk). For this reason the program, in this latter case, asks a confirmation.

2.5.2 How to delete shapes

HOW TO DELETE SHAPES

In order to delete one or more sections from the archive, it is necessary that the sections are currently extracted (Extract 57), that is, they must appear in the bottom right frame. Besides they must be selected.

To select a shape among those extracted it is sufficient to click over its row. To select more than one shape you must press the Shift button, while moving the arrow keys.

Once the shape or the shapes have been selected, you execute the command: Cut 51, so as to add the shapes to the *section in-for-being-deleted* waiting list.

2.5.3 How to modify existing shapes

HOW TO MODIFY EXISTING SHAPES

To modify an existing shape you need to select it among those extracted, then you must execute the command Modify 186.

To select a shape among those extracted it is necessary to use arrow keys to move up and down until the chosen string gets blue. You can click the row as well.

To modify composed shapes it is first necessary to extract the shapes that will be used to create the new section, modifying the old.

It is user's duty not to modify standard shapes like HEA, HEB, HEM.

2.5.4 How to add materials

HOW TO ADD MATERIALS

Adding of materials is done interactively by a proper dialog box, allowing the user to input each data referring to material. The command is Add 188. This command adds materials to the waiting list, not to true archive.

2.5.5 How to delete materials

HOW TO DELETE MATERIALS

In order to delete a material you have to select it among those extracted from archive (Extract 186).

To select a material from those extracted you can move with arrow keys until the material-row becomes blue, or you can click over it.

Once you've selected the material you've to cut it using Cut 51: this will add material to waiting list content, in the "material to be deleted" section.

2.5.6 How to modify existing materials

HOW TO MODIFY EXISTING MATERIALS

To modify an existing material you must select it among those extracted, then you must execute the command Modify 190.

To select a material among those extracted it is necessary to use arrow keys to move up and down until the chosen string gets blue. You can click the row as well.

2.5.7 How to create a sub-archive

HOW CREATE A SUB-ARCHIVE

Sections and materials extracted from archive can become a separate archive themselves (a separate *.sma* file). To do that you can use command Save extraction47.

2.5.8 How to merge two archives

HOW TO MERGE TWO ARCHIVES

In order to merge one external archive into an existing one, the active one, you can use the command Merge47. To the active shape and material archive will be added the content of the specified .sma archive. Shapes or materials having duplicated names are not added.

2.5.9 How to enquire the number of shapes and materials

HOW TO ENQUIRE THE NUMBER OF SHAPES AND MATERIALS

It may be useful to know the number of shapes and materials contained in an archive, or how many shapes and materials are curently extracted. To do so you can use the command Enquire49.

2.6 How to design with SAMBA

HOW TO DESIGN WITH SAMBA

SAMBA makes you choose one shape anong thousands thanks to proper design criteria. To do that you must extract from archive only those sections satisfying filters based upon structural layouts and shape properties. The filters are chosen by the user.
From logical standpoint, searching for a shape fit for some design criterion is just a particular extraction (Extract 57), that is the extraction of the subset of shapes satisfying the design criteria chosen by the user.

Two are the dialog boxes studied to fix filters:

the Data Filters 62 window

the Choice of a design criterion 63 window

both reached by command Extract 57.

2.7 How to study new shapes

HOW TO STUDY NEW SHAPES

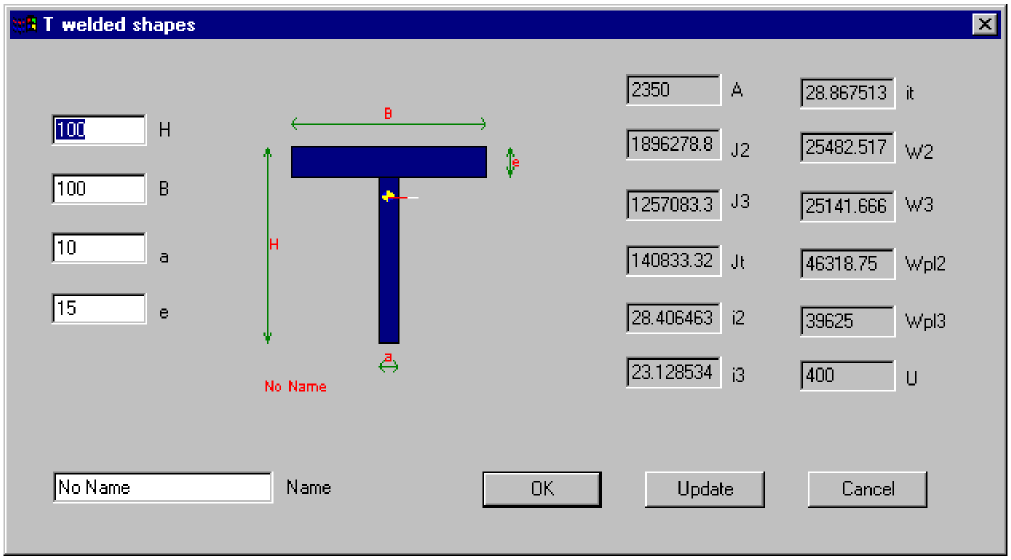
Sometimes happens to need a shape satisfying some requirements, say a given W modulus, or a given J value.

The designer is obliged to compute trying different sizes until the requested values are reached.

Using SAMBA this procedure is dramatically simplified, since SAMBA can compute automatically and interactively each data.

Imagine, for instance, you wish to add and study a new T welded shape (following is applicable to each shape kind in SAMBA).

Using command Add 66 we specify we wish to add a T shaped section, and we reach the following dialog box.

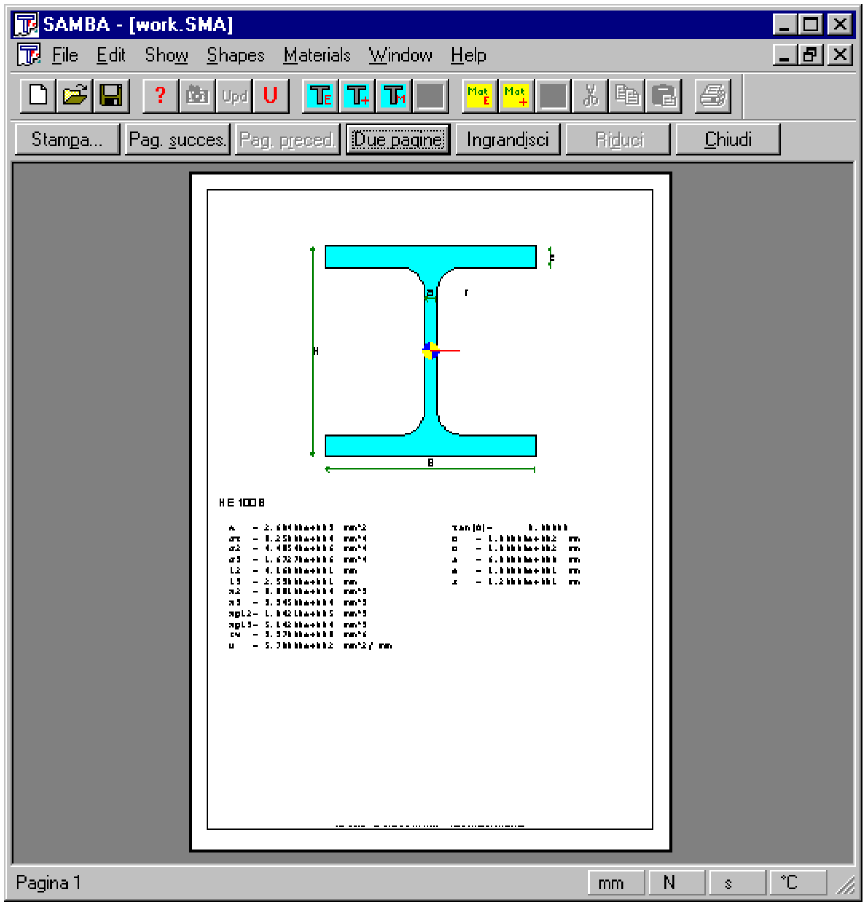


Imagine to need an overall depth non greater than 100mm, but a W2 equal to at least 30.000 mm^3. We can set increasing flange width or increasing thicknesses, and immediately know how data change, just pressing "Update" button. Using this feature is very easy to converge to best solution, in compliance with design criteria preferred, time by time.

The "Add" dialog box is therefore an environment capable of studying parametric change in sizes. It allows the user to fastly optimizc sizes, if unknown.

2.8 How to print a shape

HOW TO PRINT A SHAPE



In order to print a shape, it must appear in bottom left frame. The shape must therefore be selected among those extracted from archive (Extract 57).

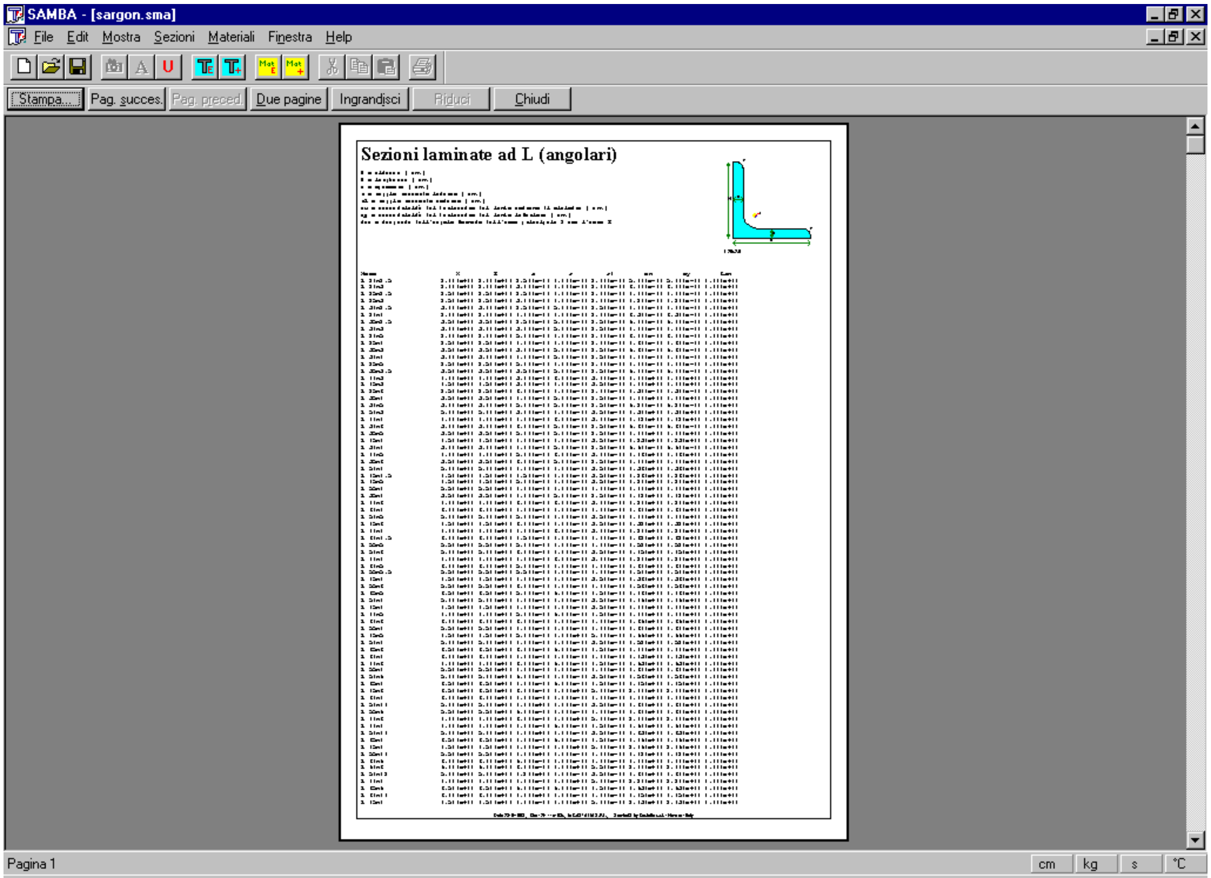
To select one shape among the others you must move using arrows until the desired row gets blue. Afterwards it is necessary to activate the botton left frame clicking inside it.

If more than one shape is selected no shape will be seen.

After all these things have been done, the command Print 47 and Print Preview 48 become available, showing active frame content.

2.9 How to print a shape collection

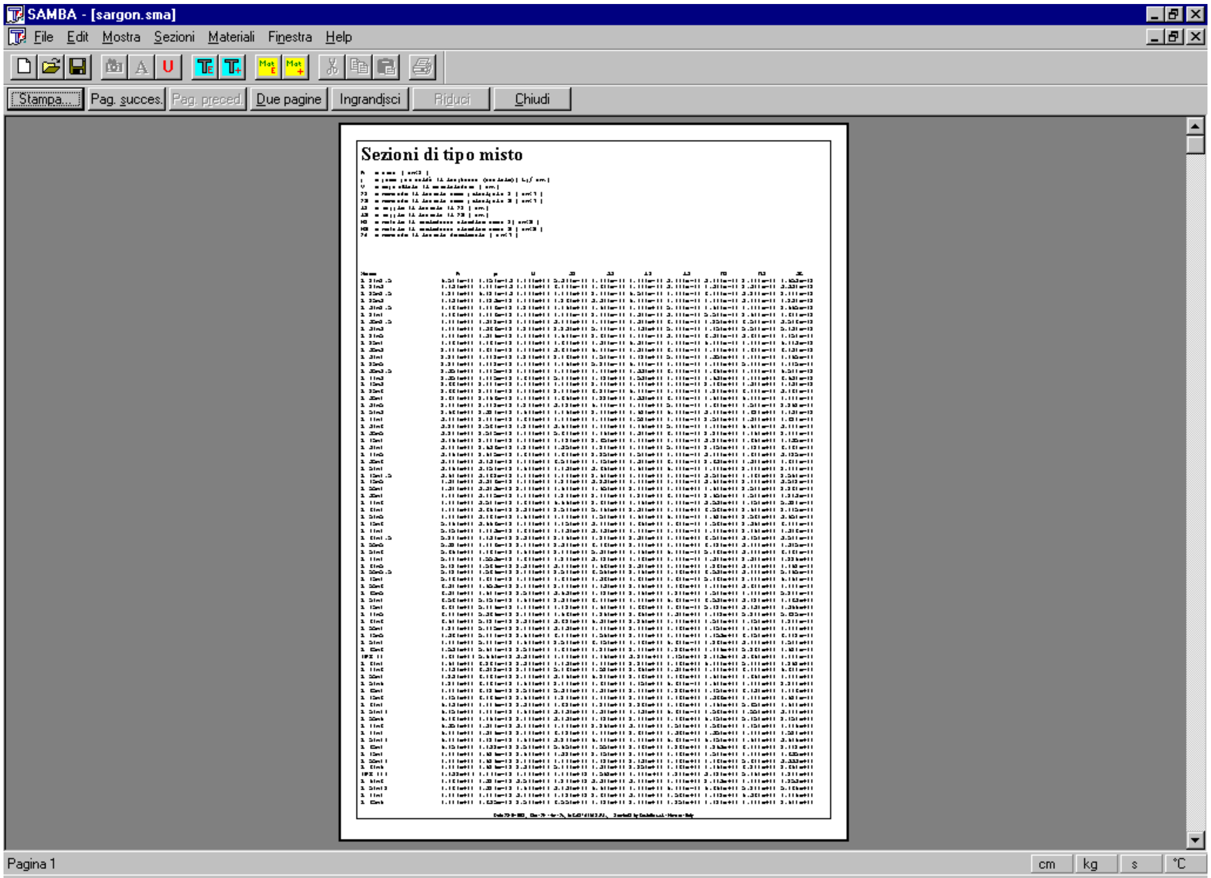
HOW TO PRINT A SHAPE COLLECTION



In order to print a shape collection this must be made up by a set of extracted shapes (command Extract 57).

Then the bottom right frame must be activated, clicking inside it.

Once these things are done the command Print 47 and Print Preview 48 become available, showing the active frame content.

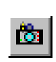


Keep in mind that the number of printed columns depends on portrait or landscape printer setting. Heading will depend on collection content: if the shapes are all of the same kind a heading referring to that kind will appear. Otherwise a generic heading will appear.

Units of printed data are those active when the command is executed.

2.10 How to transfer images to other applications

HOW TO TRANSFER IMAGES TO OTHER APPLICATIONS



The drawing of a shape is often needed for design or document preparing purposes.

Thanks to clipboard, SAMBA allows you to export the drawing of one of the shapes inside the archive to any other application: you just have to press one button. The command to be used is Photo 54.

After the command is executed it is possible to paste into any document the bitmap of the chosen shape.

Using SAMBA you can create the *dxf* file of any shape within an archive. The command is Create DXF 185. This feature is useful if you wish to use SAMBA together with dxf compatible programs.

Part III

3 Samba commands

Samba commands

Samba commands are grouped in 7 different menus according to their function. Frequently used commands have a direct button in the interface. Menus are:

File 44	File changing, reading and writing. Printing.
Edit 50	To cut, paste, change units.
Show 56	To change display configuration
Shapes 57	To act on shape archive.
Materials 186	To act on material archive.
Window 190	To change or move windows.
Help 192	To get help.

3.1 File

Menu File commands

New 45	Open a new file
Open 45	Open an existing file
Close 45	Close current file
Save 45	Save current file
Save as 46	Save current file with a new name
From Sargon 46	Imports old Sargon file (shp, etc.)
Settings 46	Modifies Samba settings
Subset 47	Creates a new archive from current subsets
Merge 47	Merges an archive with current one
Print 47	Print

Print Preview 48	Print preview
Print Setup 48	Print setup
Enquire 49	Informs about sections and materials number
Exit 49	Exit

3.1.1 Command: File-New

COMMAND: File-New

A new empty archive is created (file *.sma*) and its empty windows open. Initially the new archive is named "Samba1", but can be renamed with Save As 46.

3.1.2 Command: File-Open

COMMAND: File-Open

This command opens an existing file. File type must be *.sma,* which is the SAMBA file format. To import shapes and/or materials from Sargon (*shp, mtr, ndx e ndm* file formats), a new empty archive must be created using New 45, then command From Sargon 46 must be executed.

3.1.3 Command: File-Close

COMMAND: File-Close

This command closes active document (file *.sma*).

3.1.4 Command: File-Save

COMMAND: File-Save

This command saves onto disk the active document (file *.sma*). File is saved in the location where was read.

3.1.5 Command: File-Save As

COMMAND: File-Save As

This command saves current document with a new name. The user chooses folder, drive and name to be assigned to the new document. File extension is *.sma*.

3.1.6 Command: File-From Sargon

COMMAND: File-From Sargon

This command has been added to save backward compatibility with old Sargon files. This command reads old shape and material archives saved as .shp .ndx, .ndm and .mtr files in Sargon installation folder. New file has *.sma* extension.

To work properly this command must be executed when archives are empty, that is after command New45. Besides environment variable SARGON must have been fixed, and its value must be equal to the path of the folder where files *.shp .ndx .ndm .mtr* are written.

Once the files have been read they can be saved as a unique *.sma* file in the desired location.

3.1.7 Command: File-Settings

COMMANDO: File-Settings

This command is used tho choose SAMBA language. After a modification, close and reopen the program to activate desired language.

3.1.8 Command: File-Subset

COMMAND: File-Subset

This command is used to create a new archive from currently extracted shapes (Extract 57 and materials Extract 186).

This command is used to split archives into sub-archives in an easy and efficient way.

3.1.9 Command: File-Merge

COMMAND: File-Merge

This command merges into active archive shapes and materials contained in another archive. A shape or material can be merged only if its name is not used by another shape or material currently present in active archive.

This command is very useful to create large archives built from sub-archives furnished by others.

The archive to be merged is specified choosing its *.sma* file.

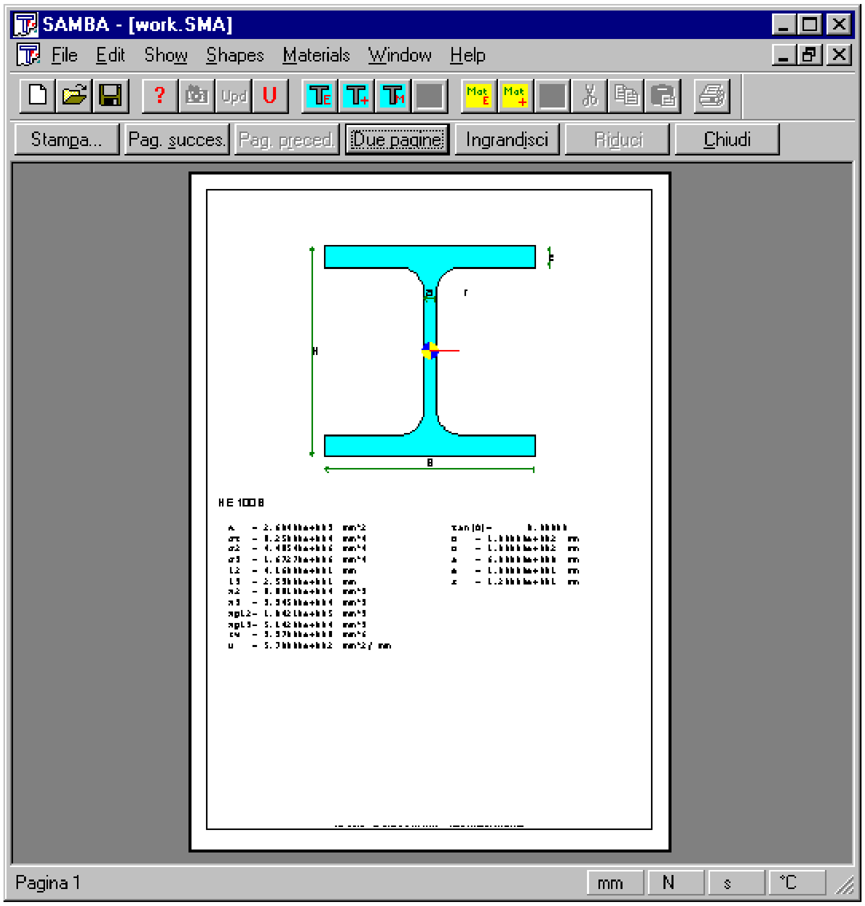
3.1.10 Command: File-Print

COMMAND: File-Print

This command sends to printer active windows content. Content can be the currently selected shape (lower left frame), or the set of the extracted shapes (lower right frame), depending on which frame is currently selected. To select a frame you must click inside it. Altough not completely this command is WYSIWYG (what you see is what you get). The printing window is not the same of screen window. Trerefore it is suggested to use Print Prewiew 48.

3.1.11 Command: File-Print Preview

COMMAND: File-Print Preview



Depending on available printer and printer setup, this command is used to preview print results.

3.1.12 Command: File-Print Setup

COMMAND: File-Print Setup

This command is used to set up print behaviour. If it is necessary, this command must be executed before printing. It is the same of what you use in Word™ or Excel™.

3.1.13 Command: File-Enquire

COMMAND: File-Enquire

This command is used to know how many sections and how many materials are is the current archive. It also informs about the currently extracted sections number and about the currently extracted materials number. As soon as the command is executed a proper dialog box 49 appears.

3.1.13.1 Archive enquire (dialog)

ARCHIVE ENQUIRE (DIALOG BOX)

This dialog box tells how many sections and how many materials are in a archive (not including waiting lists), and how many sections and materials have been currently extracted.

3.1.14 Command: File-Exit

COMMAND: File-Exit

This command is used to exit from Samba. If open documents have been modified without saving them into disk a prompt for saving appears. If they'll be saved old archives will be lost.

Prompt for saving is therefore the last chance to undo the changes.

3.2 Edit

Menu Edit commands

Undo 50	To delete last operation
Redo 50	To rerun last deleted operation
Cut 51	To cut shapes or materials
Copy 52	Copies selected shapes and materials to clipboard
Paste 53	Adds shapes or materials written in clipboard
Update 54	Updates archive to current changes
Photo 54	Transfers to clipboard active shape image
Units 55	To change unit system

3.2.1 Command: Edit-Undo

COMANDO: Edit-Annulla

This command deletes the last operation.

3.2.2 Command: Edit-Redo

COMANDO: Edit-Rifà

This command reruns last deleted operation 50.

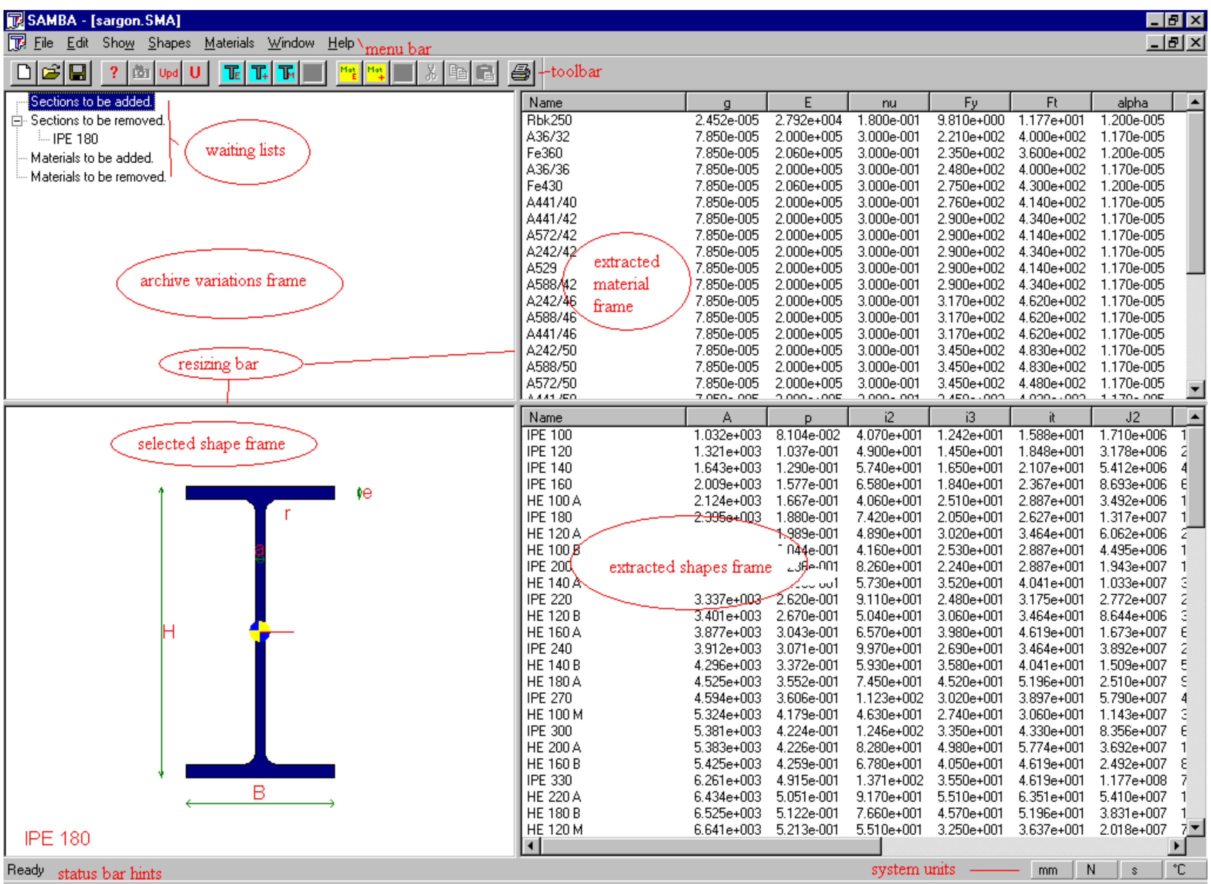
3.2.3 Command: Edit-Cut

COMMAND: Edit-Cut

This command works both on shapes and materials, depending on the frame active where the command is executed (extracted shape frame, extracted materials frame).

Extracted shapes frame

This command adds to in-for-delete shape list (top left frame), currently selected shapes in extracted shapes frame. (bottom right) (Shape Deletion 34).



It is important to understand that once "deleted" they are not actually erased from archive.

On the contrary, due to safety reasons, they are added to a waiting list. The true deletion of shapes from archive is done automatically by the program when exiting if change have been saved. It can also be done at any moment by executing command Update 54.

Cut command also copies to clipboard deleted shapes.

Extracted material frame

This command adds to the in-for-delete material list (top left frame) currently selected materials in extracted material frame (top right). (Material Deletion 35).

It is important to understand that once "deleted" they are not actually erased from archive. On the contrary, due to safety reasons, they are added to a *waiting list*. The true deletion of materials from archive is done automatically by the program when exiting if change have been saved. It can also be done at any moment by executing command Update 54.

Cut command also copies to clipboard deleted materials.

3.2.4 Command: Edit-Copy

COMMAND: Edit-Copy

This command works both on selected shapes and on selected materials, depending on which frame is active when command is executed (extracted shapes frame, extracted materials frame).

Extracted shapes frame

The command copies selected shapes to clipboard.

Extracted materials frame

The command copies selected materials to clipboard.

3.2.5 Command: Edit-Paste

COMMAND: Edit-Paste

This command works both on selected shapes and materials, depending on the frame active when the command is executed (extracted shapes frame, extracted materials frame).

Extracted shapes frame

The command adds to the shapes-to-add list the shapes written to clipboard.

It's important to understand that once the shapes have been added these are not yet actually added to the archive. On the contrary, one to safety reasons, they are added *to a waiting list* to be added in the future. Adding of shapes in waiting list to the archive is done automatically when exiting the program if changes are saved, or at any time by the command Update 54.

See also: Deleting of a shape or a materialfrom waiting list 33.

Extracted materials frame

The command adds to the materials-to-add list the materials written to clipboard.

It's important to understand that once the materials have been added these are not yet actually added to the archive. On the contrary, one to safety reasons, they are added *to a waiting* *list* to be added in the future. Adding of materials in waiting list to the archive is done automatically when exiting the program if changes are saved, or at any time by the command Update 54.

See also: Deleting of a shape or a material from waiting list 33.

3.2.6 Command: Edit-Update

COMMAND: Edit-Update

This command updates archive depending on waiting list content. Materials and shapes to be added will be added, those to be removed will be removed.

The command is available (active) only if waiting list is not empty.

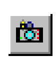
As soon as the command is executed, frame content is erased since is not up to date with archive content. Immediately afterwards frames are filled back using current filters setting.

Adding and removing acts on archive RAM image, not actually to disk file. To definetly save changes into disk a Save 45 command must be executed. So you can go back to original archives after are update: just don’t save archives to disk. Therefore, working with archives updated but not saved is possible.

This behaviour gives an excellent safety with respect to data loss.

3.2.7 Command: Edit-Photo

COMMAND: Edit-Photo



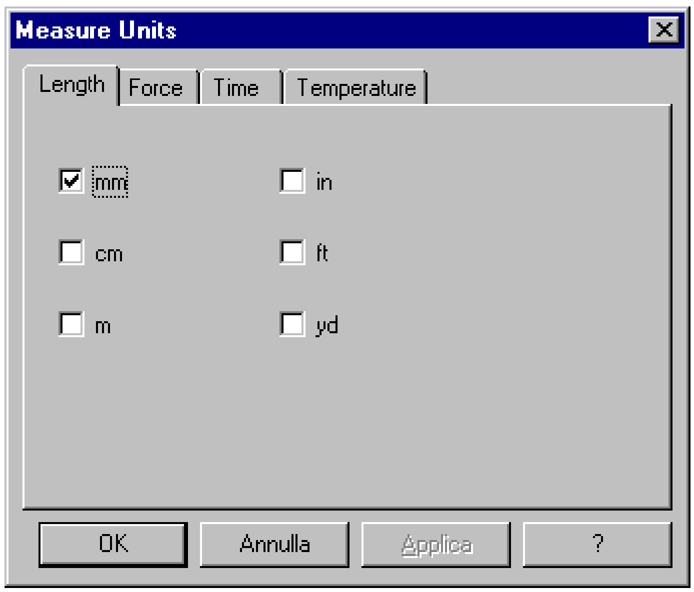
This command is used to transfer to clipboard the active shape image. The active shape is the shape selected in the extracted shapes frame (bottom right frame). This shape is also drawn in the bottom left frame.

This command is very useful because it allows transfering of images to other applications, like Write™ Word™ or Paint™.

The command is available in the toolbar.

3.2.8 Command: Edit-Units

COMMAND: Edit-Units



This command changes active unit system. All data input or output from program will have to be written or read using current unit system.

Current unit system is written into main window status bar (Grafic interface 15).

The command is available in main tool bar:

How to change unit system 25.

3.2.8.1 Time (dialog)

TIME (DIALOG BOX)

This dialog makes you choose the preferred time unit.

3.2.8.2 Force (dialog)

FORCE (DIALOG BOX)

This dialog makes you choose the preferred force unit.

3.2.8.3 Length (dialog)

LENGTH (DIALOG BOX)

This dialog makes you choose the preferred length unit.

3.2.8.4 Temperature (dialog)

TEMPERATURE (DIALOG BOX)

This dialog makes you choose the preferred temperature unit.

3.3 Show

Show menu commands

Toolbars	Shows or hides toolbars

Status bar   Shows or hides status bar

3.4 Shapes

Shapes menu commands

Extract 57	Extract a subset from shapes archive
Add 66	Adds one or more shapes
Create DXF 185	Creates the dxf file of current shape
Modify 186	Modifies current section data

3.4.1 Command: Shapes-Extract

COMMAND: Shapes-Extract

This command has a double aim: the first is to extract and browse a subset of the shapes belonging to the archive; the second is that it helps in finding the set of shapes fit for a given design purpose. Actually is always the same operation, that is the extraction of a subset satisfying a number of conditions, but it can solve design problems which are much more complex.

Imagine you've to design a simply supported beam with a concentrated load at midspan. We would like to have a displacement lower than 1/300 of the span, on applied moment lower than 0.75 times the plastic moment, and that the shape is chosen among american ones. Extract command does the search for you.

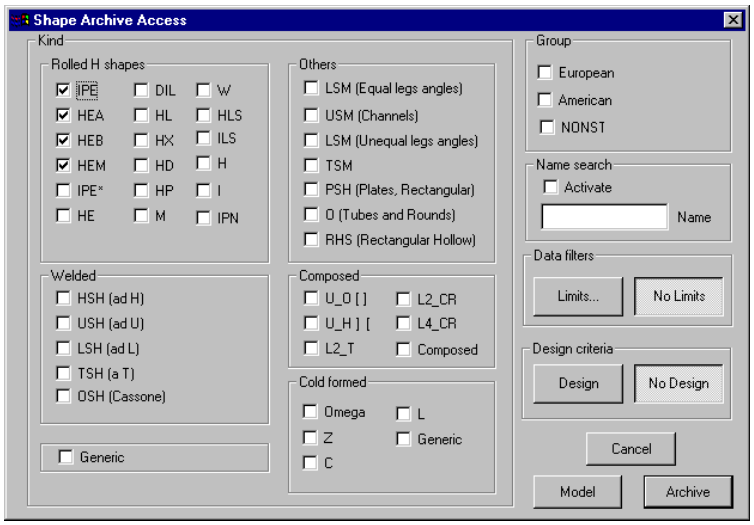
Suppose now you wish to ask for angle L 200x20 properties. In this case the command Extract allows to browse angles only, avoiding the need of browsing the full archive content.

The command is therefore useful to find out shapes having same features, following same criteria (filters).

From operating standpoint the user chooses the filters, and then the command extracts from archive all and just the shapes satisfying the filters themselves, listing them in the bottom right frame.

While the subset is browsed, selecting this or that shape, the selected shape appears in bottom left frame.

As soon as the command is executed a proper dialog box 58 appears, asking a first set of choices.

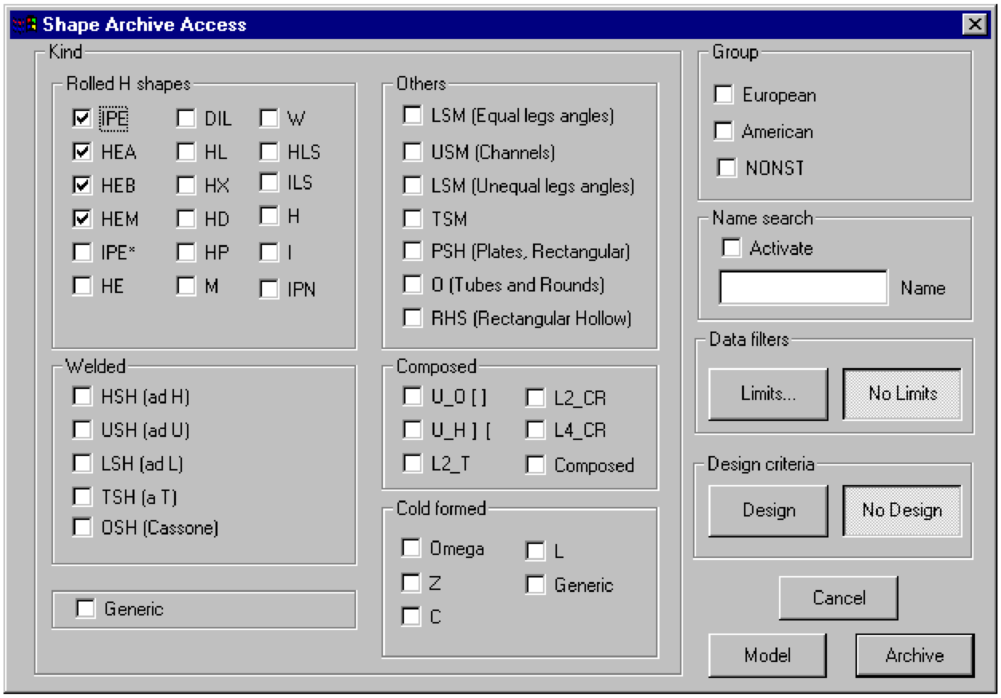


From that dialog is then possible to recall Data Filters 62 and Choice of a design criterion 63 dialog boxes. They lead to other choices and to fix other filters, that are all used additively, that is: **the extracted shapes are the shapes satisfying all the filters specified in the preceding three dialogs, none excluded.**

If no filters is specified, the whole archive is extracted (unsuggested choice, due to time and RAM need).

3.4.1.1 Shape archive access (dialog)

ACCESS TO SHAPE ARCHIVE



This dialog box is used to choose the filters used to extract a subset from the shape archive. Once the filters have been established SARGON chooses only the shapes satisfying the filters.

This dialog box has both buttons and check boxes. Check boxes are divided in three categories: type filters group filters and search by name.

Group: there are three possible group filters: European, American, non standard.

Kind: it has five boxes: **H rolled, Welded, Other, Composed, Cold formed, Generic.**

H Rolled: groups the rolled H shapes.

Welded: groups the welded (or reinforced concrete) shapes

Other: groups IPN, channels (UPN o UNP), angles (LSM), Tees (TSM), plates (PSH), rectangular shapes (PSH), tubes (O), and rounds (O).

Composed: groups the built up shapes. L2_T are two angles joined as to make a T. L2_CR are two angles joined as to make a cross. L4_CR are four angles joined as to make a cross. Generic composed are obtained collecting an arbitrary number of shapes, simple or composed.

Cold formed: groups C, L, Z, Ω and completely generic cold formed shapes.

Generic: groups the shapes identified only by their area and inertia.

Search by name: a check box named "activate" and an edit box named "Name" are set. If the check box is active, the character string in the edit box will be used for name search. In the string semicolons (";") are allowed to separate different criteria, and the "*" character as symbol meaning "any character, one or many". The following are possible search strings:

PLT*	all names beginning with PLT
PLT*;HE*100*	all names beginning with PLT and all sections HE*100*
*PLT	all names ending with PLT

Using name filter it is possible to extract sections belonging to types not included in the standard ones (subtypes, for instance). If sections called PIPPO 100, PIPPO 120, and so on have been added, since the filter "PIPPO" is not available, you can specify as search string "PIPPO*".

Only the sections satisfying at least one of the specified type filter, at least one of the specified group filter and the name search criterion will be chosen. If no group filter is specified the group will not be considered, and so for the type. If the Activate check box of the search by name filter is not checked, name filter will not be kept into account. If no filter at all is specified then only other filters will be used, if specified.

The "other filters" are data filters (Filters on DataHIDD_FILTER_SEC2) **and design filters** (Choice of a Design Criterion 63)**.**

If the other filters will not be specified as well then all the shapes in the archive will be chosen.

The dialog box has buttons as well as check boxes.

The **Limits** button is used to set other filters, the numeric data filters, in an appropriate other dialog box (Filters on DataHIDD_FILTER_SEC2). These filters are added to the previous.

The **No Limits** button switches off all the filters based on numeric data.

The **Design** button is used to set other filters, the Design filters, in a proper new dialog (Choice of a Design Criterion 63). These filters are added to the previous.

The **No Design** button switches off every filter based on a design criterion.

The **Model** button is used to choose the subset using the set of the assigned shape as primary archive (instead of that in sargon.sma). It can be used only using SARGON.

Summing up, several filter are possible. Filters based on **group**, **kind**, **name**, **numeric data** and **design criteria**.

If a shape satisfies **at least one** of the group filters activated it satisfies the group filter.

If a shape satisfies **at least one** of the type filters activated it satisfies the type filter.

If a shape satisfies the name search criterion (if activated) it satisfies the name filter. If the filter is not activated each section satisfies it.

If a shape satisfies **each** of the data filter activated it satisfies the data filter.

If a shape satisfies **each** of the design filter activated it satisfies the design filter.

The shapes extracted are those satisfying every filter (kind, group, name, data and design) specified in this dialog and in the dialogs Filters on data 62 **and** Choice of a Design Criterion 63**, none excluded.**

If no filter is specified the whole archive is extracted (usually not suggested with large archives).

Examples:

To extract **every** IPE and HE shape, **and just them**, tick IPE and HE boxes, so to activate the filter. Remove the tick from all the other boxes. Press the button **No Limit** if a limit is applied and the button **No Design** if a design criterion is applied. Press **Archive**.

To extract only IPE shapes having area greater than 1000 square mm, activate only the IPE box, press the button **Limits**, activate the Area tick, specify as minimum value 1000 (assuming you are using mm as length unit) and as maximum value a very large number. Press **OK** and come back here, press **Archive**.

To extract all the I welded shapes named HSU..., activate the HSH filter, activate the name filter and specify as search string "HSU*".

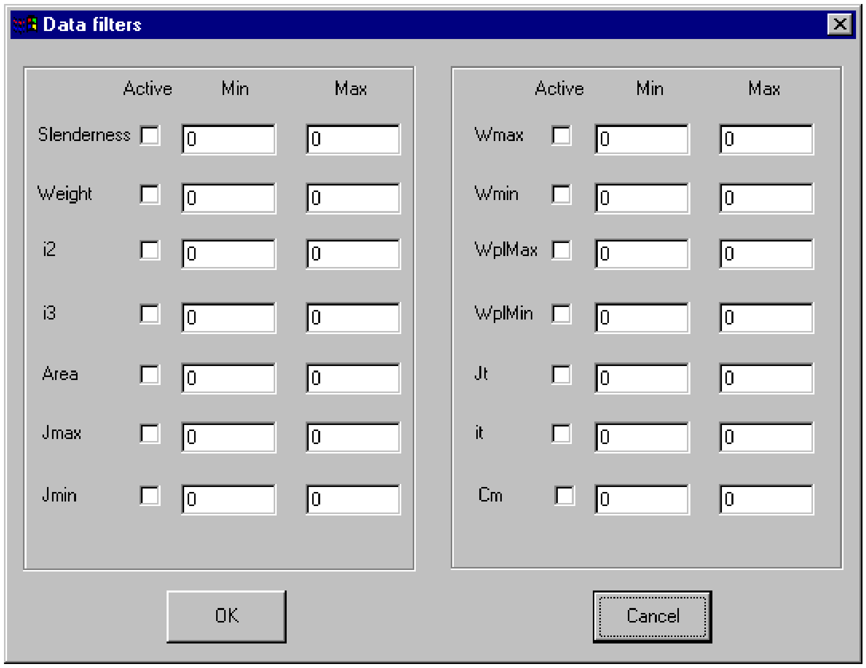
To extract only the welded I shapes named HSU.... and those name HSD.... place a tick only in the HSH check box, activate the name filter and specify as search string "HSU*;HSD*".

You have to design a simply supported 4m steel beam with a 20tons concentrated load in the middle. The design requires a translation lower than 1/500 of the span. A tensile stress lower than 1600 Kg/cm2 is required as well. You wish to use an HE shape.

You will tick the HE box and then choose **Design**. In the design criteria dialog you will choose the proper structural schema (simply supported beam with a concentrated load in the middle), fill the data regarding the span (L=400) and the force value (P=20000) and activate two criteria, setting k=500 and m=1600. We suppose you are using **Kg** and **cm** as active units. Then press **OK** and **Archive** to extract the proper shapes (if any).

3.4.1.1.1 Data filters (dialog)

DATA FILTERS



This dialog box establishes filters based upon section properties. For any property described in the dialog box (**Slenderness**, **Weight**, ...) it is possible to fix maximum and minimum values to be respected by sections to be searched. Data filters are fixed using current units. To activate the proper filter you must add a tick on the relevant box in column "**active**". A tick means the filter is active.

This dialog box is reached from button **Limits** in dialog box Shape Archive Access 58.

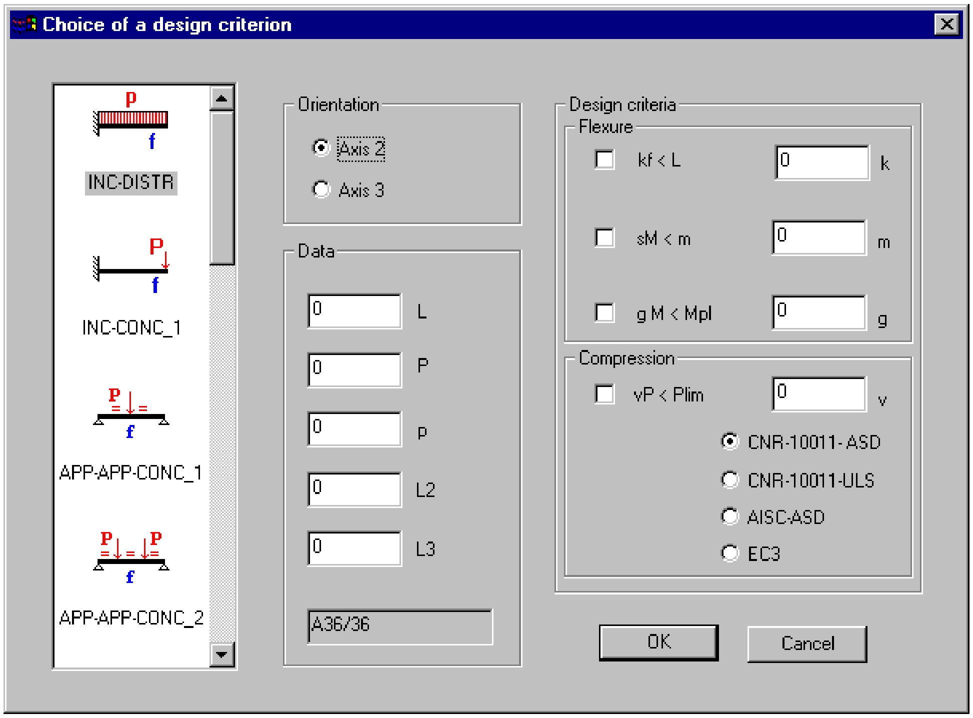
Symbol self explain themselves, except for **Cm** (warping constant), **Jt** (torsional constant), and **it** (torsional radius).

If a filter is activated then the extracted shapes will necessarily have to satisfy it. Numeric data are read depending on active units.

Slenderness and weight filters assume that the length of the element is known. These filters are therefore reserved to be used in conjunction with program Sargon. Using SAMBA as a standalone program this two filters must not be activated.

3.4.1.1.2 Choice of a design criterion (dialog)

CHOICE OF A DESIGN CRITERION



This dialog is used to specify a number of design criteria to be applied to a structural schema.

First of all you choose the structural schema for the element you wish to design. The available schemata are clearly described browsing the left control. The choice of a schema is done by selecting it (that is clicking over it). Among the available schemata there is the beam with springs at the extremes, averaged between built in and simply supported (the moment at midspan is pL^2/10, while the moment at the extremes is pL^2/40). This distribution could be useful in designing frame beams, where each node is elastically joined to the remaining structure.

Once a schema is selected length and load data fields are filled. If the structural schema implies a distributed load you must specify **p**, if it implies one or more concentrated loads you must specify **P**. Every data is decoded on the basis of active units. **P** is a force, **p** is a force for unit length.

When you specify the column schema you don't have to specify **L**, but **L2** and **L3**, that is the two effective lengths relative to principal axes 2 and 3. If the chosen schema is that of the column, **L** is ignored. If, on the other hand, the schema is not that of column, then **L2** and **L3** are ignored.

To use design criteria filters you must first select a material. If the material has not

been selected it is not possible to exit from the dialog box, unless you switch off every design criterion.

If you use Samba as a standalone application, the material selected is in the top right frame.

If you use Samba as part of Sargon the selected material is that common to every selected beam and truss element. If the selected elements do not have a material specified, or have different materials, no material will be selected.

The currently selected material name appears in the readonly edit box under edit boxes referring to lengths and loads. If this edit box is empty, no material is currently selected.

Columns

If the structural schema is that of column, you must choose the criterion relative to axial load **vP < Plim**, specifying the standard used to evaluate the stability curve and the safety factor v (v=1.2 means a safety factor = 1.2). If you choose a column then all other criteria must be switched off.

The Plim value (limit axial load) is computed using stability curves of standards.

Available standards are CNR10011-88 (allowable stress AS or limit state LS); AISC-ASD-89 standards; Eurocode 3.

Formulae provided by each standard are used in computation, so as to accomplish the design criterion. **In examining the stability situation maximum slenderness is always kept into account, as computed using specified effective lengths, no matter the axis 2 or 3 specified in the radio buttons**.

Beams

If the structural schema is that of a beam (differently loaded and constrained), then you can specify the following design criteria:

kf < L

Deflection f must be lower than L/k, where k is a design index fixed by the user. The f value computed is always the maximum, depending on the static schema (load and constraints) that have been chosen. The elastic modulus is that of selected material. The inertia value used is that of the specified axis (2 or 3, see radio buttons).

sM < m

Maximum normal stress due to flexure (sM) must be lower than the limit value, specified by user, m. Normal stress is evaluated on the basis of De Saint Venant's theory, assuming direct flexure around the principal axis specified (2 or 3). The moment is the maximum read over the beam, even if continuous.

gM < Mpl

The maximum moment read along the beam, times the safety factor g must be lower than limit plastic moment, evaluated using the yield stress of selected material, and the plastic modulus of the axis specified (2 or 3).

If the chosen schema is that of a beam, design criteria relative to columns must be switched off.

3.4.2 Command: Shapes-Add

COMMAND: Shapes-Add

This command adds shapes to the archive.
Adding of shapes using this command (you can add shapes using *cut and paste* and *drag and drop* methods as well) can be done in two ways: adding shapes one by one in an easy, interactive way, or adding them by reading a file (usually this is done when many shapes are to be read).

Adding shapes 28
Adding shapes one by one 29
Adding shapes read in a file 31.

As soon as the command is executed a dialog box, Addition of a Shape 67, appears, letting you choose how to add shapes.

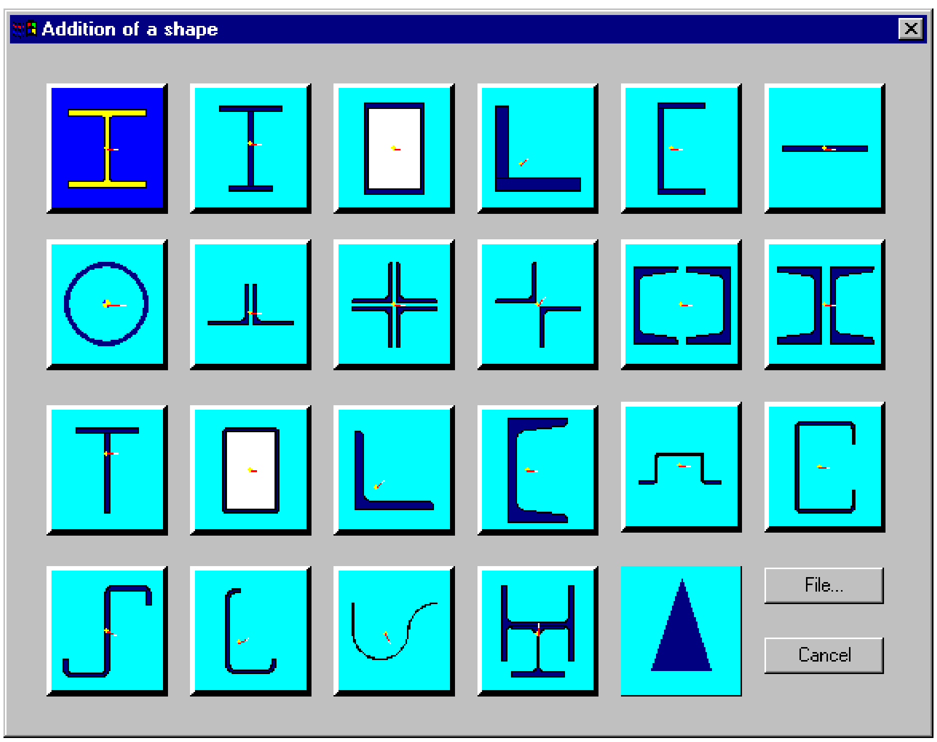
It is not allowed to add a shape having a name already used by another shape in the archive.

It is important to understand that adding shapes is a two step procedure. The first step is to add shapes *to a waiting list*. The second step is to update archives by processing waiting list content. Update is done automatically exiting from SAMBA, if you choose to save changes, or it can be done at any time by command Update 54.

See also: Delete a shape or a material from waiting list 33.

3.4.2.1 Addition of a shape (dialog)

ADDITION OF A SHAPE (DIALOG BOX)



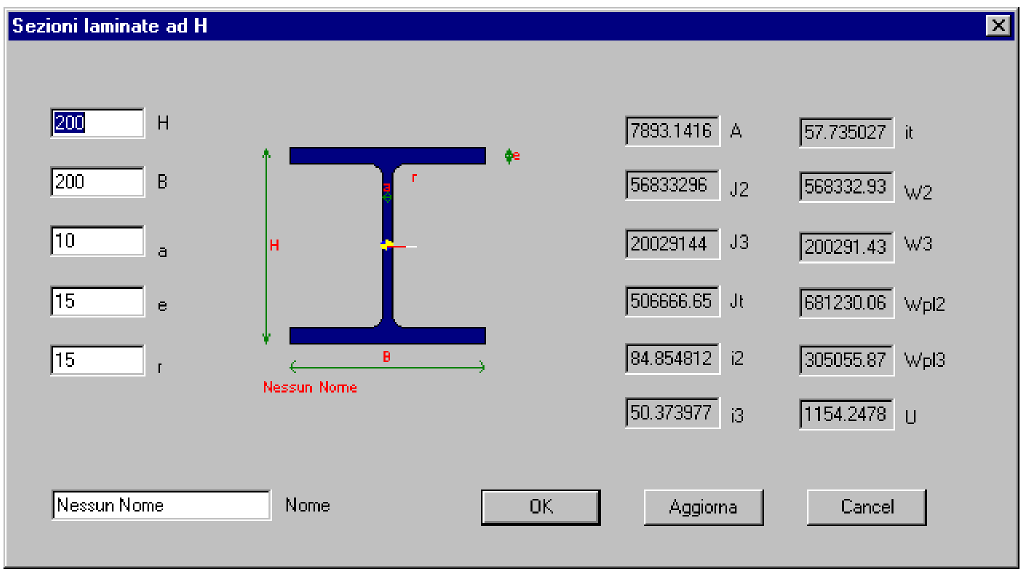
This dialog box is used to add sections. If you press one of the image buttons relative to each available section type, you will get the proper dialog box, allowing to specify the data relative to the chosen section type. If you wish to add generic composed shapes, before you execute the addition command you have to extract from the archive at least the shapes that you will use to build the new composed shape (if you did not do that, just exit using **Cancel**).

If you wish to add many sections at a time, it is possible to specify to the program the name of a data file (button **File...** 161).

3.4.2.1.1 From dialog box

3.4.2.1.1.1 Rolled H sections (dialog)

ROLLED H SECTIONS (DIALOG BOX)



This dialog box provides detailed information about a rolled H-section, and allows it to be added to the archive and its properties analysed.

When the field relating to a given quantity has a white background, it can be edited; otherwise, when greyed-out, it is non-editable (as the quantity is derived from the previous ones).

If the dialog box is opened for information purposes only, all the quantities are greyed-out and cannot be edited.

All the quantities derived from the computation that are common to all sections are shown to the right of the drawing of the section. The section measurements appear on the left.

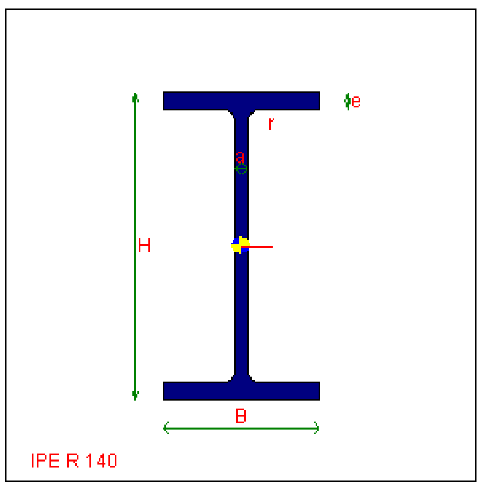
The **Update** button updates the greyed-out data on the basis of the values in the fields with a white background (the free parameters).

Since October 2005, information about limit lengths for short and intermediate links according to Eurocode 3 has been added.

For the meaning of the symbols, please see here 69 for details.

The button **Effective values** open a dialog box 143 where effective values can be computed.

ROLLED H SHAPES



These sections are set by the following parameters:

h	total height
b	flange width
a	web thickness
e	flange thickness
r	circular joint radius

The following rules apply

Each size must be greater than 0;

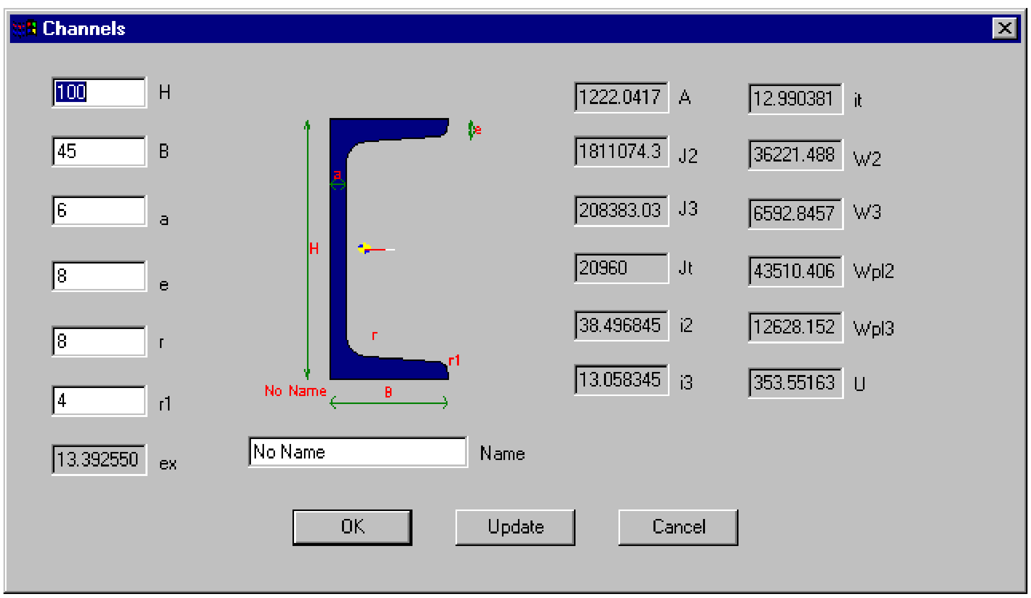
h >= 2e+2r

b >= 2e+2r

The torsional stiffness Jt does not include warping constant, which is computed in Cm.

3.4.2.1.1.2 U rolled sections w ith tapered flanges (dialog)

ROLLED U SHAPES WITH TAPERED FLANGES (CHANNELS, UPN, ISMC) (DIALOG BOX)



This dialog box is used both to have detailed information about U rolled, and to add the shape to archive. It is also used to study shape properties.

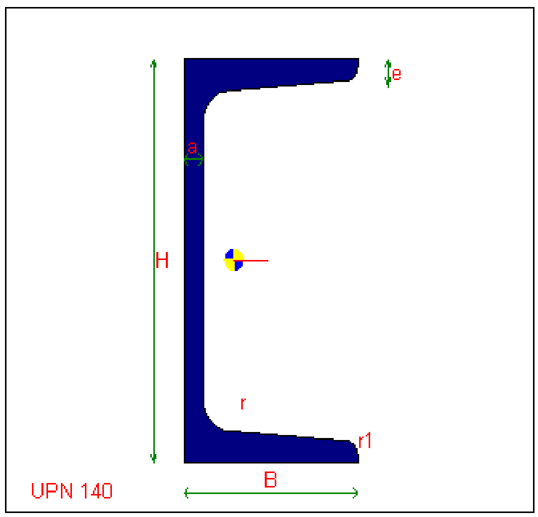
When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 71

CHANNELS



These sections are set by the following parameters:

h	total height
b	flange thickness
a	web thickness
e	flange thickness (b/2 from the extreme for h <= 300mm, (b-a)/2 from the extreme in other cases)
r	web-flange joint radius
r1	flange extreme circular radius

If h <= 300mm the internal side slope is 8% and value 'e' is computed at a distance equal to b/2 from the end. If h > 300mm it is 5% and 'e' is computed at (b-a)/2. To use different rules, add shapes read in a file 31.

Following rules apply:

every size must be > 0;

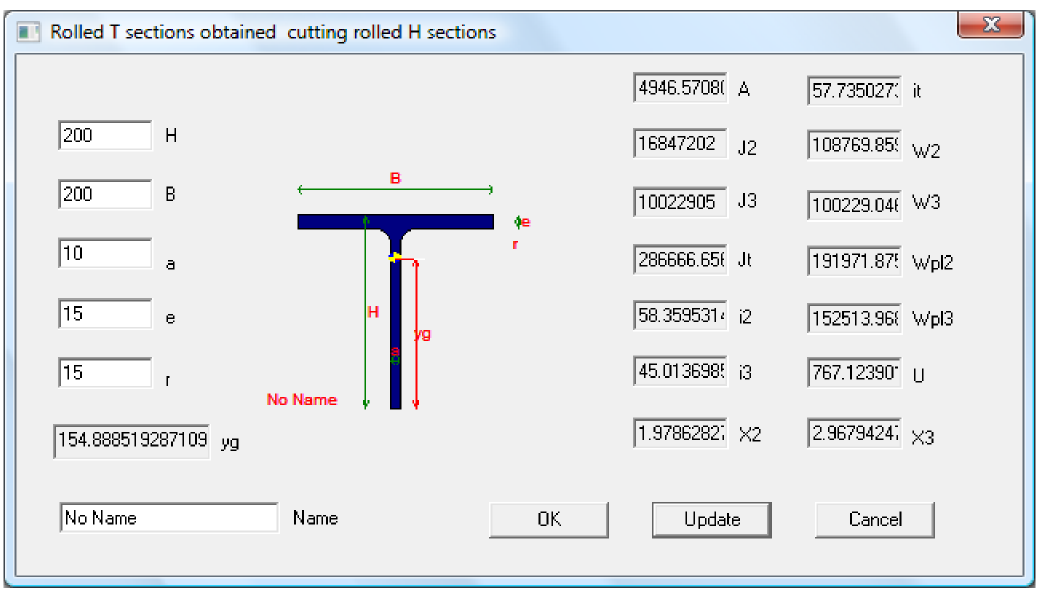
total height cannot be lower than what required by flanges

b >= a+r+r1

The torsional inertia is computed neglecting warping.

3.4.2.1.1.3 T rolled sections obtained by cutting rolled H-sections

ROLLED T SECTIONS OBTAINED BY CUTTING ROLLED H SECTIONS (DIALOG BOX)



This dialog box provides detailed information about a rolled T-section obtained by cutting H-sections, and allows it to be added to the archive and its properties analysed.

When the field relating to a given quantity has a white background, it can be edited; otherwise, when greyed-out, it is non-editable (as the quantity is derived from the previous ones).

If the dialog box is opened for information purposes only, all the quantities are greyed-out and cannot be edited.

All the quantities derived from the computation that are common to all sections are shown to the right of the drawing of the section. The section measurements appear on the left.

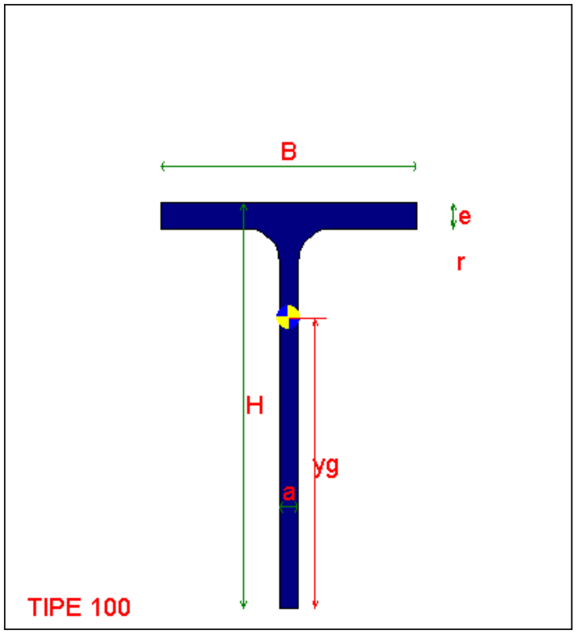
The **Update** button updates the greyed-out data on the basis of the values in the fields with a white background (the free parameters).

NB: the T-sections that are derived from a corresponding H-section, with a total height equal to half that of the original, are listed in the archive under the code “TM” followed by the name of the H-section. For example: TMHE200B is a T-section obtained by dividing an HE200B section in half. On the other hand, if only the lower flange (and the corresponding curved connecting edges) is removed, the section is added as “Tcode”, where “code” is the code of the original H-section. For example, the THE200B section.

For the meaning of the symbols, please see here 73 for details

The button **Effective values** open a dialog box 143 where effective values can be computed.

ROLLED T-SECTIONS obtained by cutting rolled H-sections



These sections are identified via the following parameters:

h total height

b flange width

a web thickness

e thickness of the flanges

r radius of curvature of the edge

The following remarks need to be noted:

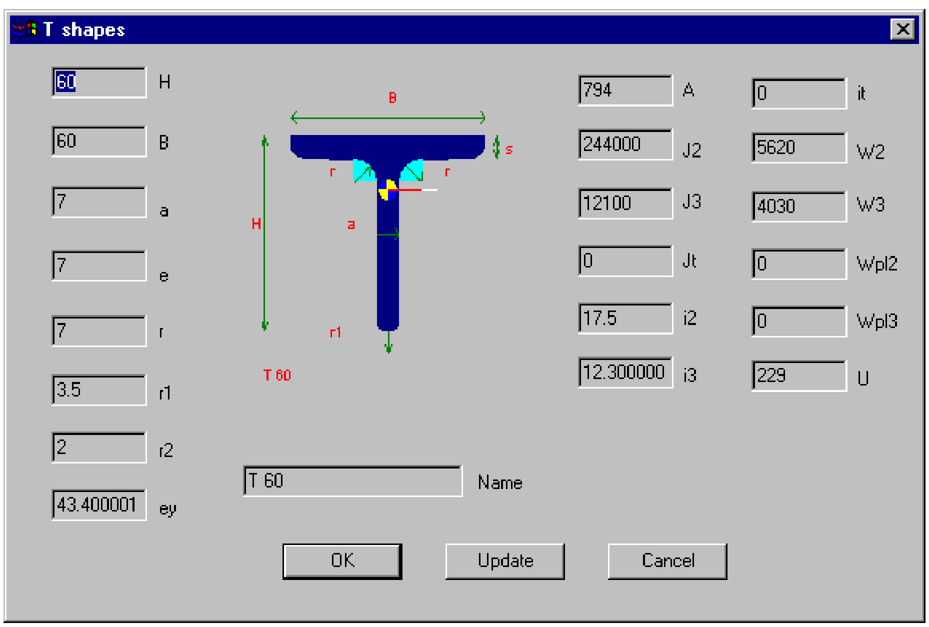
* all measurements must be greater than 0;
* h >= e+r
* b >= 2e+2r

The torsional moment of inertia does not include the warping effects (secondary torsion).

NB: the T-sections that are derived from a corresponding H-section, with a total height equal to half that of the original, are listed in the archive under the code "TM" followed by the name of the H-section. For example: TMHE200B is a T-section obtained by dividing an HE200B section in half. On the other hand, if only the lower flange (and the corresponding curved connecting edges) is removed, the section is added as "Tcode", where "code" is the code of the original H-section. For example, the THE200B section. If, on the other hand, the lower flange and the entire web is removed, the section becomes like a plate and is called "Pcode", where "code" is the code of the original H-section. For example, the PHE200B section.

3.4.2.1.1.4 T rolled sections (tapered sides) (dialog)

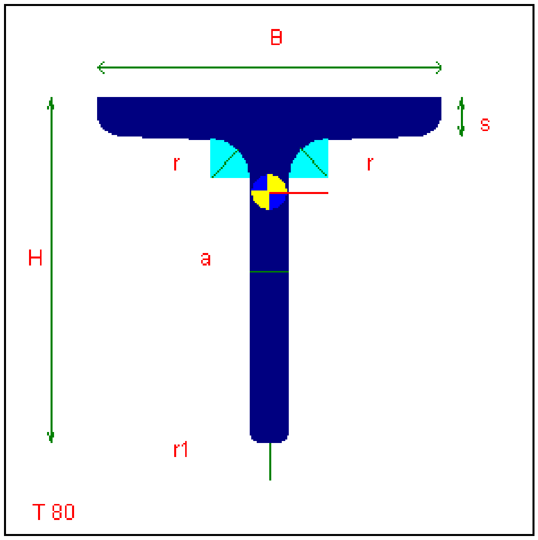
ROLLED T SHAPES (TAPERED SIDES) (DIALOG BOX)



This dialog box is used both to have detailed information about T shapes (tapered sizes). Every field has grey background and is read-only. On the left of drawing there are sizes.

As to symbol meaning see details 76

ROLLED T SHAPES (TAPERED SIDES)



These sections are set by the following parameters:

h	total height
b	flange width
a	web thickness, h/2 from bottom stem extreme
e	flange thickness, b/4 from flange extremes
r	web-flange circular joint radius
r1	flange bevel radius
r2	stem bottom bevel radius

Internal flange side slope is 2%. Stem sides slope is 2%.

Every size must be > 0;

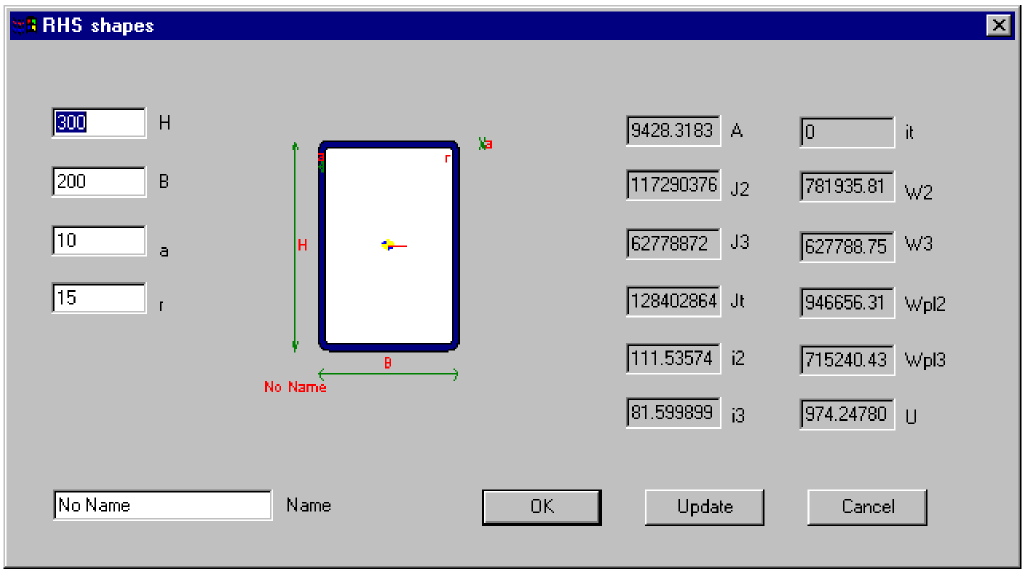
Total height cannot be lower than that required by the flange.

Total width cannot be lower than that required by the stem.

These shapes are seldom used. Their addition is not allowed.

3.4.2.1.1.5 Rectangular hollow sections (dialog)

RECTANGULAR HOLLOW SECTIONS (ROLLED RHS) (DIALOG BOX)



This dialog box is used both to have detailed information about rectangular hollow sections cava a spigoli arrotondati, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

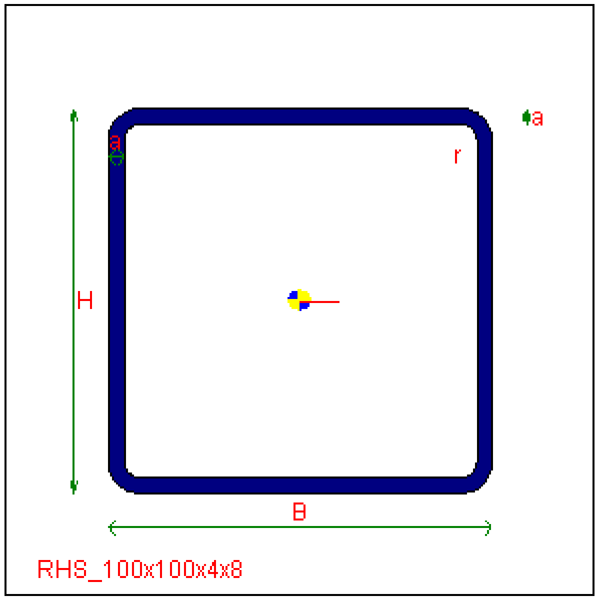
If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 78

The button **Effective values** open a dialog box 143 where effective values can be computed.

RECTANGULAR HOLLOW SECTIONS (RHS)



These shapes are set by the following parameters:

h	overall height
b	overall width
a	thickness
r	external curvature radius

Following restraints apply:

each parameter must be > 0;

r>=a

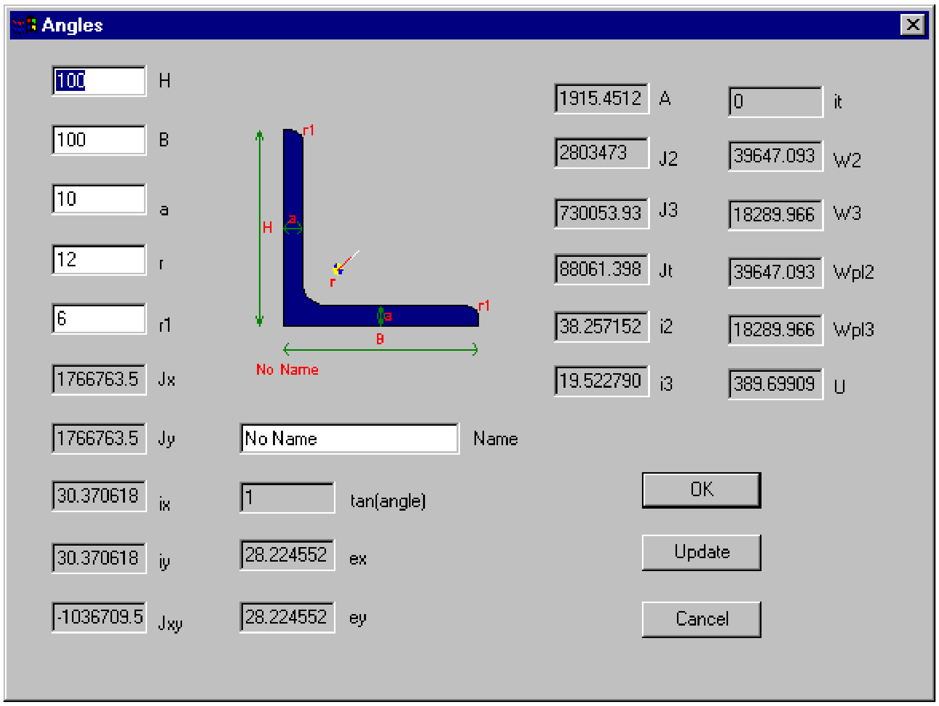
h >= 2r

b >= 2r

The torsional inertia is computed neglecting warping and using Bredt’s formulas.

3.4.2.1.1.6 L rolled sections (dialog)

ROLLED L SHAPES (ANGLES) (DIALOG BOX)



This dialog box is used both to have detailed information about L rolled, and to add the shape to archive. It is also used to study shape properties.

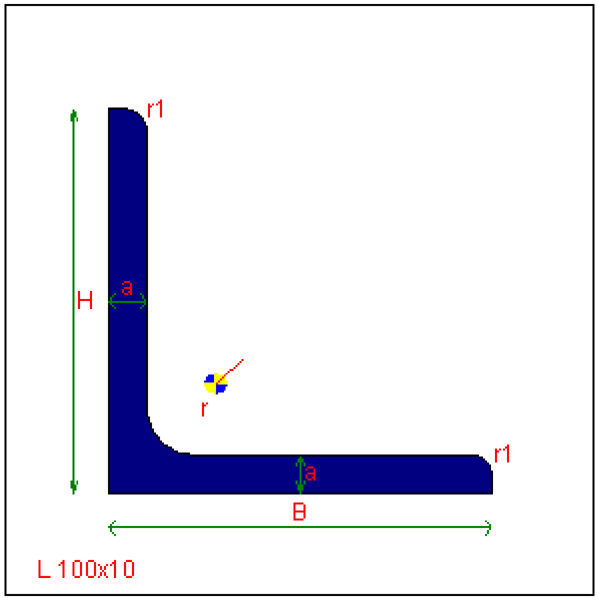
When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 80

ANGLES



These sections are set by the following parameters:

h	total height
b	total width
a	legs thickness
r	circular joint radius
r1	extreme circular bevel radius

The leg sides are parallel.

Following rules apply:

every size must be > 0;

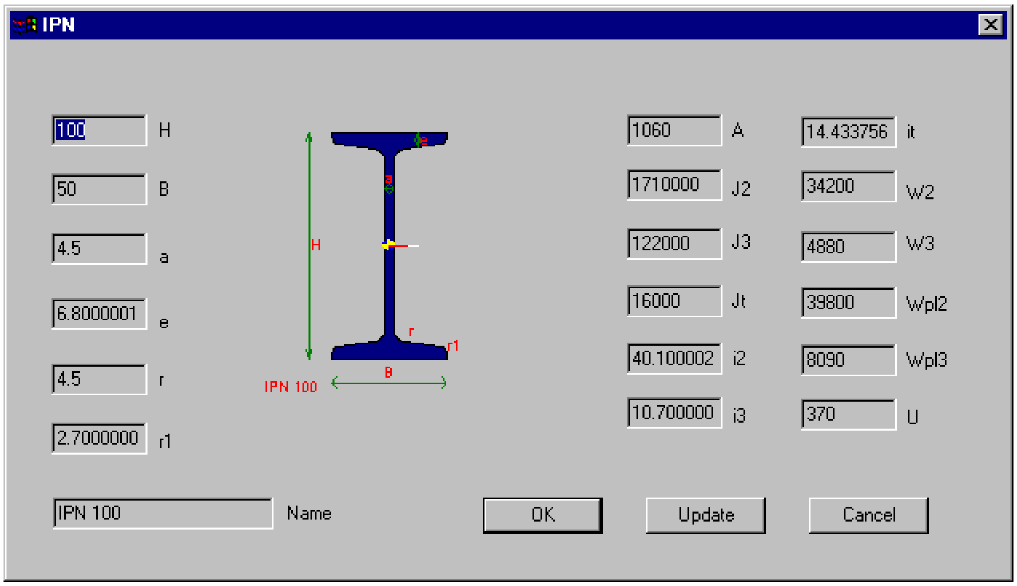
h >= a+r+r1

b >= a+r+r1

a > r1

3.4.2.1.1.7 I rolled sections w ith tapered flanges (dialog)

I ROLLED SECTIONS WITH TAPERED FLANGES (IPN, ISMB) (DIALOG BOX)

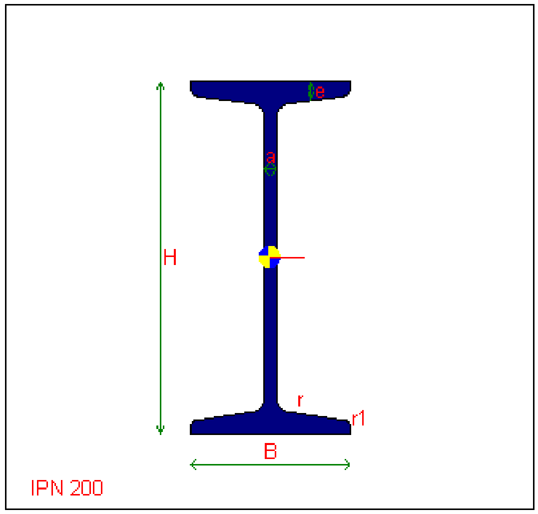


This dialog box is used to have detailed information about I rolled shapes with tapered flanges.

Every field has grey background and is read-only. On the left of drawing there are sizes.

As to symbol meaning see details 81

ROLLED I SHAPES WITH TAPERED FLANGES (IPN, ISMB)



These sections are set by the following parameters:

h	total height
b	total flange width
a	web thickness
e	flange thickness (b/4 from extremes)
r	flange-web circular joint radius
r1	extreme circular bevel radius

The side slope is 14%. Value 'e' is computed at a distance equal to b/4 from the end; to use different rules, add shapes read in a file 31.

Following rules apply:

every size must be >0;

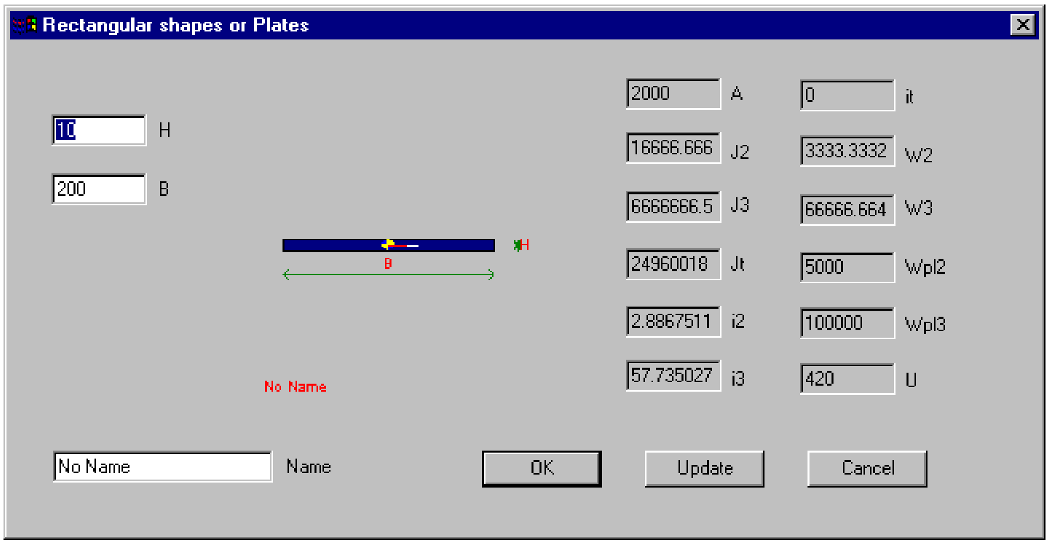
total height can't be lower than what required by flanges (formula omitted)

b >= a+2r+r1

Torsional stiffness neglects warping.

3.4.2.1.1.8 Rectangular shapes or plates (dialog)

RECTANGULAR SHAPES OR PLATES (DIALOG BOX)



This dialog box is used both to have detailed information about rectangular shapes (or a plate), and to add the shape to archive. It is also used to study shape properties.

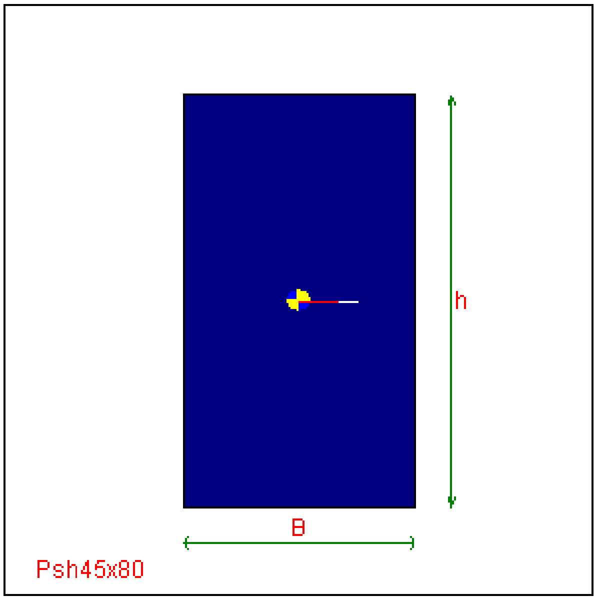
When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire, every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 83

PLATES - RECTANGULAR SHAPES



These shapes are set by the following parameters:

h height

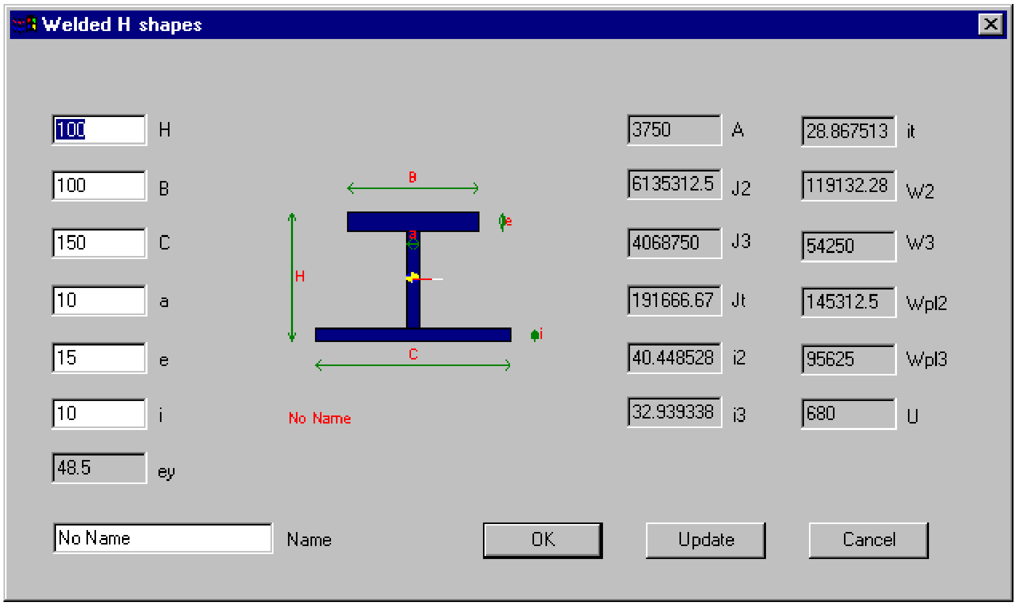
b width

each parameter must be > 0;

The inertia torsional moment is computed neglecting warping. It is computed using h/b functions.

3.4.2.1.1.9 H shapes (dialog)

H SHAPES (DIALOG BOX)



This dialog box is used both to have detailed information about H shapes, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If the dialog box is used to enquire, every field has grey background and is read-only.

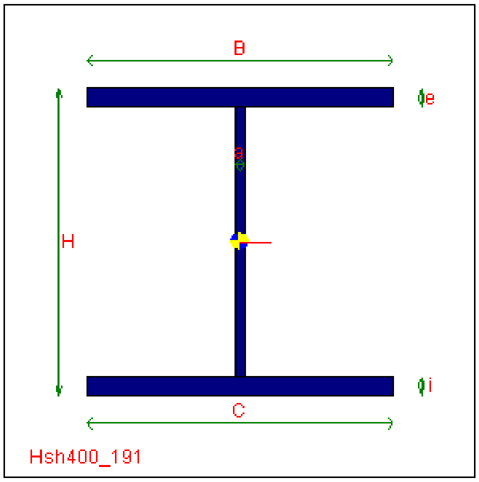
On the left of drawing there are the sizes and the **ey** distance of center from bottom external extreme of the shape.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 85

The button **Effective values** open a dialog box 143 where effective values can be computed.

H SHAPES



These shapes are set by the following parameters:

h	total height
b	top flange width
c	bottom flange width
a	web thickness
e	top flange thickness
i	bottom flange thickness

Following restraints apply:

each parameter must be > 0;

h >= e+i

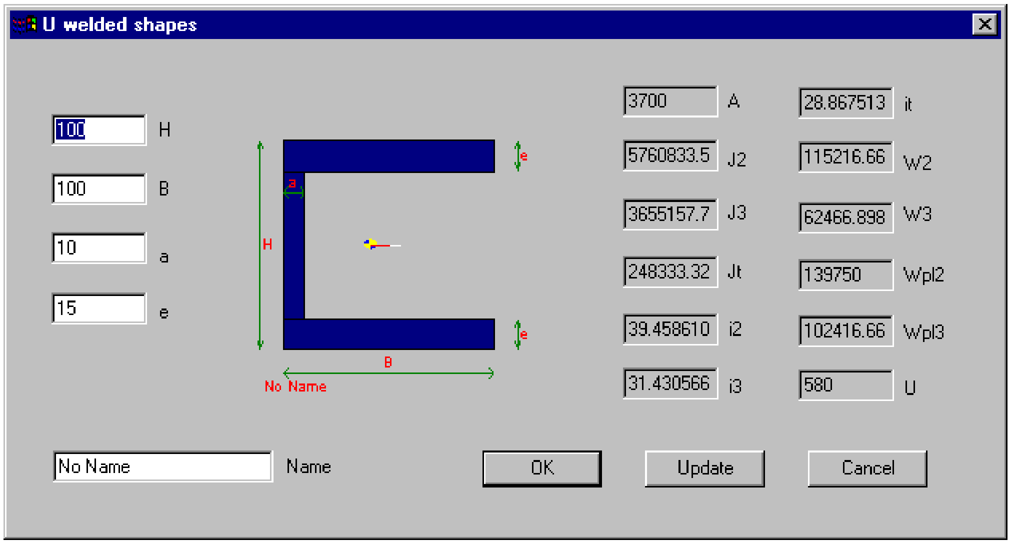
b >= a

c >= a

Second order torsional inertia moment neglects warping.

3.4.2.1.1.10 U shapes (dialog)

U SHAPES (WELDED OR NOT) (DIALOG BOX)



This dialog box is used both to have detailed information about U shapes, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

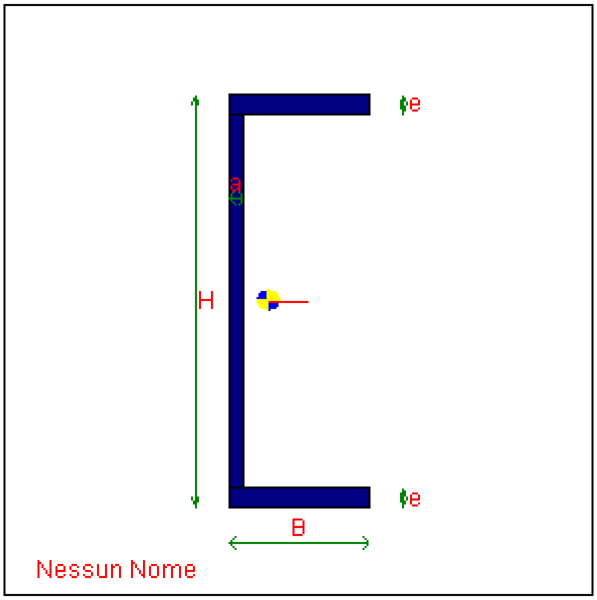
If dialog box is used to enquire, every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 87

The button **Effective values** open a dialog box 143 where effective values can be computed.

U SHAPES



These shapes are set by the following parameters:

h total height

b flange width

a web thickness

e flange thickness

Following restraints apply:

each parameter must be >0;

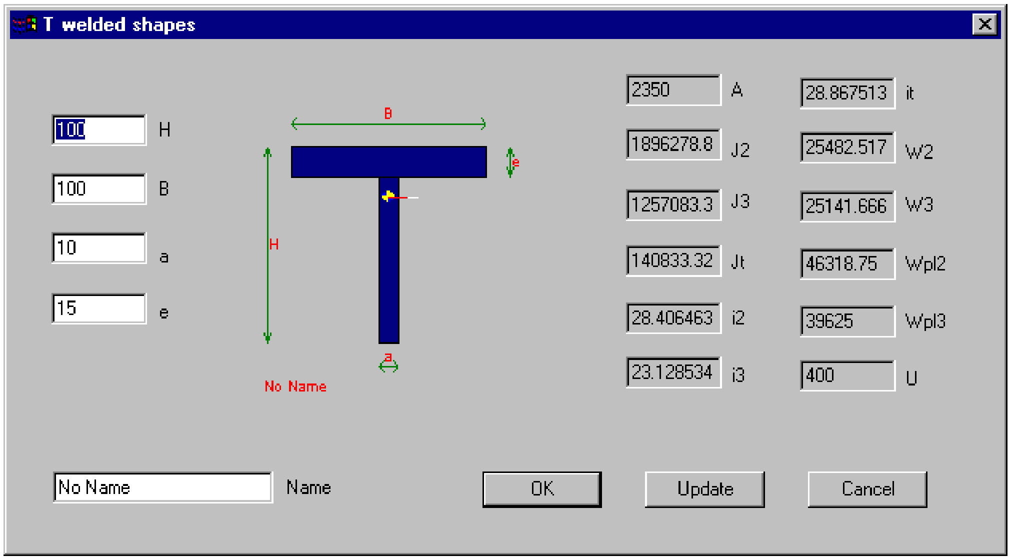
h>= 2e

b >= a

Second inertia torsional moment neglects warping.

3.4.2.1.1.11 T shapes (dialog)

T SHAPES (WELDED OR NOT) (DIALOG BOX)



This dialog box is used both to have detailed information about T shapes, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

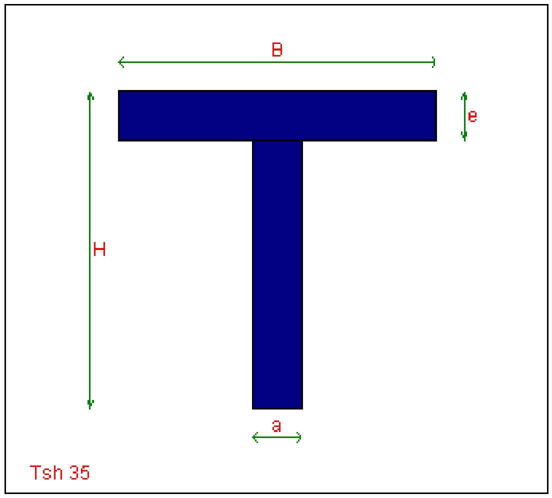
If dialog box is used to enquire, every field has grey background and is read-only. On the left of section drawing there are the sizes and the distance **ey** from the bottom of the section.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 89

The button **Effective values** open a dialog box 143 where effective values can be computed.

T SHAPES



These shapes are set by the following parameters:

h total height

b total width

a web thickness

e flange thickness

Following restraints apply:

each parameter must be > 0;

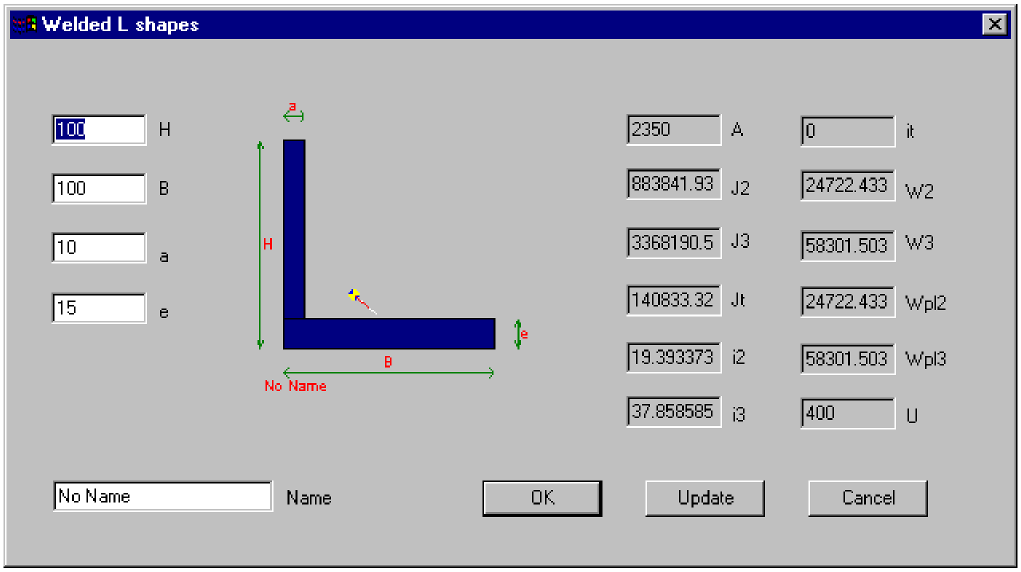
b>=a

h >= e

Second inertia torsional moment neglects warping.

3.4.2.1.1.12 L shapes (dialog)

L SHAPES (WELDED OR NOT) (DIALOG BOX)



This dialog box is used both to have detailed information about L shapes, and to add the shape to archive. It is also used to study shape properties.

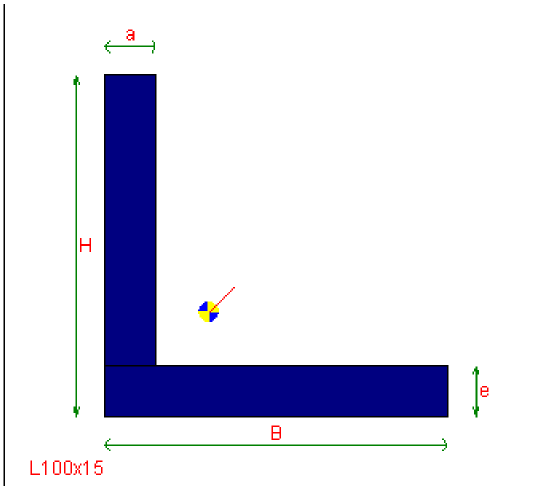
When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 91

L SHAPES



These shapes are set by the following parameters:

h	total height
b	total width
a	thickness of vertical plate
e	thickness of horizontal plate

Following restraints apply:

each parameter must be > 0;

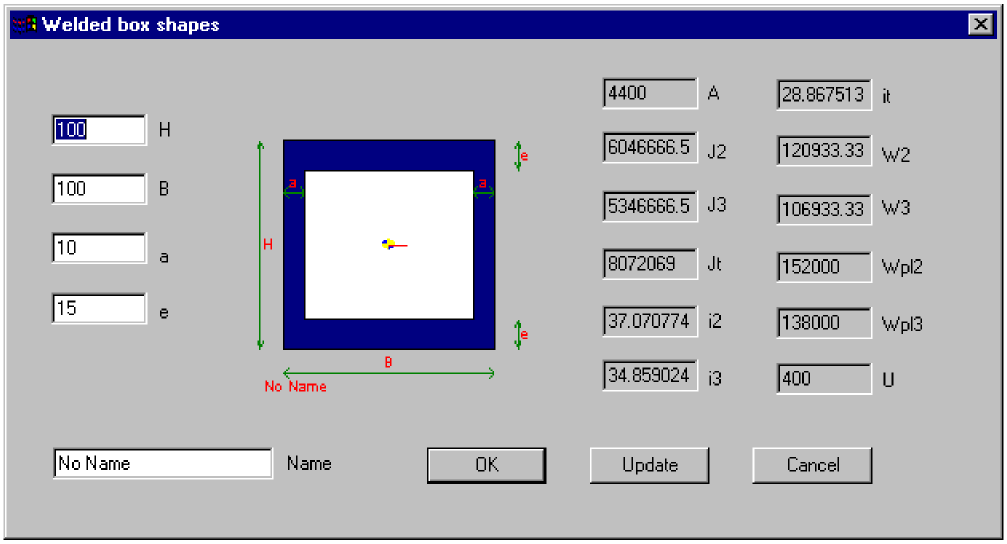
h >= e

b >= a

The second inertia torsional moment neglects warping.

3.4.2.1.1.13 Box shapes (dialog)

BOX SHAPES (DIALOG BOX)



This dialog box is used both to have detailed information about box shapes, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

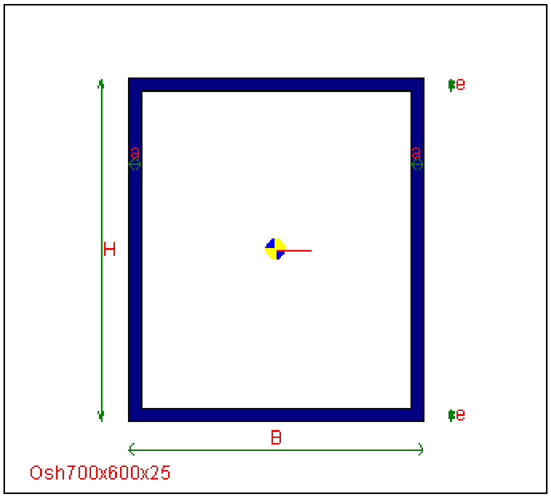
If dialog box is used to enquire, every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 93

The button **Effective values** open a dialog box 143 where effective values can be computed.

BOX SHAPES



These shapes are set by the following parameters:

h total height

b total width

a webs thickness

e flange thickness

Following restraints apply:

each parameter must be >0;

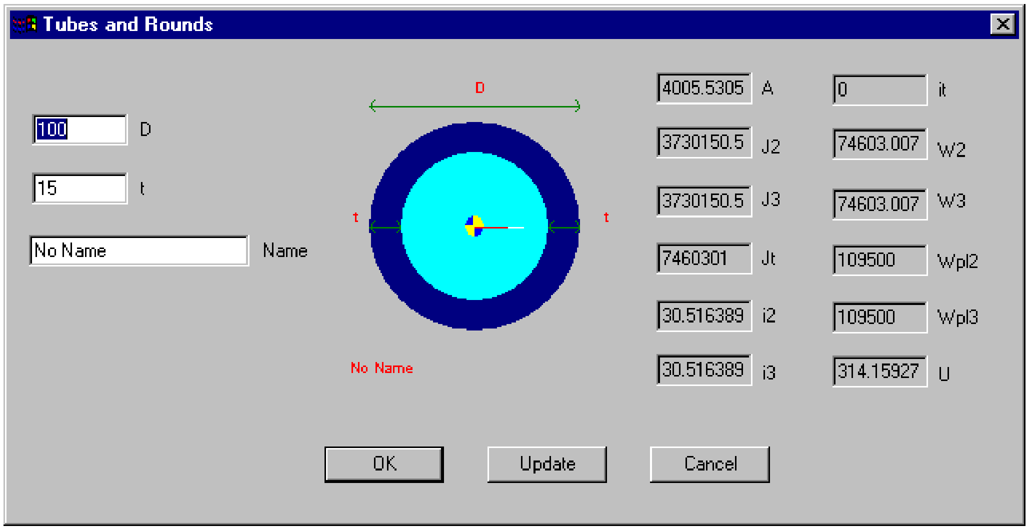
b>=2a

h >= 2e

The second inertia torsional moment neglects warping, and is computed using Bredt's fomula.

3.4.2.1.1.14 Circular hollow sections, rounds (dialog)

CIRCULAR SHAPES (ROUNDS OR CHS) (DIALOG BOX)



This dialog box is used both to have detailed information about circular shapes, and to add the shape to archive. It is also used to study shape properties.

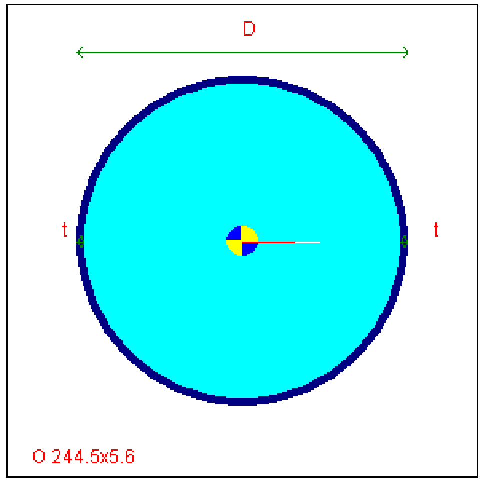
When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

As to symbol meaning see details 95

ROUNDS - CIRCULAR HOLLOW SECTIONS



These shapes are set by the following parameters:

D external diameter

t thickness

Following rules apply:

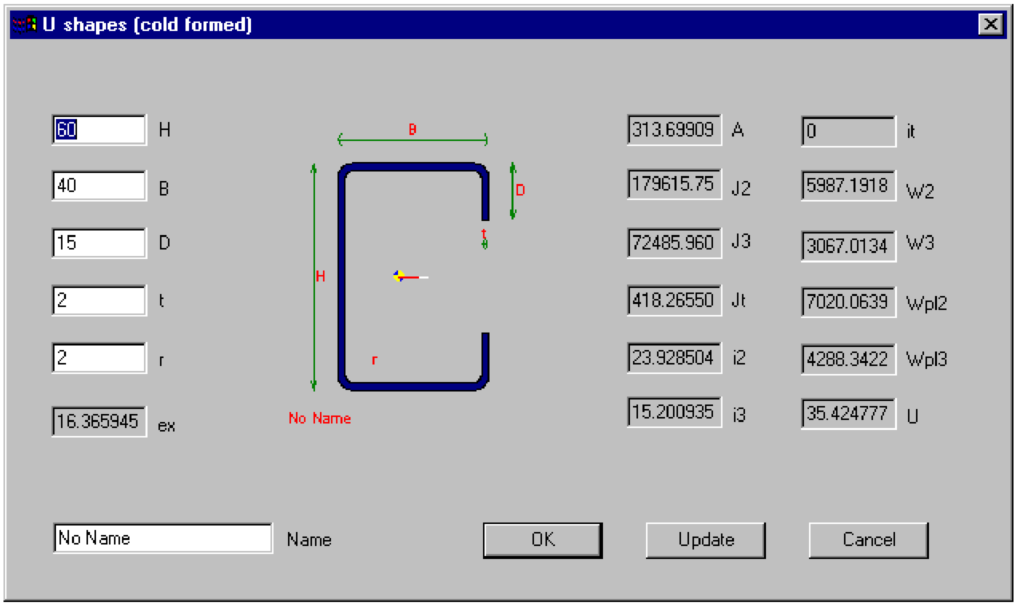
every parameter must be > 0;

D >= 2t

Rounds are obtained by setting t=D/2.

3.4.2.1.1.15 C shapes (cold formed) (dialog)

C SHAPES (COLD FORMED) (DIALOG BOX)



This dialog box is used both to have detailed information about C rolled, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

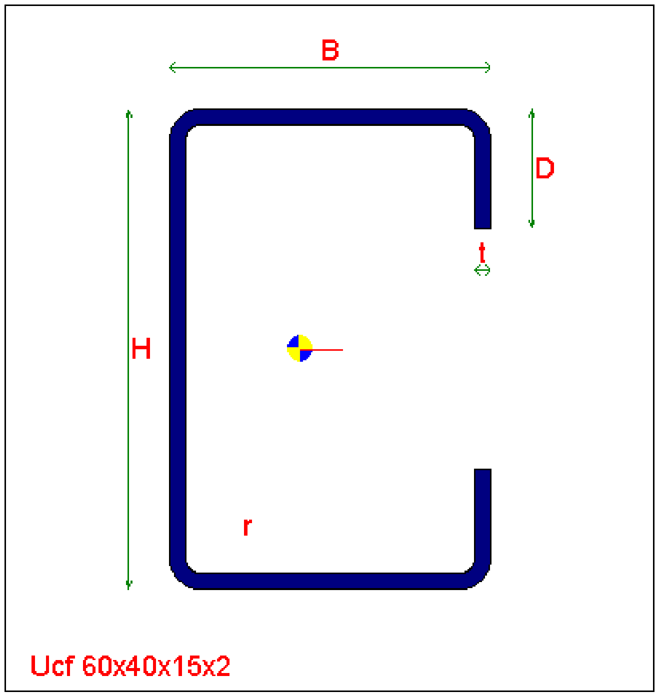
Size D can be null, as well as curvature radius r.

As to symbol meaning see details 98

The button **EN1993-1-3** open a dialog box 143 where effective values can be computed.

The Details **Details** gives access to another window which lists some important properties, computed as per appendix C of EN-1993-1-3, givens also in the effective values computation listing 152.

C SHAPES (cold formed)



These shapes are set by the following parameters:

H total overall height

B total overall width

D total length of stiffener

r internal curvature radius

t thickness

Following restraints apply:

each parameter must be > 0, except D and r, which can be = 0;

H > 2t+2r

H > 2D

B > 2t+2r

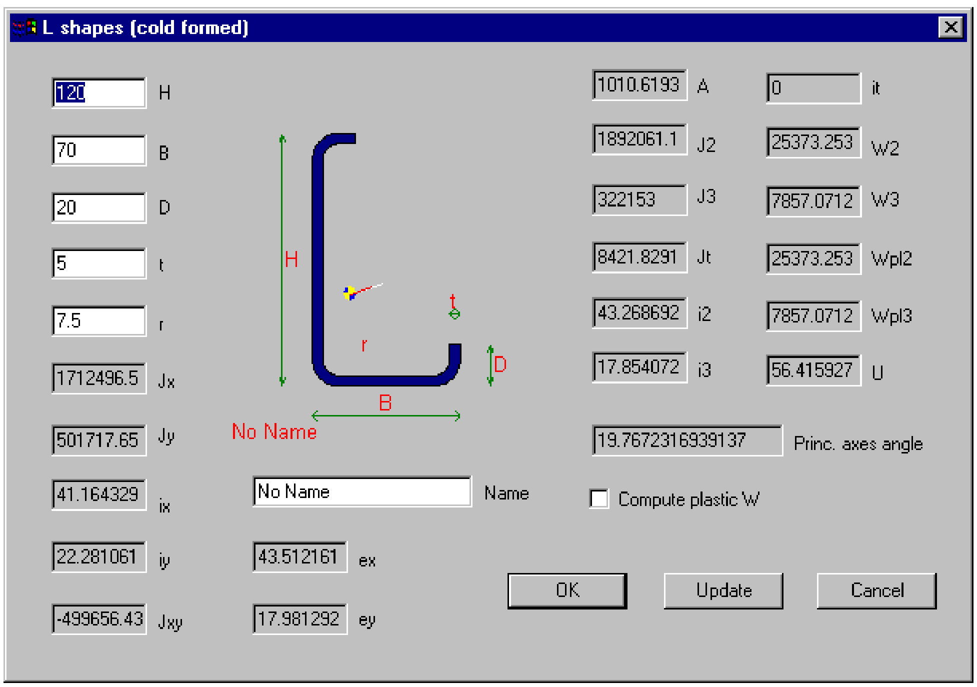
D >= 0

R >= 0

Torsional moment neglects warping.

3.4.2.1.1.16 L shapes (cold formed) (dialog)

L SHAPES (COLD FORMED) (DIALOG BOX)



This dialog box is used both to have detailed information about L rolled, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

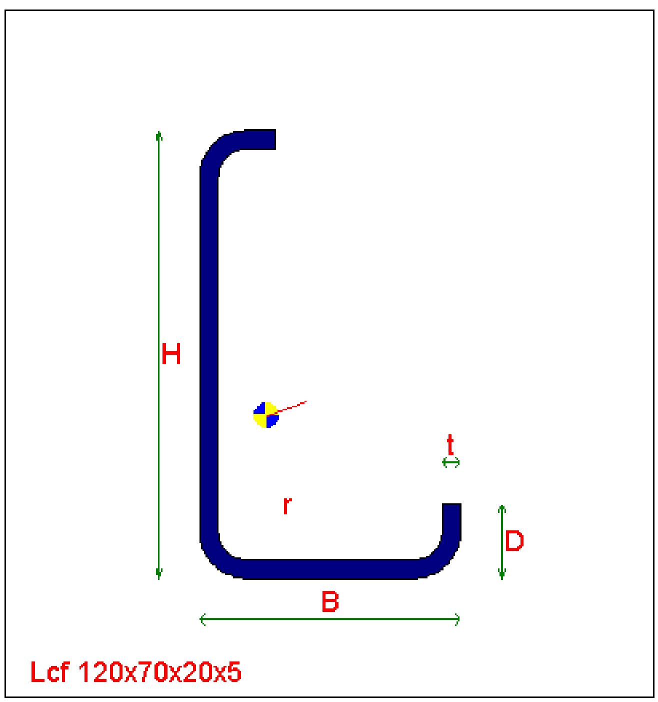
Size D can be null as well as curvature radius r.

As to symbol meaning see details 100

The button **EN1993-1-3** open a dialog box 143 where effective values can be computed.

The Details **Details** gives access to another window which lists some important properties, computed as per appendix C of EN-1993-1-3, givens also in the effective values computation listing 152.

L SHAPES (cold formed)



These shapes are set by the following parameters:

H	total overall height
B	total overall width
D	total length of stiffener
r	internal curvature radius
t	thickness

Following restraints apply:

every parameter must be > 0 except D and r which can be = 0;

H > t+r

H > D

B > D

B > t+r

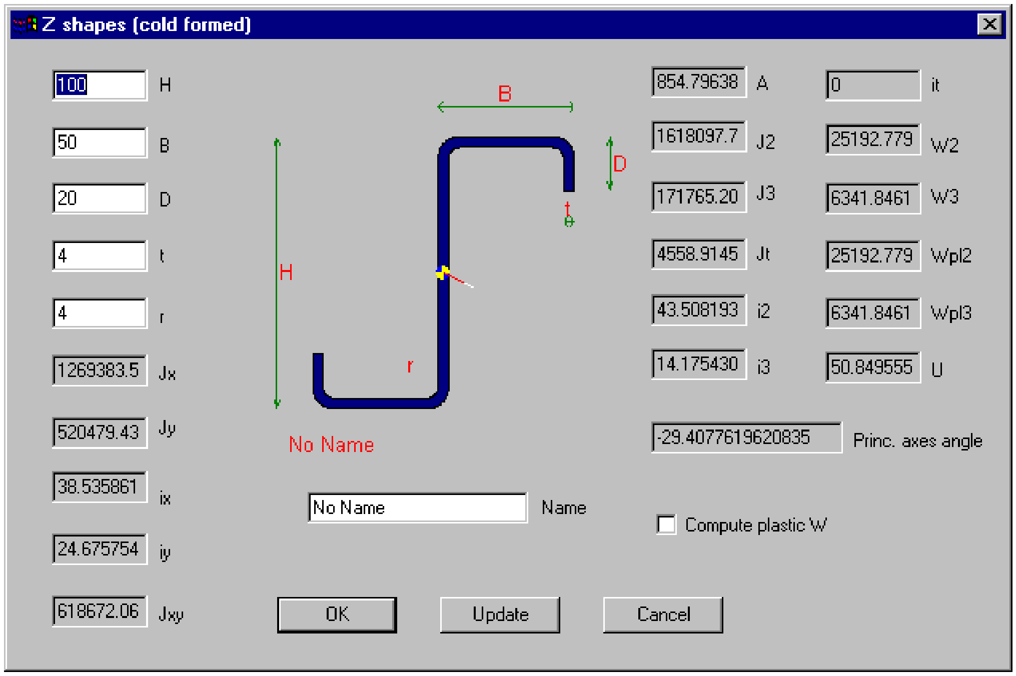
D >= 0

R >= 0

The second inertia torsional moment neglects warping.

3.4.2.1.1.17 Z shapes (cold formed) (dialog)

Z SHAPES (COLD FORMED) (DIALOG BOX)



This dialog box is used both to have detailed information about Z rolled, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

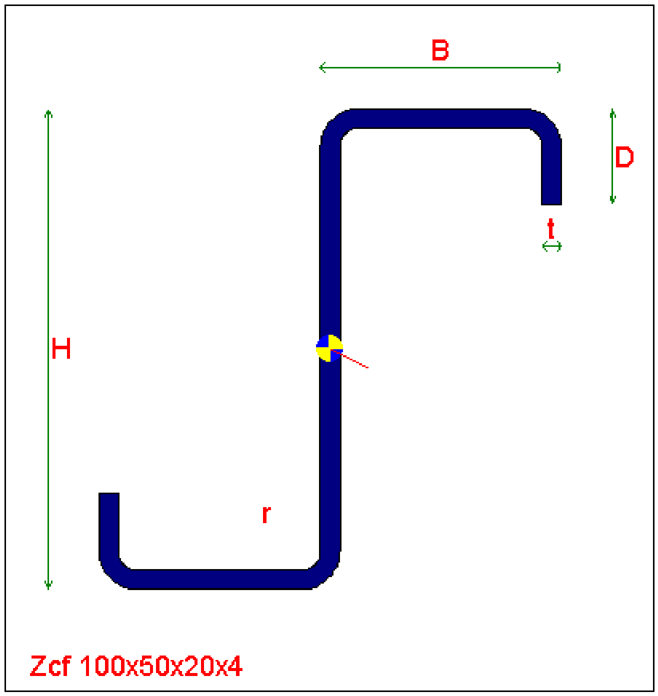
Size D can be null, as well as curvature radius r.

As to symbol meaning see details 103

The button **EN1993-1-3** open a dialog box 143 where effective values can be computed.

The Details **Details** gives access to another window which lists some important properties, computed as per appendix C of EN-1993-1-3, givens also in the effective values computation listing 152.

Z SHAPES (COLD FORMED)



These shapes are set by the following parameters:

H	total overall height
B	total overall width
D	total lenght of stiffener
r	internal curvature radius
t	thickness

Following restraints apply:

Every parameter must be > 0, except D and r, which can be set = 0;

H > 2t+2r

H > 2D

B > t+r

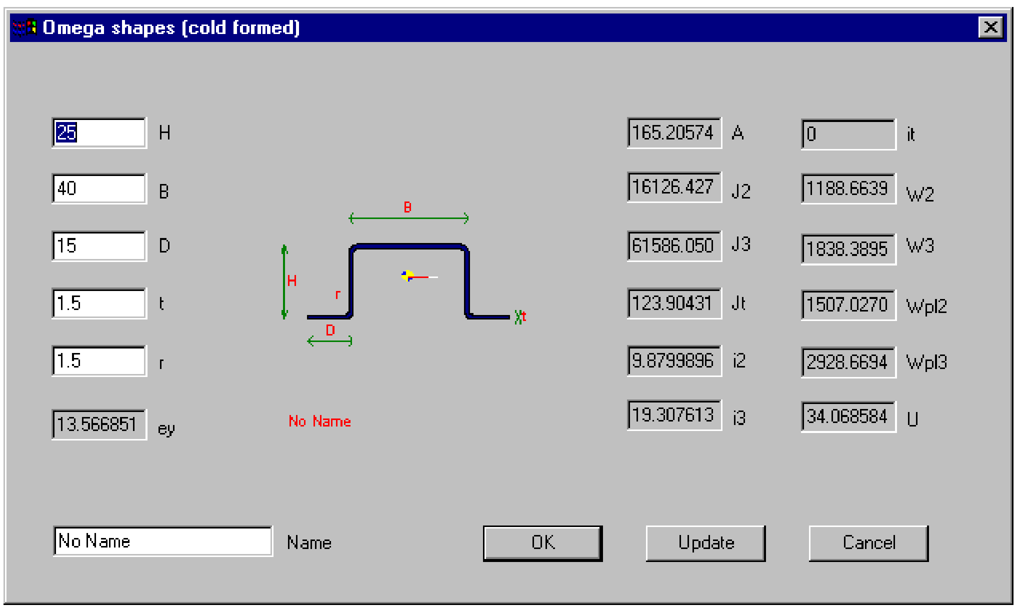
D >= 0

R >= 0

The second inertia torsional moment neglects warping.

3.4.2.1.1.18 W shapes (cold formed) (dialog)

Ω SHAPES (COLD FORMED) (DIALOG BOX)



This dialog box is used both to have detailed information about Ω rolled, and to add the shape to archive. It is also used to study shape properties.

When a field (edit box) has white background this means that you can modify the value. When a field has grey background it can not be modified (because you are just enquiring or because this value is obtained from the others).

If dialog box is used to enquire every field has grey background and is read-only. On the left of drawing there are sizes.

The **Update** button updates the grey-background values on the basis of white background values (parameters).

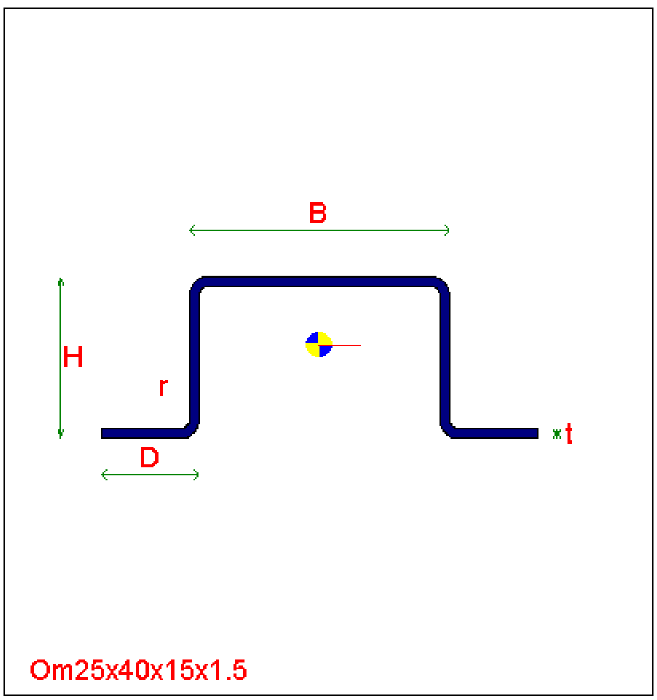
Internal radius r can be null.

As to symbol meaning see details 105

The button **EN1993-1-3** open a dialog box 143 where effective values can be computed.

The Details **Details** gives access to another window which lists some important properties, computed as per appendix C of EN-1993-1-3, givens also in the effective values computation listing 152.

Ω SHAPES (cold formed)



These shapes are set by the following parameters:

H total overall height

B	total overall width
D	total width of bottom flanges
r	internal curvature radius
t	thickness

Following restraints apply:

every parameter must be > 0, except r that can be null;

H > 2t+2r

B > 2t+2r

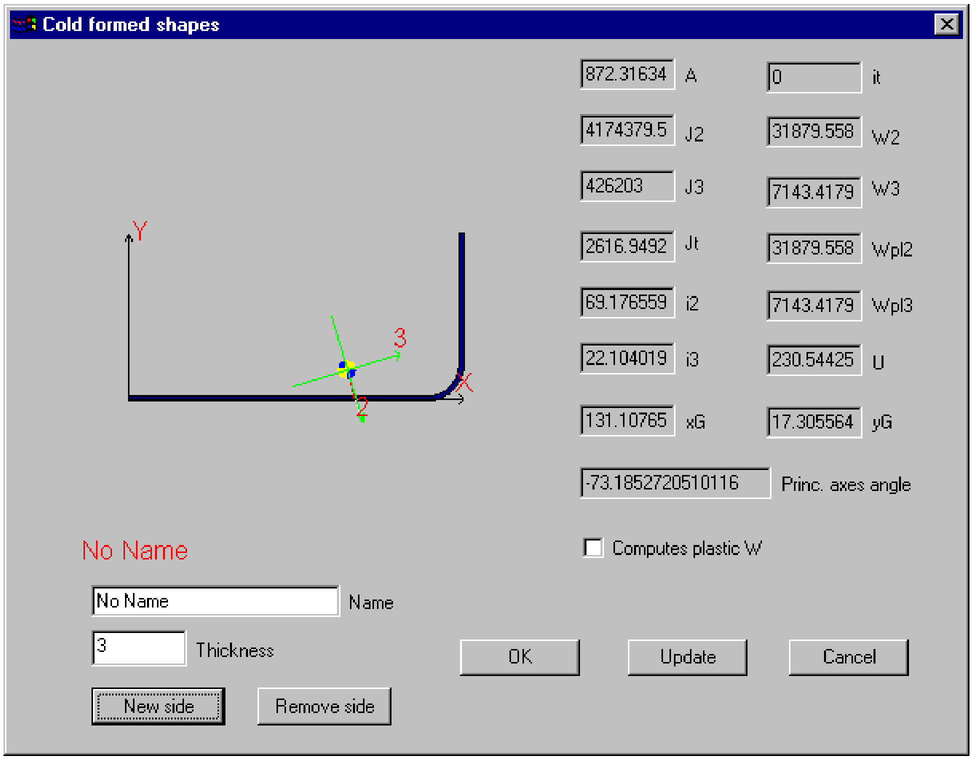
B > t+r

R >= 0

The second inertia torsional moment neglects warping.

3.4.2.1.1.19 Cold formed shapes (dialog)

COLD FORMED SHAPES (DIALOG BOX)



This dialog box is used to describe generic cold formed shapes. First of all you specify shape thickness, then you add sides, and finally you choose the name. Thickness can be changed at any time after the side addition: just change the value and press the update button.

All sizes are read on the basis of active units.

The **New side** button is used to add a new side, and calls the proper dialog box (Choice of the side kind and way to add 109).

The **Remove Side** button is used to delete the last side added.

Each time a new side is added data are recomputed. Side can also stand for holes.

Shape can be open or closed. A closed shape ends exactly in the same point where it began. Torsional constant of closed shapes is computed using Bredt's formula.

After all sides have been added you can ask the program to compute plastic moduli; you can do that by applying a tick in the proper check box and then pressing **Update** button.

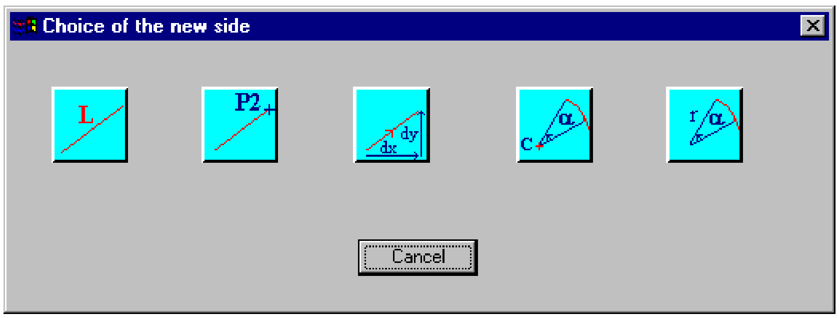
The Details button gives access to another window which lists some important properties, computed as per appendix C of EN-1993-1-3.

The contents of the subsequent dialog box may be copied and pasted; an example of such a file is given below. The terminology is the same as that in the appendix, with the sole difference that the (X, Y) axes are used instead of the (y, z) axes.

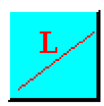
```
*******************************************************************************
*                                                                             *
*                                                                             *
*                         Cold Formed Section Computation Data                *
*                                                                             *
* Castalia srl - www.castaliaweb.com - Copyright (C)                          *
*******************************************************************************

Section is computed according to EN1993-1-3:2006, Annex C
Curved sides, if any, are divided into straight segments

Section: *******
N os:            11 - number of original sides
N ass:           11 - number of assumed straight sides
Area:              1.600e-003 - area     m^2

Sx0:              -1.401e-004     m^3 - first area moment (x,y)
Sy0:               2.704e-004     m^3 - first area moment (x,y)
Ix0:               1.608e-005     m^4 - second area moment (x,y)
Iy0:               6.508e-005     m^4 - second area moment (x,y)
Ixy0:             -2.368e-005     m^4 - mixed second area moment (x,y)

xg:                1.690e-001     m - gravity center x coordinate
yg:               -8.757e-002     m - gravity center y coordinate

Ix:                3.807e-006     m^4 - second area moment (xg, yg)
Iy:                1.938e-005     m^4 - second area moment (xg, yg)
Ixy:              -3.195e-013     m^4 - mixed second area moment (xg, yg)

Icsi:              1.938e-005     m^4 - second area moment (principal axes)
Ieta:              3.807e-006     m^4 - second area moment (principal axes)
alpha:             4.759e-306 (deg) - rotation angle of principal axes

omega,mean:        1.952e-002     m^2 - omega mean
Ixom0:             8.987e-006     m^5 - sectorial constant
Iyom0:            -2.092e-006     m^5 - sectorial constant
Iomom0:            1.445e-009     m^6 - sectorial constant

Ixom:              3.708e-006     m^5 - sectorial constant (xg, yg)
Iyom:              6.433e-007     m^5 - sectorial constant (xg, yg)
Iomom:             8.353e-007     m^6 - sectorial constant (xg, yg)

Iw:                1.701e-008     m^6 - warping constant
It:                4.801e-009     m^4 - torsional constant
xct:               1.690e-001     m - shear center x coordinate
yct:              -1.914e-001     m - shear center y coordinate
xs:                1.038e-009     m - = xct - xg
```

```
ys:                -1.038e-001      m - = yct - yg
xj:                -1.882e-009      m - non symmetry factor
yj:                -1.897e-001      m - non symmetry factor
```

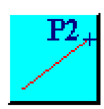
CHOICE OF THE NEW SIDE (DIALOG BOX)



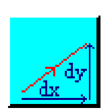
This dialog box is used to choose the kind of the side to be added, and the way to add it. To each bitmap button is linked a different dialog box and a different choice, according to following code:



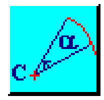
Makes you add a straight side, tangent to last side. You just have to input side length (with a proper dialog box 110).



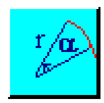
Makes you add a straight side. You must input absolute coordinates of new point (with a proper dialog box 111).



Makes you add a straight side. You must input new point coordinates relative to last point (with a proper dialog box 111).

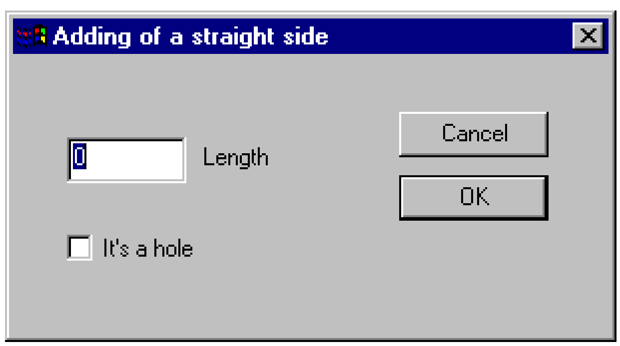


Makes you add a circular side. You must input center coordinates and angular side opening in degrees (using a proper dialog box 112).



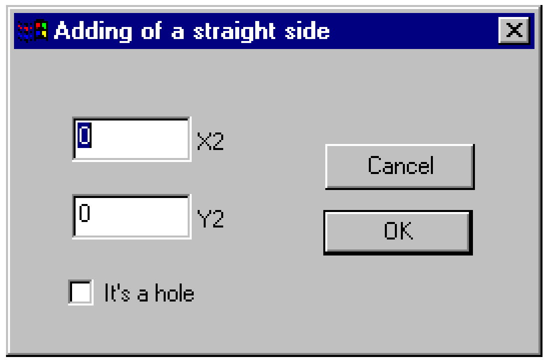
Makes you add a circular side. You must input average radius and new side angular span (with a proper dialog box 112).

ADDITION OF A STRAIGHT SIDE (DIALOG BOX)



This dialog box asks the length of the new side in active units and also asks if the side stands for a hole or not. The side will be added so as to be tangent to last added side. If no side has been added yet, this dialog box is not available, since its button is inactive.

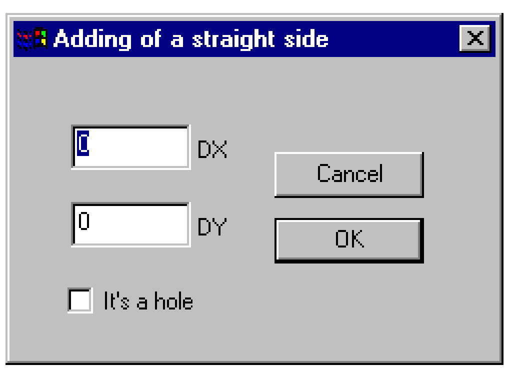
ADDITION OF A STRAIGHT SIDE (DIALOG BOX)



This dialog box asks for the coordinates of the second extreme of the new side, in current units. It also asks if the side stands for a hole or not. The first extreme of the new side is the second extreme of the previously added side. If no side has been previously added, initial point coordinates must be input (Initial Point Coordinates 113 dialog box).

If the new side creates a cusp with the previous one the program can not accept the side. Anyhow, it can add automatically a curved side, so as to smooth the cusp (in this case internal curvature radius of curved side is asked by Internal Curvature Radius 113 dialog box).

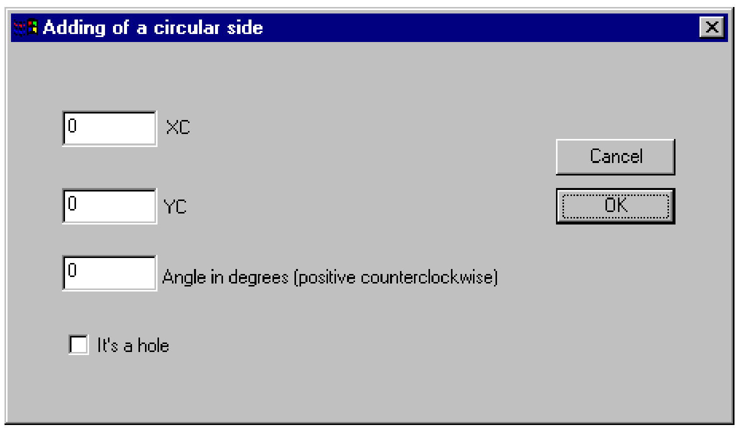
ADDITION OF A STRAIGHT SIDE (DIALOG BOX)



This dialog box asks for the coordinates of the second extreme of the new side relative to the first extreme, in current units. It also asks if the side stands for a hole or not. The first extreme of the new side is the second extreme of the previously added side. If no side has been previously added, initial point coordinates must be input (Initial Point Coordinates 113 dialog box).

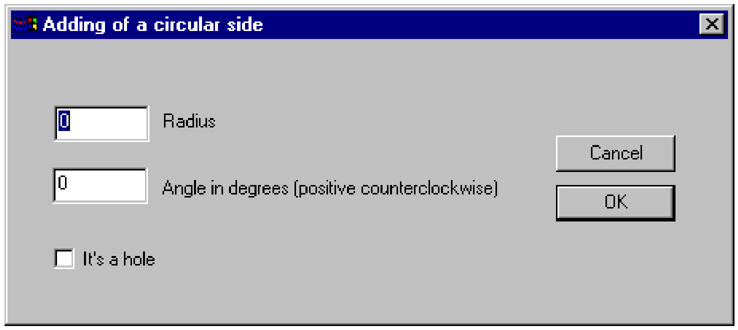
If the new side creates a cusp with the previous one the program can not accept the side. Anyhow, it can add automatically a curved side, so as to smooth the cusp (in this case internal curvature radius of side is asked by Internal Curvature Radius 113 dialog box).

ADDITION OF A CIRCULAR SIDE (DIALOG BOX)



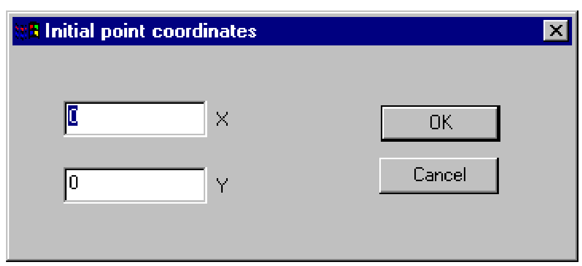
This dialog box is used to input the coordinates of the center of the circle on which lays the new side in for being added, the angular span of the new side, and if the side stands for a hole or not. The angular span must be input in degrees and is positive if counterclockwise. The new side will be tangent to the previously added one. If no side has been previously added the program asks for initial point coordinates (with a proper dialog box 113) and assumes that the initial tangent is horizontal. Center coordinates must be input using current units.

ADDITION OF A CIRCULAR SIDE (DIALOG BOX)



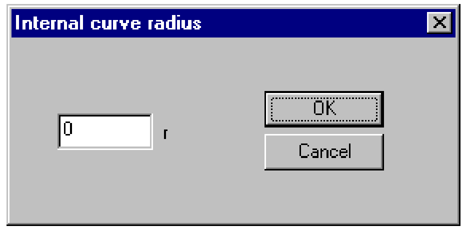
This dialog box asks the radius of the circle on which lays the new side, the angular span of the new side, and if the new side stands for a hole or not. The angular span is in degrees and is positive if counterclockwise. The new side will be tangent to the previous one. If no side has been added the program asks the initial point coordinates (with a proper dialog box 113) and assumes that initial tangent is horizontal. The center coordinates must be input using active units.

INITIAL POINT COORDINATES (DIALOG BOX)



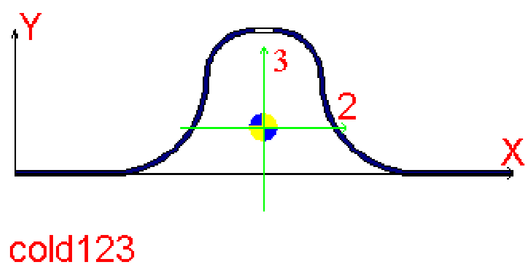
When the first side of a generic cold formed shape is added, the program asks for initial point coordinates, that is of the first extreme of the side in for being added. This dialog box is used to input initial point coordinates, using active units.

INTERNAL CURVE RADIUS (DIALOG BOX)



When a straight side forming a cusp with the previous one is added, SAMBA asks if the user wishes to add a circular side capable of smoothing the cusp. If you answer “Yes” the program asks the internal radius of point-side to be added. This is done by this dialog box. Data must be input using current units.

GENERIC COLD FORMED SHAPES



Very general cold formed shapes can be added by SAMBA. You can study shapes obtained as a set of constant thickness sides. Sides can be straight or circular, and must not create cusps (middle line is contimous with its first derivative).

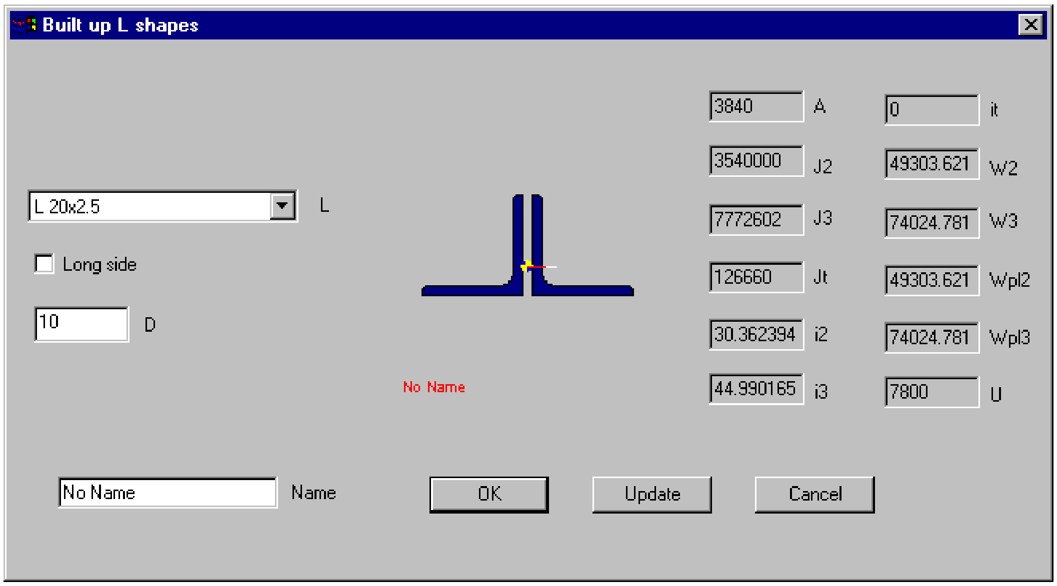
Side can stand for holes.

The shapes can be open or closed. If they are open the torsional inertia is computed as It = (1/3)Ls^3, where L is the total length and s is the thickness. If they are closed Bredt’s formula is used.

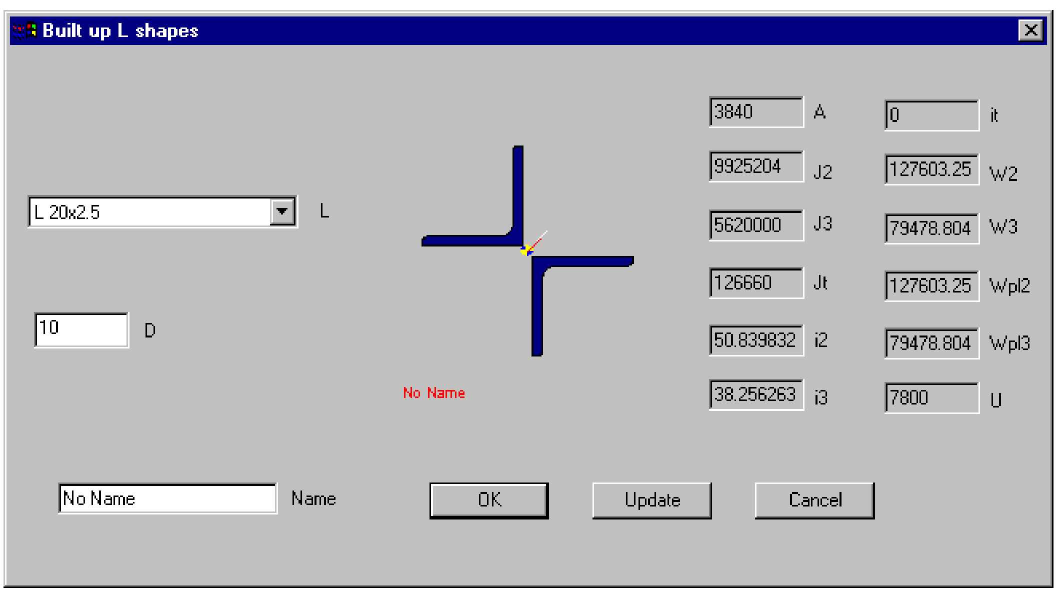
3.4.2.1.1.20 Section composed by angles (dialog)

SECTION COMPOSED BY ANGLES (DIALOG BOX)

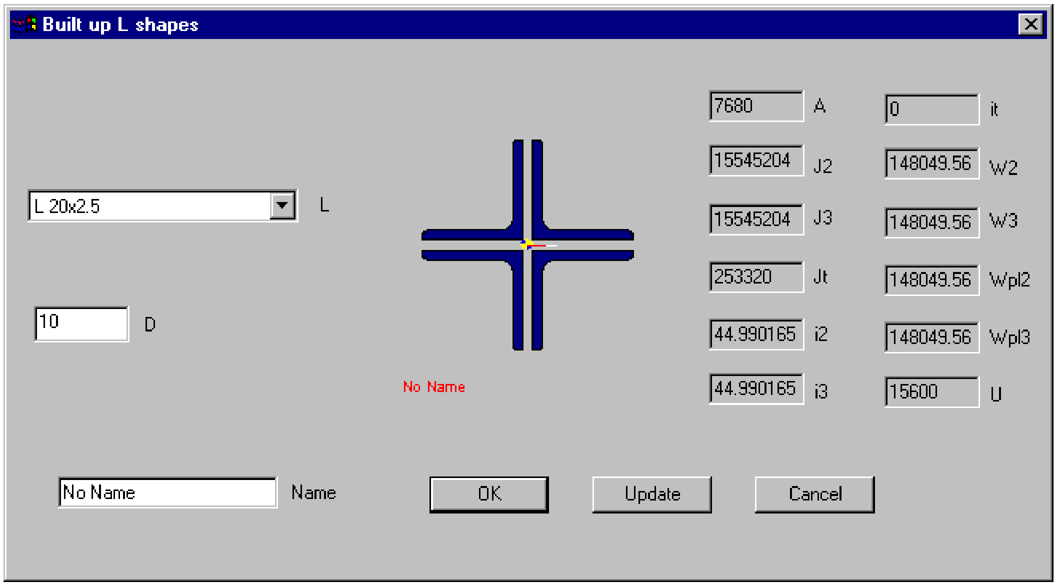
This dialog box is used for sections composed by angles. There are three possibilities:



Two angles as a T



Two angles as a cross



Four angles as a cross

In all cases you must select from list the angle to be used to create the new section. The **Upgrade** button upgrades data consequently. The distance d is input to specify the internal distance, which, in cross sections, is always the same in both directions. Distance d is kept into account in evaluating properties.

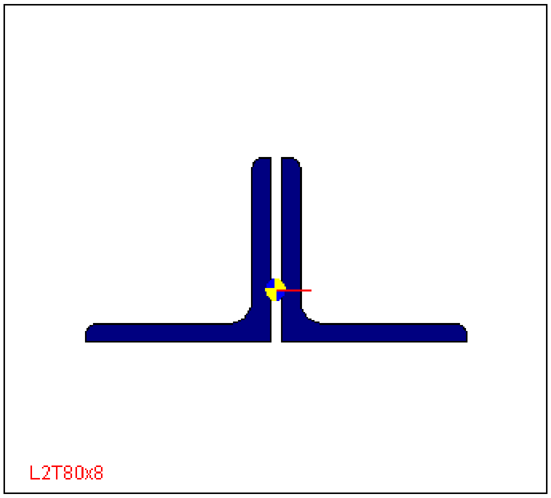
If the new shape is a T one, you must specify if contact side is the short one or the long one. This information is obviously not necessary if angle has equal sides.

As to the symbol meaning to details 116

SECTIONS COMPOSED BY ANGLES

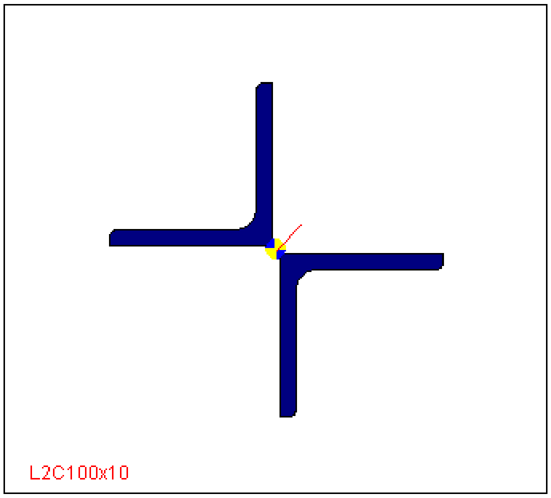
2 angles forming a T 117
2 angles forming a cross 117
4 angles forming a cross 118

T SHAPED COMPOSED ANGLES (2)



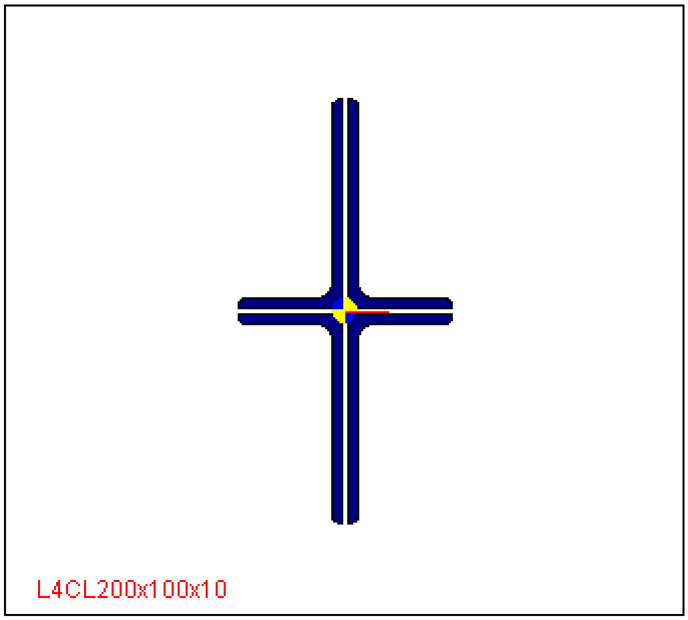
These shapes are set by three data: the name of the composing shape, the side of contact (long or short) the net internal distance d. The distance is kept into account while evaluating shape properties.

CROSS SHAPED ANGLES (2)



These sections are set by the name of the composing shape and by the clear distance d between the shapes (it is assumed that internal corners lay over a square of side d). The distance is kept into account in evaluating section properties.

CROSS SHAPED COMPOSED ANGLES (4)

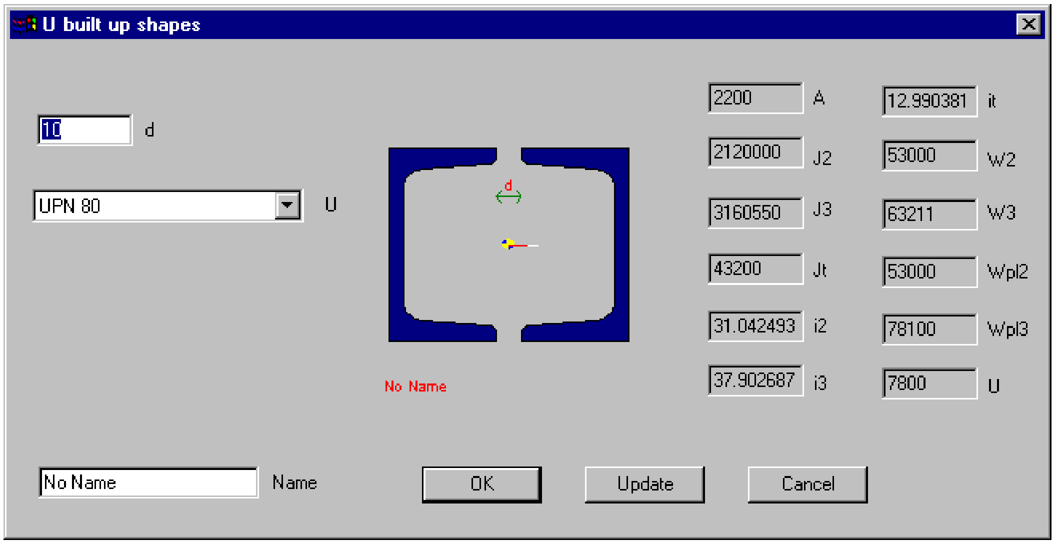


These shapes are set by specifying the name of the composing shape and the clear distance d between shapes (it is assumed that the internal corners are on a square of side d). The distance is kept into account in section properties evaluation.

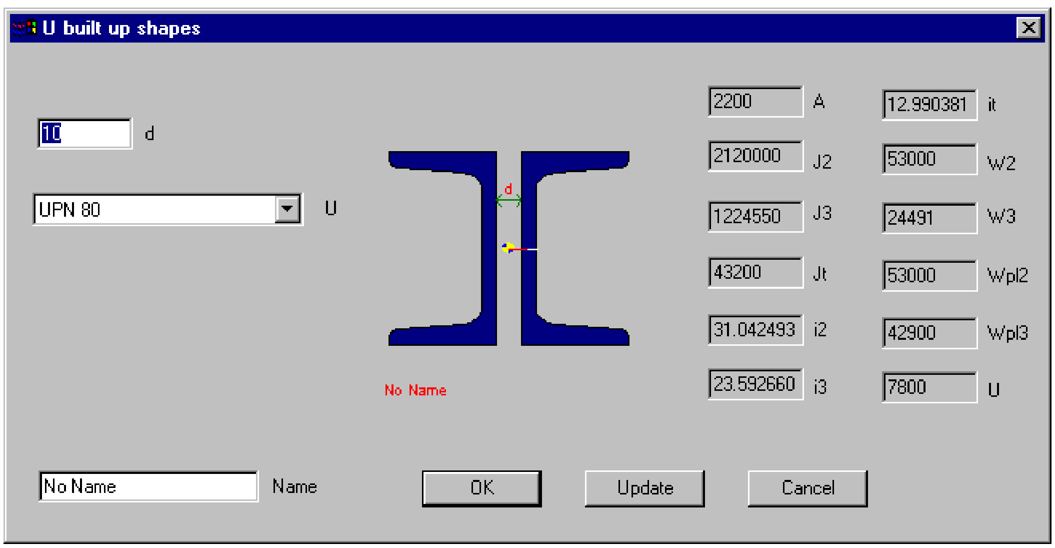
3.4.2.1.1.21 Sections composed by channels (dialog)

SECTION COMPOSED BY CHANNELS (DIALOG BOX)

This dialog box is used for sections composed by channels. It assumes different aspects depending on the composed shape for which it is used. Two cases are possible:



Two channels as][



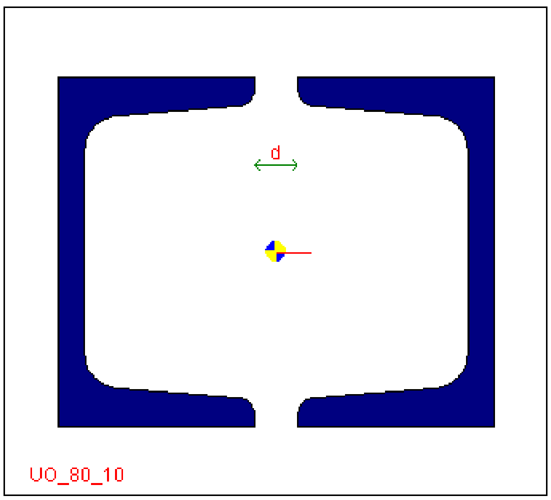
Two channels as [ ]

In all cases you must select from the list the channel to be used to compose the section. The **Update** button updates data consequently. The distance d is input to establish the internal distance: it is kept into account in computing properties.

As to the symbol meaning see details 120

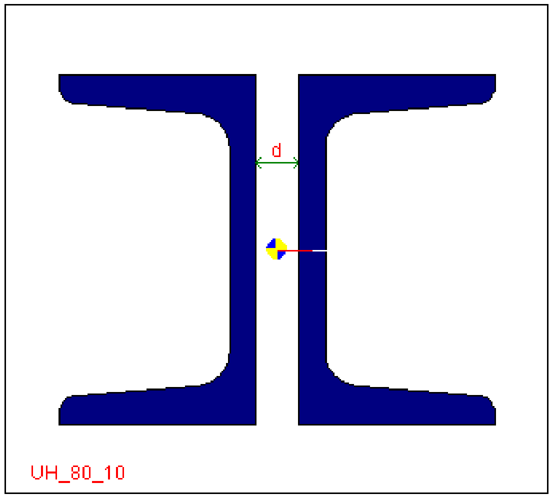
SECTIONS COMPOSED BY CHANNELS

[ ] CHANNELS (2)



These sections are set by the name of the channels used to make them, and by the internal distance between the two channels. The distance is kept into account in evaluating shape properties.

] [CHANNELS (2)



These sections are set by the name of the channels used to make them, and by the internal distance between the two. The distance is kept into account in evaluating shape properties.

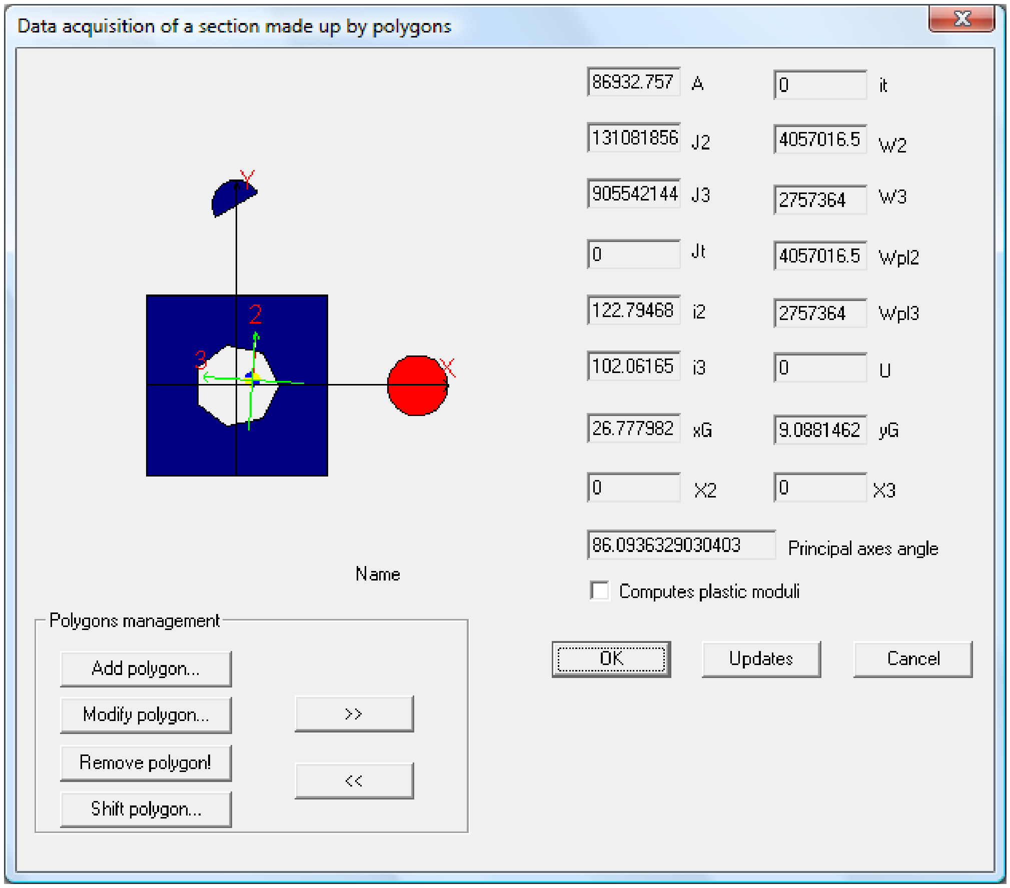
3.4.2.1.1.22 Sections composed of polygons (dialog)

SECTIONS COMPOSED OF POLYGONS (DIALOG BOX)

This important dialog box is the point of input for the data about sections which are composed of combinations of generic polygons, and is therefore a tool of some significance. This dialog box is also used to provide information about the profile.

When the field relating to a given quantity has a white background, it can be edited; otherwise, when greyed-out, it is non-editable (as the quantity is derived from the previous ones).

If the dialog box is opened for information purposes only, all the quantities are greyed-out and cannot be edited.



A polygon is added by clicking on the "**Add polygon**" button, which brings up a further dialog box 123 that allows a polygon to be defined. When closing the dialog box, the user is prompted to specify whether the polygon represents a filled or an empty object.

The ">>" and "<<" buttons are used to select one of the polygons which make up the section, and enable the user to move from one to another. The currently selected polygon is shown filled in in red.

The "**Modify Polygon…**" button allows the user to re-edit the currently selected polygon, by reaccessing the dialog box that is used to define an individual polygon.

The "**Remove Polygon**" button deletes the currently selected polygon.

The "**Translate Polygon**" button enables the user to specify a translation vector to apply to the currently selected polygon.

To compute the plastic W values as well, tick the "**Compute Plastic Ws**" box and then click **Update.**

A unique name must be chosen for the section to distinguish it from those already present in the Archive.

Dimensions are given in the active units of measurement.

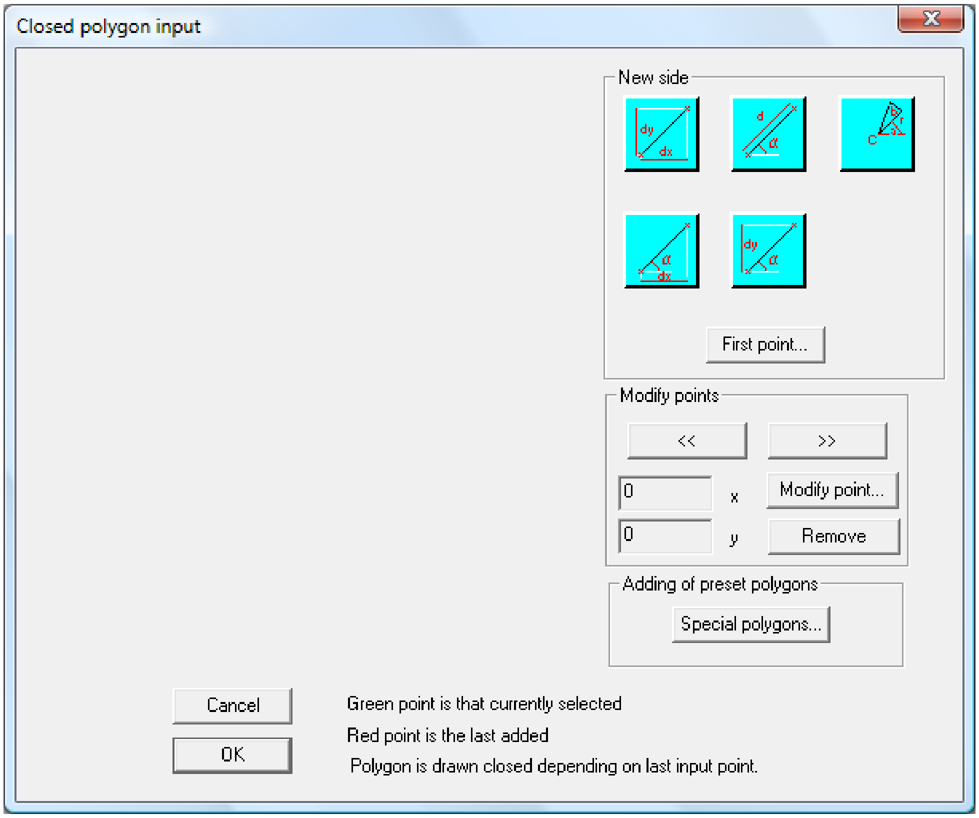
Given the generality of the problem, the torsional moment of inertia can not be computed automatically by the program (a differential equation on the partial derivatives over the domain would need to be solved when only the primary torsion would be available). It is therefore the user's responsibility to assign reasonable values for the torsional moment of inertia and the radius of gyration.

Nevertheless, the computation of the plastic section moduli is carried out automatically by the program, provided that there is a tick in the dedicated box. This initiates an iterative process that enables the plastic section moduli to be evaluated.

INPUT CLOSED POLYGON (DIALOG BOX)

This dialog box provides a workspace for defining closed polygons.

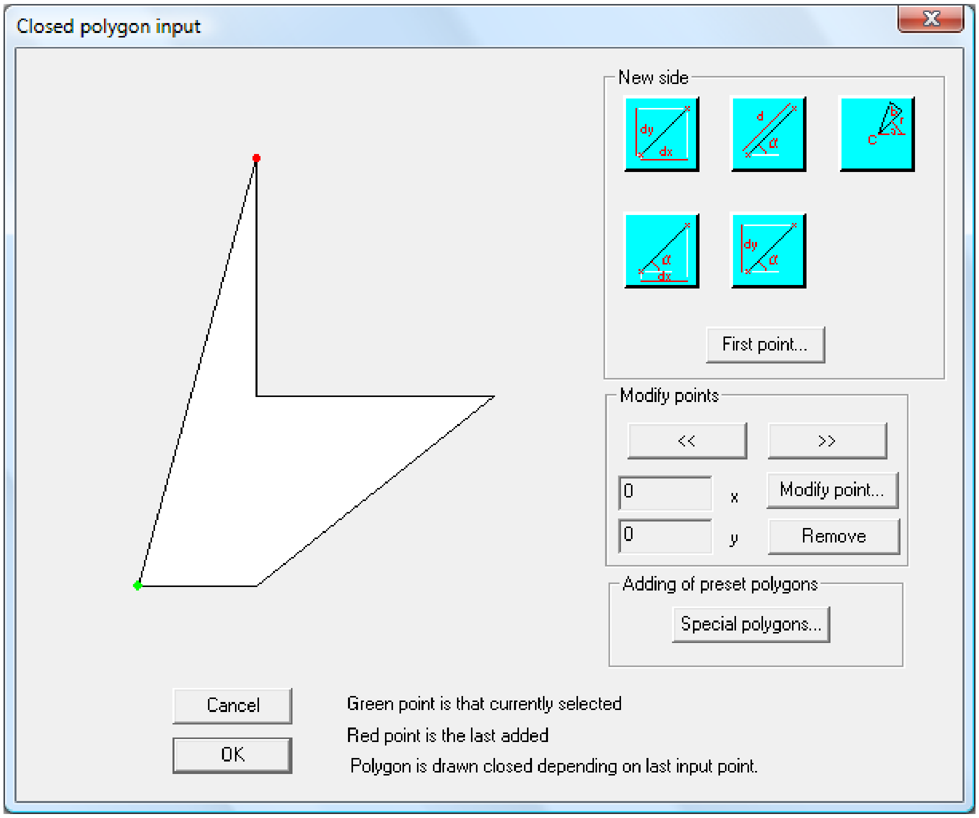
The underlying principle is that points are added one at a time until a polygon is formed. The first and last points are joined automatically in order to finish the polygon.
The window appears initially as follows:



If the polygon to be added is one of the standard types, click the **Special Polygons** button to bring up the specific dialog box 125 for the special polygons. With the special polygons, circles, rectangles, oriented semicircles or oriented regular polygons can be defined rapidly.

If the polygon is generic, however, the following steps are involved:

1 Specify the coordinates of the first point (in the active unit of measurement).
2 Then enter the subsequent points using the buttons with a blue background. These buttons offer different ways of specifying the points. The buttons in the first two columns enable the coordinates of the next point to be entered as the coordinates relative to the point just entered. These coordinates may be Cartesian (dx, dy), polar (d, α) or mixed (α , dx) (α , dy). The angle α is measured in degrees; it is positive if measured anticlockwise, and 0 corresponds to a horizontal segment. The final column enables an arc to be introduced by specifying the coordinates of the centre, its radius, initial and final flare angles and the number of subdivisions. When an arc is added, all the points on the arc are added to the points already present in the polygon.



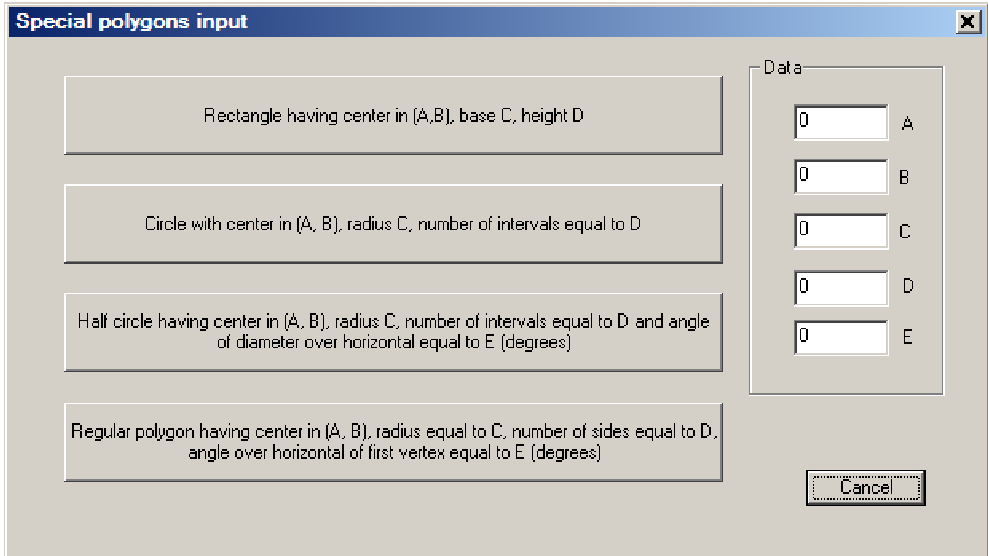
The user can move from one point to another using the "<<" or ">>" buttons. **The last point added is shown in red. The currently selected point is shown in green.** The coordinates of the currently selected point are shown in the x and y fields.

To modify the coordinates of a selected point, click on "**Modify point…**".

To remove a selected point (shown in green), click on the **"Remove"** button.

Special polygons can also be added during the process of adding a generic polygon. Note that the points on the special polygon will be added to the last point of the current polygon. For example, if the generic polygon was defined as (P1, P2, P3) and the special polygon is defined as (Q1, Q2, Q3, Q4), then the resulting polygon will be (P1, P2, P3, Q1, Q2, Q3, Q4).

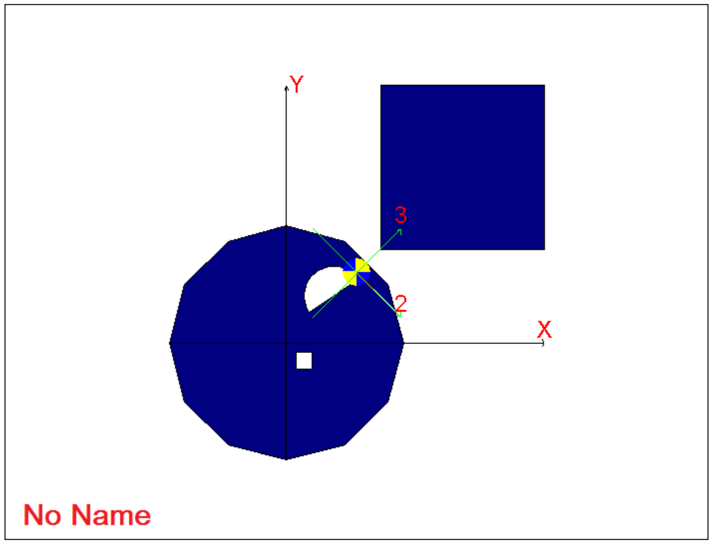
INPUT A TYPICAL POLYGON



This dialog box provides a workspace for defining special closed polygons. In practice, the data fields must be filled in according to the actual context. This depends on the type to be chosen. Once the data have been entered, press the button that corresponds to the desired choice, and the polygon will be added automatically.

Angles are always expressed in degrees (positive if measured anticlockwise). 0 corresponds to a horizontal segment oriented towards the right.

POLYGONAL SECTIONS OBTAINED BY JOINING GENERIC POLYGONS



These sections are identified as a series of polygons, each of which may represent a filled or empty object. A huge range of sections can be generated with this model.

The following remarks need to be noted:

* The overall area must be greater than zero.
* No polygon may be tangential to or intersect with another polygon.
* No empty object may contain a filled one.
* No filled object may be contained inside another.
* No empty object may be contained inside another.

Given the generality of the problem, the torsional moment of inertia can not be computed automatically by the program (a differential equation on the partial derivatives over the domain would need to be solved when only the primary torsion would be available). It is therefore the user's responsibility to assign a reasonable value for the torsional moment of inertia.

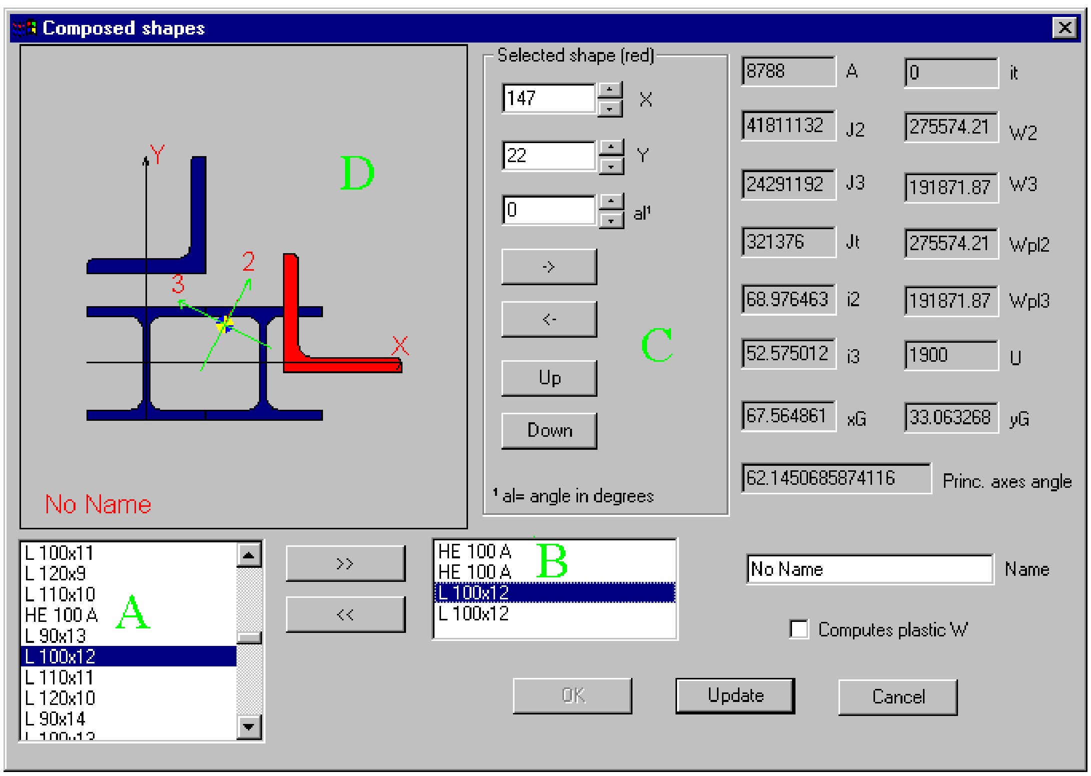
Nevertheless, the computation of the plastic section moduli is carried out automatically by the program, provided that there is a tick in the dedicated box. This initiates an iterative process which enables the plastic section moduli to be evaluated.

3.4.2.1.1.23 Generic composed shape (dialog)

GENERIC COMPOSED SHAPES (DIALOG BOX)

This important dialog box is where composed shapes data are input, and is therefore a true working environment. The dialog box is also used to output shape information.

When the background of a given field is white, this means that datum is editable, if the background is grey datum is read only (it depends on parameters or the dialog box is used in enquire mode).



<u>**Meaning and use of controls**</u>

Control A (see image)

Here all available shapes are listed, that is all the shapes which can be used to create the new section. The available shapes are those extracted when the command was executed. Therefore before executing command you must extract at least the shapes you plan to use in order to create the new shape. Among available sections there are composed and cold formed shapes, so you can have composed by cold formed and composed by composed.

Control B (see image)

Here are listed the sections making up the new shape, that is the shapes chosen until now. The selected shape (blue row) is the one painted in red in the full drawing.

Button >>

It is used to add the selected shape in control A to shapes in control B: that is to add a new composing shape.

Button <<

It is used to delete the selected shape from control B.

Controls in C area (see image)

These controls are used to move the selected shape in control B. Controls "**X**", "**Y**" stands for X and Y coordinate of selected shape center, while "a" is used to rotate the shape (a is the angle between selected shape x reference axis and composed shape X reference axis). See the article 194 describing the problem. Button "**->**", "**<-**", "**Up**" and "**Down**" are used to translate selected shape so as to search for tangent sides. For instance clicking "**->**" the selected shape will be moved on the right until one of its sides gets tangent to one of the other shapes. Move direction depends on the button choice. Using this command is very useful because it allows a fast and precise move of composing shapes, one relative to the others.

"Compute plastic W" control

If this control is active (a tick is applied) computations will include the iterative procedure used to compute plastic W (see the article 194 describing the problem). We suggest to activate the control only once you've finished to set the shapes, otherwise shapes movement will be lowered down. After you've applied the tick you must press **Update** button. If this computation is not required plastic moduli are set equal to elastic ones.

Update button

It is used to update computed data after a change which does not imply automatic computation. If, for instance, you manually modify data reported inside controls "X", "Y", and "a", or you modify the "compute plastic W" control value, you must press **Update** to get correct values.

How composed shapes are added

Once you've extracted composing shapes, if you choose to add a composed shape you'll get this dialog box.

Composing shapes are chosen among those of control A and put in control B (even more than once), using control ">>". Now you select each shape one by one, and position it in the right place using controls in C area. Buttons "**->**" "**<-**" "Up" and "Down" are particularly useful, 'cause usually shapes are mutually tangent . If you wish to change a shape added in control B you first have to remove it, and then you add the replacing shape.

If during sections moving you cross a physically unallowable layout, "OK" button gets grayed, to avoid the addition of meaningless shapes.

Moving shapes, do keep into account that shape coordinates are their center coordinates with respect to global reference axes (see the article 194 describing the problem).

If you wish detailed information about composing shapes you can double click on

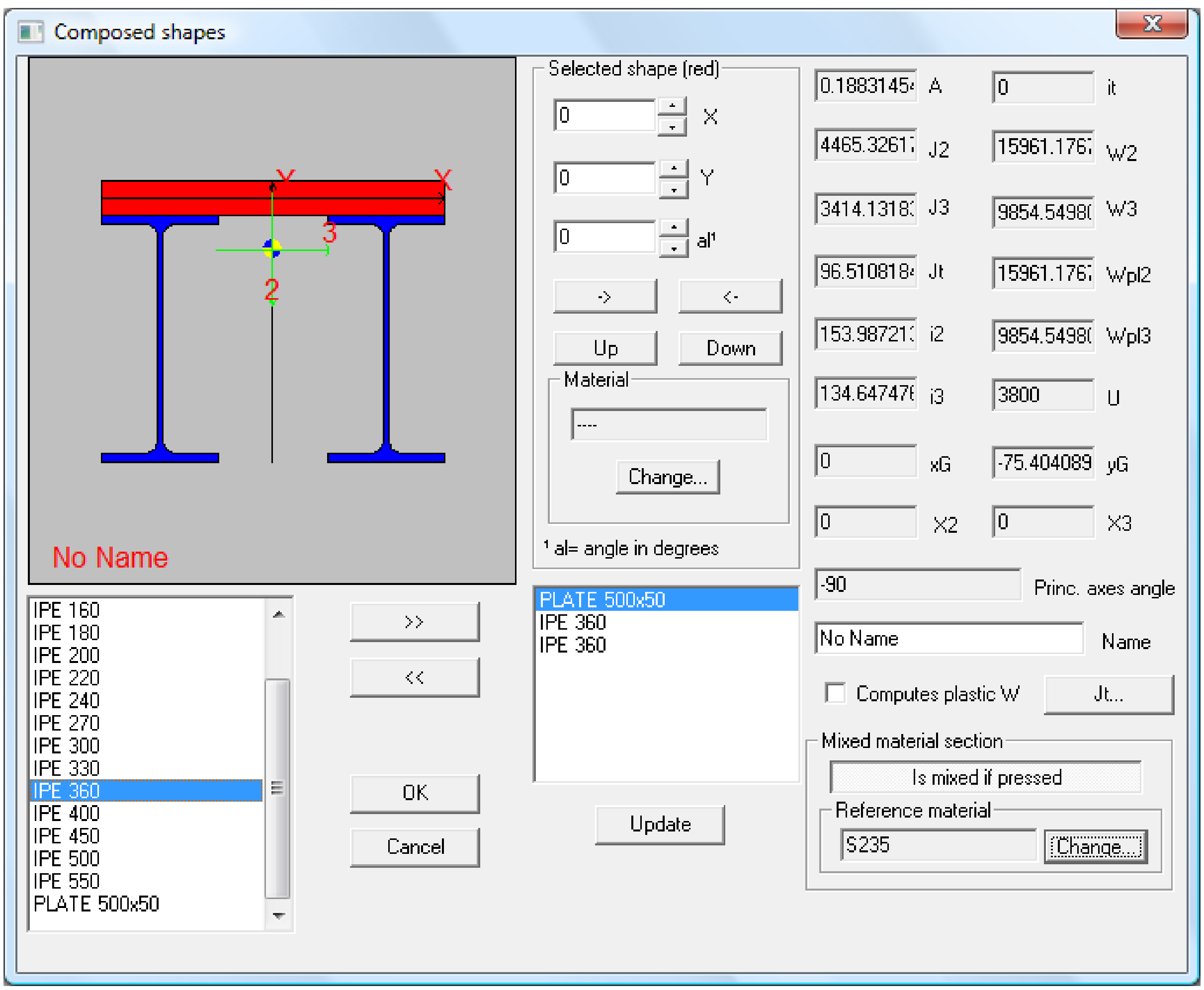
the shape (both in control A and B).

Once you've got the desired section you place a tick in "Compute plastic W " and press the **Update** button. Plastic moduli are update and are – obviously – always greater than elastic ones.

Plastic moduli computation is not a trivial problem. It may happen that the algorithm does not converge: you will get a message. This usually happens when plastic neutral axis crosses regions where sharp curves are present. Usually in sections having one center line this does not happen.

As to symbol meaning see details 140

IMPORTANT UPDATE



As from November 2004, this range of sections has been further extended to include mixed sections. In essence, the sections that make up the composite shapes may optionally be allocated a material, which in general may be different for each.

A reference material then needs to be selected for the final composite section (the material to which all the computational quantities will be homogenized).

To compute the area, the centre of gravity and the moments of inertia, the homogenization coefficient given by Kel=E/Er is used, where Er is the Young's modulus of the reference material.

The elastic section moduli are computed such that multiplying W **by the yield stress of the reference material fyr** gives the moment of first plasticization of the section, i.e. the moment at the elastic limit (at the first point to yield, regardless of the material of which it is made).

$$Mel = W * fyr$$

In practice

$$W = Min\{ (Jom * Kpl) / (d\ Kel)\}$$

where:

- Jom is the moment of inertia, homogenized for the main axis considered;
- Kpl is the ratio between the yield stress of the material at the point considered and the yield stress of the reference material;
- Kel is the ratio between the Young's modulus of the material at the point considered and the Young's modulus of the reference material;
- d is the distance of the point considered from the main axis considered.

In practice, the computation of the plastic section moduli involves calculating the plastic W values by homogenizing the areas with the factor Kpl, so that multiplying Wpl **by the yield stress of the reference material** gives the moment of full plasticization of the section.

$$Mpl = fyr * W$$

Note that there is no need for any of the sections to be made of the reference material, and therefore homogenization can be carried out against any material.

The modulus of elasticity and yield stress data is taken from the archive, without any multiplication coefficient being applied.

The "theory"

The "generic composite" section type now enables us to define mixed sections, namely sections that are made up of various other sections, each of which being made of a different material, and where all are assumed to be fully bonded, with the plane sections maintained.

Mixed steel/concrete and steel/wood sections can thus be specified, with various types of concrete or other materials of choice.

All the properties of the section will be standardised against an equivalent material, respect to which the various component parts will be homogenized. There is no need for any of the component sections to be made of the reference material.

The materials of the component sections are sourced from the archive, hence they must be present in it. Where:

n is the number of sections present
Er is the stretch modulus of the reference material
Ei is the stretch modulus of the generic material at generic point i
σyr is the yield stress of the reference material
σyi is the yield stress of the generic material at the generic point of reference, i
Keli = Ei/Er
Kpli = σyi / σyr

We have

$$A = \sum_{i}^{n} \int_{Ai} K_{eli} dA$$

$$S_x = \sum_{i}^{n} \int_{Ai} y K_{eli} dA$$

$$S_y = \sum_{i}^{n} \int_{Ai} x K_{eli} dA$$

$$x_g = S_y / A$$

$$y_g = S_x / A$$

$$I_x = \sum_{i}^{n} \int_{Ai} y^2 K_{eli} dA$$

$$I_y = \sum_{i}^{n} \int_{Ai} x^2 K_{eli} dA$$

$$I_{xy} = \sum_{i}^{n} \int_{Ai} xy K_{eli} dA$$

from which the principal axes and the moments of inertia J2 and J3 about them can be derived using the standard methods.

As for the section moduli W, these are defined such that, when multiplied by the yield stress of the reference material, they bring the section, at some point on it and for some material, to its first yield.

In practice, given the point Pi of material i, and where d is the distance from the main axis considered, we have

The stress at the point as if it were made of the reference material:

σr= Md/J

The homogenized stress (the true stress of the actual material at that point):

σi= MKelid/J

The limit condition applies when this stress is equal to the yield of material "i", and thus:

$$M K_{eli} d/J = K_{pli} \sigma_{yr}$$

The moment that achieves this value is given by:

$$M = (K_{pli} J / d K_{eli}) \sigma_{yr}$$

Therefore the modulus of the mixed section is given, as the point i varies, by the minimum value of:

$$W = \min\{K_{pli} J / d K_{eli}\}$$

With this assumption, the moment at the section's elastic limit is given by the usual formula $M = W\sigma_{yr}$. As regards the plastic moduli, these are obtained by homogenizing the areas with Kpl rather than Kel, using the formula:

$$M_{pl} = W_{pl} \sigma_{yr}$$

Thus the moment of full plasticization of the section is obtained by multiplying Wpl by the yield stress of the reference material.

At this point it is worth making a few remarks about how this data is used.

With the mixed sections, we need to proceed as follows. The sections must be attributed to the elements in the usual way, although in order for the use of these sections to be meaningful, the **only** material that must be allocated to them is the reference material, i.e. the material that the sectional properties have been homogenized against.

That said, the mixed sections may be used interchangeably with the others, and the elastic behaviour of the mixed beams can be correctly modelled, in order to obtain stresses and displacements that are consistent with the theory.

In terms of the results that follow on from this, we need to make the following observations.

The stress values (N/A), (M/W) and (N/A+M/W) are meaningless, in that the stress obtained is an ideal, homogenized stress, i.e. it is the stress that would apply at the point of first plasticization if this were made of the reference material, which in general is not going to be the case.

An indirect estimate of the level of utilisation of the section in the elastic phase is given by the following dimensionless quantity:

$$sfr = \left|\frac{N}{N_{el}}\right| + \left|\frac{M_2}{M_{2el}}\right| + \left|\frac{M_3}{M_{3el}}\right| = \left|\frac{N}{A_{el}\ \sigma_{yr}}\right| + \left|\frac{M_2}{W_{2el}\sigma_{yr}}\right| + \left|\frac{M_3}{W_{3el}\sigma_{yr}}\right|$$

where the W values are those computed by the program (and already described above) as elastic Ws, while Ael is a homogenized area defined so as to give the axial action of the first plasticization when multiplied by σyr.

Given that

$$N = \sum_{i=1}^{n} \int_{Ai} (\varepsilon E_i) dA = \varepsilon \left(\sum_{i=1}^{n} \int_{Ai} E_i dA \right) = \varepsilon E_r \left(\sum_{i=1}^{n} \int_{Ai} K_{eli} dA \right) = \varepsilon E_r A$$

where A is the homogenized area computed by the program, the axial action of the first plasticization is obtained by requiring that the normal stress at the generic point is equal to the yield stress, taking the minimum axial action:

$$\varepsilon = \frac{N}{E_r A}$$

$$\sigma_i = E_i \frac{N}{E_r A} = \sigma_{yi}$$

from the above, the following result applies at the generic point

$$N = A \frac{K_{pli}}{K_{eli}} \sigma_{yr}$$

hence

$$A_{el} = A \min \left\{ \frac{K_{pli}}{K_{eli}} \right\}$$

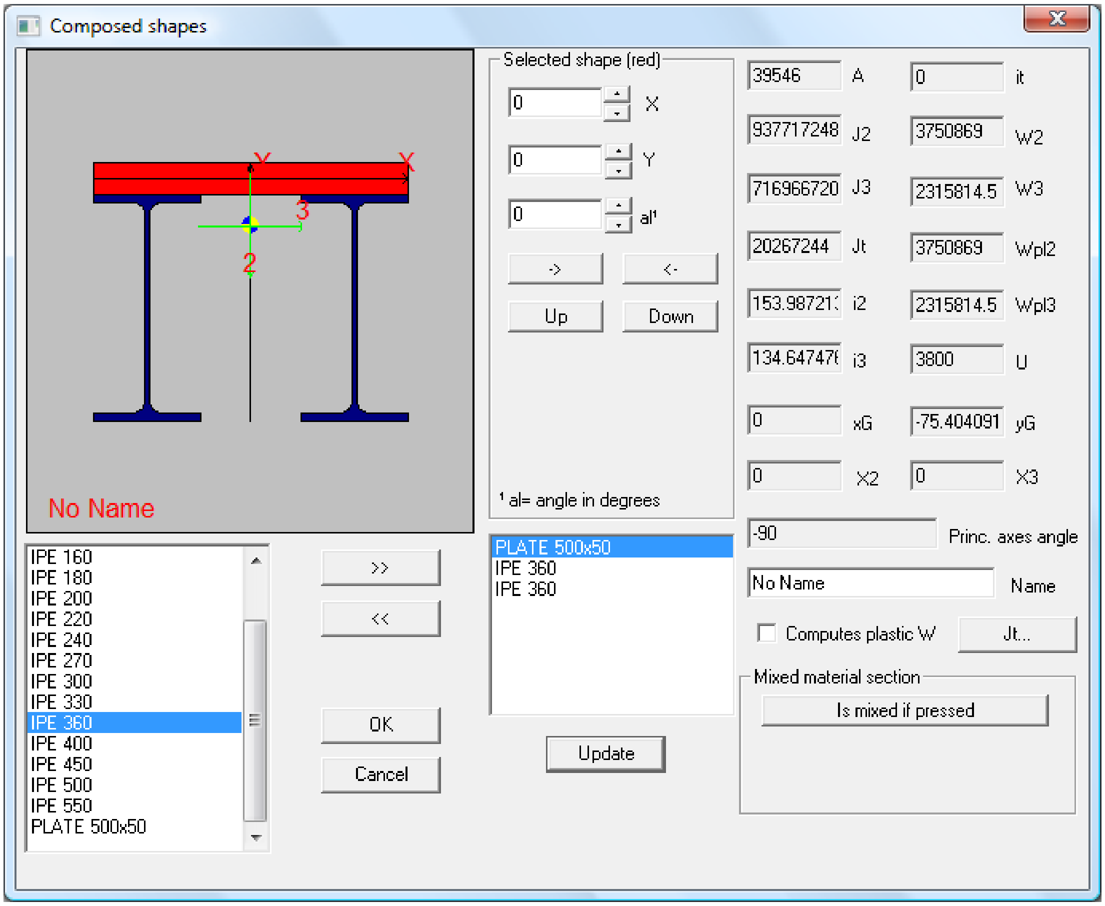
The axial action of full plasticization is obtained instead by the following relation:

$$A_{pl} = \sum_{i}^{n} \int_{Ai} K_{pli} dA$$

We can now use these results to define a coefficient of plastic utilisation, as follows:

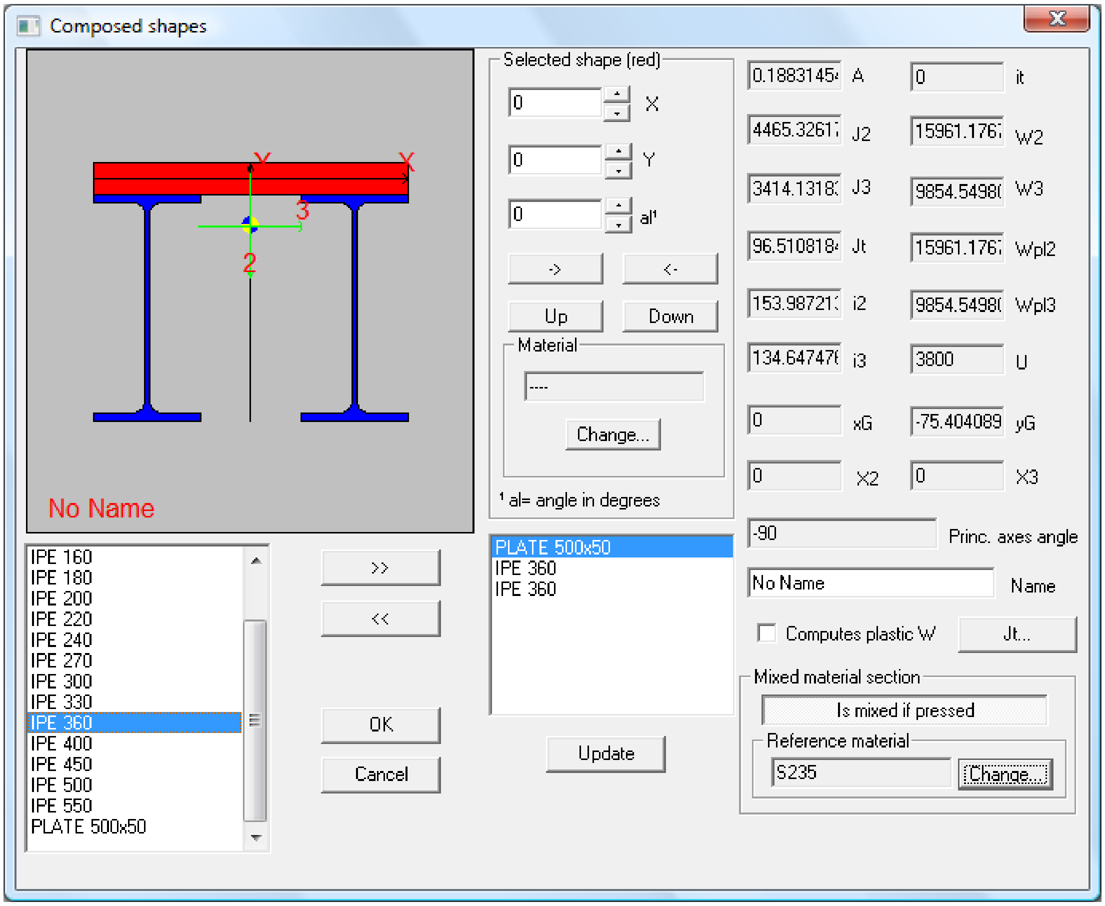
$$sfr = \left| \frac{N}{N_{pl}} \right| + \left| \frac{M_2}{M_{2pl}} \right| + \left| \frac{M_3}{M_{3pl}} \right| = \left| \frac{N}{A_{pl}\sigma_{yr}} \right| + \left| \frac{M_2}{W_{2pl}\sigma_{yr}} \right| + \left| \frac{M_3}{W_{3pl}\sigma_{yr}} \right|$$

MIXED SECTIONS – USER NOTES

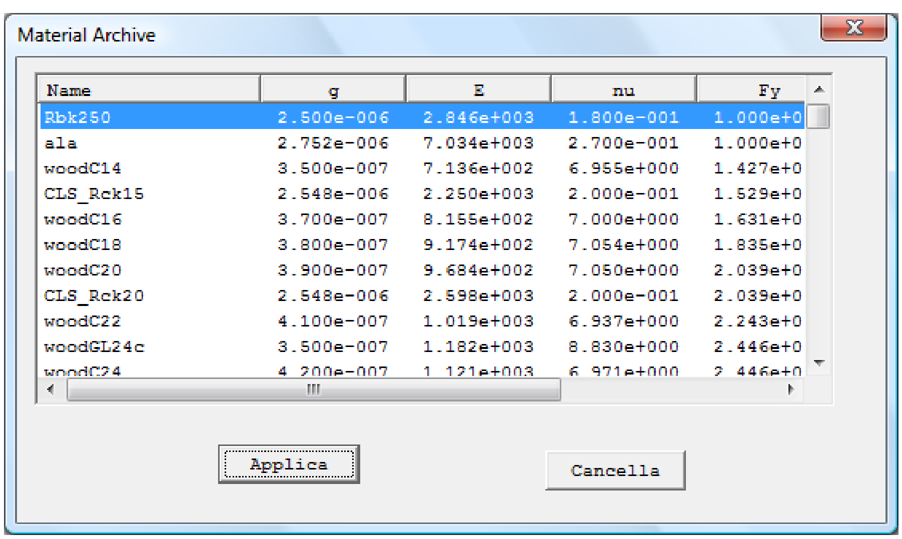


In practice, the controls have been relocated to make room for a new "gateway" button, "Mixed if pressed". Initially the button is un-pressed, and the dialog box appears as shown in the figure above. When the button is pressed, the dialog box appears as seen below, and the controls are enabled to provide the functionality needed to define:

- The reference material for the overall section (the Change button in the panel at the bottom).
- The material of which the generic section selected and shown in red is composed (the Change button in the panel containing the translation and rotation controls).



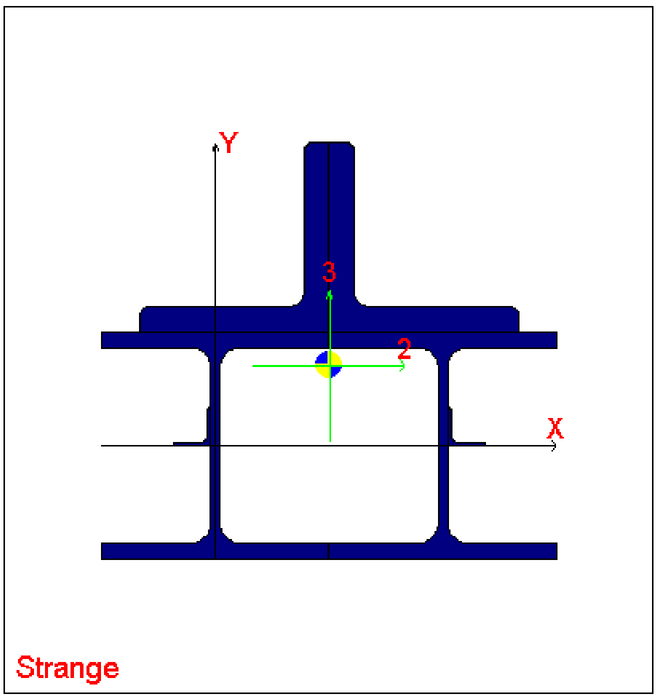
The reference material and the material of each individual section that makes up the overall section will need to be defined by selecting from the list of materials in the archive in the usual way, using the dialog box shown below.



Both the component sections and the component materials must already be present in the archive before the command is run.

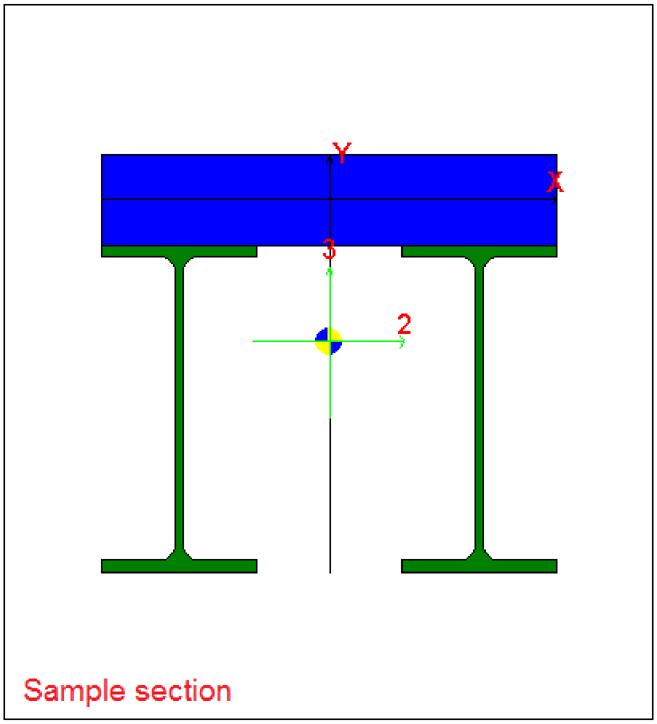
To compute the plastic moduli, tick the corresponding box and click on the Update button.

GENERIC COMPOSED SHAPES



SAMBA can describe generic composed shapes. This means that you describe sections obtained by collecting an arbitrary number of shapes, defining each shape position in plane. (shape center position and rotation angle).

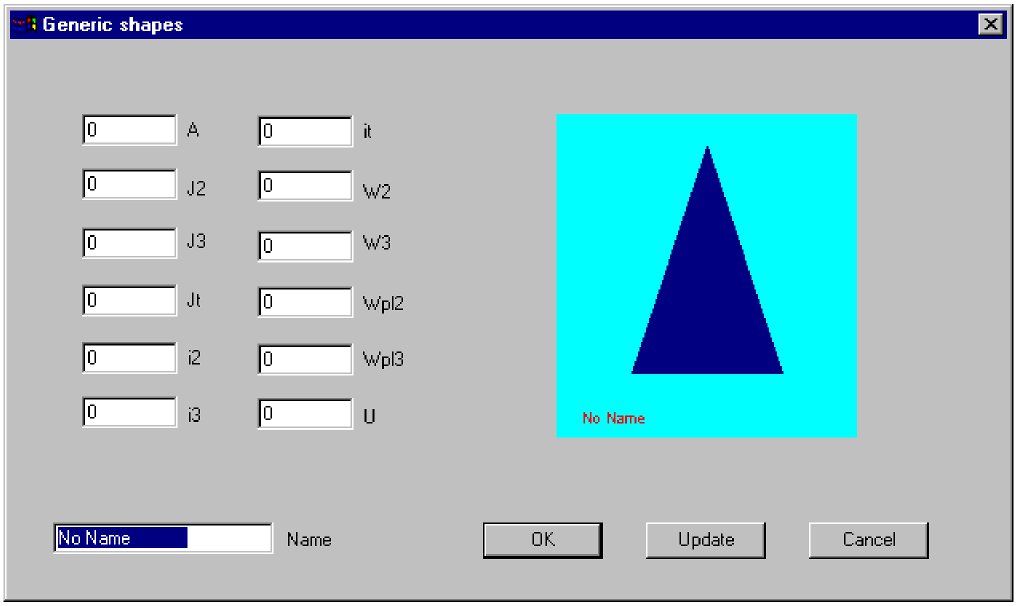
It is also possible to define composed shapes of composed sections.



Samba has handled mixed sections (those with an arbitrary number of materials) as particular generic composite shapes since November 2004.

3.4.2.1.1.24 Generic shapes (dialog)

GENERIC SHAPES (DIALOG BOX)

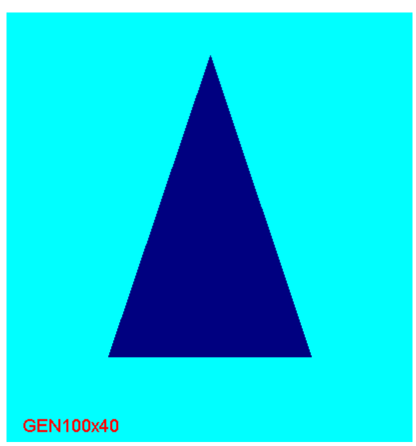


This dialog box is used both to have detailed information about generic shapes, and to add the shape to the archive.

A *generic shape* is here intended as a shape whose static data are known, but nothing else.

As to the symbol meaning, see details 142

GENERIC SHAPES



These shapes are directly set specifying their area and inertia values. These shapes are not within those described by the program. You must specify the following parameters:

F	area
J2	second inertia moment around principal axis 2
J3	second inertia moment around principal axis 3
Jt	second torsional inertia moment
i2	inertia radius around axis 2
i3	inertia radius around axis 3
U	superficie di verniciatura
Cm	warping constant (=Iw)
W2	section moduls (axis 2)
W3	section moduls (axis 3)
Wpl2	plastic section modulus (axis 2)
Wpl3	plastic section modulus (axis 3)

Following rules apply:

every parameter must be > 0.

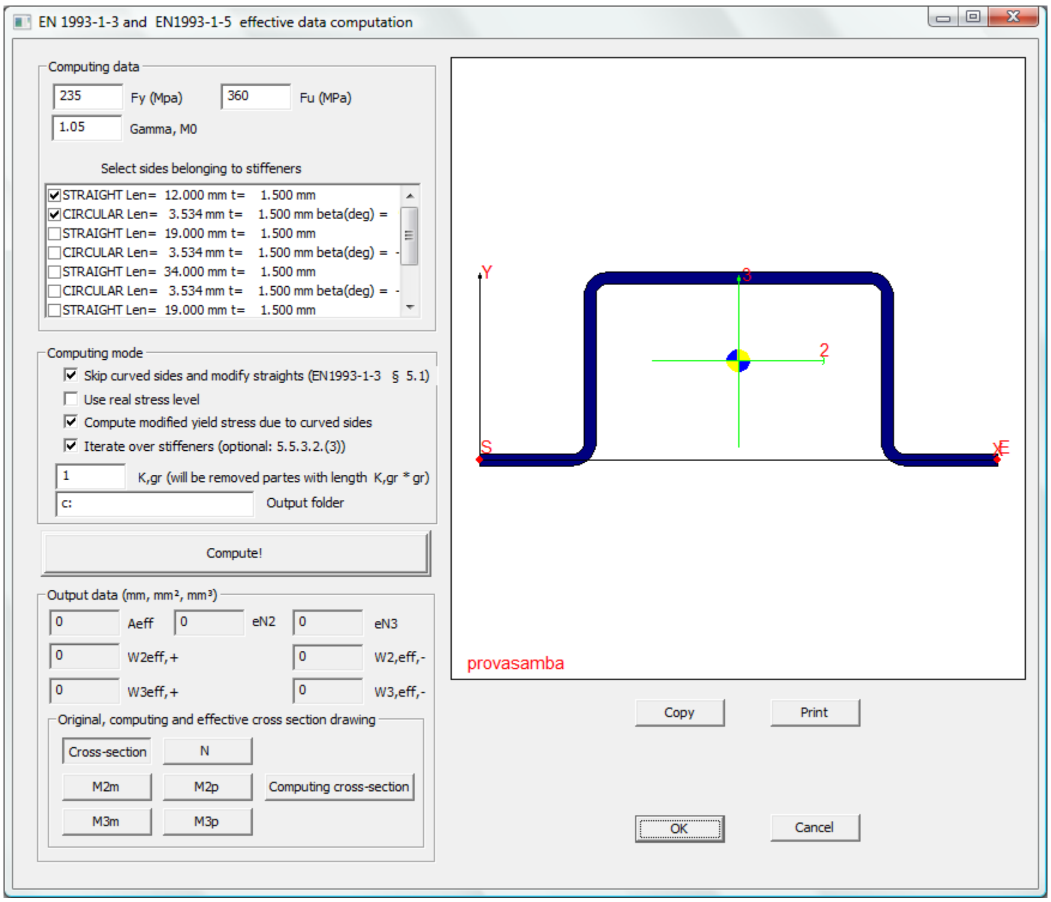
3.4.2.1.1.25 Effective data computation (dialog)

EFFECTIVE DATA COMPUTATION (DIALOG BOX)

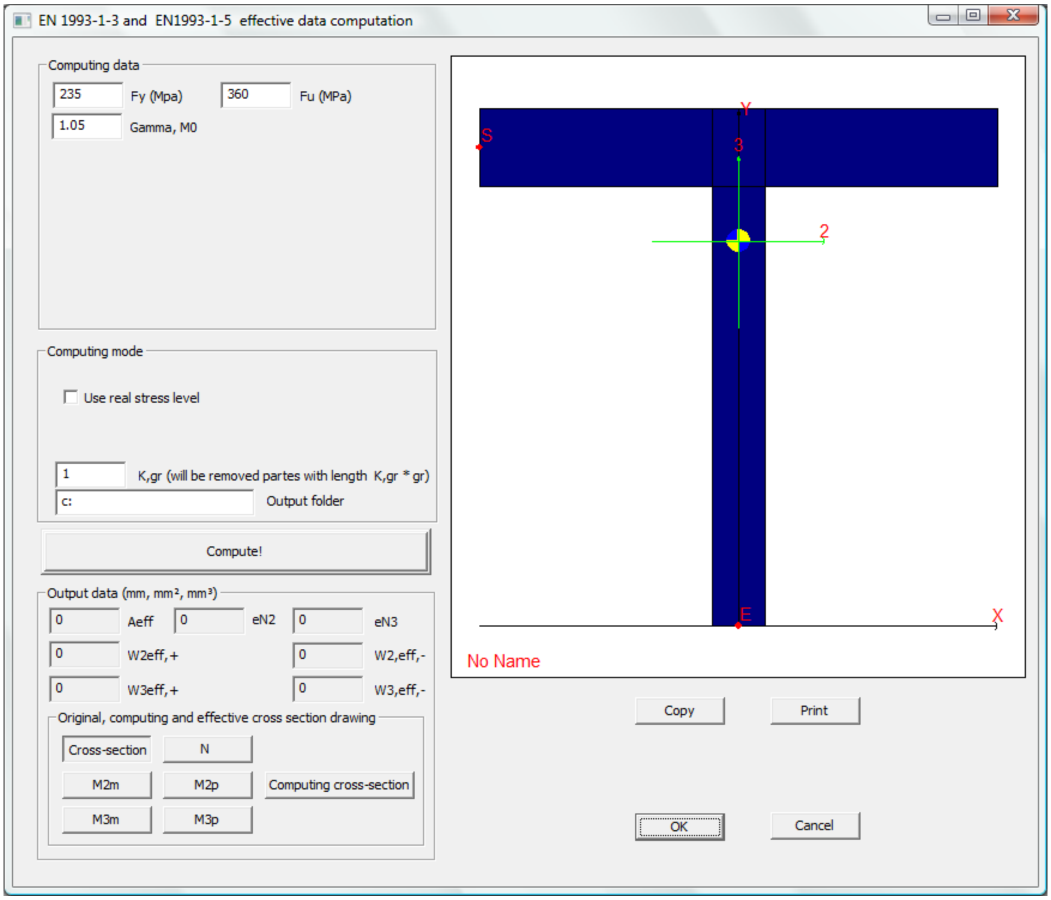
N.B.: for an exhaustive description of.... per una descrizione più approfondita del calcolo delle caratteristiche efficaci di profili in classe 4, si rimanda alla guida del programma CLASS4 di Castalia srl. In Samba, infatti, sono state riversate delle funzionalità del suddetto programma (con alcune limitazioni riguardanti ulteriori profili presenti in CLASS4) relative al calcolo dei profili in classe 4. La guida di questo programma contiene spiegazioni di base, note sull'implementazione degli algoritmi, discussione delle problematiche, validazione dei risultati e altri contenuti. La guida di CLASS4 è consultabile liberamente all'indiritto http://www.castaliaweb.com/ita/P/CL4/HTML/index.html.

NON C'E' LA GUIDA DI CLASS4 IN INGLESE!

This dialog box is used to compute the effective values of class 4 profiles according to EN1993-1-3 and EN1993-1-5. The dialog box for cold formed shapes is a little bit different from other shapes, but the structure is the same.



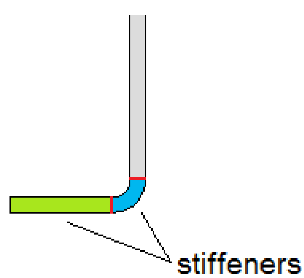
Example: cold formed shape



Example: non cold formed shape

Computing data

In these section, material properties must be defined (Fy, Fu and Gamma,M0). In the list of shape sides (*for cold formed only*) must be ticked the sides considered as stiggeners (both straight sides and following circular sides).

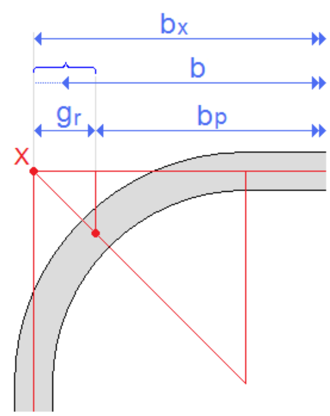


Computing mode

In this section, *for cold formed only* the user defines if shape with round corners must be straighten according to paragraph 5.1 of the European Standard. *For all the shapes,* the user defines if real stress levels must be used (if this option is ticked, a compressed side with $\sigma_1 < f_y$ will be computed using $\lambda_{p,red}$ instead of λ_p). *For cold formed only*, user defines if modified yield stress due to curved sides must be computed (work hardening) and if iterations must be performed in order to re-compute effective part when stiffener buckling occurs or if computetion must be stopped, according to 1993-1-3 paragraph 5.5.3.2(3); at last, kgr value must be fixed (it is equal to 1 by default): this parameter defines sides length when straighten computation area is assumed; side length b_p is equal to b_x-gr, where b_x is the length given by extending each side to the line of adjacent straight sides; b_p and b are:

$$b_p=b_x-g_{r,1}-g_{r,2}$$

$$b=b_p+(1-k_{gr})g_{r,1}+(1-k_{gr})g_{r,2}$$



Output listing folder can be changed: default folder is *c:*.

Compute!

The button *Compute!* runs effective values computation according to European Standard. Proper messages warn the user if some Standard criteria are not satisfied (for example, if a stiffener is too long). At the end of the computation, output listing 148 can be automatically opened.

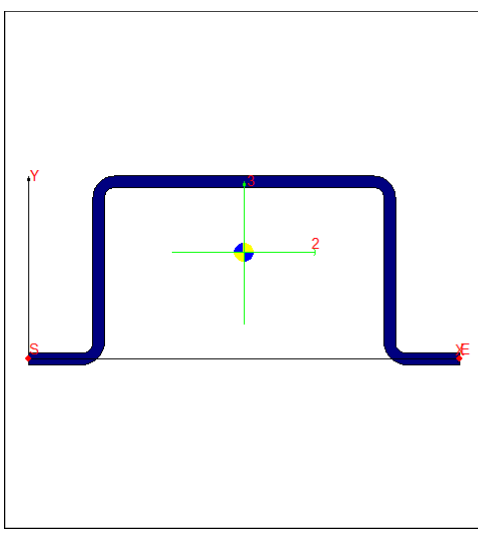
Output data and picture

After the computation, use buttons in **Original, computing and effective cross section drawing** to display the following images:

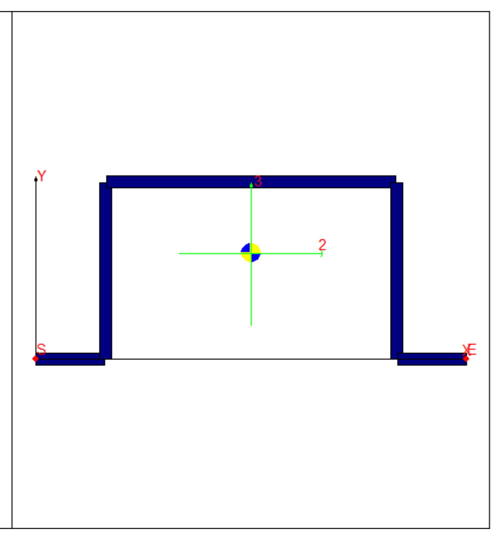
- *Cross-section*: gross cross-section is displayed (default image, computation is not required).
- *Computing cross-section*: cross-section used for computation, it can coincide or not with the gross one.
- *N, M2p, M2m, M3p, M3m*: effective cross-sections for axial force, positive (p) bending moment around axis 2, negative (m) bending moment around axis 2, positive bending moment around axis 3, negative bending moment around axis 3.

Current image can be printed or copied and pasted in documents, reports, etc.

The following figure shows the gross-cross section of a cold formed shape (on the left) and the straighten computation section of the same shape (on the right).

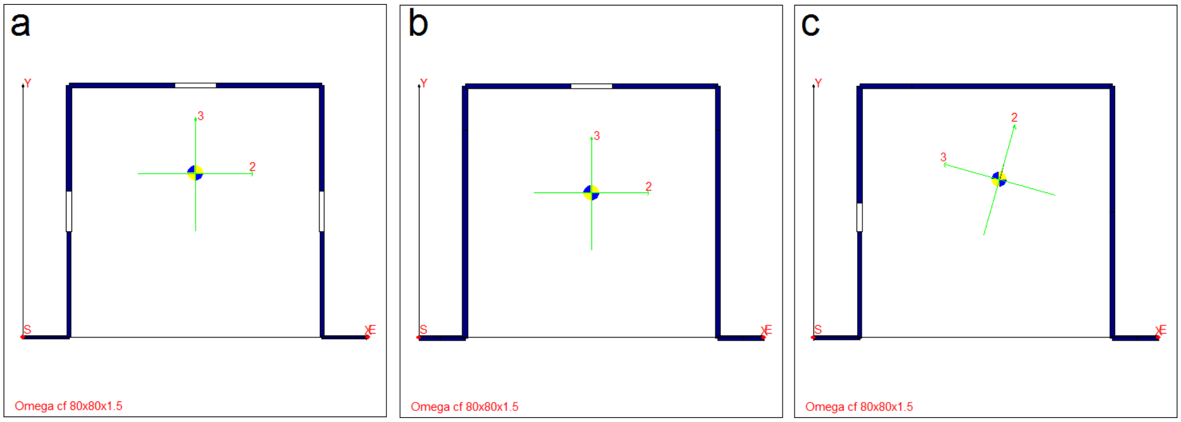


Gross cross-section



Computation cross-section

The following figure show effective cross-sections computed by CLASS4 for a cold formed shape in these conditions: axial force (a), positive bending moment M2 (b) and negative bending moment M3 (c).



Non-effective parts are in white

Notes:

- For rectangular hollow sections (RHS) curved corners are never straightened.
- For hot-rolled H and T shapes, round corners are replaced in computation section with rectangular areas.
- If a section with straightened curved corners is computed as fully effective for a load condition, the corresponding gross cross-section value is assumed.

OUTPUT LISTING WITH EFFECTIVE DATA

The output listing contains information about gross cross-section, computation section, computation settings and results.

The listing is in the folder146 defined by the user. File name is: *"section_name -fy=??? -gm=???.txt"* , where ??? are the values defined for yield stress and safety factor.

An example listing is reported below, with comments and explanations of the different sections. Output listing parts have a grey background.

```
****************************************************
*                                                  *
*              Effective data computation          *
*                                                  *
*               EN 1993-1-3 and EN1993-1-5         *
*                                                  *
*      Castalia srl - Italy - www.castaliaweb.com  *
****************************************************
```

After the heading, the first part of output listing contains a description of the **gross cross-section** and its sides. The following data are given: section name, number of sides, gravity center coordinates (*xg*, *yg*), total area, inertia moments *J2* and *J3* (2 refers to y axis, 3 to z axis),bending moduli *W2* and *W3*, principal axes angle alpha (degrees).

For each side (element) are given: side number (#), type and thickness; extremes coordinates (*x1*, *y1* and *x2*, *y2*) line segments *gr1* and *gr2* to be removed from straightened side extremes; side lenght (*len*) and b_p lenght.

Material data are given: yield stress f_{yb}, ultimate stress f_u, safety factor γ_{M0} (*gamma*), f_d value equal to f_{yb}/γ_{M0} and f_{ya} value according to EN1993-1-3:2006 paragraph 3.2.2(3).

Since the first part of the listing refers ti gross cross-section, without curved corners straightening, gr are always null and b_p length is equal to original side.

While b_p is the length for b/t computation, b is the sum of b_p and gr segments (or a part of them):

$$b=b_p+(1-K_{gr})g_{r,1}+(1-K_{gr})g_{r,2}$$

```
----------------------------------------
-    Gross cross-section description   -
----------------------------------------


Cross-section name:  Omega cf
Number of sides : 9
xg=     53.500 mm  yg=     46.794 mm  Area=  3.902e+002 mm²
J2=  3.370e+005  mm^4   J3=  5.071e+005  mm^4   W2=  7.088e+003  mm³   W3=  9.478e+003  mm³
```

```
 Angle principal axes (deg)=    0.000

Cross-section side description

Element #   1 - Straight element - Thickness=    1.500 mm
       x1 =   0.000 mm  y1 =   0.000 mm
       x2 =  12.000 mm  y2 =   0.000 mm
       gr1=   0.000 mm  gr2=   0.000 mm
       b=  12.000 mm  bP =  12.000 mm
Element #   2 - Circular element - Length=    3.534 mm - Thickness=    1.500 mm
       xs =  12.000 mm  ys =   0.000 mm
       xe =  14.250 mm  ye =   2.250 mm
       xc =  12.000 mm  yc =   2.250 mm  bet(deg)=  90.000
Element #   3 - Straight element - Thickness=    1.500 mm
       x1 =  14.250 mm  y1 =   2.250 mm
       x2 =  14.250 mm  y2 =  76.250 mm
       gr1=   0.000 mm  gr2=   0.000 mm
       b=  74.000 mm  bP =  74.000 mm
Element #   4 - Circular element - Length=    3.534 mm - Thickness=    1.500 mm
       xs =  14.250 mm  ys =  76.250 mm
       xe =  16.500 mm  ye =  78.500 mm
       xc =  16.500 mm  yc =  76.250 mm  bet(deg)= -90.000
Element #   5 - Straight element - Thickness=    1.500 mm
       x1 =  16.500 mm  y1 =  78.500 mm
       x2 =  90.500 mm  y2 =  78.500 mm
       gr1=   0.000 mm  gr2=   0.000 mm
       b=  74.000 mm  bP =  74.000 mm
Element #   6 - Circular element - Length=    3.534 mm - Thickness=    1.500 mm
       xs =  90.500 mm  ys =  78.500 mm
       xe =  92.750 mm  ye =  76.250 mm
       xc =  90.500 mm  yc =  76.250 mm  bet(deg)= -90.000
Element #   7 - Straight element - Thickness=    1.500 mm
       x1 =  92.750 mm  y1 =  76.250 mm
       x2 =  92.750 mm  y2 =   2.250 mm
       gr1=   0.000 mm  gr2=   0.000 mm
       b=  74.000 mm  bP =  74.000 mm
Element #   8 - Circular element - Length=    3.534 mm - Thickness=    1.500 mm
       xs =  92.750 mm  ys =   2.250 mm
       xe =  95.000 mm  ye =   0.000 mm
       xc =  95.000 mm  yc =   2.250 mm  bet(deg)=  90.000
Element #   9 - Straight element - Thickness=    1.500 mm
       x1 =  95.000 mm  y1 =   0.000 mm
       x2 = 107.000 mm  y2 =   0.000 mm
       gr1=   0.000 mm  gr2=   0.000 mm
       b=  12.000 mm  bP =  12.000 mm


fyb =   235.00 MPa  fu=   360.00 MPa  gamma=    1.050  fd=   223.81 MPa
```

```
fya =   249.42 MPa
```

Then, user settings are given. For example:

```
User's choice: circular elements will be deleted modifying straight element
size

User's choice: maximum compression stress levels on side will be considered

User's choice: perform modification ("iteration") for stiffeners

User's choice: gr addition modification factor (kgr=1-> gr are removed,
kgr=0-> gr are kept) kgr =     1.00
```

Similarly to gross cross-section, now is given the **computation section**. If round corners have been straightened, the total number of computation section sides is lower than gross cross-section one; sides length is greater because of the straightening and positions of their extremes is. In addition, gr will not be null, generally, and b will be different from b_p (if Kgr is not equal to 1).

```
----------------------------------------------------
-  Computing section data (circular sides removed) -
----------------------------------------------------



Cross-section name:  Omega cf
Number of sides : 5
xg=     53.500 mm  yg=     46.835 mm  Area=  3.881e+002 mm²
J2= 3.338e+005 mm^4   J3= 5.038e+005 mm^4   W2= 7.015e+003 mm³   W3= 9.417e+003 mm³
 Angle principal axes (deg)=    0.000

Cross-section side description

Element #   1 - Straight element - Thickness=    1.500 mm
       x1 =   0.000 mm  y1 =   0.000 mm
       x2 =  13.591 mm  y2 =   0.000 mm
       gr1=   0.000 mm  gr2=   0.659 mm
       b=  13.591 mm  bP =  13.591 mm
Element #   2 - Straight element - Thickness=    1.500 mm
       x1 =  14.250 mm  y1 =   0.659 mm
       x2 =  14.250 mm  y2 =  77.841 mm
       gr1=   0.659 mm  gr2=   0.659 mm
```

```
       b=  77.182 mm  bP =  77.182 mm
Element #   3 - Straight element - Thickness=    1.500 mm
       x1 =  14.909 mm  y1 =  78.500 mm
       x2 =  92.091 mm  y2 =  78.500 mm
       gr1=   0.659 mm  gr2=   0.659 mm
       b=  77.182 mm  bP =  77.182 mm
Element #   4 - Straight element - Thickness=    1.500 mm
       x1 =  92.750 mm  y1 =  77.841 mm
       x2 =  92.750 mm  y2 =   0.659 mm
       gr1=   0.659 mm  gr2=   0.659 mm
       b=  77.182 mm  bP =  77.182 mm
Element #   5 - Straight element - Thickness=    1.500 mm
       x1 =  93.409 mm  y1 =   0.000 mm
       x2 = 107.000 mm  y2 =   0.000 mm
       gr1=   0.659 mm  gr2=   0.000 mm
       b=  13.591 mm  bP =  13.591 mm
```

In the following section, some important values are given, according to EN-1993-1-3 Annex C. Here, axes are called x and y instead of y and z.

- section name
- number of original sides and number of assumed straight sides
- total area
- first area moments *Sx0* e *Sy0* about x and y axes
- second area moments *Ix0*, *Iy0* e *Ixy0* around x and y axes
- gravity center coordinates *xg*, *yg*
- second area moments *Ix*, *Iy* e *Ixy* around x and y axes shifted to gravity center
- second area moments *Icsi* e *Ieta* around principal axes
- angle of the principal axes *alpha*
- ω mean value, *omega,mean*
- sectorial constants *Ixom0, Iyom0, Iomom0*
- sectorial constants *Ixom, Iyom, Iomom*
- warping constant *Iw* and torsional constant *It*
- le coordinate del centro di taglio *xct e yct*
- values *xs*=xct-xg and *ys*=yct-yg

- non symmetry factors *xj* and *yj*

```
---------------------------------------
-  General data of computing section  -
---------------------------------------

Section is computed according to EN1993-1-3:2006, Annex C
Curved sides, if any, are divided into straight segments

Section: Omega cf
N os:             5 - number of original sides
N ass:            5 - number of assumed straight sides
Area:               3.881e+002 - area    mm^2

Sx0:                1.818e+004    mm^3 - first area moment (x,y)
Sy0:                2.076e+004    mm^3 - first area moment (x,y)
Ix0:                1.185e+006    mm^4 - second area moment (x,y)
Iy0:                1.615e+006    mm^4 - second area moment (x,y)
Ixy0:               9.724e+005    mm^4 - mixed second area moment (x,y)

xg:                 5.350e+001    mm - gravity center x coordinate
yg:                 4.684e+001    mm - gravity center y coordinate

Ix:                 3.338e+005    mm^4 - second area moment (xg, yg)
Iy:                 5.037e+005    mm^4 - second area moment (xg, yg)
Ixy:                1.852e-003    mm^4 - mixed second area moment (xg, yg)

Icsi:               5.037e+005    mm^4 - second area moment (principal axes)
Ieta:               3.338e+005    mm^4 - second area moment (principal axes)
alpha:              6.242e-007 (deg) - rotation angle of principal axes

omega,mean:        -3.595e+003    mm^2 - omega mean
Ixom0:             -1.320e+008    mm^5 - sectorial constant
Iyom0:             -4.769e+007    mm^5 - sectorial constant
Iomom0:             1.276e+010    mm^6 - sectorial constant

Ixom:              -5.735e+007    mm^5 - sectorial constant (xg, yg)
Iyom:               1.766e+007    mm^5 - sectorial constant (xg, yg)
Iomom:              7.744e+009    mm^6 - sectorial constant (xg, yg)

Iw:                 2.808e+008    mm^6 - warping constant
It:                 2.911e+002    mm^4 - torsional constant
xct:                5.291e+001    mm - shear center x coordinate
yct:                1.138e+002    mm - shear center y coordinate
xs:                -5.889e-001    mm - = xct - xg
ys:                 6.700e+001    mm - = yct - yg
xj:                -5.889e-001    mm - non symmetry factor
yj:                 7.945e+001    mm - non symmetry factor
```

Information about starting, intermediate and end stiffeners are given (presence, number of folds).

```
-------------------
-  Stiffeners     -
-------------------

Starting stiffener has 1 edge fold
End stiffener has 1 edge fold
There is no intermediate stiffener
```

In the following section, all the computation required to get effective area in compression are given. For each side (*element*) of the **computation section** these data are reported:

- element number (#);
- doubly supported element or outstanding element;
- if outstanding, which end is free and which one is connected to another side (supported);
- side length b, as previously defined ($b=b_p+(1-K_{gr})g_{r,1}+(1-K_{gr})g_{r,2}$);
- *gr1, gr2* and b_p have been previously defined;
- thickness *t*;
- b_p*:t* is the ratio between b_p and t;
- side ends coordinates (*x1*, *y1* e *x2*, *y2*);
- stresses σ_1 and σ_2 (*sigma1* and *sigma2*);
- k_σ (*Ksigma*) is buckling coefficient;
- *Lambda,p* is plate relative slenderness;
- *rho* is the reduction factor according to EN1993-1-5:2006 par. 4.4(2);
- *Chi* (χ) is side reduction factor for buckling;
- *Lambda,p,red;*
- each side can be fully or partially effective
- the effective area of the side is given; if side is not fully effective, the area is lower than the total one;
- *Area,kgr* value is given: it is the part of the total area involved by gr segments, eventually re-added;

- b_{eff} is the effective width at the extremes (*end 1* and *end 2*);
- uneffective width

Information about the stiffeners:

- Start / end stiffener could be in tension: if this situation occurs, it's reported;
- if it is not in tension, start/end stiffener will be modified if buckling is reached;
- *As* and *Is* values are given (stiffener area and first area moment);
- *K* is the support given from the other sides, *s,cr* (σ_{cr}) is critic elastic stress;
- *lam,s* (λ_s) is stiffener slenderness.

```
---------------------------------------
-  Effective area due to compression  -
---------------------------------------


Element       #1 : outstand element (stiffener) supported at end 2, free at end 1
       b=14.25 mm  gr1=0.00 mm  gr2=0.66 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
       x1=        0.00 mm   y1=         0.00 mm   x2=    13.59 mm  y2=     0.00 mm
       sigma1= -223.81 MPa  sigma2=  -223.81 Mpa
       Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.66  Lambda,p,red=    0.37  rho=   1.000
       Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)

Element       #2 : doubly supported element
       b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
       x1=       14.25 mm   y1=         0.66 mm   x2=    14.25 mm  y2=    77.84 mm
       sigma1= -223.81 MPa  sigma2=  -223.81 Mpa  stress ratio psi=     1.00
       Ksigma= 4.00      Lambda,p= 0.91     rho=   0.836
       Partially effective element. Area = 9.676e+001 mm²  (Area,kgr = 0.000e+000 mm²)
       beff at end 1=32.254 mm -beff at end 2=32.254 mm -uneffective width =12.673 mm

Element       #3 : doubly supported element
       b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
       x1=       14.91 mm   y1=        78.50 mm   x2=    92.09 mm  y2=    78.50 mm
       sigma1= -223.81 MPa  sigma2=  -223.81 Mpa  stress ratio psi=     1.00
       Ksigma= 4.00      Lambda,p= 0.91     rho=   0.836
       Partially effective element. Area = 9.676e+001 mm² (Area,kgr = 0.000e+000 mm²)
       beff at end 1=32.254 mm -beff at end 2=32.254 mm -uneffective width =12.673 mm

Element       #4 : doubly supported element
```

```
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       92.75 mm   y1=        77.84 mm   x2=    92.75 mm  y2=     0.66 mm
      sigma1= -223.81 MPa  sigma2=  -223.81 Mpa  stress ratio psi=     1.00
      Ksigma= 4.00      Lambda,p= 0.91     rho=   0.836
      Partially effective element. Area = 9.676e+001 mm²  (Area,kgr = 0.000e+000 mm²)
      beff at end 1=32.254 mm -beff at end 2=32.254 mm -uneffective width =12.673 mm

Element       #5 : outstand element (stiffener) supported at end 1, free at end 2
      b=14.25 mm  gr1=0.66 mm  gr2=0.00 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=       93.41 mm   y1=         0.00 mm   x2=   107.00 mm  y2=     0.00 mm
      sigma1= -223.81 MPa  sigma2=  -223.81 Mpa
      Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.66  Lambda,p,red=    0.37  rho=   1.000
      Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)

Start stiffener will be modified (distorsional buckling).
As=75.631 mm² Is=1.152e+003 mm^4  K=2.030e-001 N/mm², s,cr= 185.273 MPa lam,s =1.13
Chi=0.66

End stiffener will be modified (distorsional buckling).
As=75.631 mm² Is=1.152e+003 mm^4  K=2.030e-001 N/mm², s,cr= 185.273 MPa lam,s =1.13
Chi= 0.66
```

With the same structure previously seen for the effective area in compression, the following section contains data for the computation of positive bending moment M2 resistance modulus.

```
----------------------------------------------------
-  Effective bending modulus due to a positive M2  -
----------------------------------------------------


Element       #1 : outstand element (stiffener) supported at end 2, free at end 1
      b=14.25 mm  gr1=0.00 mm  gr2=0.66 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=        0.00 mm   y1=         0.00 mm   x2=    13.59 mm  y2=     0.00 mm
      sigma1= -223.81 MPa  sigma2=  -223.81 Mpa
      Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.79  Lambda,p,red=    0.40  rho=   1.000
      Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)

Element       #2 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       14.25 mm   y1=         0.66 mm   x2=    14.25 mm  y2=    77.84 mm
      sigma1= -220.81 MPa  sigma2=   130.30 Mpa  stress ratio psi=    -0.59
      Ksigma= 14.93      Lambda,p= 0.47     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #3 : doubly supported element
```

```
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       14.91 mm   y1=        78.50 mm   x2=    92.09 mm  y2=    78.50 mm
      sigma1=  133.29 MPa  sigma2=   133.29 Mpa  stress ratio psi=     0.00
      Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm² (Area,kgr=  0.000e+000 mm²)

Element       #4 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       92.75 mm   y1=        77.84 mm   x2=    92.75 mm  y2=     0.66 mm
      sigma1=  130.30 MPa  sigma2=  -220.81 Mpa  stress ratio psi=    -0.59
      Ksigma= 14.93      Lambda,p= 0.47     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #5 : outstand element (stiffener) supported at end 1, free at end 2
      b=14.25 mm  gr1=0.66 mm  gr2=0.00 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=       93.41 mm   y1=         0.00 mm   x2=   107.00 mm  y2=     0.00 mm
      sigma1= -223.81 MPa  sigma2=  -223.81 Mpa
      Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.79  Lambda,p,red=    0.40  rho=   1.000
      Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)

Start stiffener will be modified (distorsional buckling).
As=49.510 mm² Is=9.857e+002 mm^4  K=2.030e-001 N/mm², s,cr= 261.828 MPa lam,s =0.95
Chi=0.79

End stiffener will be modified (distorsional buckling).
As=49.510 mm² Is=9.857e+002 mm^4  K=2.030e-001 N/mm², s,cr= 261.828 MPa lam,s =0.95
Chi=0.79
```

The same is reported for negative bending moment M2 resistance modulus.

```
----------------------------------------------------
-  Effective bending modulus due to a negative M2  -
----------------------------------------------------


Element       #1 : outstand element supported at end 2, free at end 1
      b=14.25 mm  gr1=0.00 mm  gr2=0.66 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=        0.00 mm   y1=         0.00 mm   x2=    13.59 mm  y2=     0.00 mm
      sigma1=  223.81 MPa  sigma2=   223.81 Mpa  stress ratio psi=     0.00
      Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
      Fully effective element. Area = 2.039e+001 mm² (Area,kgr=  0.000e+000 mm²)

Element       #2 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       14.25 mm   y1=         0.66 mm   x2=    14.25 mm  y2=    77.84 mm
```

```
      sigma1=  220.55 MPa  sigma2=  -161.59 Mpa  stress ratio psi=    -1.36
      Ksigma= 33.44      Lambda,p= 0.31     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #3 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       14.91 mm   y1=        78.50 mm   x2=    92.09 mm  y2=    78.50 mm
      sigma1= -164.85 MPa  sigma2=  -164.85 Mpa  stress ratio psi=     1.00
      Ksigma= 4.00      Lambda,p= 0.91     rho=   0.836
      Partially effective element. Area = 9.676e+001 mm² (Area,kgr = 0.000e+000 mm²)
      beff at end 1=32.254 mm -beff at end 2=32.254 mm -uneffective width =12.673 mm

Element       #4 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       92.75 mm   y1=        77.84 mm   x2=    92.75 mm  y2=     0.66 mm
      sigma1= -161.59 MPa  sigma2=   220.55 Mpa  stress ratio psi=    -1.36
      Ksigma= 33.44      Lambda,p= 0.31     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #5 : outstand element supported at end 1, free at end 2
      b=14.25 mm  gr1=0.66 mm  gr2=0.00 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=       93.41 mm   y1=         0.00 mm   x2=   107.00 mm  y2=     0.00 mm
      sigma1=  223.81 MPa  sigma2=   223.81 Mpa  stress ratio psi=     0.00
      Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
      Fully effective element. Area = 2.039e+001 mm² (Area,kgr=  0.000e+000 mm²)

Start stiffener is in tension.
End stiffener is in tension.
```

...for positive bending moment M3 resistance modulus...

```
----------------------------------------------------
-  Effective bending modulus due to a positive M3  -
----------------------------------------------------


Element       #1 : outstand element supported at end 2, free at end 1
      b=14.25 mm  gr1=0.00 mm  gr2=0.66 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=        0.00 mm   y1=         0.00 mm   x2=    13.59 mm  y2=     0.00 mm
      sigma1=  149.72 MPa  sigma2=   102.27 Mpa  stress ratio psi=     0.00
      Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
      Fully effective element. Area = 2.039e+001 mm² (Area,kgr=  0.000e+000 mm²)

Element       #2 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
```

```
      x1=       14.25 mm   y1=         0.66 mm   x2=    14.25 mm  y2=    77.84 mm
      sigma1=  100.29 MPa  sigma2=   137.63 Mpa  stress ratio psi=     0.00
      Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #3 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       14.91 mm   y1=        78.50 mm   x2=    92.09 mm  y2=    78.50 mm
      sigma1=  135.65 MPa  sigma2=  -133.79 Mpa  stress ratio psi=    -1.01
      Ksigma= 24.25      Lambda,p= 0.37     rho=   1.000
      Fully effective element. Area = 1.158e+002 mm² (Area,kgr=  0.000e+000 mm²)

Element       #4 : doubly supported element
      b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
      x1=       92.75 mm   y1=        77.84 mm   x2=    92.75 mm  y2=     0.66 mm
      sigma1= -136.41 MPa  sigma2=  -173.74 Mpa  stress ratio psi=     0.79
      Ksigma= 4.47      Lambda,p= 0.86     rho=   0.883
      Partially effective element. Area = 1.023e+002 mm²  (Area,kgr = 0.000e+000 mm²)
      beff at end 1=35.827 mm -beff at end 2=32.351 mm -uneffective width = 9.004 mm

Element       #5 : outstand element (stiffener) supported at end 1, free at end 2
      b=14.25 mm  gr1=0.66 mm  gr2=0.00 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=       93.41 mm   y1=         0.00 mm   x2=   107.00 mm  y2=     0.00 mm
      sigma1= -176.36 MPa  sigma2=  -223.81 Mpa
      Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.65  Lambda,p,red=    0.37  rho=   1.000
      Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)

Start stiffener is in tension.
End stiffener will be modified (distorsional buckling).
As=75.816 mm² Is=1.152e+003 mm^4  K=2.030e-001 N/mm², s,cr= 184.883 MPa lam,s =1.13
Chi=0.65
```

...and for negative bending moment M3 resistance modulus.

```
----------------------------------------------------
-  Effective bending modulus due to a negative M3  -
----------------------------------------------------


Element       #1 : outstand element (stiffener) supported at end 2, free at end 1
      b=14.25 mm  gr1=0.00 mm  gr2=0.66 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
      x1=        0.00 mm   y1=         0.00 mm   x2=    13.59 mm  y2=     0.00 mm
      sigma1= -223.81 MPa  sigma2=  -176.36 Mpa
      Ksigma= 0.50  Lambda,p= 0.45  Chi=    0.65  Lambda,p,red=    0.37  rho=   1.000
      Fully effective element. Area = 2.039e+001 mm²  (Area,kgr =  0.000e+000 mm²)
```

```
Element       #2 : doubly supported element
       b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
       x1=       14.25 mm   y1=         0.66 mm   x2=    14.25 mm  y2=    77.84 mm
       sigma1= -173.74 MPa  sigma2=  -136.41 Mpa  stress ratio psi=     0.79
       Ksigma= 4.47      Lambda,p= 0.86     rho=   0.883
       Partially effective element. Area = 1.023e+002 mm²  (Area,kgr = 0.000e+000 mm²)
       beff at end 1=32.351 mm -beff at end 2=35.827 mm -uneffective width = 9.004 mm

Element       #3 : doubly supported element
       b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
       x1=       14.91 mm   y1=        78.50 mm   x2=    92.09 mm  y2=    78.50 mm
       sigma1= -133.79 MPa  sigma2=   135.65 Mpa  stress ratio psi=    -1.01
       Ksigma= 24.25      Lambda,p= 0.37     rho=   1.000
       Fully effective element. Area = 1.158e+002 mm² (Area,kgr=  0.000e+000 mm²)

Element       #4 : doubly supported element
       b=78.50 mm  gr1=0.66 mm  gr2=0.66 mm  bP=77.18 mm  t=1.50 mm  bP:t =    51.45
       x1=       92.75 mm   y1=        77.84 mm   x2=    92.75 mm  y2=     0.66 mm
       sigma1=  137.63 MPa  sigma2=   100.29 Mpa  stress ratio psi=     0.00
       Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
       Fully effective element. Area = 1.158e+002 mm²  (Area,kgr = 0.000e+000 mm²)

Element       #5 : outstand element supported at end 1, free at end 2
       b=14.25 mm  gr1=0.66 mm  gr2=0.00 mm  bP=13.59 mm  t=1.50 mm  bP:t =9.06
       x1=       93.41 mm   y1=         0.00 mm   x2=   107.00 mm  y2=     0.00 mm
       sigma1=  102.27 MPa  sigma2=   149.72 Mpa  stress ratio psi=     0.00
       Ksigma= 0.00      Lambda,p= 0.00     rho=   1.000
       Fully effective element. Area = 2.039e+001 mm² (Area,kgr=  0.000e+000 mm²)

Start stiffener will be modified (distorsional buckling).
As=75.816 mm² Is=1.152e+003 mm^4  K=2.030e-001 N/mm², s,cr= 184.883 MPa lam,s =1.13
Chi=0.65

End stiffener is in tension.
```

The class computed for this section is given here.

```
The cross-section is in class 4
```

At the end of the listing, all the effective values are reported: the effective area for compression A_{eff}, the shifts of the effective section along the principal axes (e_{N2}, e_{N3}), resistance moduli for positive and negative bending moment around axis 2 (W_{eff2p} e W_{eff2m}) and resistance moduli for positive and negative bending moment around axis 3 (W_{eff3p} e W_{eff3m}).

```
Aeff           : effective area
eN2            : shift of effective section center along axis 2
eN3            : shift of effective section center along axis 3
Weff2p         : effective modulus for positive bending M2
Weff2m         : effective modulus for negative bending M2
Weff3p         : effective modulus for positive bending M3
Weff3m         : effective modulus for negative bending M3

Aeff= 2.927e+002 mm²  eN2= 0.000e+000 mm - eN3= 4.278e+000 mm
Weff2p= 6.006e+003 mm³ - Weff2m= 6.941e+003 mm³
Weff3p= 6.830e+003 mm³ - Weff3m= 6.830e+003 mm³
```

3.4.2.1.2 From file

Summary of the strings related to different shape kinds.

_UNITS 161	_HEA 162	_HAA 163	_HEB 163
_HEM 164	_HSM 164	_IPE 165	_IPE* 165
_IPN 166	_THSM 166	_USM 167	_RHS 167
_LSM 168	_PSH 168	_HSH 169	_USH 169
_TSH 169	_LSH 170	_OSH 170	_OOO 171
_UCF 171	_LCF 172	_ZCF 172	_OMCF 172
_COLD 173	_L2T 175	_L2CR 175	_L4CR 176
_U_O 177	_U_H 177	_UHCF 178	_POLI 179
_COMP 180			

.

3.4.2.1.2.1 String _UNITS

_UNITS

It is the string used to change units, while reading data from a file. It has effect starting from the row immediately after the _UNITS row itself. The format is

_UNITS unit

where "unit" can assume the following values:

m	meters.
mm	millimiters.
cm	centimeters.
in	inches.
ft	feet.
yd	yards.

3.4.2.1.2.2 String _HEA

_HEA

_HEA is the keyword used to add rolled HEA shapes. The string format is the following:

```
_HEA   name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.3 String _HAA

_HAA

_HEA is the keyword used to add rolled HEAA shapes. The string format is the following:

```
_HAA   name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.4 String _HEB

_HEB

_HEB is the keyword used to add rolled HEB shapes. The string format is the following:

```
_HEB  name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.5 String _HEM

_HEM

_HEM is the keyword used to add rolled HEM shapes. The string format is the following:

```
_HEM   name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.6 String _HSM

_HSM

_HSM is the keyword used to add rolled H shapes. The string format is the following:

_HSM name h b a e r

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes(IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.7 String _IPE

_IPE

_IPE is the keyword used to add rolled IPE shapes. The string format is the following:

```
_IPE   name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.8 String _IPE*

_IPE*

_IPE* is the keyword used to add rolled special IPE shapes. The string format is the following:

```
_IPE*  name   h   b   a   e   r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled H Shapes (IPE, HE, W, DIL, HLS...) 69.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.9 String _IPN

_IPN

_IPN is the keyword used to add rolled I shapes with tapered flanges (IPN, ISMB). The string format is the following:

```
_IPN    name    h    b    a    e    r    r1
```

where "name" is the name of the new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled I shapes with tapered flanges 81.

Notes

- The slope of the sides is 14%.
- By default, the value 'e' is computed at a distance equal to b/4 from the ends (european shapes): to change this setting (and to modify other information) three further codes can be added to standard string; these codes are described in Advanced used of shapes addition from file 182.

3.4.2.1.2.10 String _THSM

_THSM

_THSM is the keyword used to add rolled T sections obtained by cutting rolled H sections. The string format is the following:

```
_THSM    name    h    b    a    e    r
```

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled T sections obtained by cutting rolled H sections 73.

3.4.2.1.2.11 Stringa _USM

_USM

_USM is the keyword used to add rolled U shapes with tapered flanges (UPN, ISMC). The string format is the following:

```
_USM   name   h   b   a   e   r   r1
```

where "name" is the name of the new section (it must not exceed 20 characters). As to the symbols meaning go to Rolled I shapes with tapered flanges 71.

Notes

By default, the slope and the point where 'e' is computer are the following:

- if h<=300mm, slope is 8% and 'e' is computed at a distance equal to b/2 from the ends
- if h >300mm slope is 5% and 'e' is computed at (b-a)/2

To change this setting (and to modify other information) three further codes can be added to standard string; these codes are described in Advanced used of shapes addition from file 182.

3.4.2.1.2.12 String _RHS

_RHS

_RHS is the keyword used to add rectangular hollow sections (RHS). The string format is the following:

_RHS name h b a r

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rectangular Hollow Sections (RHS) 78.

3.4.2.1.2.13 String _LSM

_LSM

_LSM is the keyword used to add angles. The string format is the following:

_LSM name h b a r r1

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Angles 80.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.14 String _PSH

_PSH

_PSH is the keyword used to add rectangular shapes or plates. The string format is the following:

_PSH name h b

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rectangular shapes or Plates 83.

3.4.2.1.2.15 String _HSH

_HSH

_HSH is the keyword used to add H shaped sections. The string format is the following:

_HSH name h b c a e i

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to H Shaped Sections 85.

3.4.2.1.2.16 String _USH

_USH

_USH is the keyword used to add U shaped sections. The string format is the following:

_USH name h b a e

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to U Shaped Sections 87.

3.4.2.1.2.17 String _TSH

_TSH

_TSH is the keyword used to add T shaped sections. The string format is the following:

_TSH name h b a e

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to T Shaped Sections 89.

3.4.2.1.2.18 String _LSH

_LSH

_LSH is the keyword used to add L shaped sections. The string format is the following:

_LSH name h b a e

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to L Shaped Sections 91.

3.4.2.1.2.19 String _OSH

_OSH

_OSH is the keyword used to add welded rectangular hollow sections (boxes). The string format is the following:

_OSH name h b a e

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Box shapes 93.

3.4.2.1.2.20 String _OOO

_OOO

_OOO is the keyword used to add rounds shapes or circular hollow sections (CHS). The string format is the following:

_OOO name D t

where name is name of new section (it must not exceed 20 characters). As to the symbols meaning go to Rounds, Circular Hollow Sections (O, CHS) 95.

Three further codes can be added at the end of the string; for more information, see Advanced use of shape addition from file 182.

3.4.2.1.2.21 String _UCF

_UCF

_UCF is the keyword used to add U cold formed shapes (with stiffeners - C shapes- or without - U shapes -). The string format is the following:

_UCF name H B D r t

where "name" is the name of the new shape (it must not exceed 20 characters). As to the symbol meaning go to U shapes (cold formed) 98.

3.4.2.1.2.22 String _LCF

_LCF

_LCF is the keyword used to add L cold formed shapes (with or without stiffeners). The string format is the following:

_LCF name H B D r t

where "name" is the name of the new shape (it must not exceed 20 characters). As to the symbol meaning go to L shapes (cold formed) 100.

3.4.2.1.2.23 String _ZCF

_ZCF

_ZCF is the string used to add cold formed Z shapes. The string format is the following:

_ZCF name H B D r t

where "name" is the name of the new section (must not exceed 20 characters). As to the symbol meaning go to Cold formed Z shapes 103.

3.4.2.1.2.24 String _OMCF

_OMCF

_OMCF is the string used to add cold formed Ω shapes. The string format is the following:

_OMCF name H B D r t

where "name" is the name of the new section (it must not exceed 20 characters). As to the symbol meaning go to Cold formed 105 Ω 105 shapes 105.

3.4.2.1.2.25 String _COLD

_COLD

It is the string used to add cold formed shapes. The string block format is the following:

_COLD name nside open thick xi yi compwpl
side_1
side_2
....
side_nside

where "side" can be straight:

STRA hole dx dy

or circular

CIRC hole α radius

And where

- "name" is the name of the new shape (it must not exceed 20 characters)
- nside is the section side number
- open is a code specifying if the section is open (open = 1) or closed (open = 0).
- Thick is the thickness
- Xi is the abscissa of the first extreme of the first side (starting point)
- Yi is the quote of the first extreme of the first side (starting point)
- compwpl is a code = 0, if plastic moduli must not be computed and must therefore be set equal

to the elastic ones, =1 if plastic moduli must be computed;

- STRA is the straight side identifier
- Hole is a code equal to 0 if the side is NOT a hole, equal to 1 if the side is a hole
- Dx is the x variation from the first to the second extreme of the straight side to add
- Dy is the y variation from the first to the second extreme of the straight side to add
- CIRC is the circular sides identifier (circular arcs)
- α is the angular span of the circular side, positive if counterclockwise (degrees)
- radius is the radius of the circle on which lays the circular side

In the section name blank spaces must be replaced by "?", as in the following example (Ω shape):

```
_UNITS mm
_COLD     prcold  5   1   4.0  0.   0.   1
STRA     0    0    -100.
CIRC     0    90.  50.
STRA     1    50.  0.
CIRC     0    90   50
STRA     0    0    100
```

The following rules should be applied:

- The sides define the average line of a constant thickness shape
- Asking for plastic moduli requires an extra computational effort, which is not negligeable, since, for each added section a double iteration loop is started. In particular cases it is possible that the procedure does not converge. If this happens the problem is noticed and the plastic moduli are set equal to the elastic ones.
- Sections must not overlap. Therefore the sides must create a line continuous with its first derivative: there must not be cusps. Automatic tests are made so as to avoid this errors.

- As always all the sizes are read depending on the last _UNITS card read, or, if this is missing, using mm.

See also Generic cold formed shapes 114.

3.4.2.1.2.26 String _L2T

_L2T

It is the string used to add two angles back to back (T shaped angles). The string format is the following:

_L2T name namelsm d side

where "name" is the name of the new section (it must not exceed 20 characters), namelsm is the name of the angle to be used in order to create the new, composed shape, d is the clear distance between the two shapes, and side is a code that tells if join side is the long one (side = 1) or the short one (side = 0).
When angles have equal sides, the "side" code is a dummy value.

White spaces in namelsm must be replaced by "?", as in the following example:

```
_UNITS mm
_L2T    2L100x10   L?100x10    10.     0
```

See also T shaped composed angles 117.

3.4.2.1.2.27 String _L2CR

_L2CR

_L2CR is the string used to add two cross shaped angles. The string format is the following:

_L2CR name namelsm d

where "name" is the name of the new shape (it must not exceed 20 characters), namelsm is the name of the angle to be used in order to create the new composed shape, d is the clear distance between the two angles.

White spaces in namelsm must be replaced by "?", as in the following example:

_UNITS mm
_L2CR 2L100x10 L?100x10 10.

See also Cross shaped angles(2) 117.

3.4.2.1.2.28 String _L4CR

_L4CR

_L4CR is the string used to add four angles in a cross shape. The string format is the following:

_L4CR name namelsm d

where "name" is the name of the new shape (it must not exceed 20 characters), namelsm is the name of the angle to create the new shape, d is the clear distance between the four angles.

White spaces in namelsm must be replaced by "?", as in the following example:

_UNITS mm

_L4CR 2L100x10 L?100x10 10.

See also Cross shaped angles (4) 118.

3.4.2.1.2.29 String _UO

_U_O

_U_O is the string used to add two channel joined to create a [] shape . The string format is the following:

_U_O name nameusm d

where "name" is the name of the new shape (it must not exceed 20 characters), nameusm is the name of the channel to be used to create the new shape, d is the clear distance between the final flange points of the channels.

White space must be replaced by "?" in “nameusm”, as in the following example:

_UNITS mm
_U_O 2UPNO100_10 UPN?100 10.

See also [ ] Channels 120.

3.4.2.1.2.30 String _UH

_U_H

_U_H is the string used to add two channel joined to create a][shape . The string format is the following:

_U_H name nameusm d

where "name" is the name of the new shape (it must not exceed 20 characters), nameusm is the name of the channel to be used to create the new shape, d is the clear distance between the final flange points of the channels.

White space must be replaced by "?" in “nameusm”, as in the following example:

_UNITS mm

_U_H 2UPNH100_10 UPN?100 10.

See also] [Channels 120.

3.4.2.1.2.31 String _UHCF

_UHCF

_UHCF is the keyword used to add two composed C sections (cold formed) with a H shape. The string format is the following:

```
_UHCF   name   nameucf   d
```

where "name" is name of new section (it must not exceed 20 characters), "nameucf" is the name of single C cold formed shape used to create the composed shape, d i the distance between the C shapes.

If single shape name has spaces, substitute them with "?", as in the following example:

```
_UNITS mm
_UHCF    2UCF28x28x1.5   UCF?28x28x1.5    10.
```

3.4.2.1.2.32 String _POLI

_POLI

_POLI is the keyword used to add sections composed by polygon shapes (full or empty). The string format is the following:

```
_POLI    name    npoli    compwpl    it    Jt
poli_1
poli_2
...
poli_npoli
```

where each "poli" block is like the following:

```
npoints    code
x1         y1
x2         y2
...
xnpoints   ynpoints
```

And where

- "name" is the name of the new shape è il nome della nuova sezione (it must not exceed 20 characters)
- npoli is the number of polygons composing the shape
- compwpl is a code, if = 0 plastic moduli are not computed and are equal to elastic moduli, if = 1 plastic moduli are computed
- it is the radius of torsional inertia
- Jt is the moment of torsional inertia
- npoints is the number of points defining the polygon
- code is equal to 0 if the polygon is empty and equal to 1 if it is full
- xi, yi are the coordinates of polygon generic point

For example, the following is a square section with a central square hole:

```
_POLI   prova   2   1   28.86   10546875.
4       1
-50     -50
50      -50
50      50
-50     50
4       0
-12.5   -12.5
12.5    -12.5
12.5    12.5
-12.5   12.5
```

3.4.2.1.2.33 String _COMP

_COMP

_COMP is the string used to add composed shapes. The string block format is the following:

_COMP name nshp compwpl

name_shp_1 x y α

name_shp_2 x y α

....

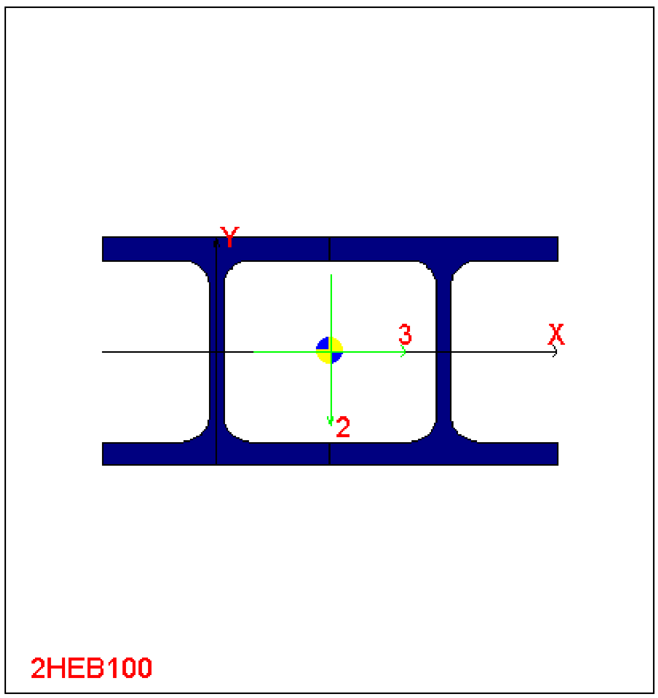
name_shp_nshp x y α

where

- "name" is the name of the new section (if must not exceed 20 characters)
- nshp is the number of composing shapes
- compwpl is a code, if = 0 plastic moduli should not be computed and will be set equal to the elastic ones; if = 1 plastic moduli will be computed;
- name_shp_1 is the name of the first composing shape;

- name_shp_2 is the name of the second composing shape
- name_shp_nshp is the name of the last composing shape
- x is the abscissa of the center of the composing shape specified in that row;
- y is the ordinate of the center of the composing shape specified in that row;
- α is the angle in degrees (positive counterclockwise) formed by x axis of composing shape with respect to X axis of composed shape.

White spaces in names should be replaced by “?” as in the foolowing example (II shapes):




```
_UNITS mm
_COMP     2HEB100        2      1
HE?100?B     0.      0.      0.
HE?100?B     100.    0.      0.
_COMP     2HEB120        2      1
HE?120?B     0.      0.      0.
HE?120?B     120.    0.      0.
```

Following rules apply:

- **composing shapes must be in archive *before* the execution of Add coomand and file reading**;
- composing shapes are decoded depending on their names, which must therefore be written exactly according to the rule of replacing white spaces by "?";
- asking plastic moduli computation requires an extra computational work which is not negligeable. It is also possible that convergence is not reached. If this happens the problem is notified and plastic moduli are set equal to elastic ones.
- Shapes must non overlap. Automatic test are executed with the aim of avoiding such possibility.
- As always each quote is decoded on the basis of the last _UNITS card, or, if this is missing, using mm.

See also Generic composed shapes 140.

3.4.2.1.2.34 Advanced use of shapes addition from file

ADVANCED USE OF SHAPES ADDITION FROM FILE

For some shape, it is possible to add three further codes to the standard string. It is an advanced tool and usually it's not needed for the addition of a user profile. The three additional codes are used to define if a shape is given in a Standard or not, to define the Standard and to mark it for selection filters. Different Standards may give different rules for shape definition.

The standard string of a rolled L section 168, for example, has the following format:

```
_LSM  name   h   b   a    r   r1
```

It can be modified into:

```
_LSM   name    h    b    a     r    r1    cod1    cod2    cod3
```

The three codes (all present or all missing) have the following meaning:

- **cod1** defines shape kind: for example, code 47 defines an angle with equal sides, code 26 an angle with unequal sides... AMPLIARE
- **cod2** defines the source of the shape (1 European standard, 2 American, 3 non standard, 4 Japanese, 5 Chinese)
- **cod3** defines if the shape is given in a Standard (cod3 = 1) or if it is a user shape (2)

For some shapes, different Standards give different rules for section definition. Involved shapes are rolled I with tapered flanges (for example, european IPN) and rolled channels with tapered flanges (european UPN). Let's see these differences in detail.

Rolled I shapes with tapered flanges

If the standard string is used

```
_IPN    name    h    b    a    e    r    r1
```

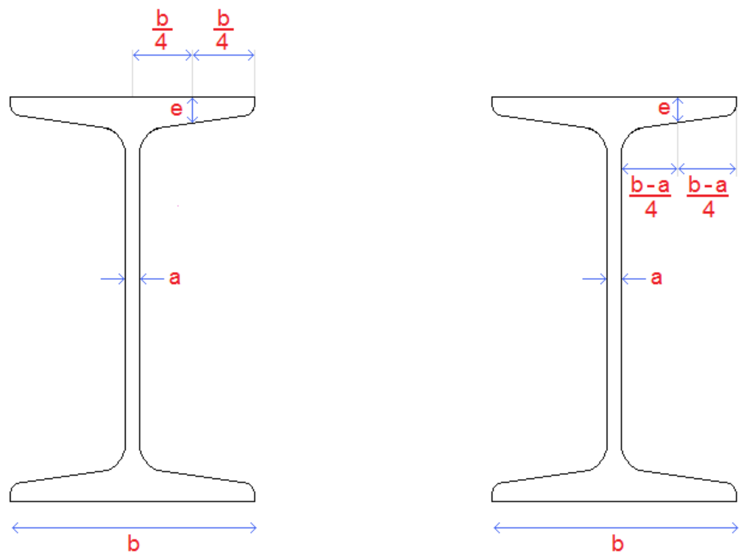
or the additional codes define the European Standard

```
_IPN    name    h    b    a    e    r    r1    14    1    1
```

flange thickness 'e' is computed at a distance equal to b/4 from the ends (on the left in the picture below); otherwise, if the additional codes define the Indian Standard, with the following string

```
_IPN    name    h    b    a    e    r    r1    14    5    1
```

thickness 'e' will be computed at a distance equal to (b-a)/4 from the ends (on the right in the picture below).



Rolled channel shapes with tapered flanges

If the standard string is used

```
_USM   name   h   b   a   e   r   r1
```

or the additional codes define the European Standard

```
_USM   name   h   b   a   e   r   r1   15   1   1
```

the slope of tapered sides and the distance from the ends where 'e' is computed are given in the following table.

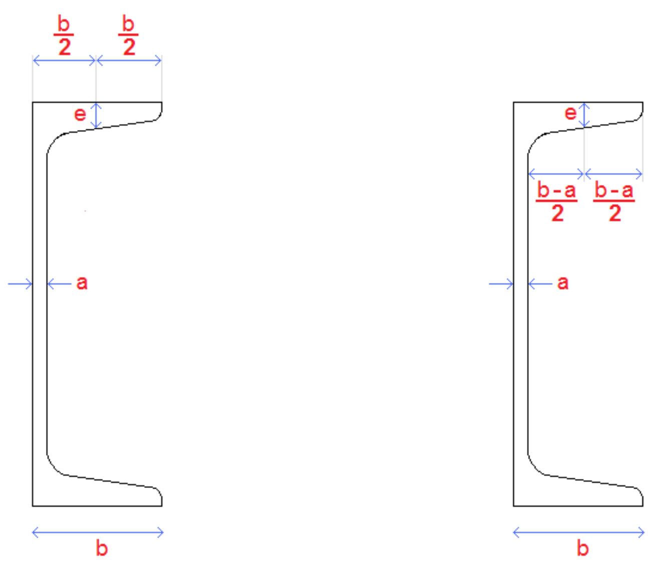
	h <= 300mm	h > 300mm

distance	b / 2	(b - a) / 2
slope	8%	5%

Otherwise, if the Indian Standard is defined

```
_USM    name    h    b    a    e    r    r1    15    5    1
```

the slope of tapered sides is always equal to 10% and 'e' is always computed at a distance from the ends equal to (b-a)/2.



In current Samba version these are the only possible variations..

3.4.3 Command: Shapes-Create DXF

COMMAND: Shapes-Create DXF

This command is used to create the dxf file of the active shape. The active shape is the shape selected (blu) in the shapes extracted frame (bottom right). If more than one shape is selected the command is not active.

In the .dxf file the shape will be described using the following rules:

- The shape is drawn in XY plane;
- The units are those active when the command is executed.

3.4.4 Command: Shapes-Modify

COMMAND: Shapes-Modify

This command is used to modify the shape currently selected in the extracted sections frame. If there are not extracted shapes or it is not selected any shape the command is unavailable.

As soon as the command is executed a dialog box window appears, whose content depends on the shape type (Add shapes one by one in an interactive way 29), filled with the section current data. To modify the section you have to modify one or more data.

It is strongly recommended not to modify standard sections data, like W, HEB, HEA, HEM, angles or channels.

3.5 Materials

Material Menu Commands

Extract 186	Extract a subset from material archive
Add 188	Add a material
Modify 190	Modifies the selected material

3.5.1 Command: Material-Extract

COMMAND: Material-Extract

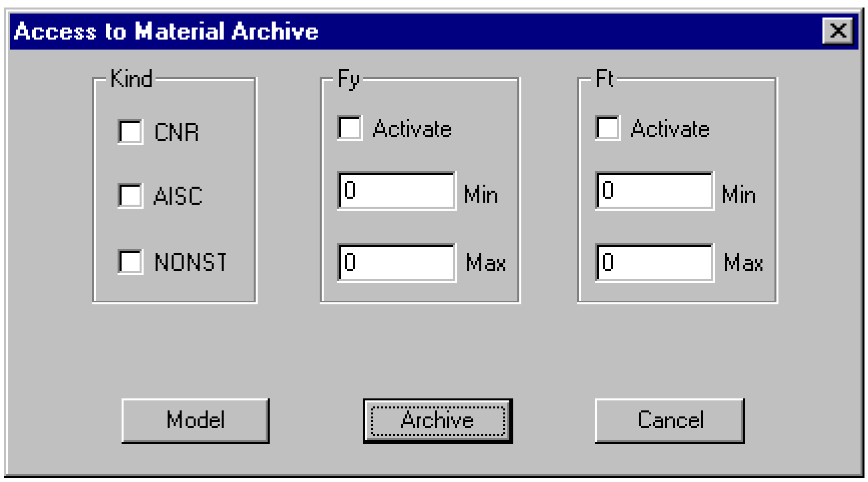
As soon as the command is executed, the user has in front of her/him a proper dialog box 187, which enables her/him to specify logical or numerical criteria used to extract materials.

Generally the number of materials of archive is not high, and so you can directly press OK without specifying any filter.

The extracted materials are listed in top right frame.

3.5.1.1 Access to material archive (dialog)

ACCESS TO MATERIAL ARCHIVE (DIALOG BOX)



This dialog makes you look at a material archive. The archive can be the general one (**Archive**) or the current model one (**Model**).

Archive access uses the filter specified (**Kind**, **F** ed **F**)

Kind: standard referring to the material

F : yield stress. To activate this filter you must select **Activate** and specify two values.

F : ultimate stress. To activate this filter you must select **Activate** and specify two values.

If there is not a filter all the materials present in the chosen archive will be listed. If a filter is applied only materials satisfying filter conditions will be listed.

3.5.2 Command: Material-Add

COMMAND: Material-Add

This command enables the user to add materials to the archive, through dialog box Adding Materials 188.

It is not allowed to add a material with a name equal to that of another material yet present in the archive.

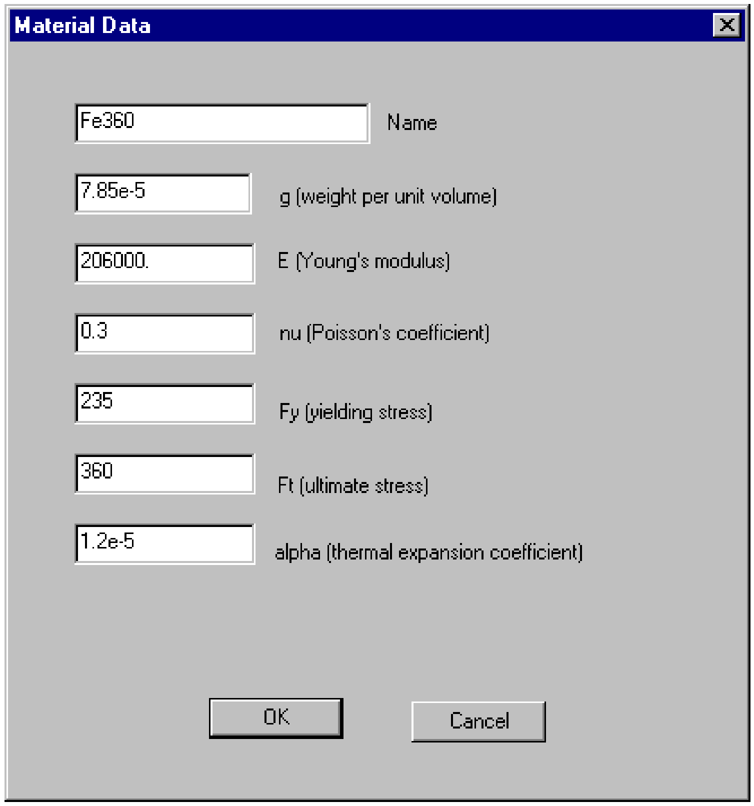
See: Adding materials 35

It is important to understand that once materials have been added, they are not actually added to archive, but only added to a waiting list. The true addition is done automatically exiting from the program if changes are saved, otherwise at any moment by command Update 54.

See also: Delete a shape or a material from waiting list 33.

3.5.2.1 Addition of a material (dialog)

ADDITION OF A MATERIAL (DIALOG BOX)



This dialog box is used to add a material to the archive, to modify an existing material data, or to have information about an existing material.

If data fields have grey background they cannot be modified.

The meaning of the symbols is the following:

- Name — name of the new material (max 20 caratteri)
- G — weight per unit volume using active units
- E — elastic Young's modulus, using active units
- Nu — Poisson's coefficient
- Fy — yield stress or elastic limit, using active units
- Ft — failure or ultimate stress, using active units
- Alpha — thermal expansion coefficient, using active units

3.5.3 Command: Materials-Modify

COMMAND: Materials-Modify

This command is used to modify currently selected material data If there is not any material selected or there are not extracted materials the command is not available.

As soon as the command is executed the dialog box used to set data appears (Material Addition188), filled with currently selected material data. To modify just change material data.

3.6 Window

Window Menu Commands

New Window 190	Creates a new window of the open archive.
Cascade 190	Arrange windows in a cascade.
Tile 191	Tile windows.
Arrange Icons 191	Arrange icons of open windows.

3.6.1 Command: Window-New Window

COMMAND: Window-New Window

This command creates a new window to show current archives. It must not be confused with the command that creates a new archive: this command only creates a new window of on existing document.

3.6.2 Command: Window-Cascade

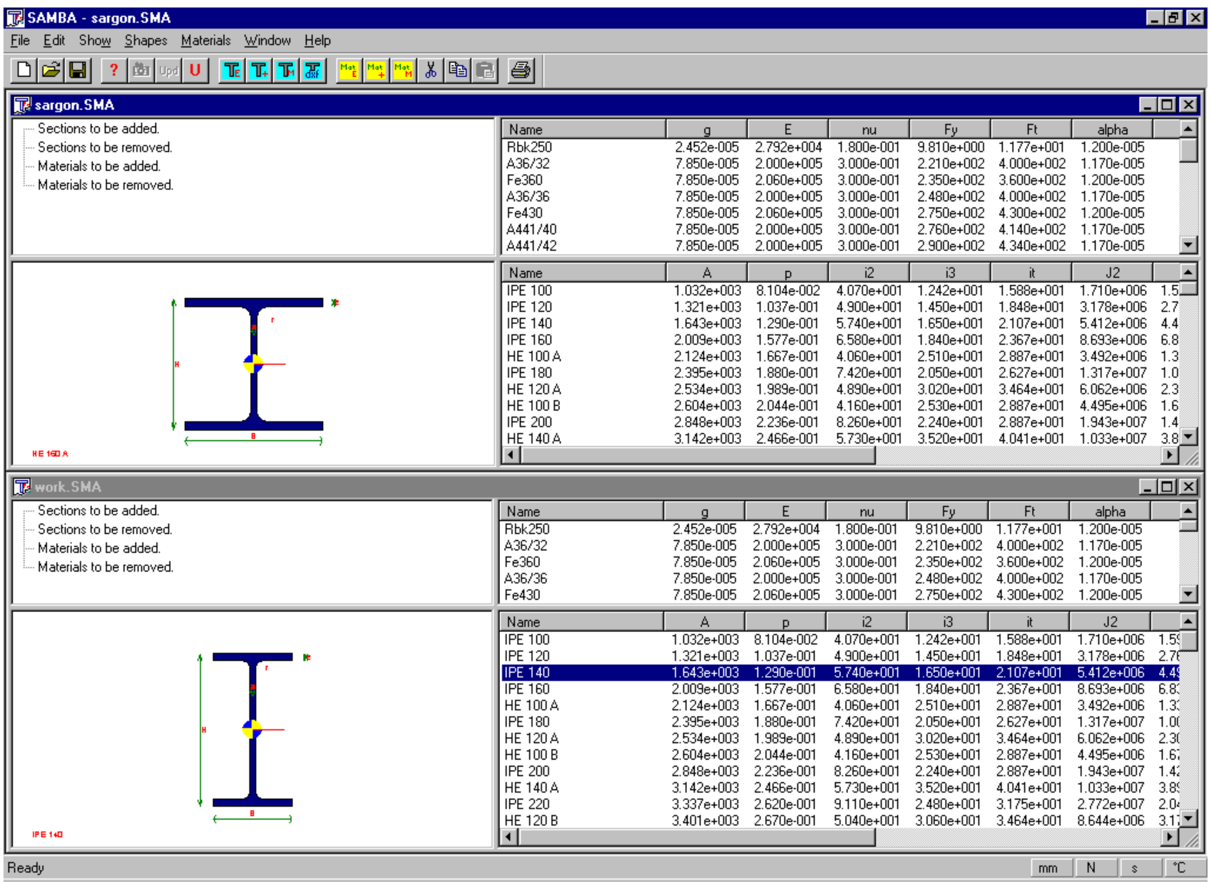
COMMAND: Window-Cascade

This command aarranges active windows.

3.6.3 Command: Window-Tile

COMMAND: Window-Tile

This command tiles (horizontally) active windows.



3.6.4 Command: Window-Arrange Icons

COMMAND: Window-Arrange Icons

This command arranges main window icons.

3.7 Help

Help menu command

Index 192	Calls help.
About Samba 192	Gives information about SAMBA.

3.7.1 Command: Help-Index

COMMAND: Help-Index

This command calls help.

3.7.2 Command: Help-About SAMBA

COMMAND: Help-About Samba

This command gives information about Samba and Castalia s.r.l., its producer.

Part IV

4 Elastic and plastic flexural properties of generic shapes

Elastic and plastic flexural properties
Automatic computation of generic sections

Paolo Rugarli
[*Costruzioni Metalliche*, 4-1998]

Foreword

The search for better design and economic solutions leads more and more frequently to the use of non standard sections. The concept of *standard section* itself is loosing its meaning, due to the increasing number of available shapes.

Steel sections producers have usually sold their products together with small design manuals, detailed or not, listing all shape properties. In the meanwhile the manual number has grown, but none has solved the problem in full. The best effort made in Italy remains the Italian translation of the classic German text “Stahl im Hochbau”([1]), which gives a wide range of simple or composed shapes, and a large number of data, unfortunately not any more upgraded.

Text [1] is one of the vertex of the classic "manualistic" approach, thick volumes to be open in the most different cases, but it is common to believe that this approach should be updated in the light of today language, that is software. This need is not depending on fashion consideration: this need is to complete the effort made by those who wrote our classic texts, that is answering to a large number of problems. The designers and the producers today wish they can describe any section in an efficient and fast way, gaining all the section properties they need. A particular interest is directed toward those sections made up of a number of elementary sections (composed sections), and those sections cold formed, widely used by the industry.

This work explains the procedure followed by the Author to implement section computation in a very general way, within the SAMBA (Shape And Material Brisk Archive) project.

The objective of this work is to compute elastic and plastic flexural properties on a section or a set of sections completely general. The work will be focused on the numeric and computational aspects featuring the problem, pointing out some of the problems to solve.

The section can be simple, composed, cold formed and can have holes: the procedure is completely general.

Description of a section using polygons

Generalities

In this work each section will be described as the set of a given number m of closed polygons, referred to a coordinate system (x, y). Each polygon can stand for a filled or for an empty region (a hole). Synthetically the section is so that

$$\Theta = \bigcup_{i=1}^{m} h_i P_i \qquad (1)$$

where Pi is the i-th polygon and hi is equal to +1 if this polygon is full, -1 if it is empty. It is straightforward that each curved side can be approximated by a given number of straight sides, if the number of straight sides is sufficiently high.

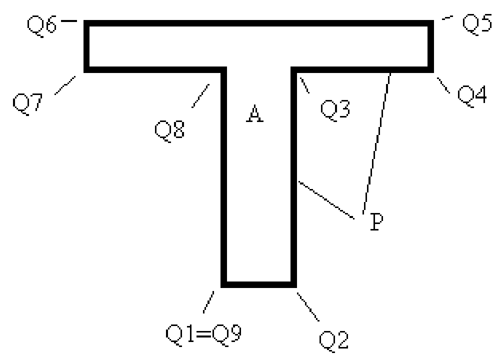


fig. 1

Each polygon Pi is described by n+1 points of the plane and by n sides, being the point Q1 coincident by definition with point Qn+1.

If this description is to have a meaning, it is necessary that no side of one polygon intersects another side (of the same polygon or of another polygon).

The points of each polygon are ordered from Q1 a Q n+1 in a counterclockwise way.

Integral computations

We are interested in the computetion of the following integral, defined in domain A internal to polygon P:

$$\int_A x^p y^q dA$$

where p and q are two integers positive or null. Using Green's formula we have:

$$\int_A x^p y^q dA = \int_P \frac{x^{p+1}}{(p+1)} y^q dy \qquad (2)$$

where polygon P is the boundary of A.

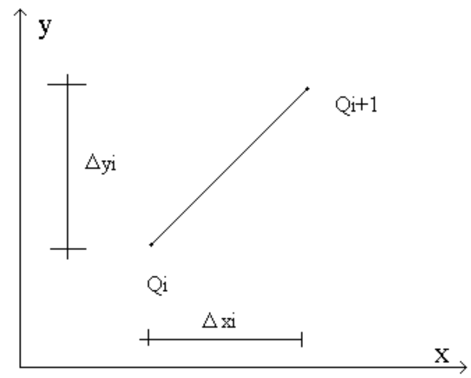


fig. 2

Therefore

$$\int_P \frac{x^{p+1}}{(p+1)} y^q dy = \sum_{i=1}^{n} \int_{Q_i}^{Q_{i+1}} \frac{x^{p+1}}{(p+1)} y^q dy \qquad (3)$$

If Qi has coordinates xi and yi and Δxi = xi+1-xi we can set, along the side Qi, Qi+1:

$$x = x_i + \lambda \Delta x_i \qquad (4.a)$$

$$y = y_i + \lambda \Delta y_i \qquad (4.b)$$

$$dy = \Delta y_i \; d\lambda \qquad (5)$$

where λ is a nondimensional abscissa comprised between 0 and 1. Substituting (4)-(5) in (2) (3) we get

$$\int_A x^p y^q dA = \sum_{i=1}^{n} \int_0^1 \frac{(x_i + \lambda \Delta x_i)^{p+1}}{(p+1)} (y_i + \lambda \Delta y_i)^q \Delta y_i d\lambda \qquad (6)$$

The defined integral in (6) can be evaluated numerically or in a closed formula. We introduce the short symbol (with three or four indexes)

$$Q_{ipq} = \int_0^1 \frac{(x_i + \lambda \Delta x_i)^{p+1}}{(p+1)} (y_i + \lambda \Delta y_i)^q \Delta y_i d\lambda \qquad (7)$$

where Qi is the starting point and p and q are the exponents of x and y, respectively. Thanks to (7) we can write

$$\int_A x^p y^q dA = \sum_{i=1}^{n} Q_{ipq} \qquad (8)$$

Some integrals are particularly useful. Precisely:

$$Q_{i00} = \int_0^1 (x_i + \lambda \Delta x_i) \Delta y_i d\lambda \tag{9.a}$$

$$Q_{i10} = \int_0^1 \frac{(x_i + \lambda \Delta x_i)^2}{2} \Delta y_i d\lambda \tag{9.b}$$

$$Q_{i01} = \int_0^1 (x_i + \lambda \Delta x_i)(y_i + \lambda \Delta y_i) \Delta y_i d\lambda \tag{9.c}$$

$$Q_{i11} = \int_0^1 \frac{(x_i + \lambda \Delta x_i)^2}{2} (y_i + \lambda \Delta y_i) \Delta y_i d\lambda \tag{9.d}$$

$$Q_{i20} = \int_0^1 \frac{(x_i + \lambda \Delta x_i)^3}{3} \Delta y_i d\lambda \tag{9.e}$$

$$Q_{i02} = \int_0^1 (x_i + \lambda \Delta x_i)(y_i + \lambda \Delta y_i)^2 \Delta y_i d\lambda \tag{9.f}$$

All these defined integrals are easily computable in a closed way. For instance:

$$Q_{i00} = x_i \Delta y_i + \frac{1}{2} \Delta x_i \Delta y_i$$

$$Q_{i10} = \frac{1}{6} \Delta y_i \left(x_{i+1}{}^2 + x_{i+1} x_i + x_i{}^2 \right)$$

and so on.

The result can be generalized if the section follows (1), that is if the section is made up of a set of m polygons, full or empty. In this case, the integral will be from point Qj of polygon i to point Qj+1 of the same polygon i, or shortly from Qij to Qij+1. Finally, generalizing (8) with a four index equation

$$\int_{\otimes} x^p y^q dA = \sum_{i=1}^{m} h_i \sum_{j=1}^{n} Q_{ijpq} \tag{10}$$

that is each integral is reduced to algebraic sums.

Elastic flexural properties

Using the notation introduced we have:

$$A = \int dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij00} \tag{11.a}$$

$$I_x = \int y^2 dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij02} \tag{11.b}$$

$$I_y = \int x^2 dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij20} \quad (11.c)$$

$$I_{xy} = \int xy dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij11} \quad (11.d)$$

$$S_x = \int y dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij01} \quad (11.e)$$

$$S_y = \int x dA = \sum_{i=1}^{m} \sum_{j=1}^{n} h_i Q_{ij10} \quad (11.f)$$

From (11) it is possible to evaluate the section center G and the principal axes using ordinary methods. Let γ be the angle formed by principal axis u with axis x.
The distance of a generic point Qij (point j of polygon i) from axis u, is

$$d_{uij} = \left|(x_{ij} - x_G)\cos(\gamma) - (y_{ij} - y_G)\sin(\gamma)\right|$$

and from axis v, is

$$d_{vij} = \left|(x_{ij} - x_G)\sin(\gamma) - (y_{ij} - y_G)\cos(\gamma)\right|$$

We now just set

$$W_u = \frac{I_u}{\max_{ij}\{d_{uij}\}} \quad (12.a)$$

$$W_v = \frac{I_v}{\max_{ij}\{d_{vij}\}} \quad (12.b)$$

finding the elastic section moduli.

Composed sections

One of the most frequent and interesting situation for the steel structures designer is the possibility to create a "composed" sectionassembling other elementary sections, so as to reach a given goal. In this field there are no rules limiting the possible choices, so it seens that any list, no matter how complete, is to be not complete enough. Often the need to join in a particular way the elementary sections depends on particular layouts, or on other reasons leading to an unrepeatable design need. The problem solution is to create a software able to let the designer free to join the shapes as he/she likes it. The computation procedure must be specialized to treat the problem efficiently.

Let us then call "composed section" Φ the reunion of an arbitrary high number f of elementary sections Θ. Each section Θ is referred to its Coordinate System (SC) (x, y) and has its proper principal axes (u,v) forming an angle γ with SC (x,y). We call instead (X,Y) the SC of the composed shape, and (U, V) its principal axes SC.

The position of each elementary section Θk in plane is described by three numbers: its center coordinates (Xk, Yk), and the angle αk of axis xk with respect to axis X.

First of all we note that the method previously described is still valid, since even a composed section satisfies (1), that is, it can be seen as a set of proper polygons. Of course, for the method to be applicable it is necessary that all polygons are referred to the same SC (X, Y), which can be done by imposing to all polygons i of section k, Pki, a rototranslation depending on (Xk, Yk) and αk.

Software must update real time section computed data, while the user translates and rotates freely the elementary sections in the plane.

The overlapping tests assume a particular importance, since elementary sections cannot intersect. It is therefore important to assure that current choice of Xk, Yk and αk, that is the way the user has decided to move the current section in plane, does not violate these regularity condition. This is done checking that no polygon of currently displaced section, Pki , intersects the polygons of the other sections, and that no polygons of a section is contained or contains another polygon, picked by another section. Practically software must not accept as definitive situations where these conditions are not met, but just allow to "pass them over".

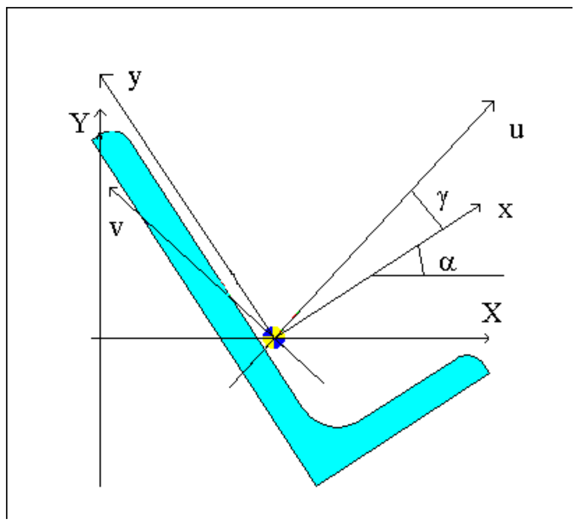


fig. 3

Besides the general method described, it is possible to use a direct method to compute second and first moments of the composed section, and to establish its principal axes position, starting from the same data of elementary sections. The formulae are the following:

$$A = \sum_{k=1}^{f} A_k \tag{13.a}$$

$$S_X = \sum_{k=1}^{f} A_k Y_k \tag{13.b}$$

$$S_Y = \sum_{k=1}^{f} A_k X_k \tag{13.c}$$

$$I_X = \sum_{k=1}^{f} \left(I_{Xk} + A_k Y_k^2\right) \tag{13.d}$$

$$I_Y = \sum_{k=1}^{f} \left(I_{Yk} + A_k X_k^{\,2}\right) \qquad (13.e)$$

$$I_{XY} = \sum_{k=1}^{f} \left(I_{XYk} + A_k X_k Y_k\right) \qquad (13.f)$$

Besides, setting βk=αk+γk

$$I_{Xk} = I_{vk} sin^2(\beta_k) + I_{uk} \cos^2(\beta_k) \qquad (14.a)$$

$$I_{Yk} = I_{vk} \cos^2(\beta_k) + I_{uk} sin^2(\beta_k) \qquad (14.b)$$

$$I_{XYk} = -(I_{uk} - I_{vk}) sin(\beta_k)\cos(\beta_k) \qquad (14.c)$$

Equations (14) give the elementary section k second inertia moment, with respect to axes parallel to (X, Y) and passing through elementary section center. Substituting (14) into (13) we find the properties of the composed shape with respect to its own SC, as a function of the elementary section properties, of elementary sections positions (Xk, Yk) and of the rotation αk applied to them.

Once (13) are obtained, using general or direct method, it is afterward possible to compute the composed section center, its principal axes and its angle γ (angle between X and U). To gain the "center" second moment of inertia it will be sufficient to use the well known shift formulae. To compute section moduli the polygon description will anyhow be necessary, and the (12) evaluations.

Cold formed sections: some specializations

We define here "cold formed" a section that can be identified by an average line K and a constant thickness t. We assume that the line K is made up of straight and circular sides. Due to regularity conditions we set

K C1

That is the average line must be continuous with its first derivative. In this case the elastic properties can be computed using closed formulae. We set

$$K = \bigcup_{i=1}^{n} l_i \qquad (15)$$

where li is the generic side, straight or circular. We now write the contribution of each side to the relevant data. If li is straight, it is inclined of γ over reference axis x, has its center in Gi and is long bi, is is, easily

$$S_{xi} = t b_i y_{Gi} \qquad (16.a)$$

$$S_{yi} = t b_i x_{Gi} \qquad (16.b)$$

$$I_{xi} = \frac{1}{12} b_i t^3 \cos^2(\gamma) + \frac{1}{12} t b_i^3 sin^2(\gamma) \quad (16.c)$$

$$I_{yi} = \frac{1}{12} b_i t^3 sin^2(\gamma) + \frac{1}{12} t b_i^3 \cos^2(\gamma) \quad (16.d)$$

$$I_{xyi} = -\frac{1}{12} b_i t^3 sin(\gamma)\cos(\gamma) + \frac{1}{12} t b_i^3 sin(\gamma)\cos(\gamma) \quad (16.e)$$

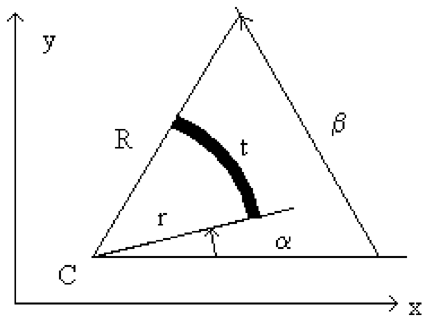


fig. 4

If li is a circular arc, we have, setting by definition zk= Rk-rk:

$$S_{xi} = \frac{y_C}{2} z_2(\beta - \alpha) + \frac{z_3}{3}(\cos(\alpha) - \cos(\beta)) \quad (17.a)$$

$$S_{yi} = \frac{x_C}{2} z_2(\beta - \alpha) + \frac{z_3}{3}(sin(\beta) - sin(\alpha)) \quad (17.b)$$

$$I_{xi} = \frac{y_C^2}{2}(\beta - \alpha) z_2 + \frac{2}{3} y_C z_3 (\cos(\alpha) - \cos(\beta)) + \frac{(\beta - \alpha)}{8} z_4 + \frac{z_4}{16}(sin(2\alpha) - sin(2\beta)) \quad (17.c)$$

$$I_{yi} = \frac{x_C^2}{2}(\beta - \alpha) z_2 + \frac{2}{3} x_C z_3 (sin(\beta) - sin(\alpha)) + \frac{(\beta - \alpha)}{8} z_4 + \frac{z_4}{16}(sin(2\beta) - sin(2\alpha)) \quad (17.d)$$

$$I_{xyi} = \frac{x_C y_C}{2}(\beta - \alpha) z_2 + \frac{1}{3} y_C z_3 (sin(\beta) - sin(\alpha)) - \frac{1}{3} x_C z_3 (\cos(\beta) - \cos(\alpha)) + \frac{z_4}{8}(sin^2(\beta) - sin^2(\alpha)) \quad (17.e)$$

where xc and yc are the center coordinates, α and β are the two angle in figure, R and r are the external and internal radius, respectively.

The section properties are obtained summing up contributions of each side, for instance

$$I_x = \sum_{i=1}^{n} I_{xi}$$

where we use (16.c) or (17.c) depending on the side type, straight or circular.

To compute the section moduli W is anyhow necessary to transform the average line K of thickness t, into its equivalent closed polygon P, which is done *bordering* K of a thickness t/2, and transforming the circular sides in polygons with an appropriate number of sides.

Plastic flexural properties

Generality

The plastic section moduli computation has an increasing importance, due to the increasing popularity of limit state standards (EC3, BS, AISC, etc.).

Let us refer a section to its elastic principal axes (u, v). Given a generic plastic neutral axis (PNA) k (fig. 5) of equation

au+bv+c=0

where

$$\sqrt{a^2+b^2}=1$$

this divides the section into two regions, a pulled region Ak+ and a compressed region Ak-. In the pulled region normal stress is +fy, in the compressed region it is–fy. Let us introduce the point function s(Q) thus defined:

s(Q) = sign(au+bv+c) = +1 if Q Ak+

s(Q) = sign(au+bv+c) = -1 if Q Ak-

At each generic plastic neutral axis k(PNAk) we get an axial force and two bending moments, that is

$$N_{pk} = \int_A s_k(Q) f_y dA \qquad (18.a)$$

$$M_{upk} = \int_A s_k(Q) f_y v dA \qquad (18.b)$$

$$M_{vplk} = \int_A s_k(Q) f_y u dA \qquad (18.c)$$

The tern fyΛk = {Nplk, Muplk, Mvplk}T is a point over the limit domain (one and not two because we assume that PNA is oriented). The vector Λk has as components the plastic moduli relative to the generic PNA chosen. Precisely we have:

$$A_{plk} = \frac{N_{plk}}{f_y} = \int_A s_k(Q) dA = \int_{A^+} dA - \int_{A^-} dA \qquad (19.a)$$

$$Z_{upk} = \frac{M_{uplk}}{f_y} = \int_A s_k(Q) v dA = \int_{A^+} v dA - \int_{A^-} v dA \qquad (19.b)$$

$$Z_{vplk} = \frac{M_{vplk}}{f_y} = \int_A s_k(Q)udA = \int_{A^+} udA - \int_{A^-} udA \qquad (19.c)$$

Integrals computation

Let a polygon Pi , having internal domain Ai , be cut by an axis s. We will call Pi' the polygon (equivalent to Pi) obtained adding to Pi the points found intersecting the sides of Pi with s.

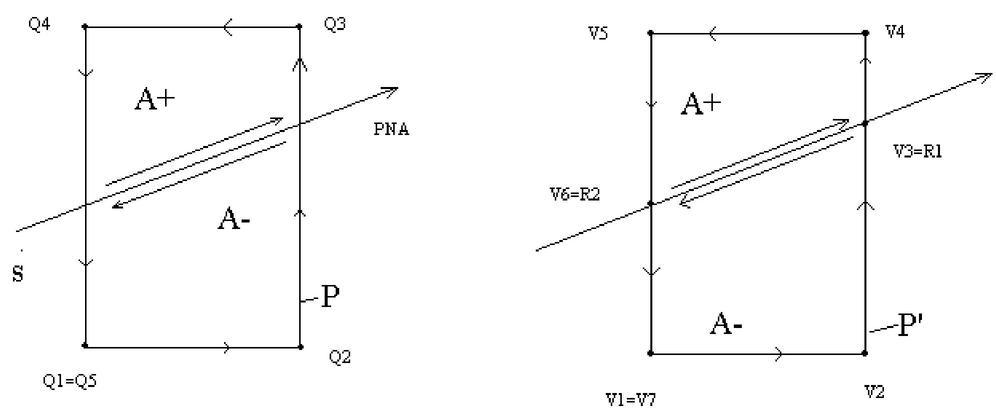


fig. 5

If initially the points of Pi are (n+1), the points of Pi' will be in general (n+1+r). The r new points stand all over s. We call Vij the points of the new polygon Pi' (j goes from 1 to n+1+r), and we order the r new points found, Ril, along s starting from the first toward the last, so that first and last are the most distant (fig. 6).

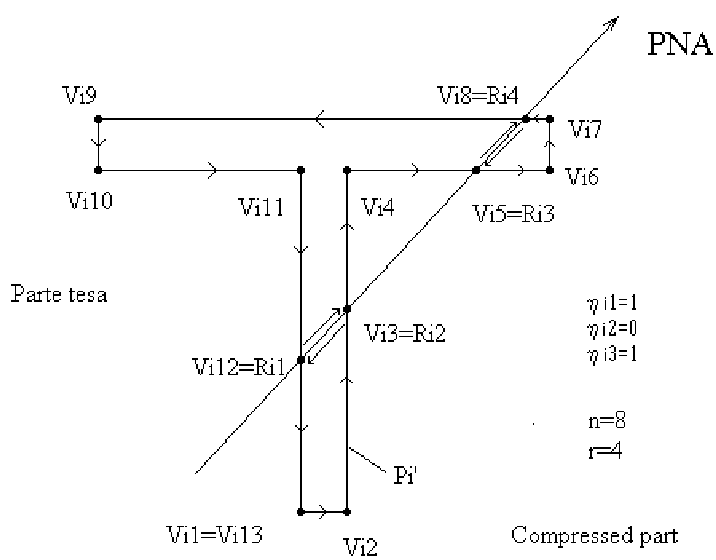


fig. 6

Given a couple of successive points Ril ed Ril+1, both laying over the polygon i, and a plastic neutral axis of equation au+bv+c=0, we introduce the function ηil(Ril) so defined (fig. 6):

ηil = sign(bΔuil - aΔvil)	if the middle point of segment RilRil+1 is inside Pi'
ηil = 0	if the middle point of segment RilRil+1 is outside Pi'

This function ηil then equals +1 or –1, depending on the vector going from Ril a Ril+1 : if it has the same sign of PNA it equals +1, if has opposite sign equals -1, if the segment RilRil+1 does not belong to the domain it equals 0.

The need to introduce this function is purely informatic. It keeps into account two things: the first is that not every segment laying on s is effectively part of the section, and this must be understood by computer (for instance the segment Ri2Ri3 in figure 6). The second is that going from R1 to R2,R3 et cetera, you can run along PNA in its positive or negative verse, and this must be kept into account in evaluating contributions, which have positive sign only if they belong to the boundary of the pulled region, that is only if you run along the boundary in the verse of PNA (fig.5).

It can be shown that

$$\int_{Ai} s(Q)u^p v^q dA = \left(\sum_{j=1}^{n+r} s(V_{ij})V_{ijpq} \right) + 2\left(\sum_{l=1}^{r-1} \eta_{il} R_{ilpq} \right) \qquad (20)$$

where as usual

$$V_{ijpq} = \int_0^1 \frac{\left(u_{ij} + \lambda \Delta u_{ij}\right)^{p+1}}{(p+1)} \left(v_{ij} + \lambda \Delta v_{ij}\right)^q \Delta v_{ij} d\lambda \qquad (21)$$

and similarily for Rilpq.

For a section made up of m polygons Pi, transformed into equivalent polygons Pi' (getting new points Ril), we can then set, remembering (19) and applying (20):

$$A_{plk} = \sum_{i=1}^{m} h_i \left[\sum_{j=1}^{n+r} s_k(V_{ij})V_{ij00} + 2\sum_{l=1}^{r-1} \eta_{il} R_{il00} \right] \qquad (22.a)$$

$$Z_{uplk} = \sum_{i=1}^{m} h_i \left[\sum_{j=1}^{n+r} s_k(V_{ij})V_{ij01} + 2\sum_{l=1}^{r-1} \eta_{il} R_{il01} \right] \qquad (22.b)$$

$$Z_{vplk} = \sum_{i=1}^{m} h_i \left[\sum_{j=1}^{n+r} s_k(V_{ij})V_{ij10} + 2\sum_{l=1}^{r-1} \eta_{il} R_{il10} \right] \qquad (22.c)$$

The (22) tell how to compute limit moduli (and therefore limit actions) given a plastic neutral axis k. Note that values of hi are +1 if polygon Pi is full, -1 if polygon Pi is empty. Similarily sk(Vij) are +1 o –1 depending on the position of Vij with respect to PNA k (in pulled or compressed region), and that il is 1,-1 or 0. Therefore (22) are the sum with proper signs of a given number of integrals (9).

Search for plastic moduli

Among all the possible plastic neutral axes k, to which are associated the terns Λk, we are interested to the two axes PNAu and PNAv so that the two terns get, respectively

$$\Lambda u = \{0, Zu, 0\} \qquad (23.a)$$
$$\Lambda v = \{0, 0, Zv\} \qquad (23.b)$$

that is, to those PNA generating stress distributions in equilibrium with simple flexural actions.

Let us suppose we wish to get Zu. This is done with an iterative process, trying to cancel Zv and Npl.

Let us first consider how to cancel Npl.

Given a generic PNA slope angle ϕ , and written PNA equation in the form

$$v\cos(\phi)-u\sin(\phi)-c = 0$$

it is easy to see that exists one and only one value of c, $\underline{c}=\underline{c}(\phi)$, and therefore one and only one PNA of angle ϕ, so that pulled region is equal to compressed region, that is so that

$$Apl = Ak+ - Ak- =0 \qquad (24)$$

This condition is necessary to have a purely bent section, that is to cancel Npl.
The $\underline{c}$ value corresponding to each generic ϕ can be found with an iterative method, using, for instance, the secant method (i is now the iteration index):

$$c_{i+1} = c_i - A_{pli}\frac{(c_i - c_{i-1})}{(A_{pli} - A_{pl(i-1)})}$$

The error ε is computed as

$$\varepsilon_i = \frac{|A_{pli}|}{A} < TOLERANCE \qquad (25)$$

Iteration is stopped when disequation (25) is satisfied.
At each c variation, leading to a translation of PNA at constant slope, we must compute the corresponding moduli using (22).

Let us now consider the Zv cancel.

To the value $\underline{c}$ obtained with a generic ϕ are mapped tern of the kind

$$\{ 0, Zu(\phi), Zv(\phi) \}$$

that is terns where Zv is not 0. The problem is to find the value of ϕ which cancels Zv, which is done with an iterative process. Let us set (i is the iteration index):

$$\phi_{i+1} = \phi_i - Z_{vi} \frac{(\phi_i - \phi_{i-1})}{(Z_{vi} - Z_{v(i-1)})} \quad (26)$$

evaluating the error as

$$\varepsilon_i = \frac{|Z_{vi}|}{W_v} < TOLERANCE \quad (27)$$

To each new ϕ a full iteration on c is done, to find the value c which meets (24). With the couple (ϕi, c(ϕi)) (22) are computed, the error is then evaluated through (27) and then a new ϕ is predicted with (26). Iteration is stopped when the (27) is satisfied.

Conclusion

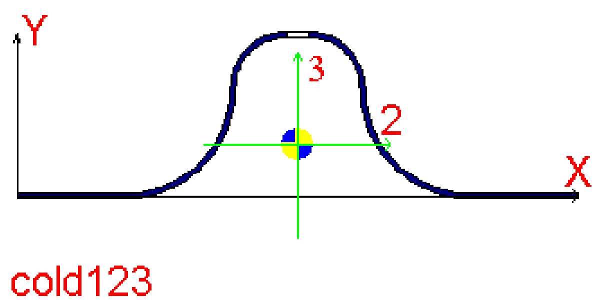


fig. 7

The procedure here described has been implemented in the program SAMBA, and with it the elastic and plastic properties of complex composed and cold formed sections, like those shown in figures 7 (cold formed section with hole) and 8 (generic composed section) have been computed.

The generality of the method and its ready-to-implement features have allowed to solve the problem in a great number of cases, gaining the original goal.

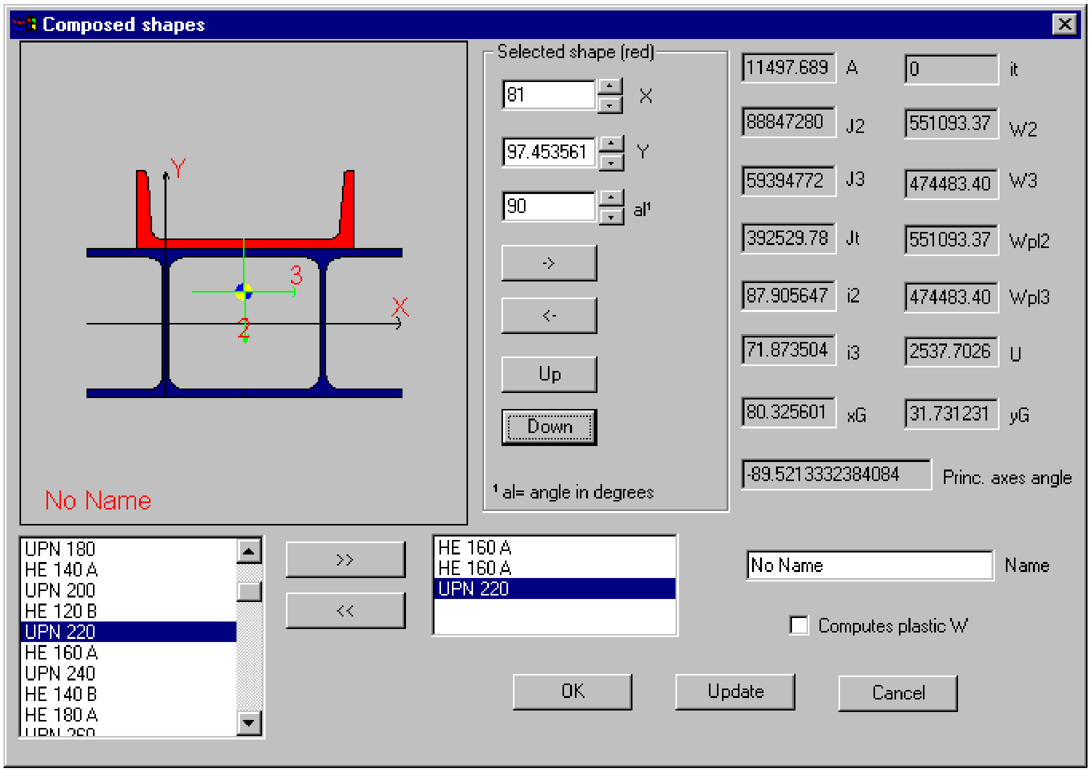


fig.8

For instance, the study of composed shapes is done through dialogue of fig. 8, in which you can see as elementary sections (central rectangle, bottom) are added or removed (>>, <<) choosing them from a list (left rectangle).

The selected section (red in figure) can then be translated or rotated continuously (controls “X”, “Y”, “al”) or displaced "springly", searching for tangent-to-others conditions (buttons ->, <-, “su” [up], “giù”[down]).

Section data are upgraded continuously, while the plastic moduli can be computed at request, starting the double iteration described (“Computes plastic W”, in fig. 8).

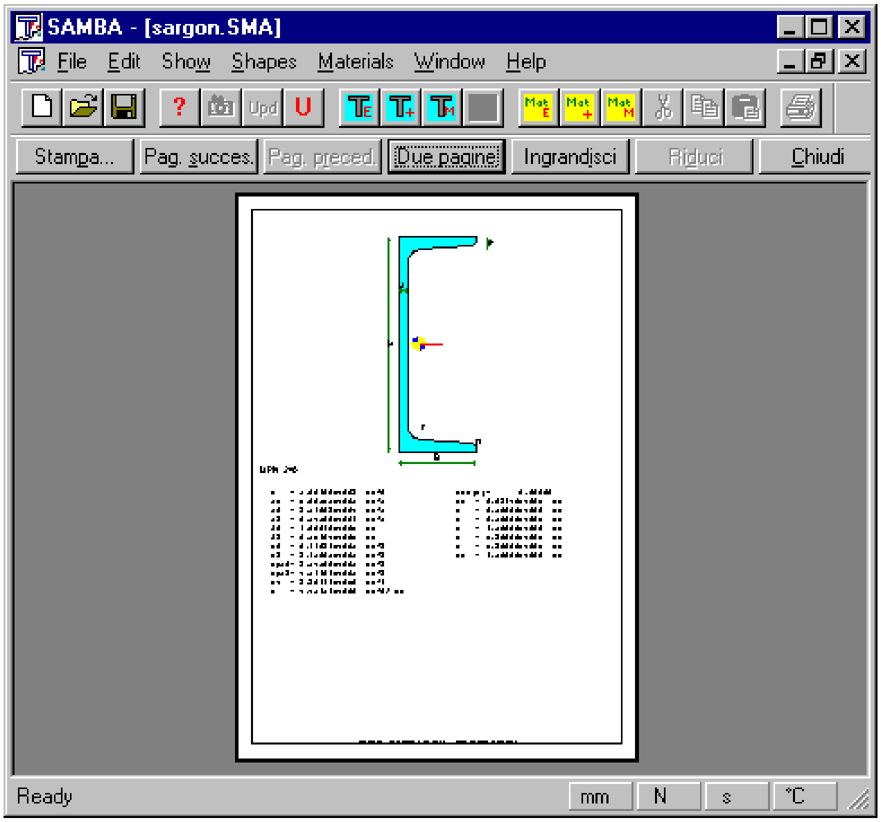


Fig.9

Section data can then be printed to any device (fig.9).

Legend

α	angle between axis x and axis X, initial angle angle of circular side
β	final angle of circular side
γ	Angle between principal axis u and axis x
Δx_i	by definition equal to $x_{i+1}-x_i$
ε	error in an iterative process
ϕ	Angle of slope of PNA over axis u
η_{il}	function of points R*il* and R_{il+1}
λ	Nondimensional abscissa comprised between 0 and 1
Γ	boundary of A
$\Gamma+$	boundary of A+
$\Gamma-$	boundary of A-
Λ	plastic moduli vettore contenente i moduli plastici
Θ	Section made up by polygons
a	parameter of PNA equation
b	length of a straight side of a cold formed shape, parameter of PNA equation
c	parameter of PNA equation
d	distance of a point to an axis

f	number of elementary sections composing a new composed section
fy	yield stree
h	function establishing if a polygon is full or empty
i	index of a point over a polygon P, index of the polygons of Θ, iteration index, side index
j	index of a point over polygon Pi
k	index of the elementary section, index of the generic PNA
l	side of cold formed shape, index
m	number of polygons of a section
n	number of sides of a polygon
p	exponent iteger or null
q	exponent integer or null
r	internal radius of circular side, number of (new) points of P laying on s
s	straight line of PNA
s(Q)	function of point Q
t	thickness of a cold formed shape
z_k	R^k-r^k

A	internal domain of a polygon, section area
A+	pulled region
A-	Compressed region
C	center of the circle to which belongs a circular side
G	section center
H	common part between Γ+ and Γ-
I	second moment of area
M	bending moment
N	axial force
P	polygon
PNA	plastic neutral axis
Q	point of the plane if with one or two indexes, defined integral value if with three or four indexes
R	external radius of circular side, point of polygon P’ laying over s
S	first moment of area (static moment)
V	point of the plane belonging to polygon P’
Z	plastic section modulus
W	elastic section modulus
(x,y)	coordinate system of a section
(X,Y)	coordinate system of a composed section
(u,v)	principal reference system of a section
(U,V)	principal reference system of a composed section

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