



Steel connections design According to EC3

**User's Manual**



Version 1.0  
April 2017



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## 2 DISCLAIMER

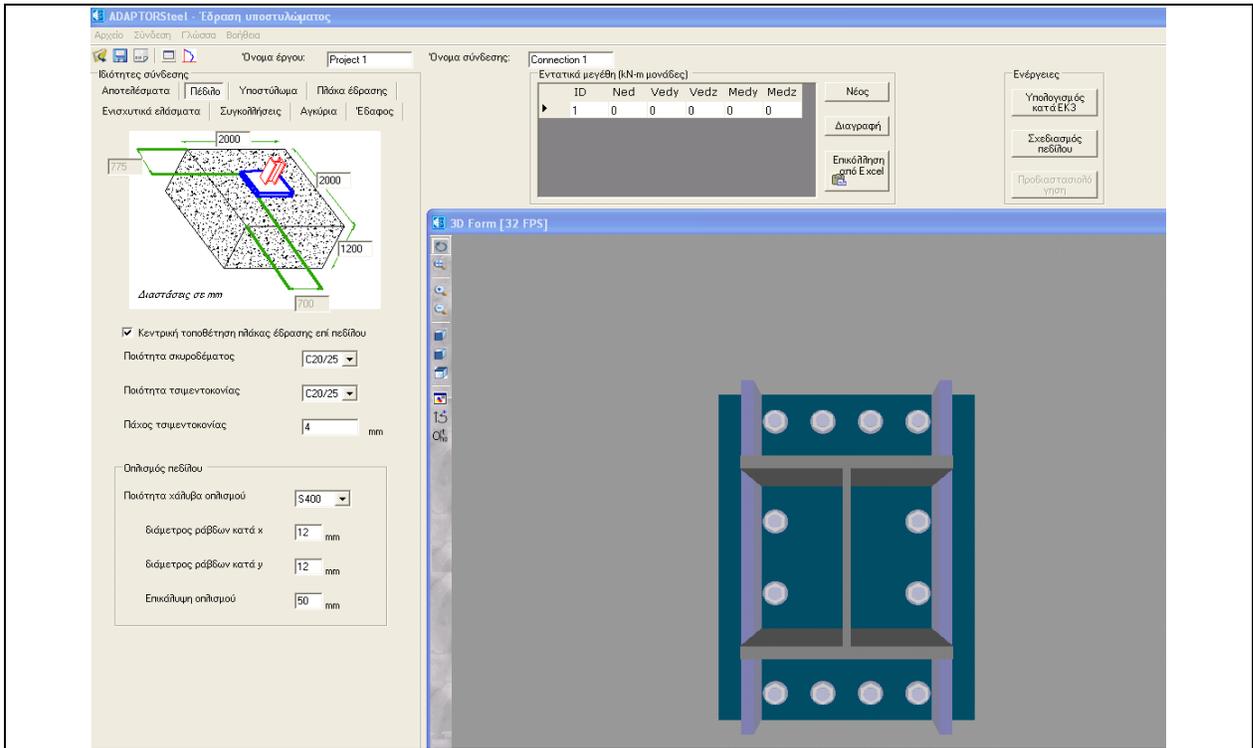
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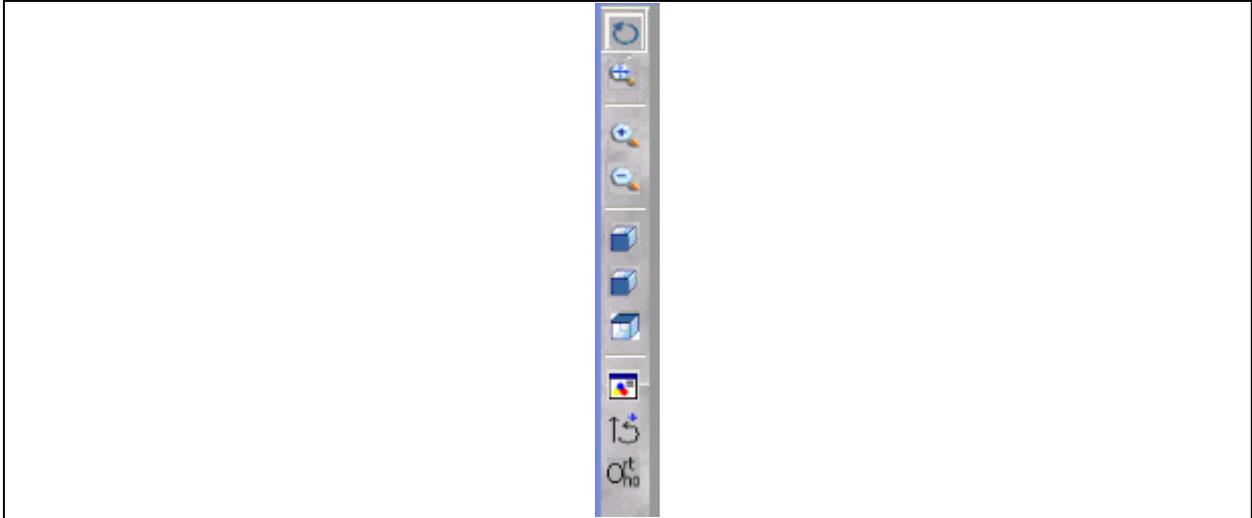
### 3 PRAXIS GENERAL DESCRIPTION

Thank you for choosing Praxis for the structural design of your steel connections. We are confident that after you familiarize with the program it will become a useful tool for your projects.



Picture 3.1

For example, when the user selects the base plate connection the above window appears. At the centre of the window there is a 3D view of the connection. On the left of the window is the following toolbar.



Picture 3.2

The user can rotate the 3D view by clicking on the first button of the toolbar and by clicking on the second button he can move the 3D view.

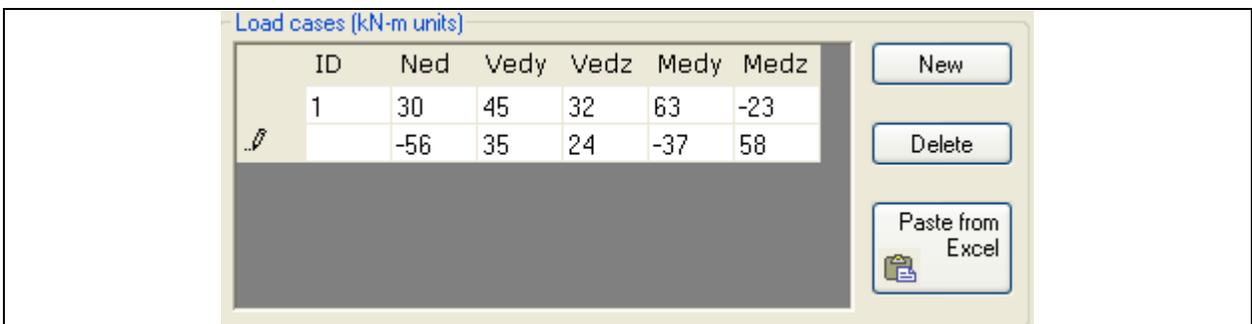
When the user clicks on the third and the fourth button he can zoom in and out of the image. With the fifth button the user can change the color of the background, whereas by clicking on the sixth button the positive connection loads appear.

The option Connection's Properties gives the user the capability to select between a number of tabs each one of which refers to a connection parameter.



Picture 3.3

The option Load Cases gives the user the capability to define the connection load cases.

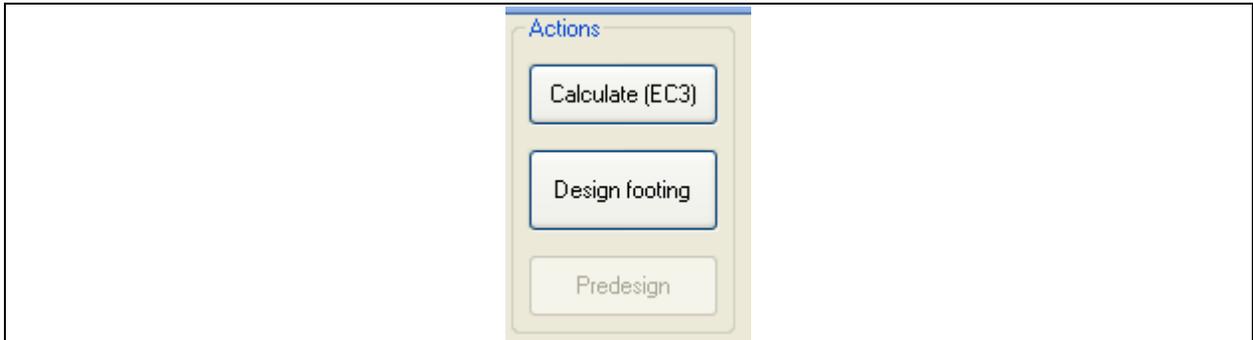


Picture 3.4

The user can add more than one load cases by clicking on New. If the user wants to delete one or more load cases he has already defined, he must click at the specific load combination and then click at Delete.

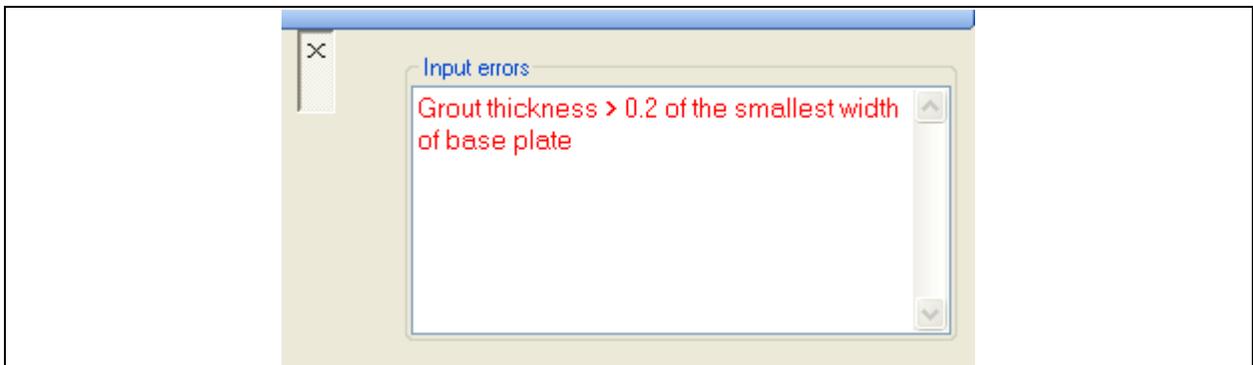
The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

To start the connection design the user clicks on Calculate in the frame of the option Actions.



*Picture 3.5*

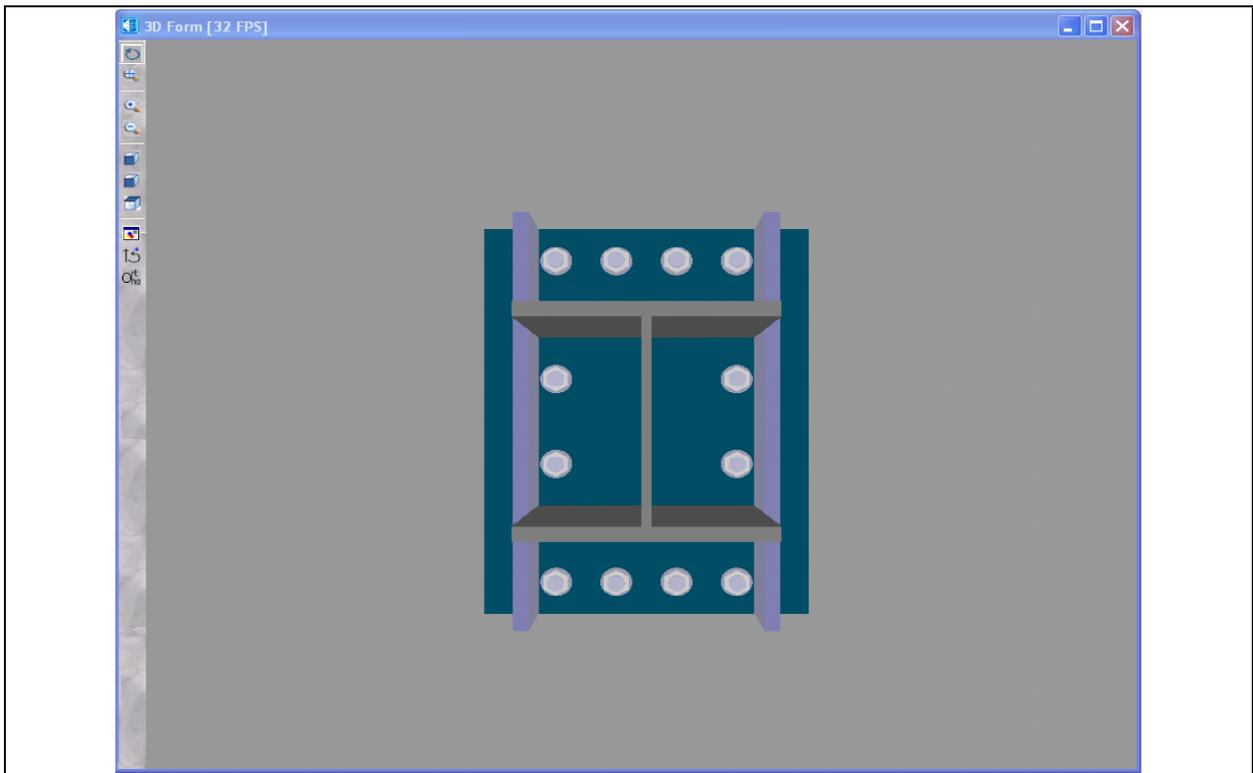
On the right side of the window is the Input errors where the user can see the data entry errors.



*Picture 3.6*

## 4 BASE PLATE CONNECTION

This connection refers to a column-to-footing connection. The cross-section of the column can be either of I type or hollow. The connection is subjected to pure biaxial bending (not superposition of uniaxial bending). All types of anchors are supported (straight, with hook, with a nut, with square or rectangular anchorage plate). Apart from the anchors and the base plate the program also designs the footing, taking into consideration the soil parameters and the member forces. The user can also add stiffeners to increase the bearing capacity of the steel connection. All the components of the connection are checked according to EC3 while the program also produces the failure surface about the major and minor axis of the column.



*Picture 4.1*

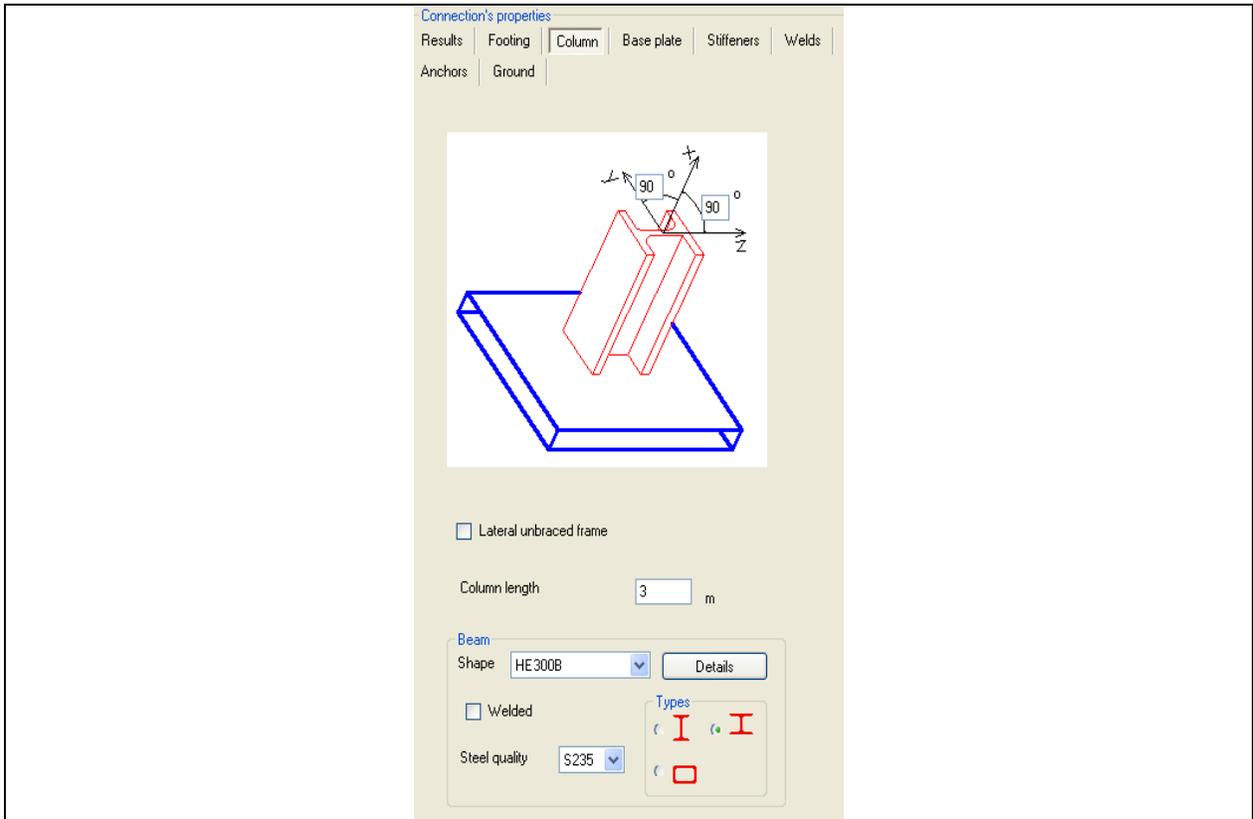
The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 4.2*

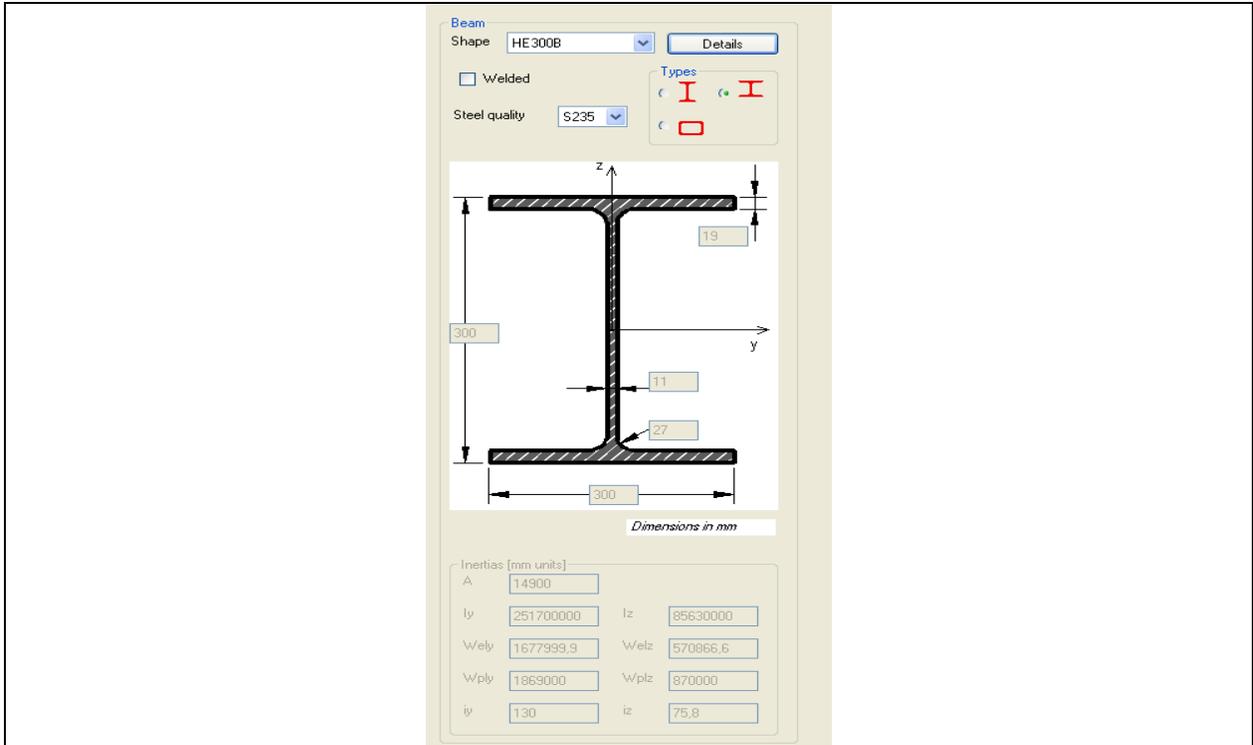
## 4.1 Column

The Column tab gives the user the capability to define the column parameters. The user can define the column length and whether the frame will be laterally unbraced or not (by checking the Lateral unbraced frame option).



**Picture 4.3**

The user can also define the type, the shape and the steel grade of the column. By clicking on the button Details the user can see the dimensions and the inertia characteristics of the column section.

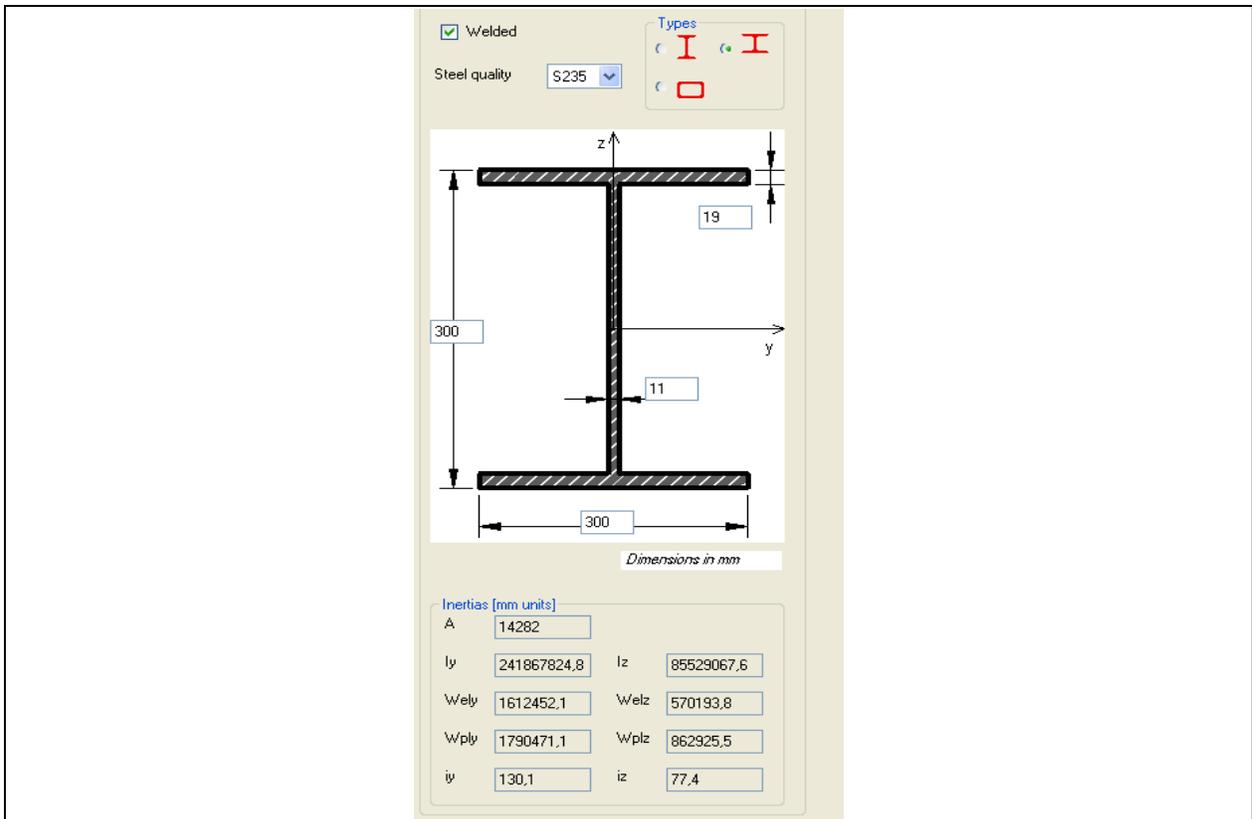


Picture 4.4



Picture 4.5

By clicking on the Welded option the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.

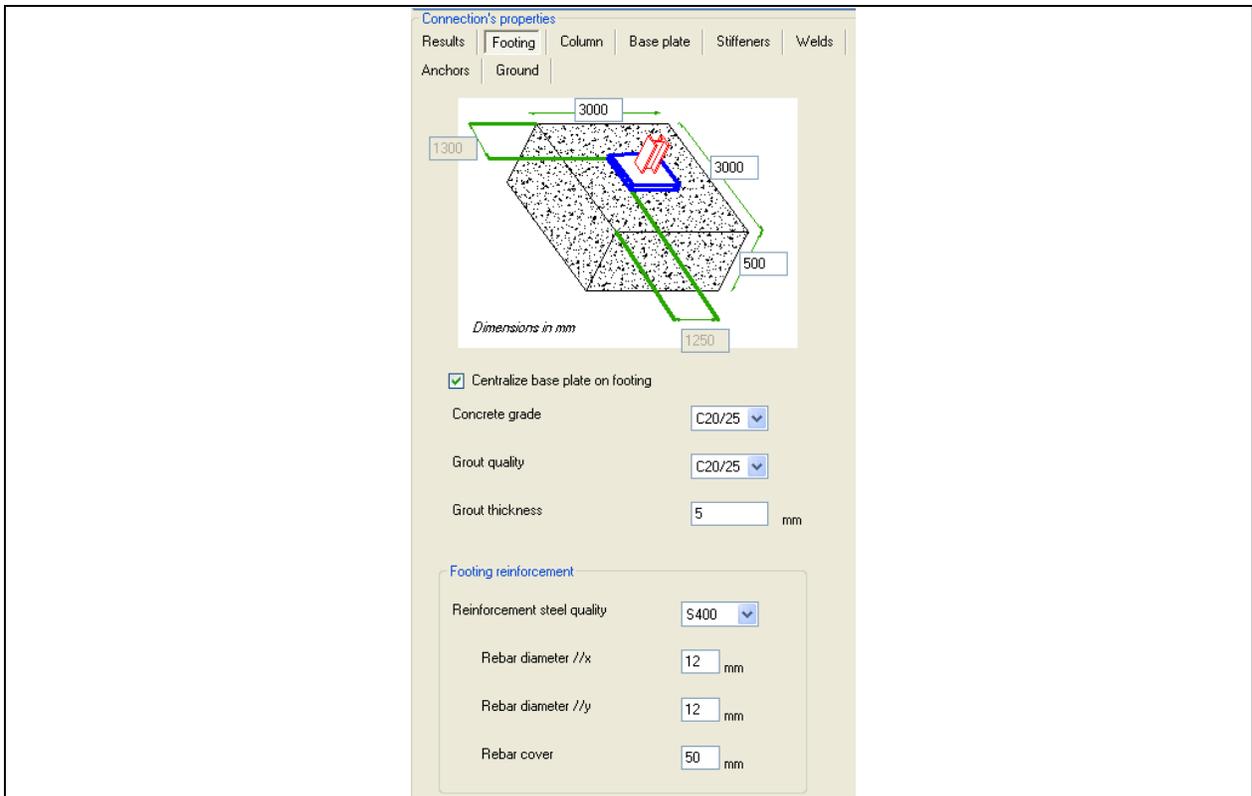


Picture 4.6

## 4.2 Footing

By choosing the tab Footing the user can define the footing dimensions, the concrete grade and the grout quality and thickness.

The user can also choose to place the base plate at the centre of the footing. When doing that the dimensions specifying the base plate position relative to the footing become inactive.

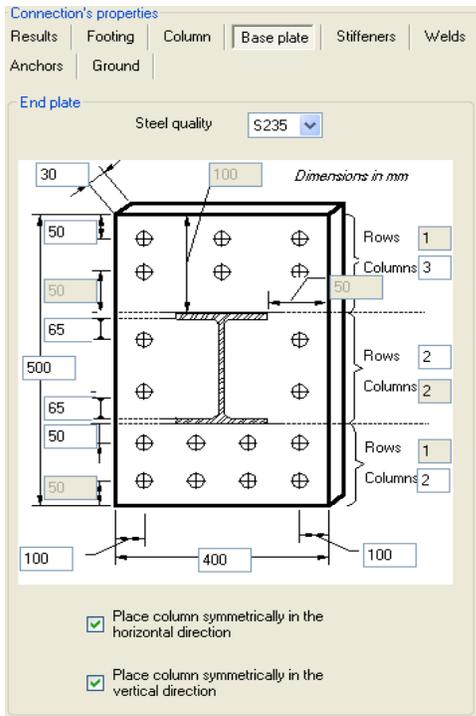


**Picture 4.7**

The user can also define the footing reinforcement steel quality, the rebar diameter along the axes x, y and the rebar cover.

### 4.3 Base plate

At the tab Base plate the user can define the number of the anchor rows and columns placed on the end plate. When the options Place column symmetrically in the horizontal direction and Place column symmetrically in the vertical direction are active, the column is placed in the centre of the end plate. Alternatively, the user can move the column in the horizontal or in the vertical direction at will.

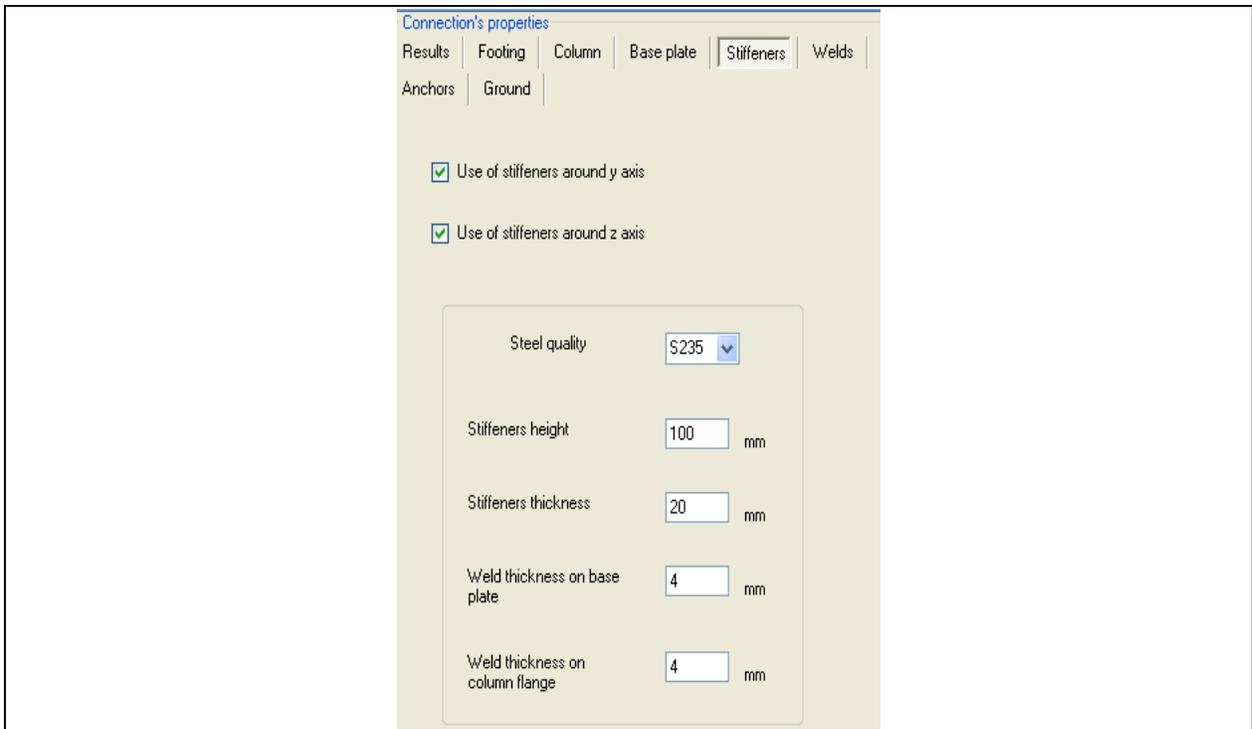


Picture 4.8

The user can also define the end plate steel quality.

#### 4.4 Stiffeners

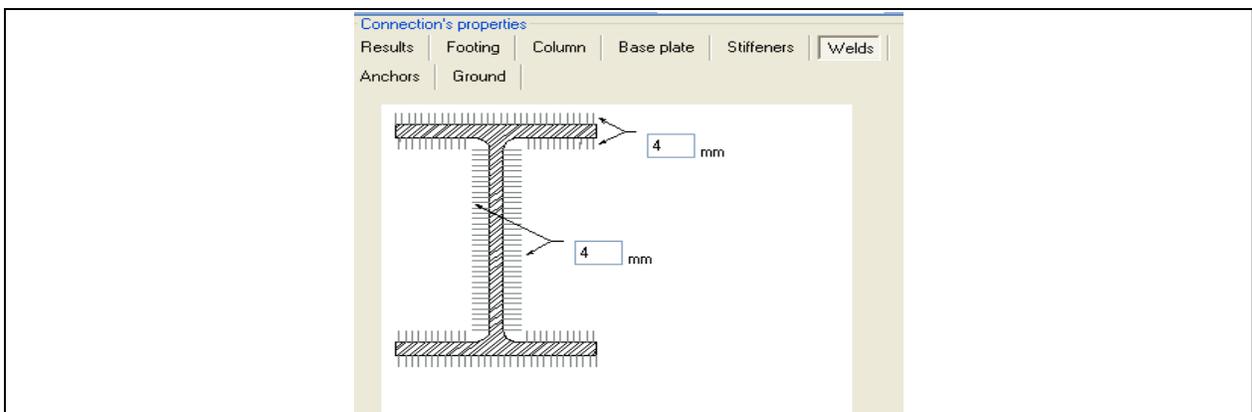
By clicking on the tab Stiffeners the following window appears. Inside the user has the capability to select the use of stiffeners either along the major or minor axis or both. Additionally the user can define the stiffeners steel quality, their height and thickness in mm and the weld thickness on the base plate and on the column flange, also in mm.



Picture 4.9

## 4.5 Welds

Choosing the tab Welds the user can define the column web weld thickness and the column flange weld thickness on base plate.

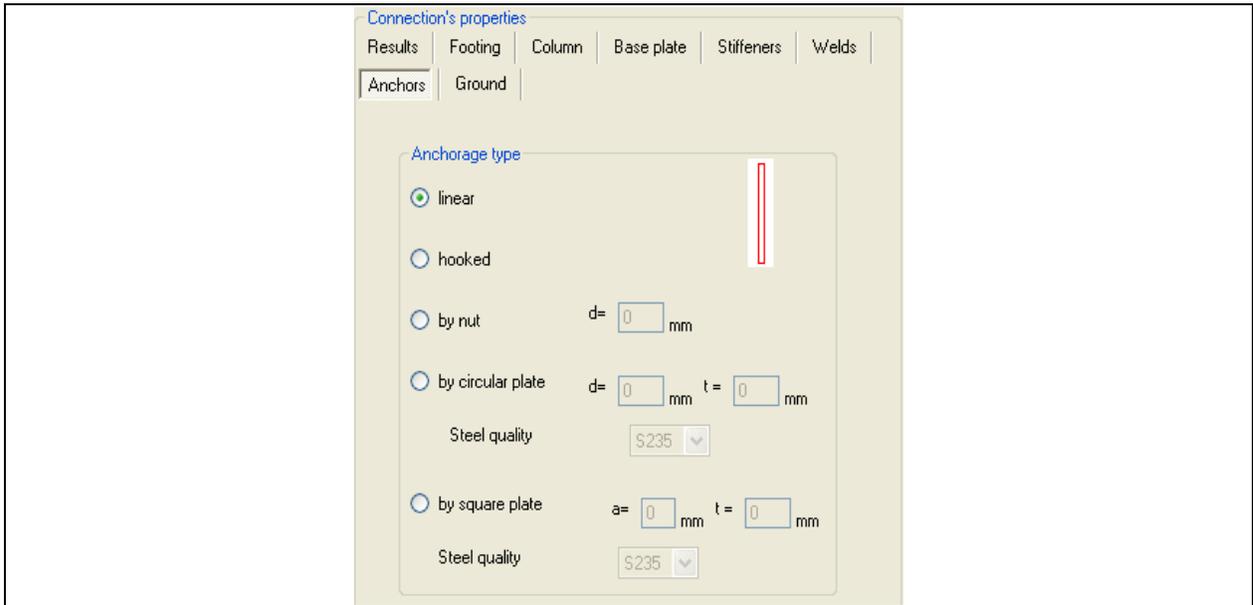


Picture 4.10

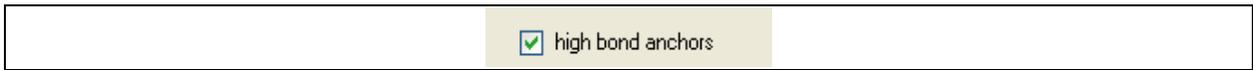
## 4.6 Anchors

The anchorage type of the base plate connection can be defined at the Anchors tab. The user can choose either linear or hooked anchorage, or anchorage by nut, anchorage by circular or square plate. When the user selects one of the last three anchorage types he also has the capability to define the

diameter, the thickness and the dimensions of the respective anchorage plates as well as their steel quality. The anchorage is designed according to ETAB 001- Annex C.

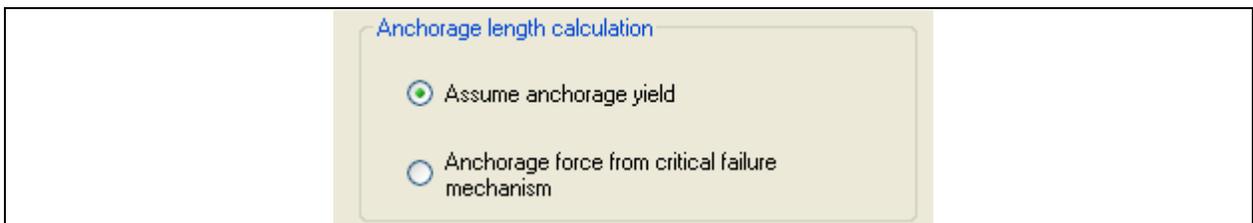


**Picture 4.11**



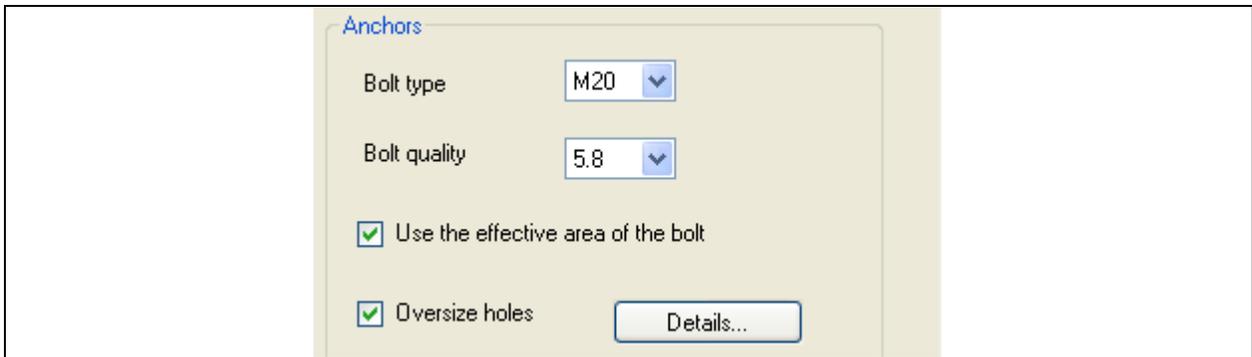
**Picture 4.12**

The program gives the user the capability to use high bond anchors by clicking the appropriate option.



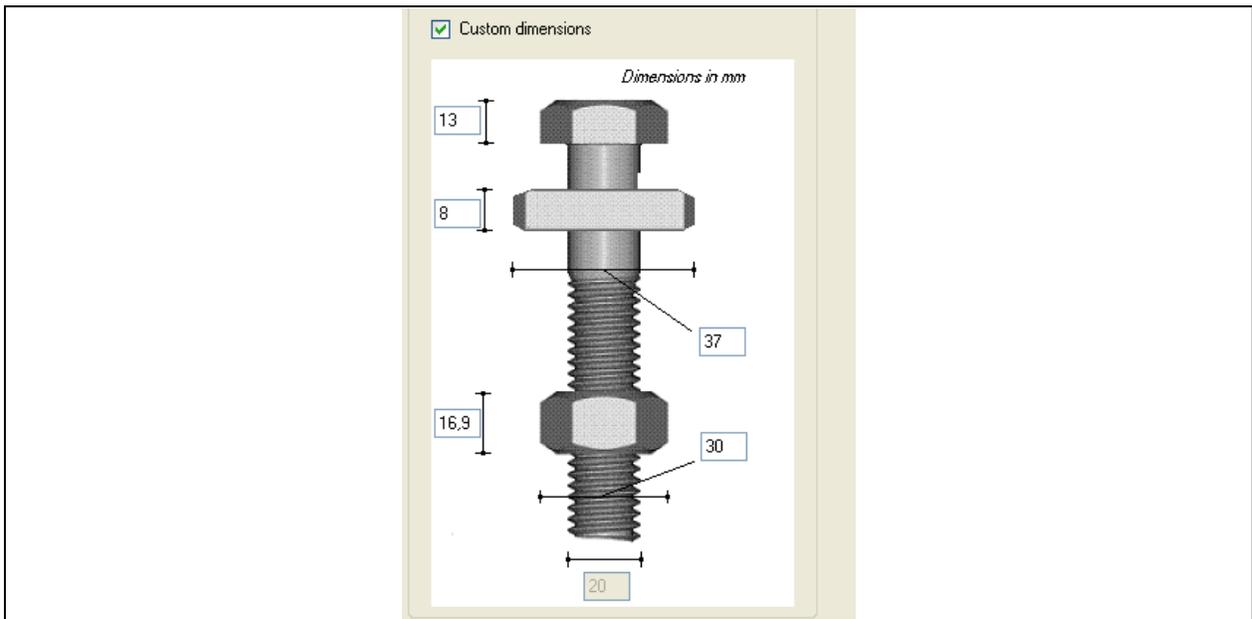
**Picture 4.13**

The program also gives the user the capability to calculate the anchorage length either based on Greek Concrete Design Code or based on the developed anchorage force from the critical failure mechanism.



**Picture 4.14**

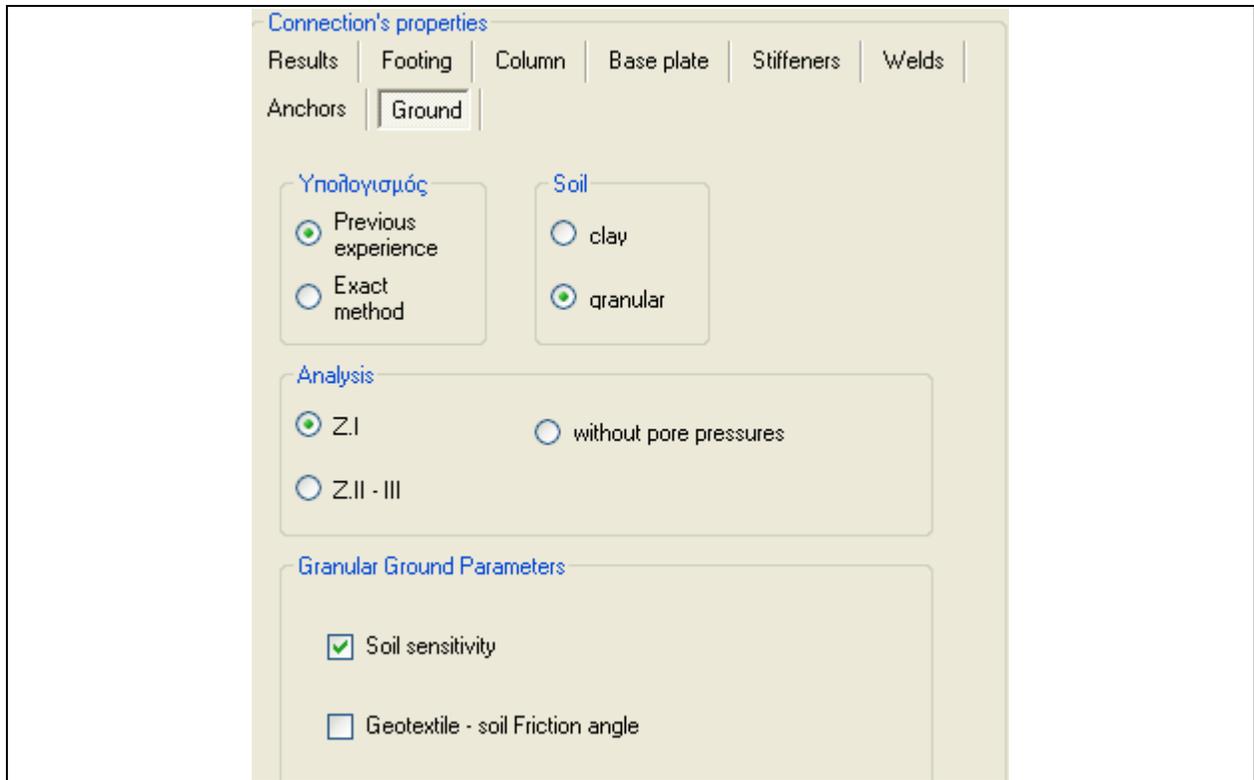
The user can also define the bolt type and quality and has the capability to choose the use of the effective area of the bolt and/or oversize holes. When the user clicks on Details the following image appears where the user can see the bolt type dimensions he defined. Clicking on Custom dimensions the user defines the bolt dimensions he prefers.



**Picture 4.15**

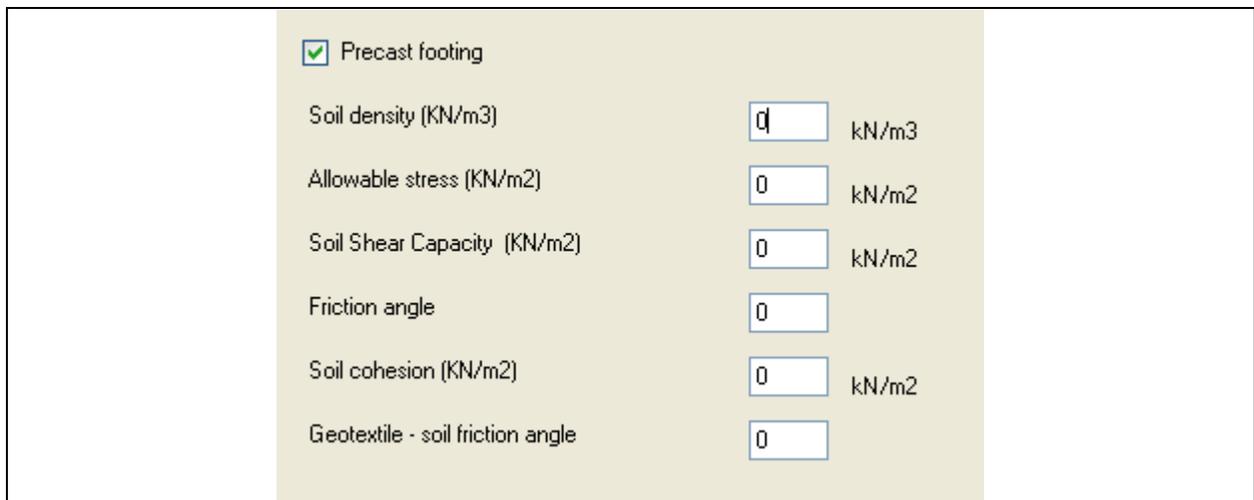
## 4.7 Ground

By selecting the tab Ground the user can define the footing design parameters.



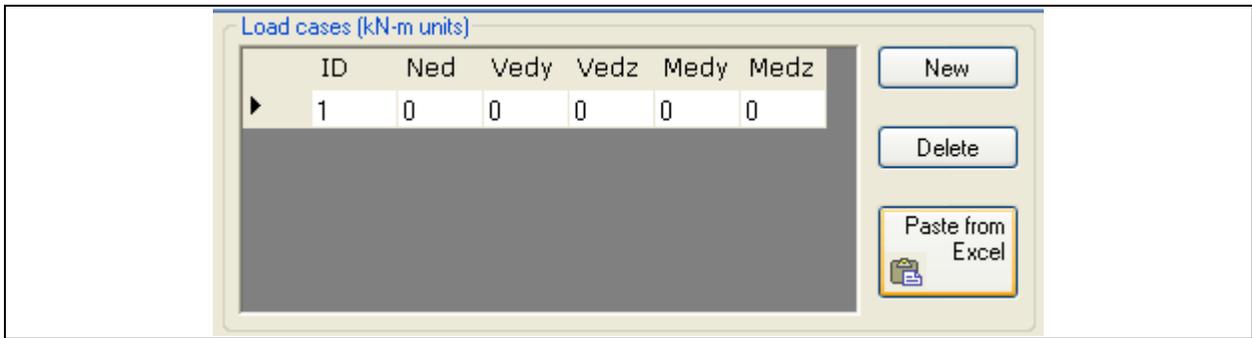
Picture 4.16

The user selects the soil type by clicking either clay or granular soil. When the user selects granular soil he then has to define its parameters such as Soil sensitivity and Geotextile–soil Friction angle. The user can also specify the ground seismic zone by clicking either Z.I, or Z.II- III, or without pore pressures.



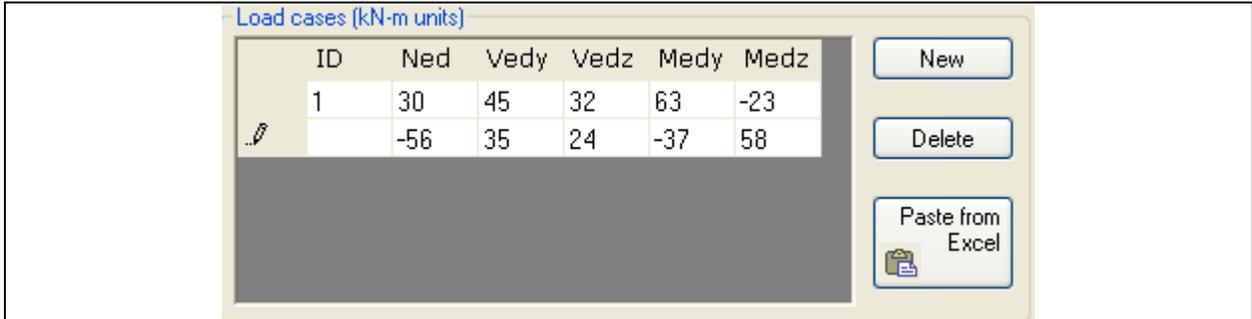
Picture 4.17

By clicking on Precast footing, the user can input the ground parameters (Soil density, Allowable stress, Soil Shear Capacity, Friction angle, Soil cohesion, Geotextile – soil friction angle) he prefers.



*Picture 4.18*

The next step for the column base plate connection design is to define the load cases. The user can add more than one load cases by clicking on New. If the user wants to delete one or more load cases he has already defined, he can do so by clicking on the specific load combination and then on Delete.



*Picture 4.19*

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The program is now ready to design the column base plate connection. The user clicks on Calculate (EC3) and the interaction diagram for  $M_y/M_z$  and  $N$  for the defined load case appears.



Picture 4.20

The user can see the design results in the tab Results on the the left side of the window.

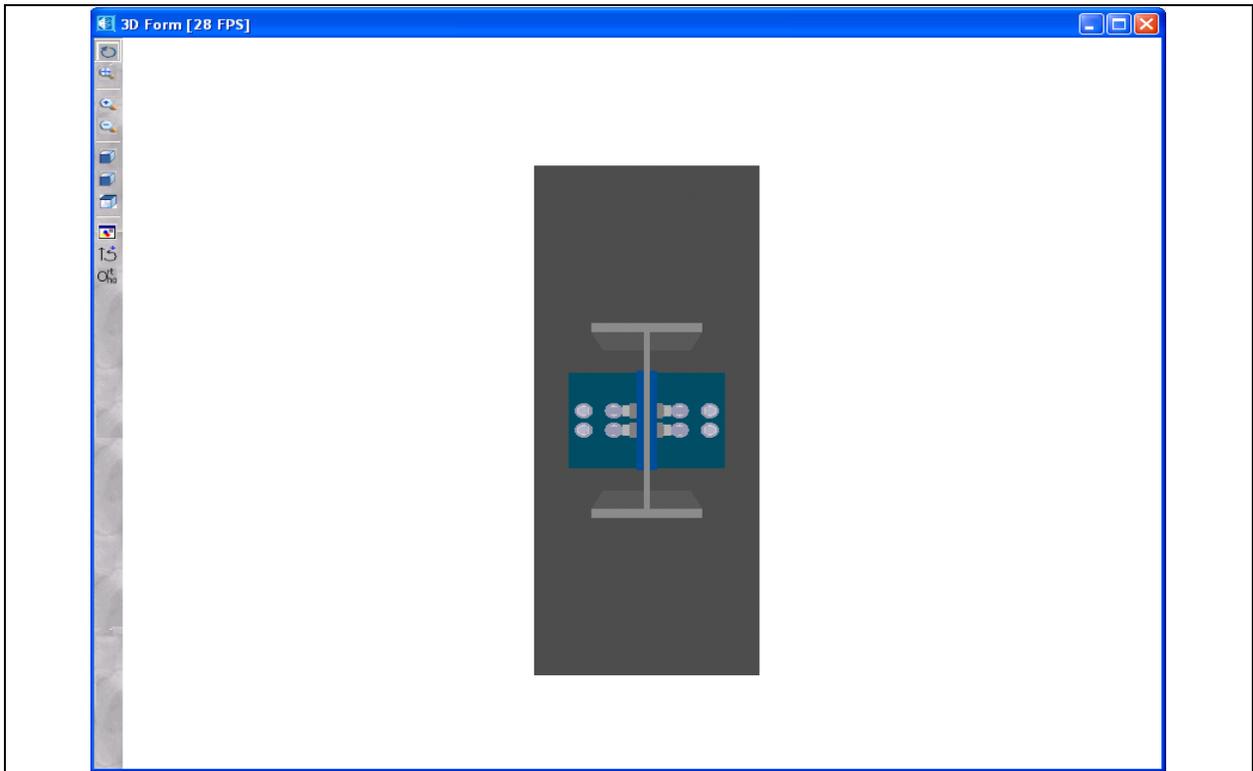
	Strengths	Capacities
Connection Bending around yy column axis	139,4 kNm	0,452
Connection Bending around zz column axis	36,715 kNm	0,626
Axial-shear force bolt interaction failure	NO	0,844
Bolts in bearing (y axis)	3801,6 kN	0,009
Bolts in bearing (z axis)	3571,2 kN	0,009
Column welds maximum stress	20,785 kN / cm <sup>2</sup>	0,098
Rotation around y axis	0 rad	
Rotation around z axis	0 rad	
<b>Anchorage design according to ETAG 001 - Annex C</b>		
Anchorage length	861,72 mm	
Anchorage length sufficiency (pull-out checking)	NO!	
Anchorage plate in bending		
Concrete in compression in anchorage region		
Concrete cone failure	2639,961 kN	0,2
Concrete splitting failure	1156,947 kN	0,457
Concrete pryout failure	6335,907 kN	0,007
Concrete edge failure for shear force //yy	415,239 kN	0,054
Concrete edge failure for shear force //zz	393,303 kN	0,02

Picture 4.21

The red colour of the text means that the capacity is exceeded (capacity > 1.0)

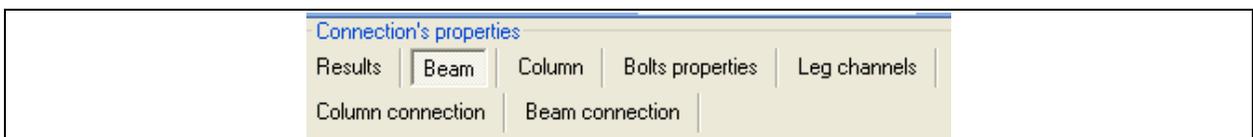
## 5 BEAM COLUMN CONNECTION WITH DOUBLE CLEAT

This connection refers to a beam-to-column shear connection through the use of two equal or unequal angle cleats. The cleats can be hot rolled or welded. The program performs all the relevant checks according to EC3 (bolts shear capacity, bolts bearing capacity, block shear capacity, bending and shear capacity of the angle cleats etc.).



*Picture 5.1*

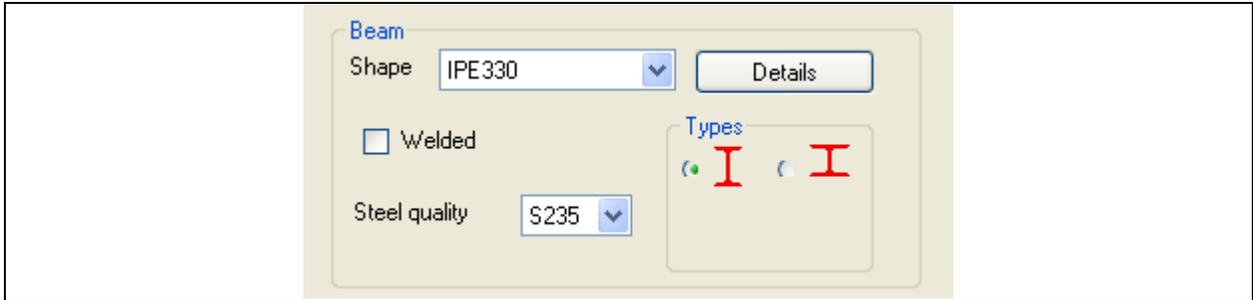
The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 5.2*

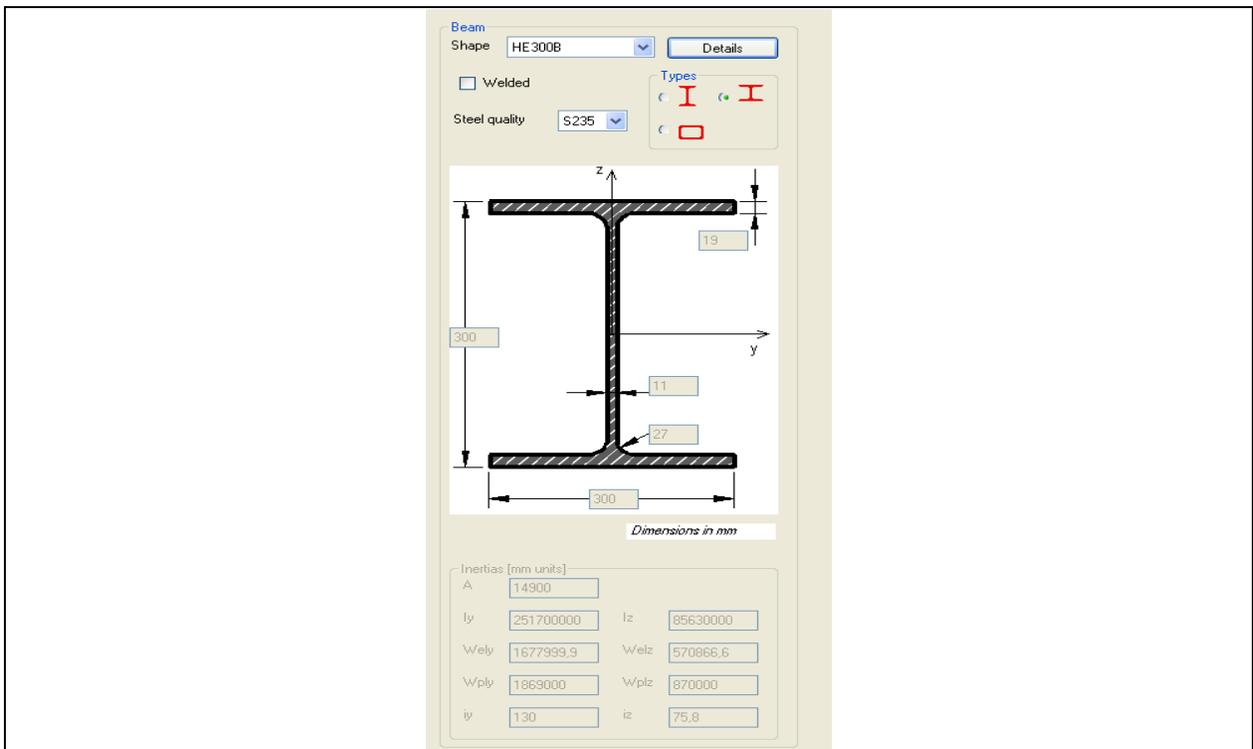
### 5.1 Beam

By clicking on the tab Beam the user can define the shape, the type and the steel quality of the beam.



Picture 5.3

When the user clicks on Details he has the capability to see the dimensions and the inertia characteristics of the beam section the user defined.

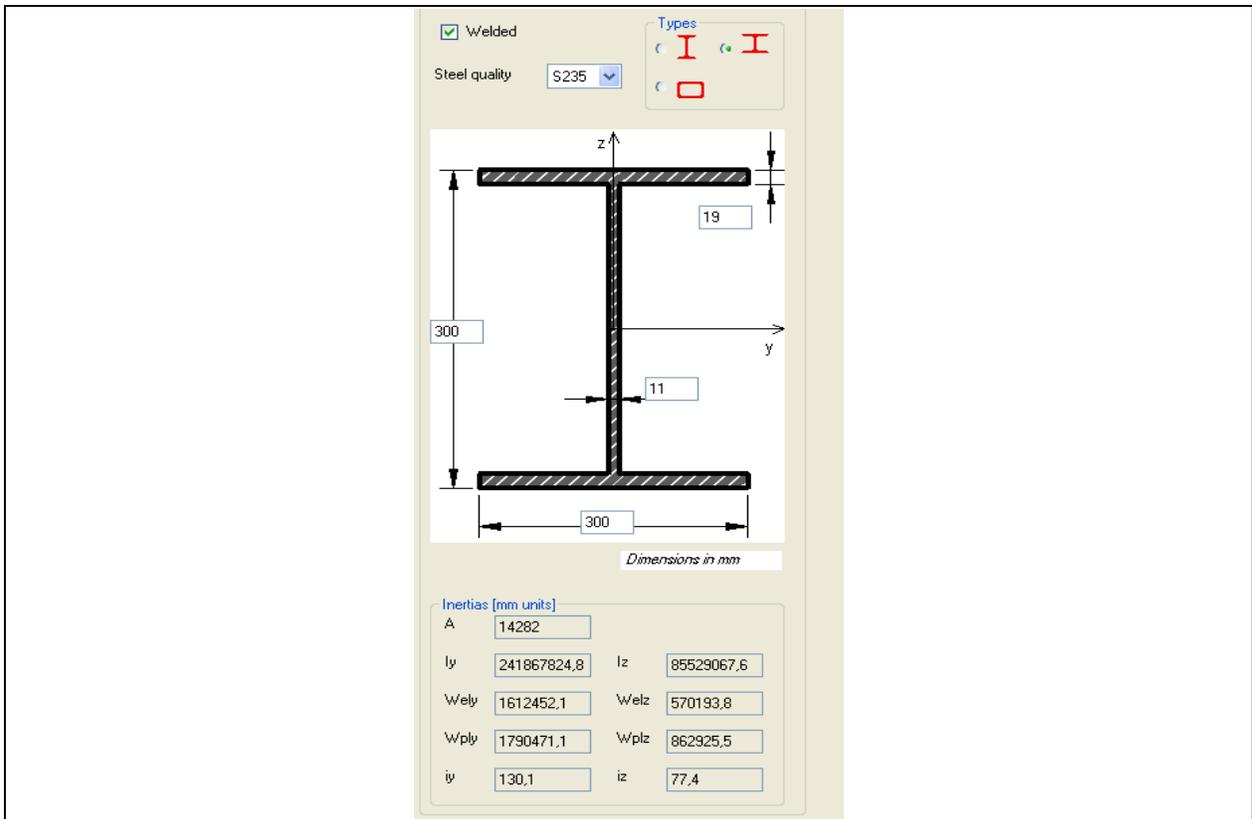


Picture 5.4



Picture 5.5

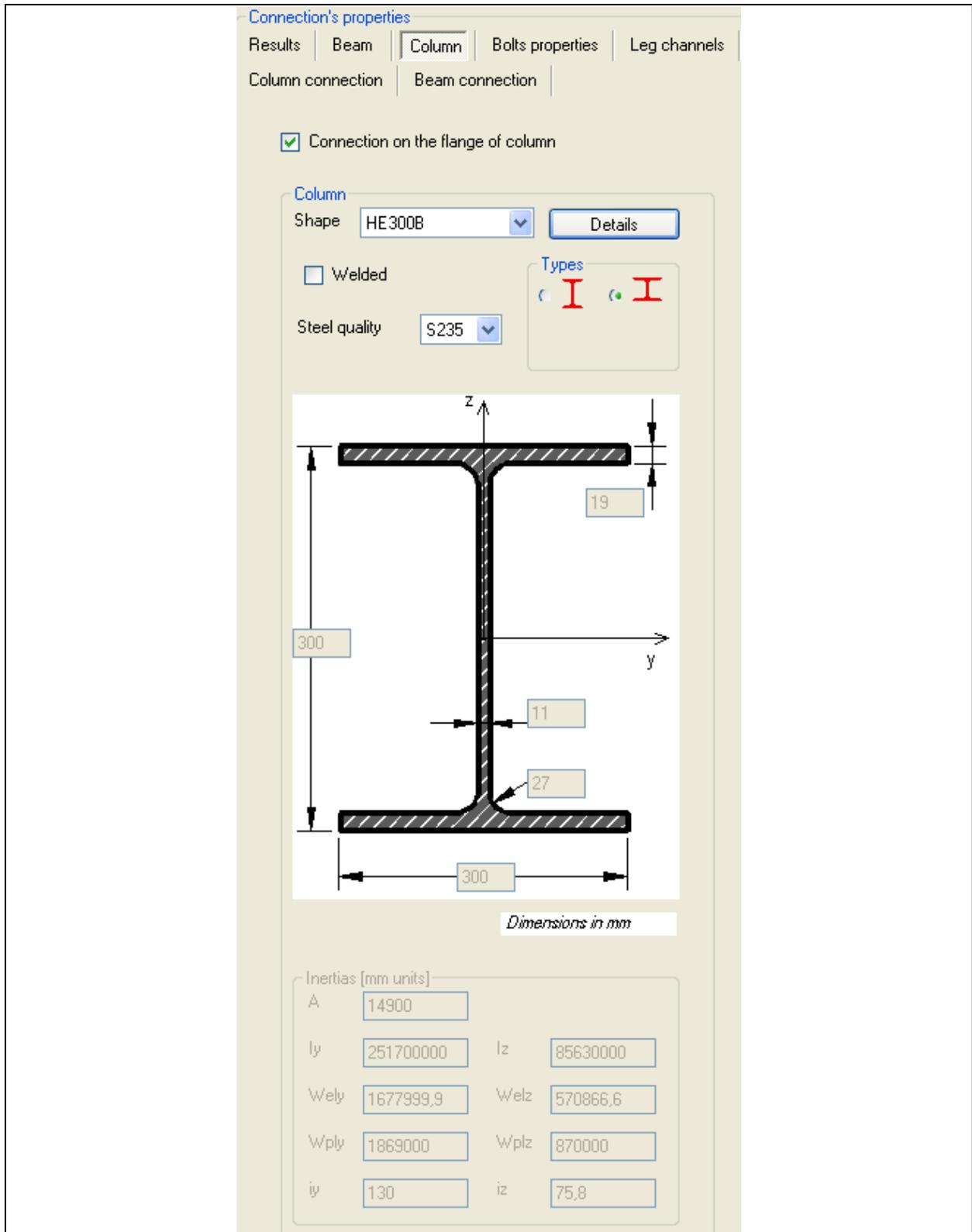
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 5.6

## 5.2 Column

In the tab Column the user defines the shape, the type and the steel quality of the column. When the user clicks on Details he can see the dimensions and the inertia characteristics of the selected beam section.

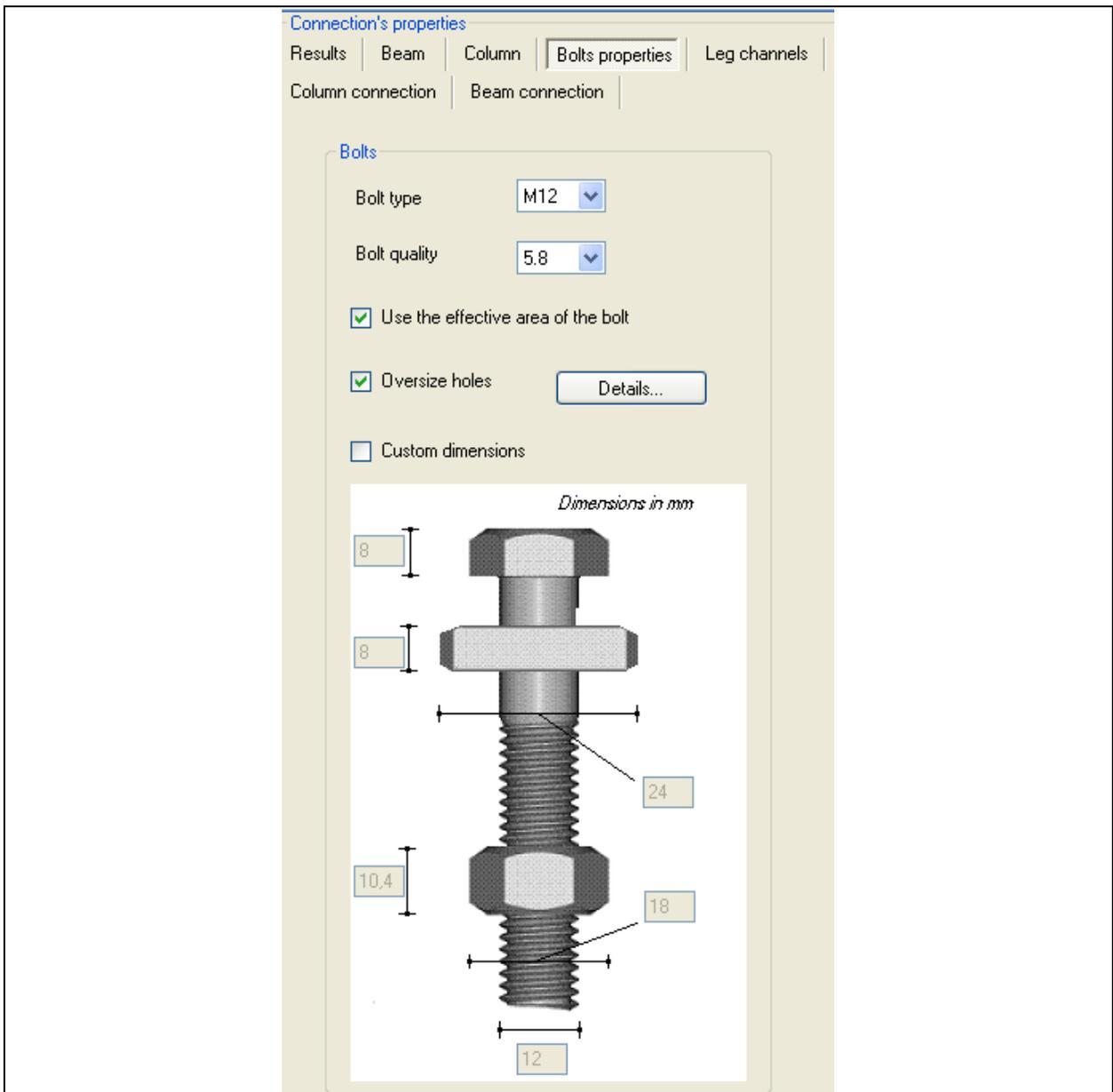


**Picture 5.7**

By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.

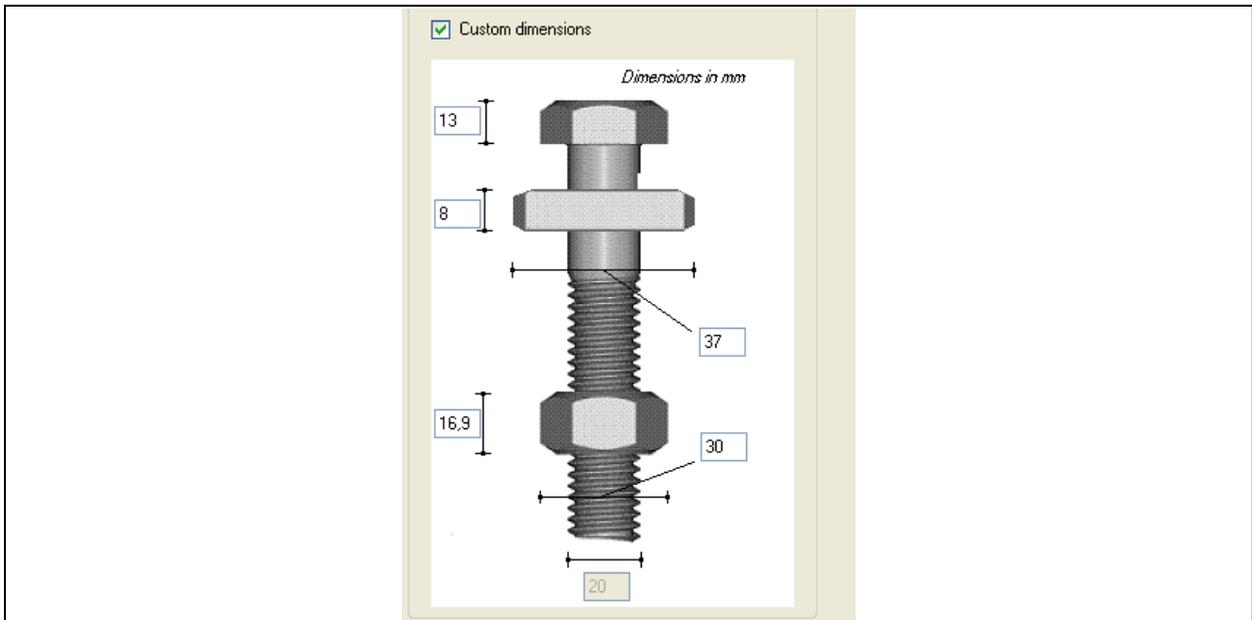
### 5.3 Bolt properties

The definition of the bolt parameters can be done by selecting the tab Bolts properties. The user selects the bolt type, the bolt quality and has the option to use the effective area of the bolt and/or oversize holes.



Picture 5.8

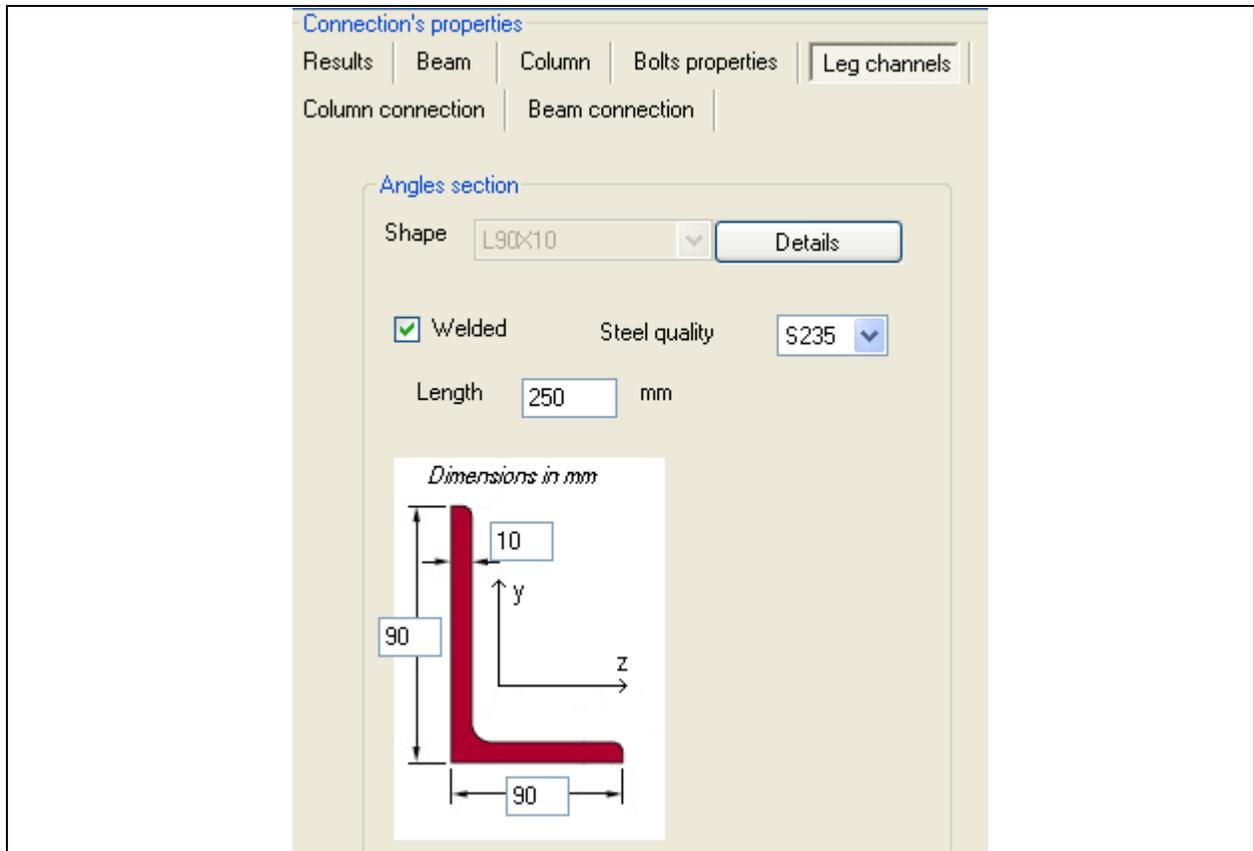
When the user clicks on Details the following image appears, where the user can see the bolt type dimensions he defined, according to DIN 7990, DIN 7969, EN 24034, EN 24032, DIN 6914. Clicking on Custom dimensions the user defines the bolt dimensions he prefers.



**Picture 5.9**

#### 5.4 Leg channels

By clicking on the tab Leg channels the user can define the shape and the steel quality of the angles section. The user can select either a standard or a welded angle section. When the user selects a welded angle section the option Shape becomes inactive and he defines the welded angle section dimensions in the appropriate form.

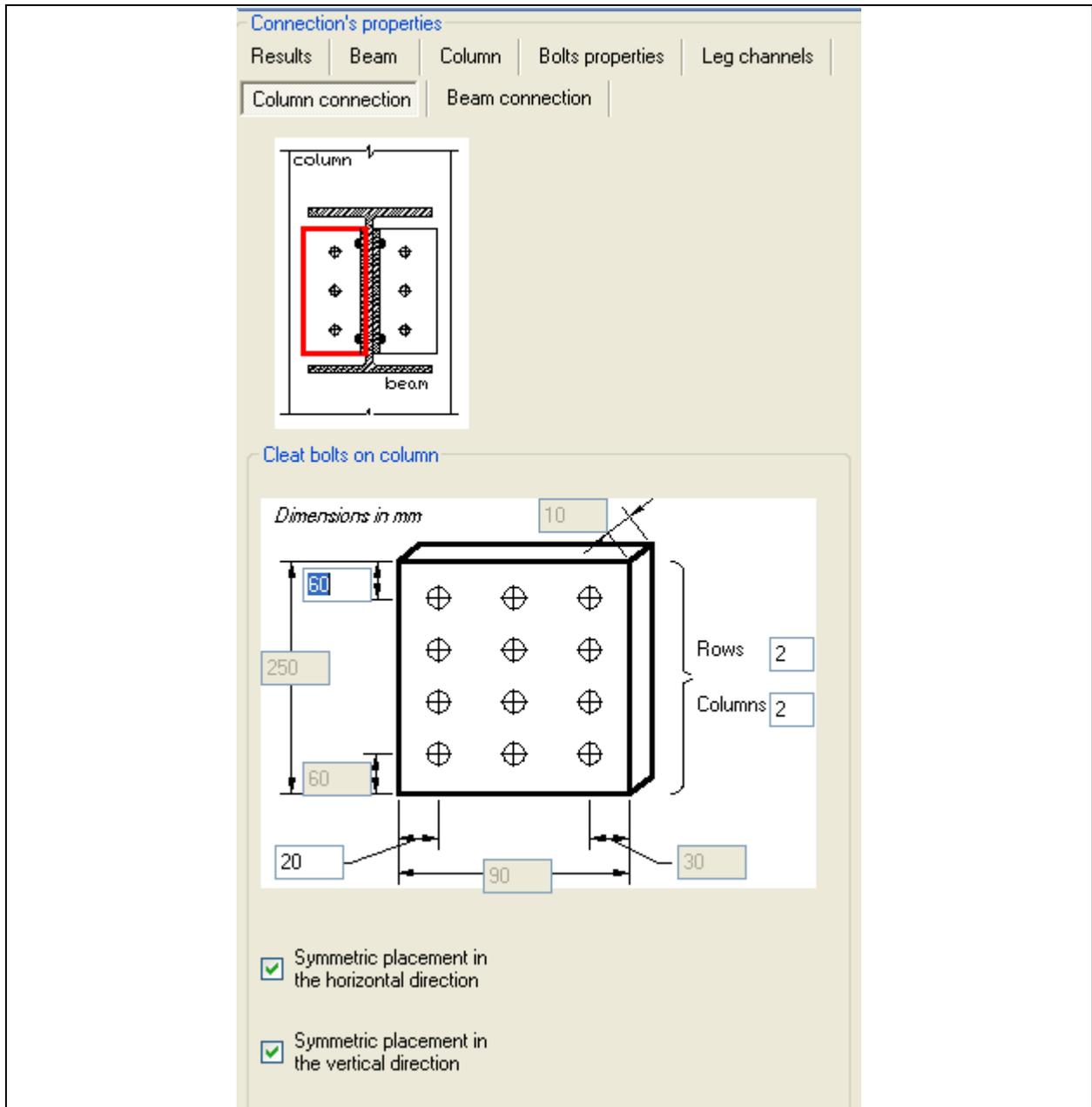


Picture 5.10

Inside this tab the user can also define the angles length.

## 5.5 Column connection

When the user clicks on the tab Column connection an indicative angle cleat attached to the column appears. Onto that cleat the user defines the rows and the columns of the bolts used in the connection. Additionally the user defines the bolts distance from the cleat edges.

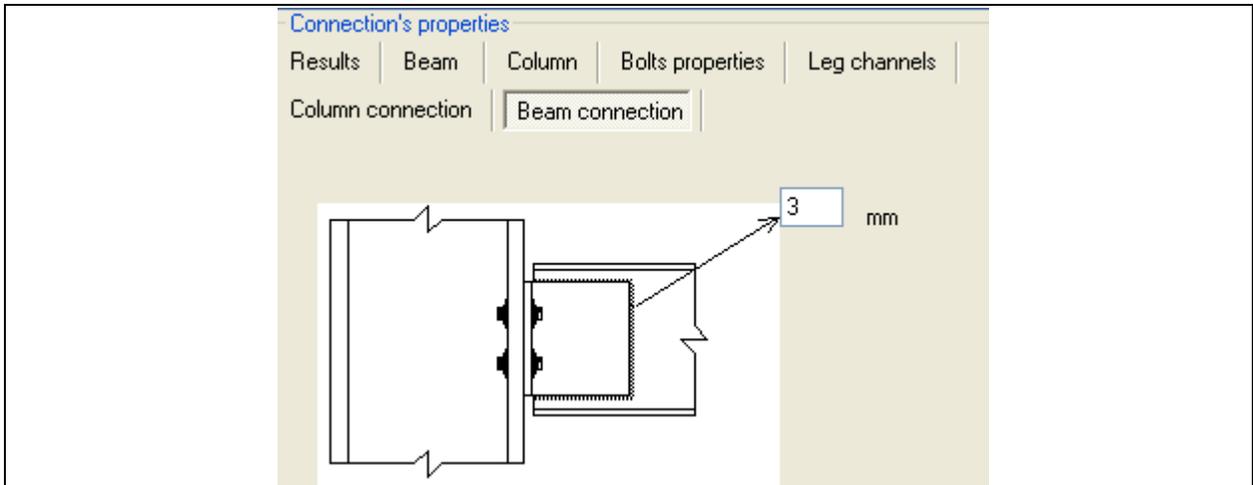


Picture 5.11

The user can select symmetric placement either in the horizontal, or in the vertical direction by clicking on the appropriate option.

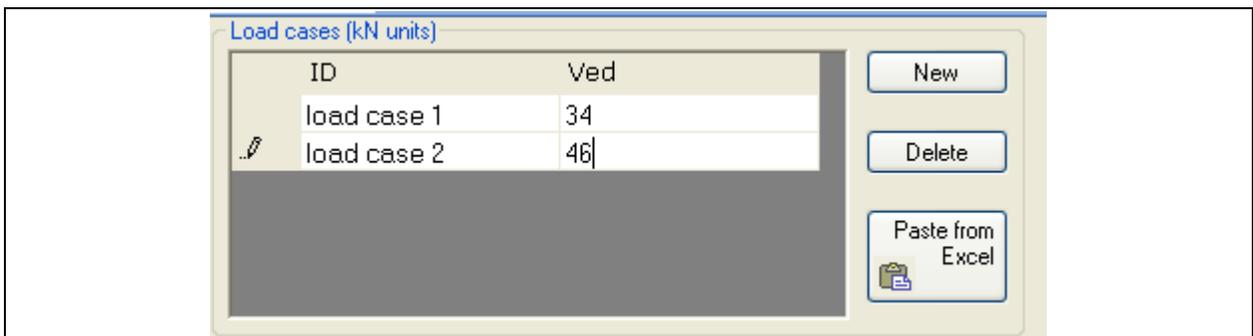
## 5.6 Beam connection

The angle cleat is welded to the beam web. The user in the tab Beam connection can specify the weld thickness.



Picture 5.12

Then the user defines the connection load cases.



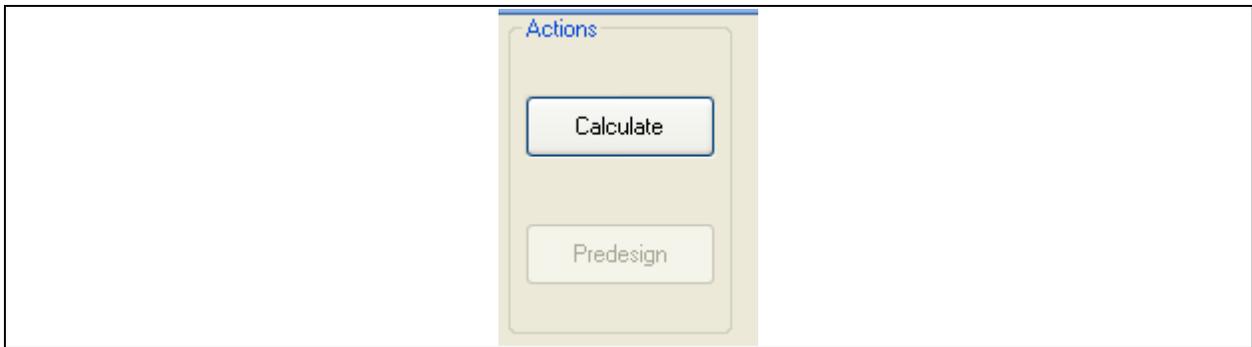
Picture 5.13

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined he must click on the specific load combination and then click at Delete.

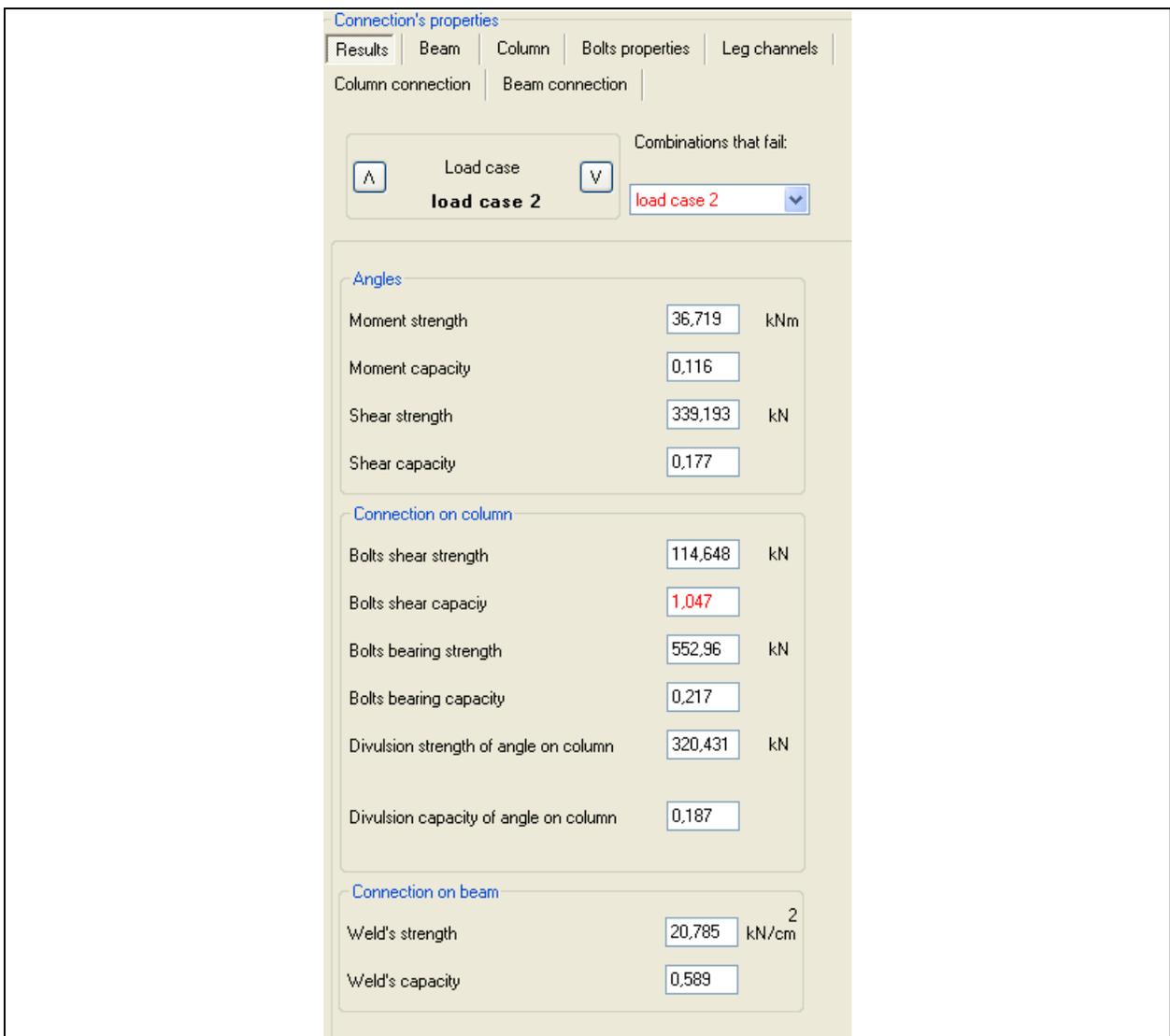
The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The beam column connection design starts when the user clicks on Calculate



Picture 5.14

The design results are shown in the tab Results.

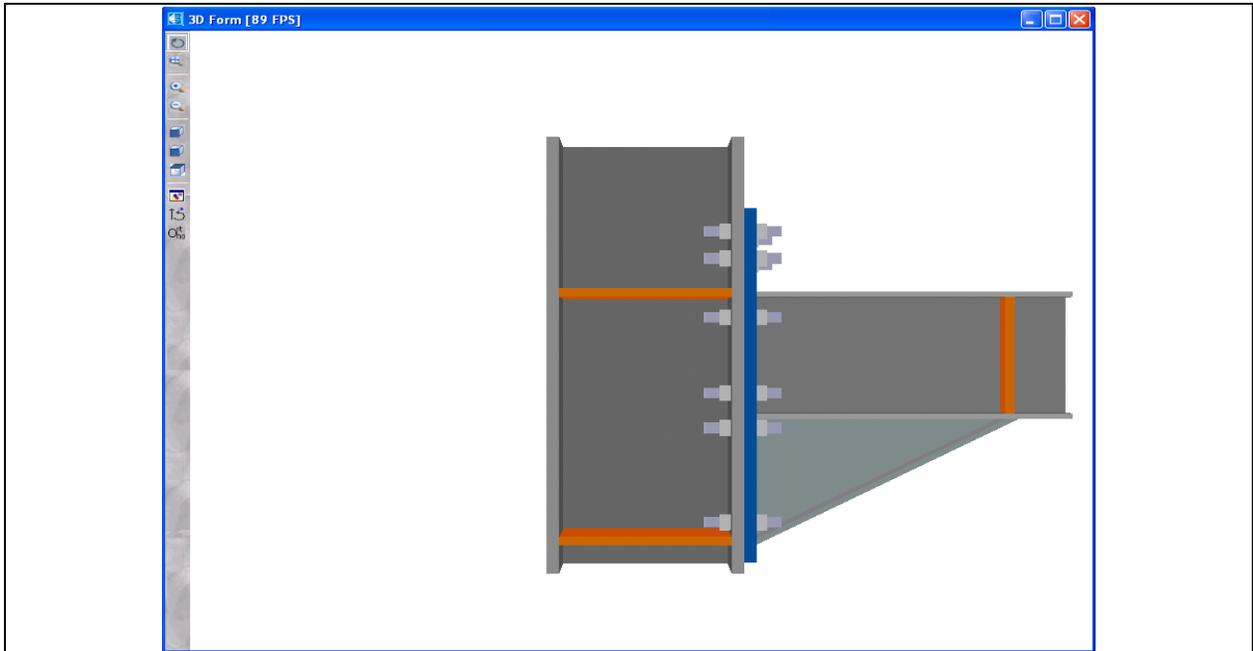


Picture 5.15

The red colour of the text means that the capacity is exceeded (capacity > 1.0). The critical combinations are also shown in red.

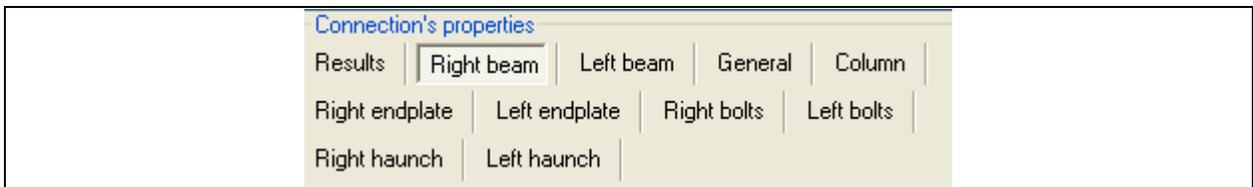
## 6 ENDPLATE BEAM COLUMN CONNECTION

This type of connection can transfer bending moment from the beam to the column through the end plate. The user can design the connection with a beam either on one or both sides of the column, add beam and/or column stiffeners as well as haunches to increase the bearing capacity of the connection. All the components of the connection are checked according to Part 1-8 of Eurocode 3. The checks refer not only to the capacity of the connection elements but to the developed deformation of the connection (rotational capacity) as well.



Picture 6.1

The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.

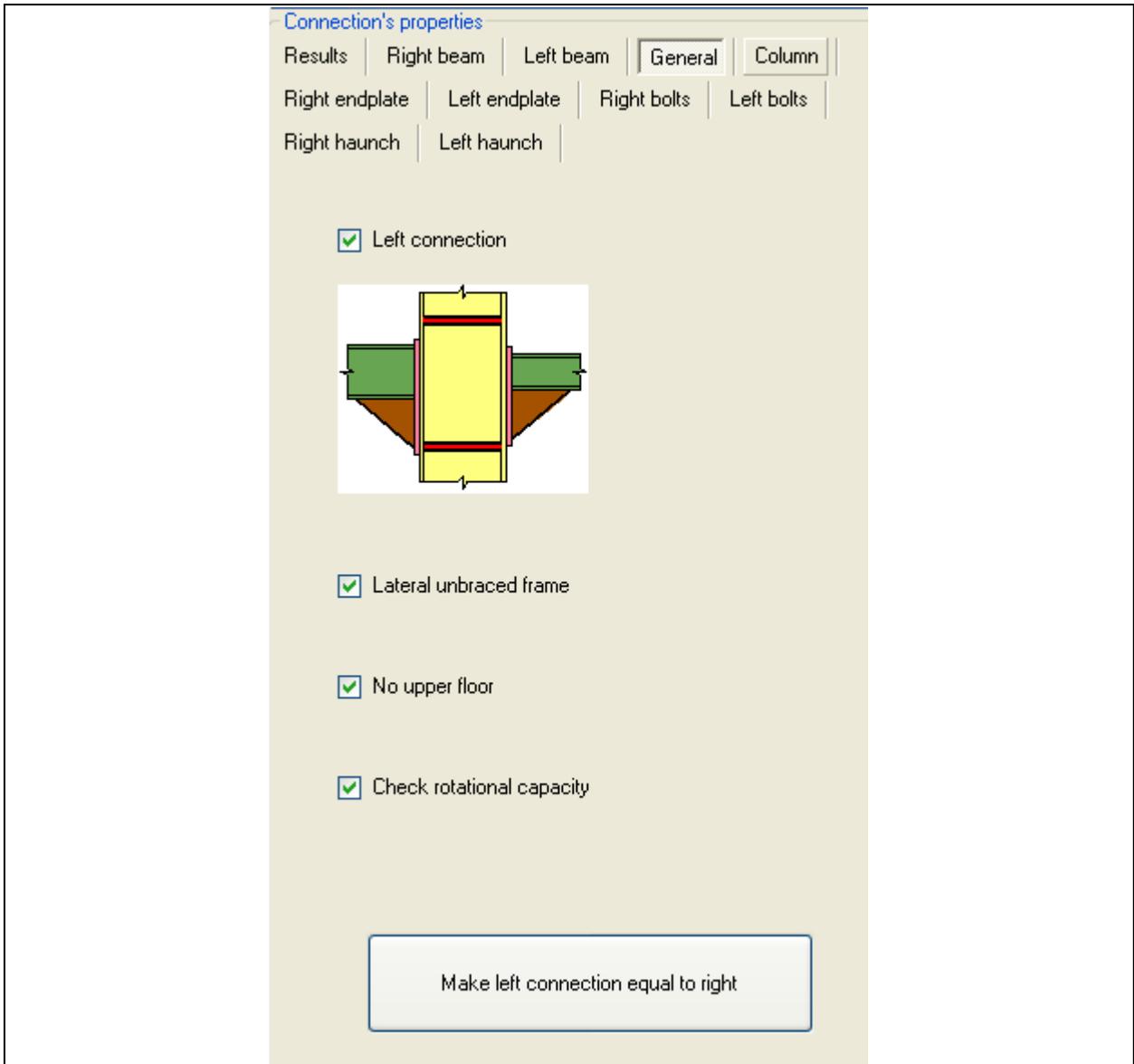


Picture 6.2

### 6.1 General

The tab General refers to the general connection parameters. The user can select frame either laterally unbraced or not, the absence or not of upper floor as well as the rotational capacity check according to paragraph 6.4.1 Part (1-8) of Eurocode 3.

The program also gives the user the capability to specify the simultaneous existence of a left connection. When the option left connection is active the user can make left connection equal to right by clicking on the button Make left connection equal to right.



Picture 6.3

## 6.2 Column

By clicking on the tab Column a column detail appears in the window. The user can select the existence of transverse stiffeners and backing plates on the column by clicking the appropriate options. When the user selects the use of stiffeners and backing plates he has to define their thickness as well as their geometry.

Connection's properties

Results | Right beam | Left beam | General | Column

Right endplate | Left endplate | Right bolts | Left bolts

Right haunch | Left haunch

Dimensions in mm

Backing plates

Steel quality: S235 | Thickness: 20 mm

Distance from endplate: 50 mm

200 mm

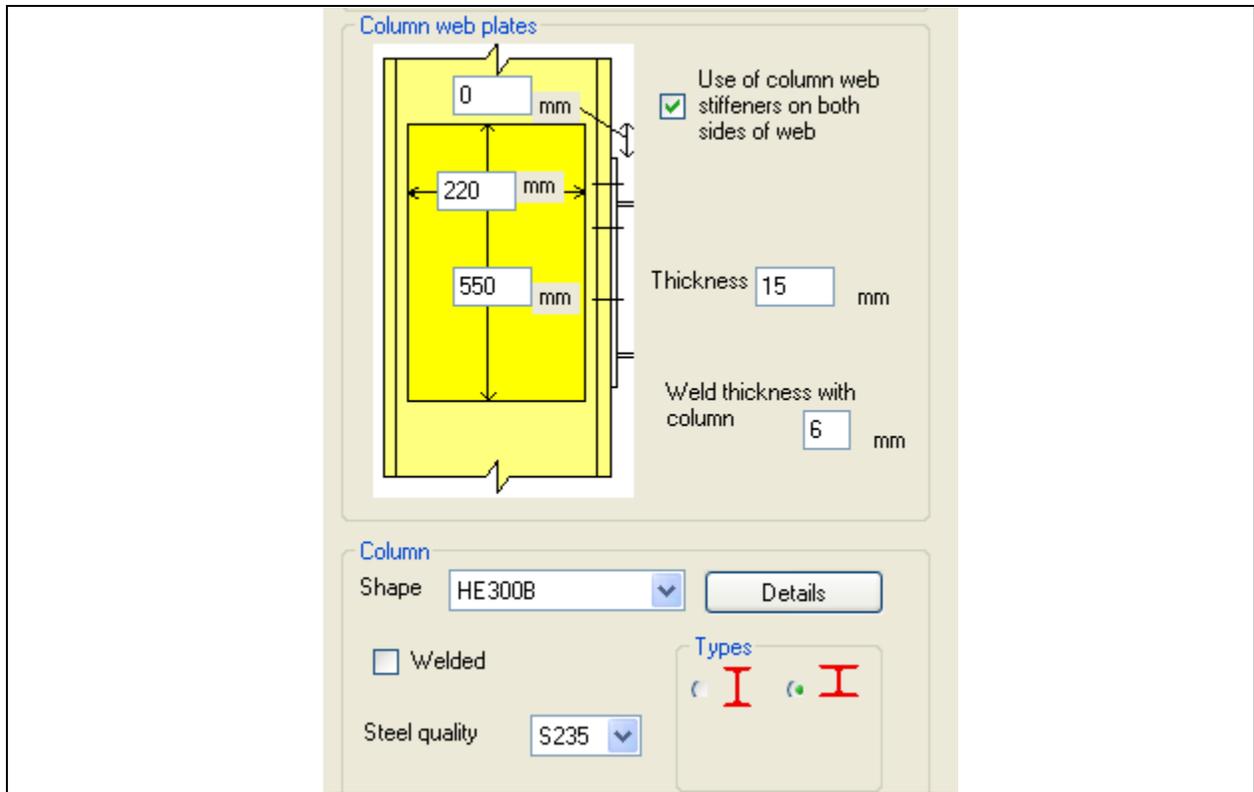
250 mm

Transverse flange stiffener

Steel quality: S235

100 mm

Picture 6.4



Picture 6.5

Apart from the column flange plates, the program gives the user the capability to use column web stiffeners as well. When clicking on Use of column web stiffeners on both sides of web, the Column web plates window becomes active. There the user can define the thickness and the geometry of these plates therefore the weld thickness on column. Then the user defines the shape, the type and the steel quality of the column section.

When the user clicks on Details he can see the dimensions and the inertia characteristics of the specified beam section.

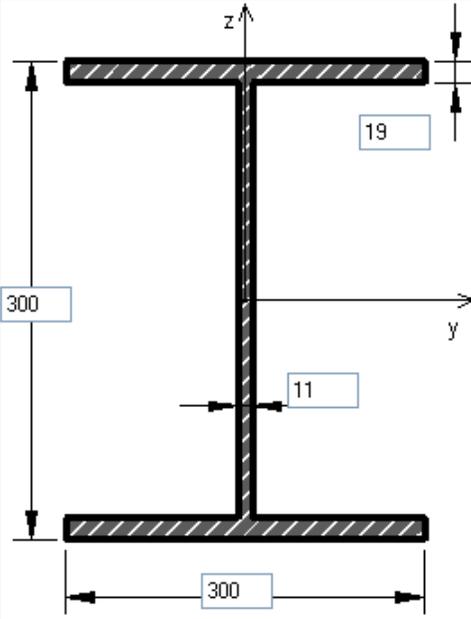
Column

Shape

Welded

Steel quality

Types    



Dimensions in mm

Inertias [mm units]

A	<input type="text" value="14282"/>		
$I_y$	<input type="text" value="241867824,8"/>	$I_z$	<input type="text" value="85529067,6"/>
$W_{ely}$	<input type="text" value="1612452,1"/>	$W_{elz}$	<input type="text" value="570193,8"/>
$W_{ply}$	<input type="text" value="1790471,1"/>	$W_{plz}$	<input type="text" value="862925,5"/>
$i_y$	<input type="text" value="130,1"/>	$i_z$	<input type="text" value="77,4"/>

Picture 6.6

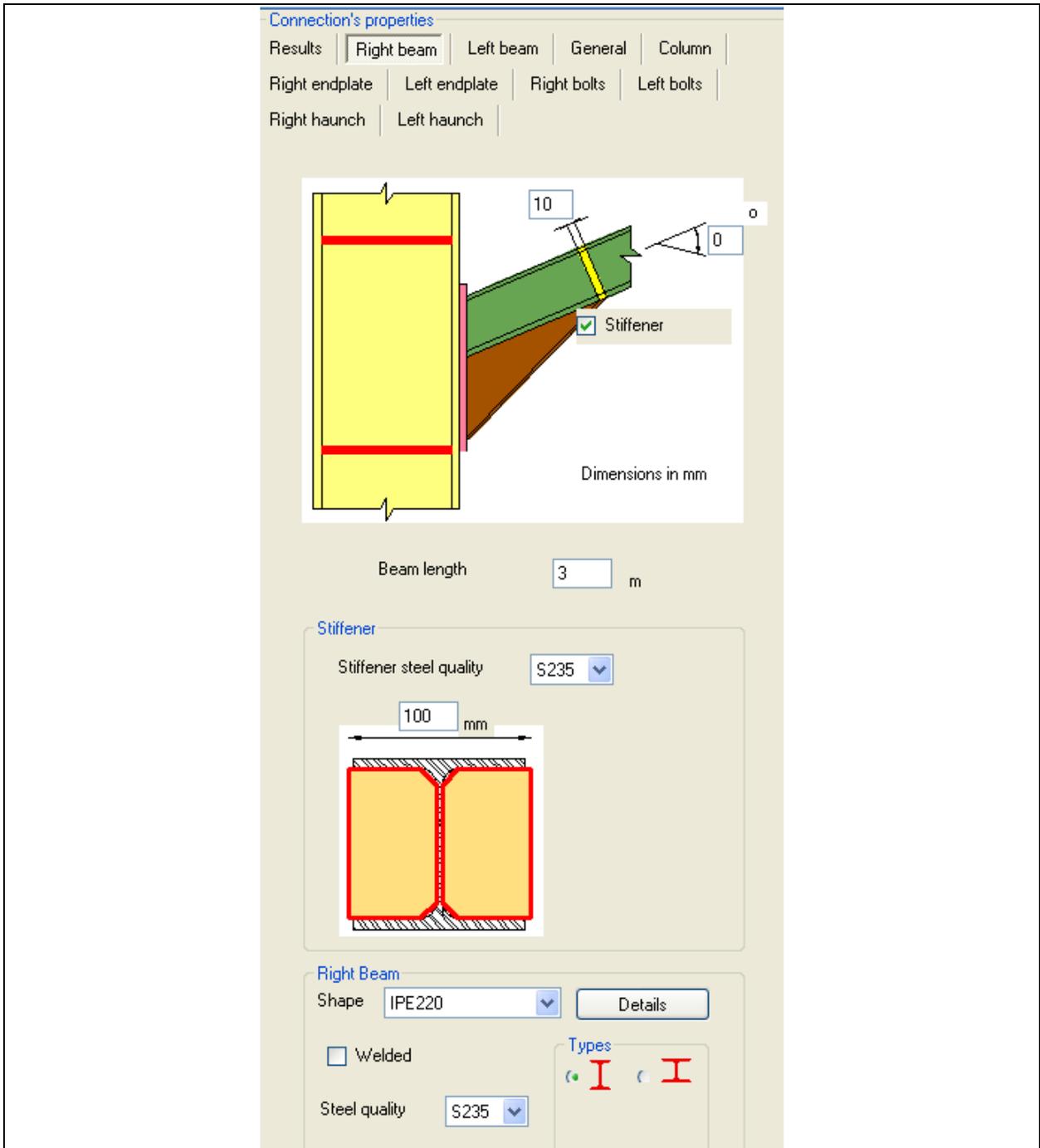
Welded

Picture 6.7

By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.

### 6.3 Right beam

When the user clicks on the tab Right beam has the capability to see a beam detail as shown below.

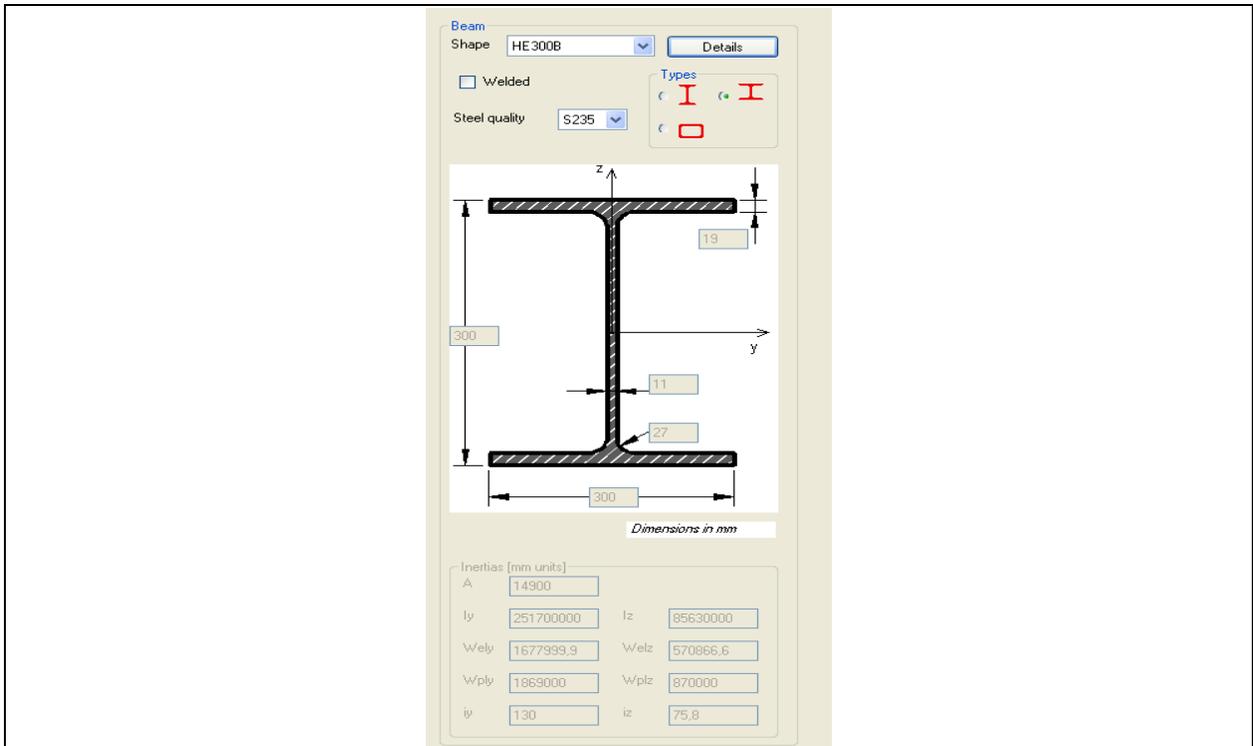


Picture 6.8

There the user can define the angle between the beam and the horizontal, as well as the beam length. The user can also select the use of stiffeners. In that case he can define their thickness and length as well as the steel quality.

Inside the Right Beam box the user can set the shape, type and steel quality of the respective beam section.

When the user clicks on Details he can see the dimensions and the inertia characteristics of the specified beam section.

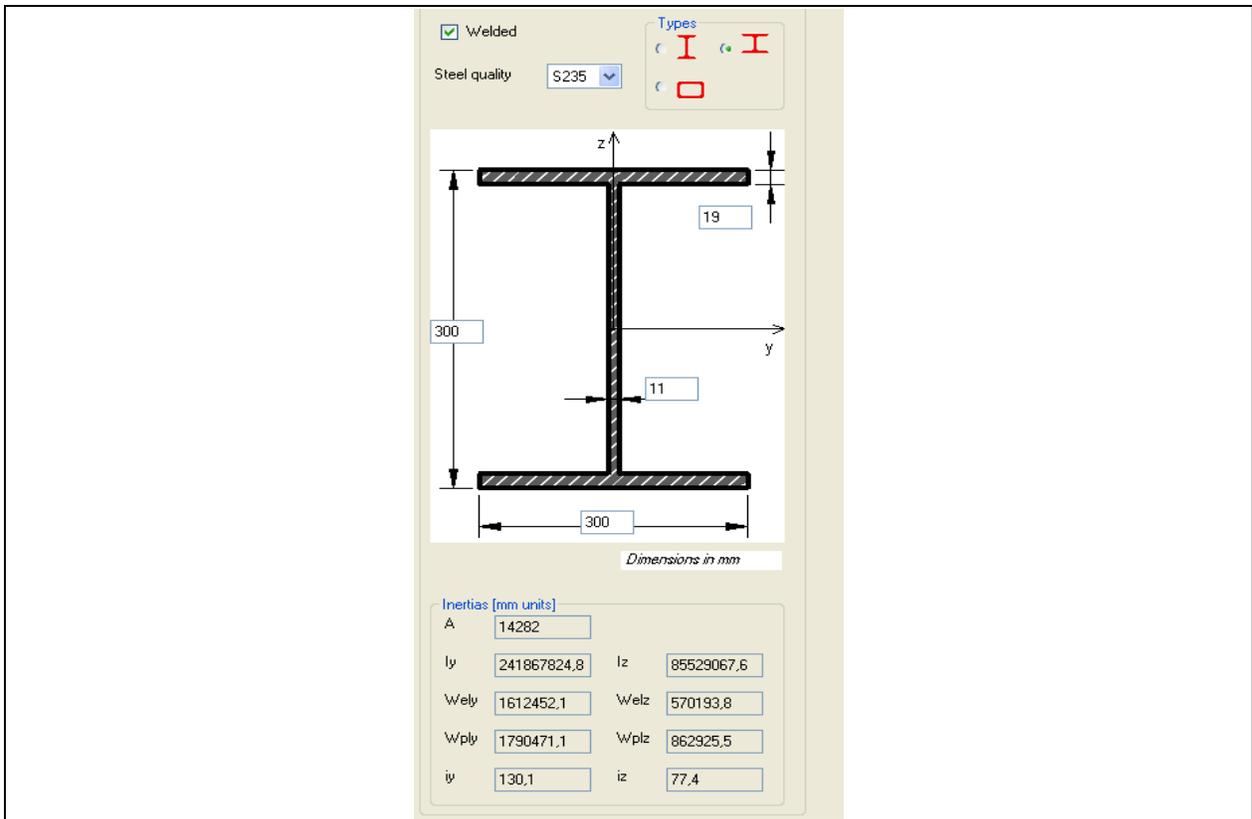


Picture 6.9



Picture 6.10

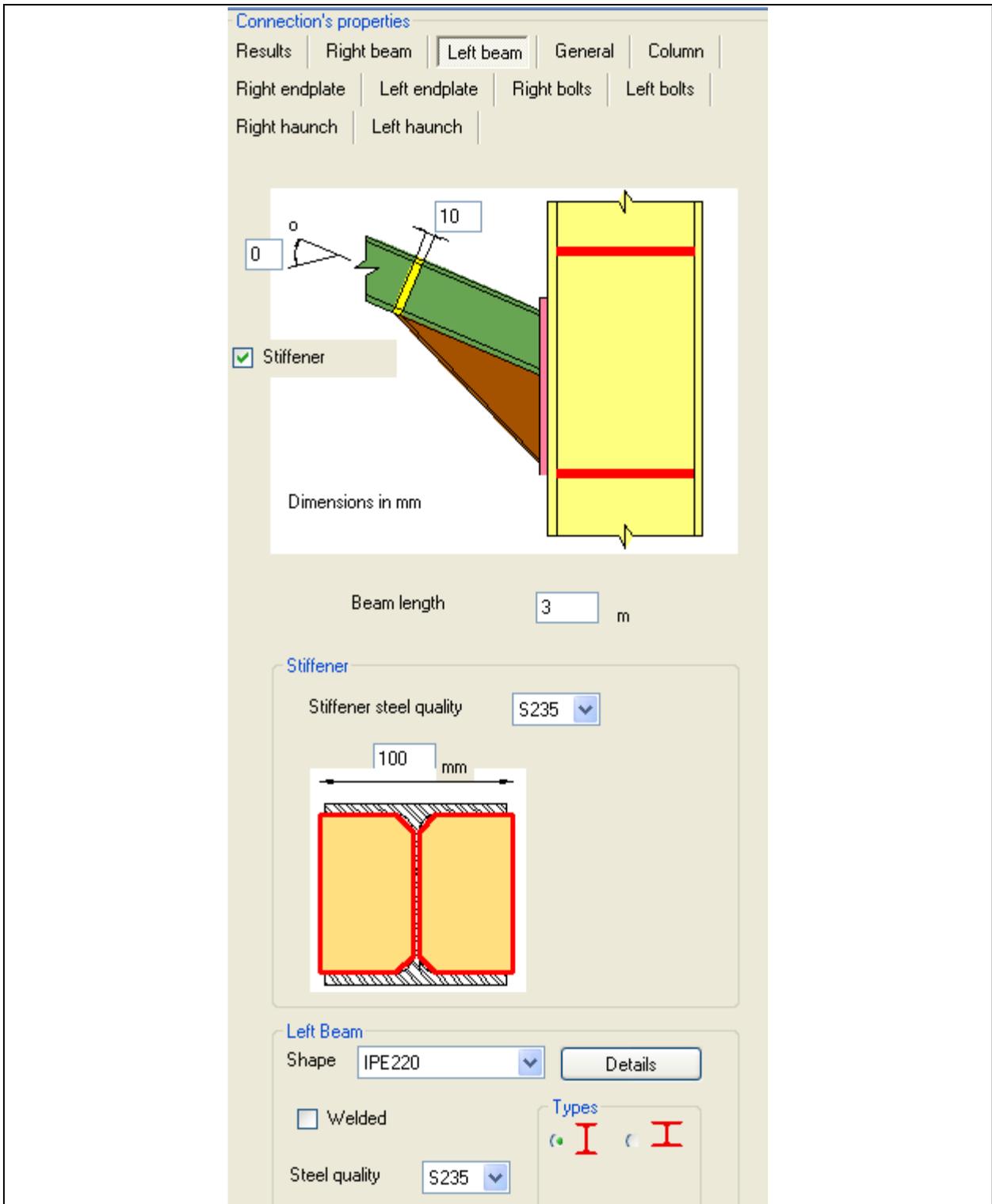
By clicking on the option Welded the user can define the dimensions of the welded section and the program automatically calculates the section inertia characteristics.



Picture 6.11

## 6.4 Left beam

The tab Left beam becomes active only after the user has selected the existence of the left connection in the tab General.

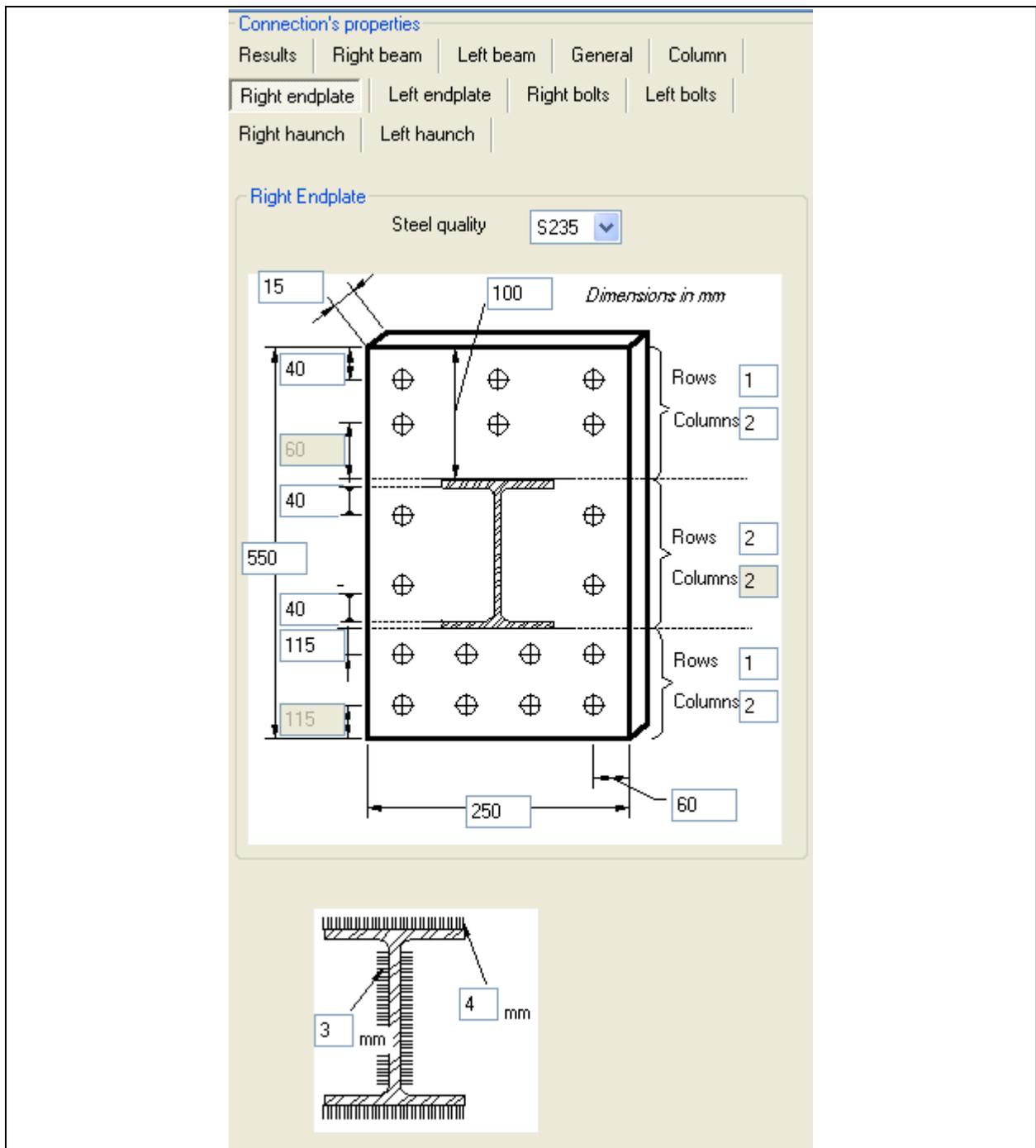


Picture 6.12

The Left beam tab parameters are similar to the Right beam tab parameters.

## 6.5 Right endplate

When the user selects the Right endplate tab an endplate detail appears in the window.

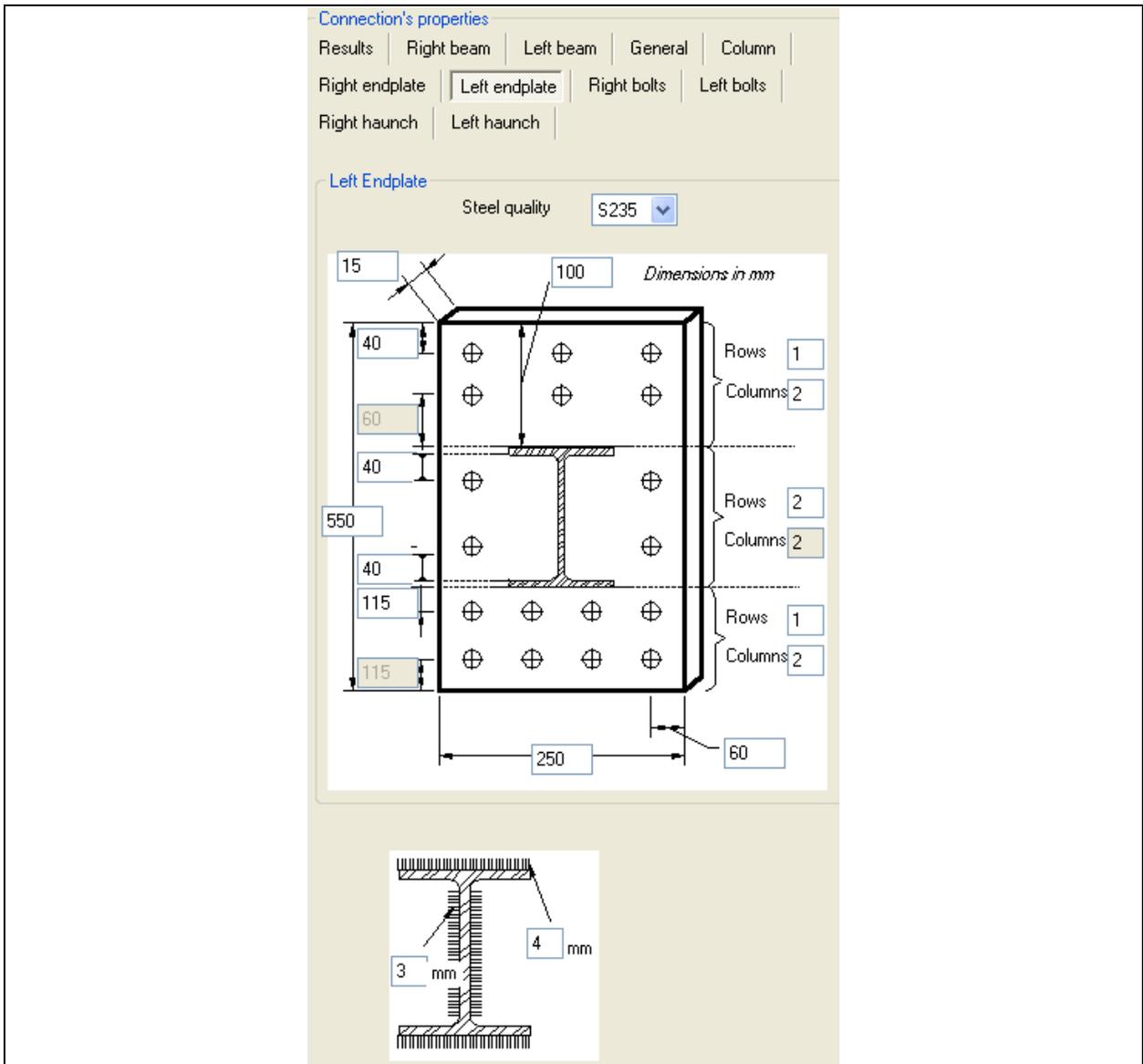


Picture 6.13

There the user can define the endplate dimensions, its thickness as well as endplate steel quality and the column welds thickness. The user can also define the number of the bolt rows and columns and the layout of the bolts on the endplate.

## 6.6 Left endplate

The tab Left endplate becomes active only after the user has selected the existence of the left connection in the tab General.

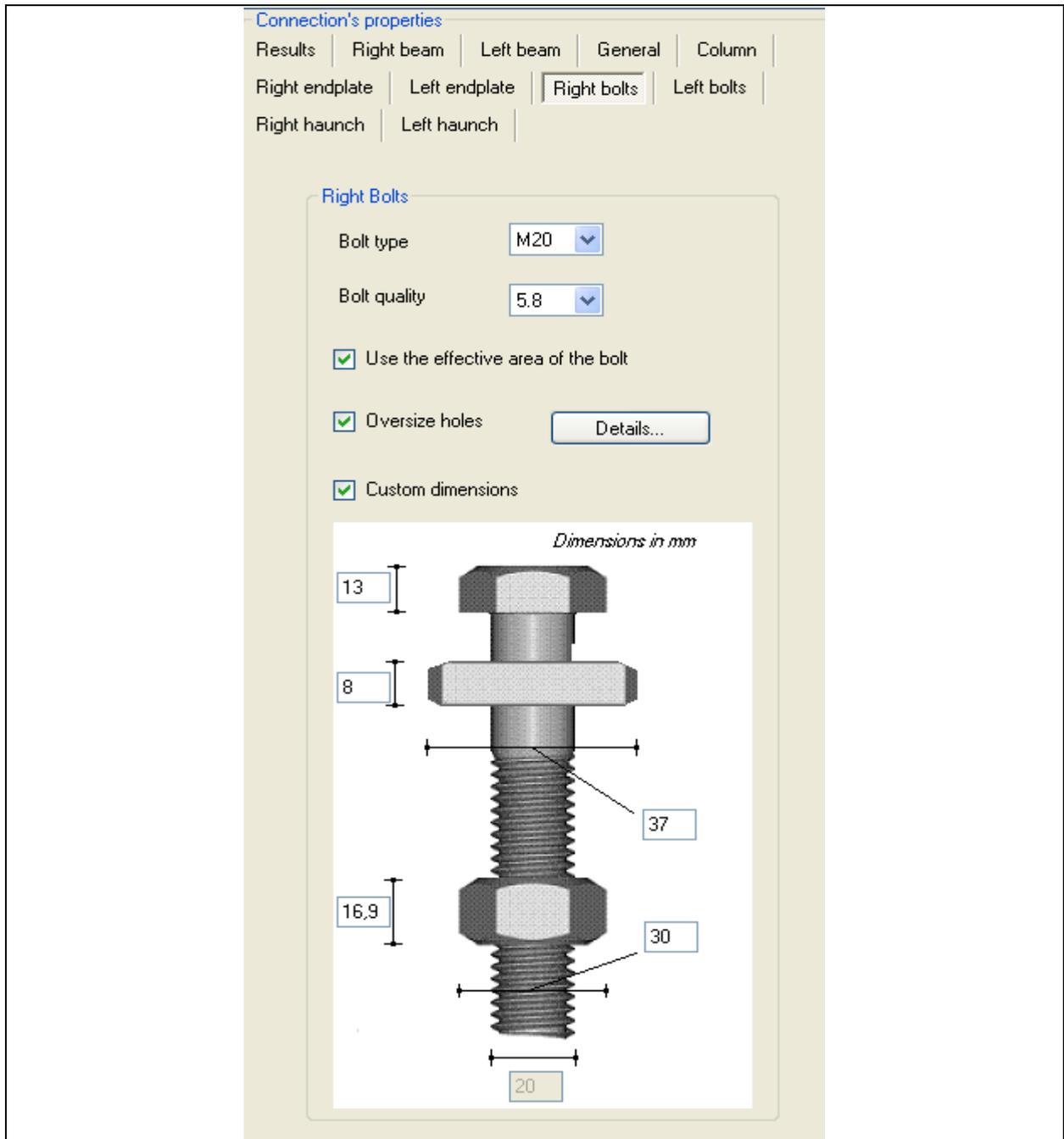


Picture 6.14

## 6.7 Right bolts

Inside the tab Right bolts the user selects the bolt type, the bolt quality and whether the effective area of the bolt will be used and/or oversize holes.

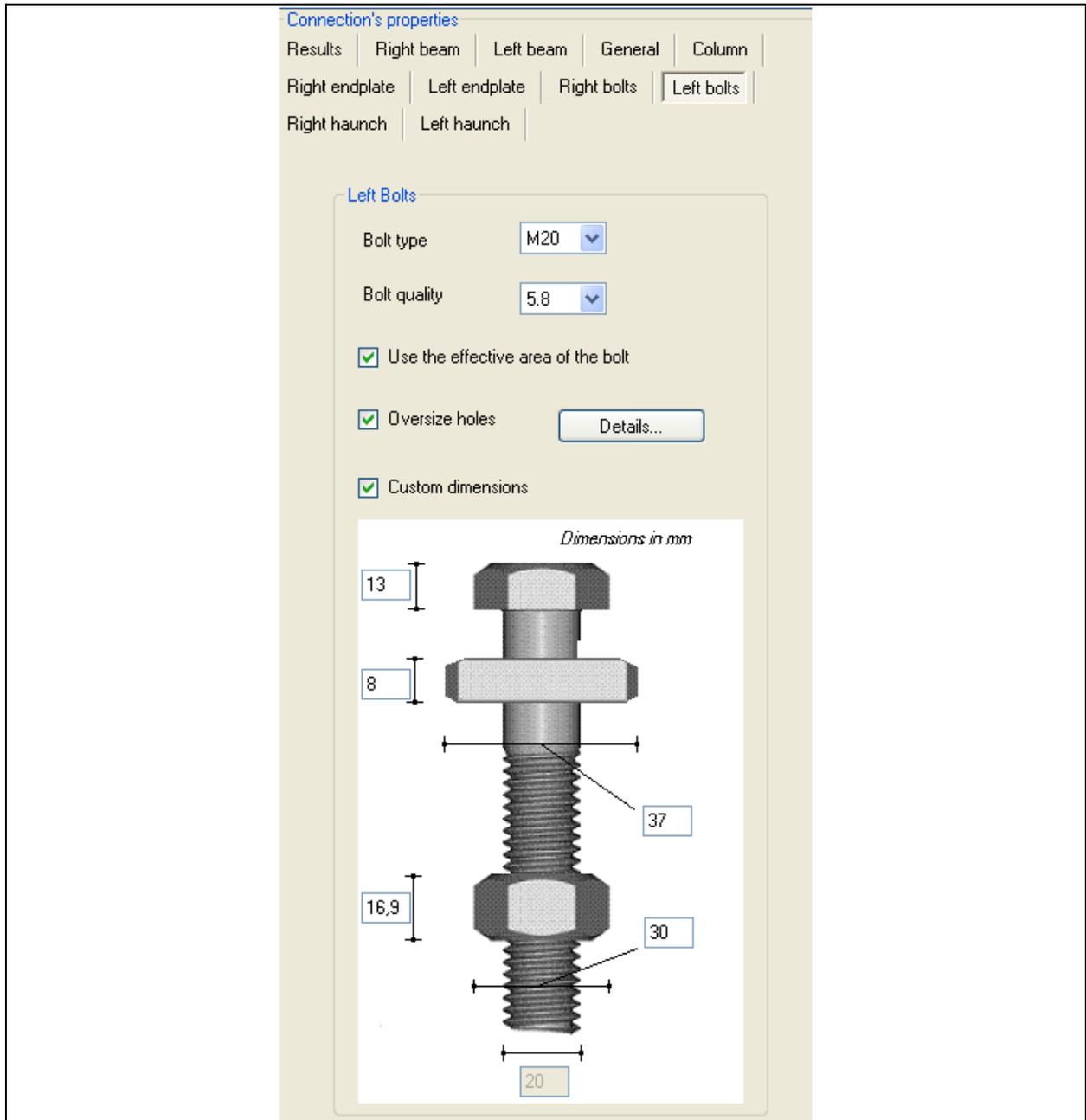
When the user clicks on Details he can see the bolt type dimensions he defined according to DIN 7990, DIN 7969, EN 24034, EN 24032, DIN 6914. Clicking on Custom dimensions the user defines the bolt dimensions he prefers.



Picture 6.15

## 6.8 Left bolts

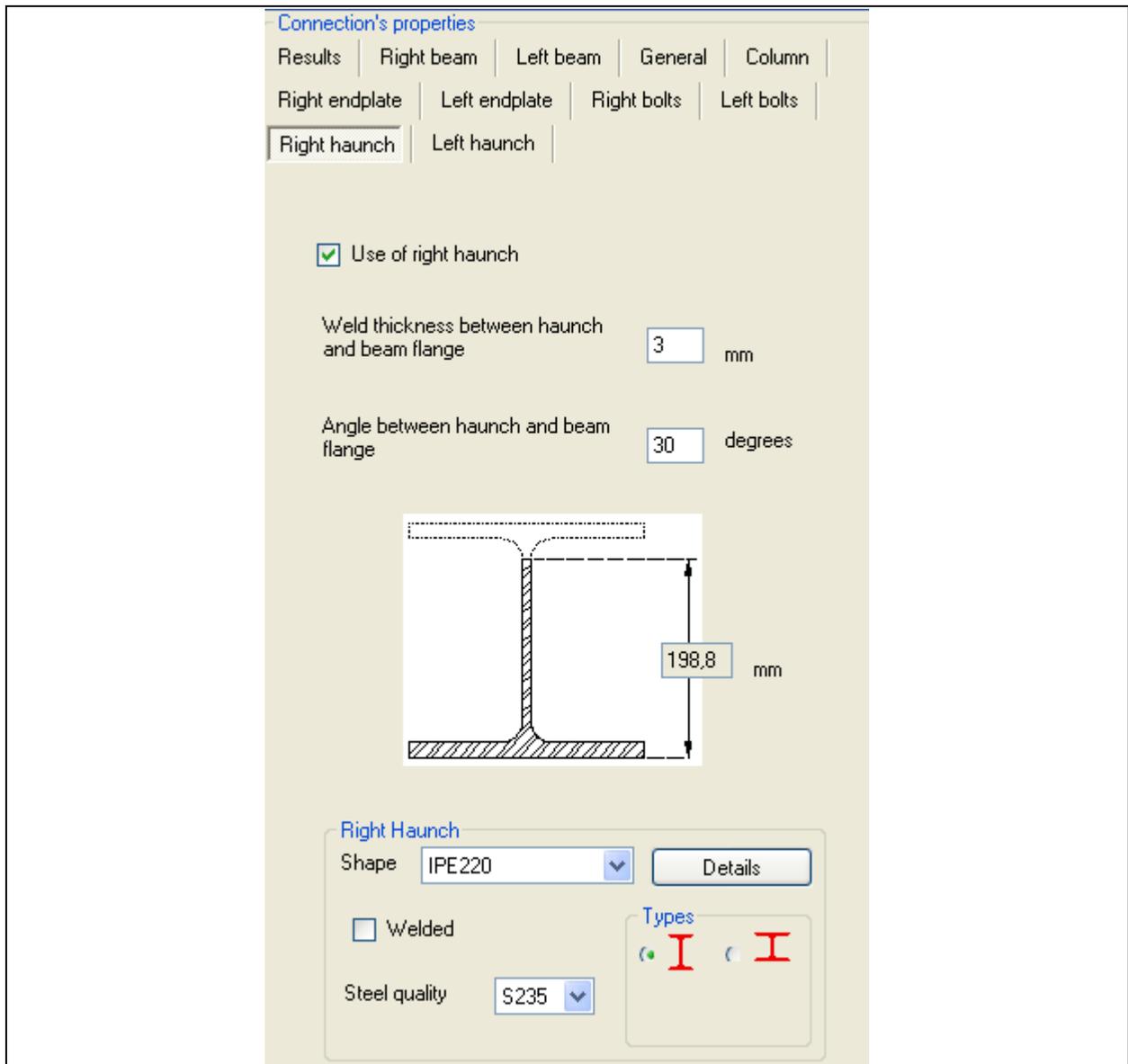
The tab Left bolts becomes active only after the user has selected the existence of the left connection in the tab General and its parameters are similar to the Right bolts tab parameters.



Picture 6.16

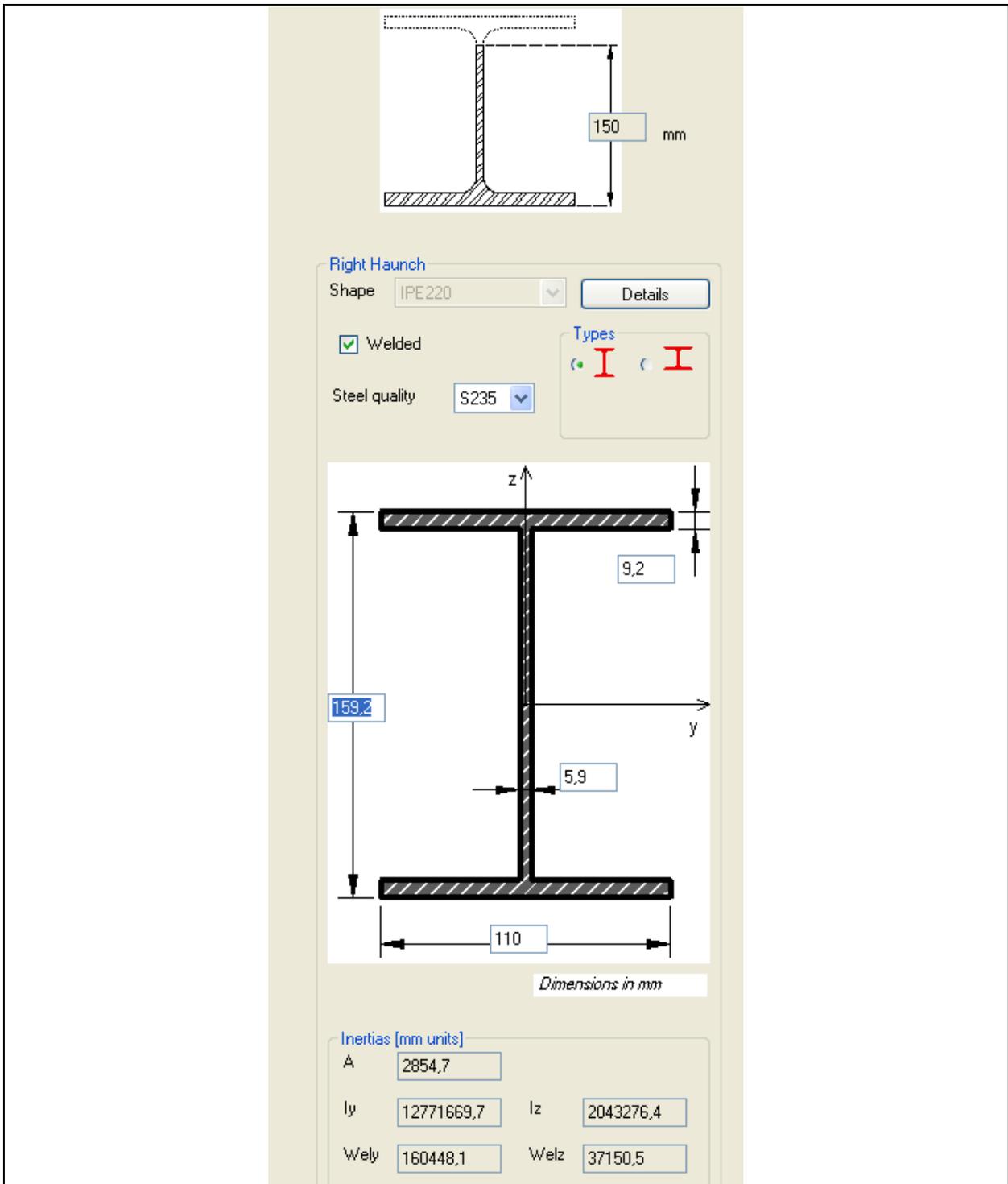
## 6.9 Right haunch

The program gives the user the capability either to select the use of right haunch or not by clicking on the option Use of right haunch. If he does so, the following window appears.



Picture 6.17

The user can define the weld thickness and the angle between haunch and beam flange. He can also specify the haunch shape and type as well as the steel quality. When the user wants to define the haunch height he has to click on Welded and a haunch detail appears in the window.

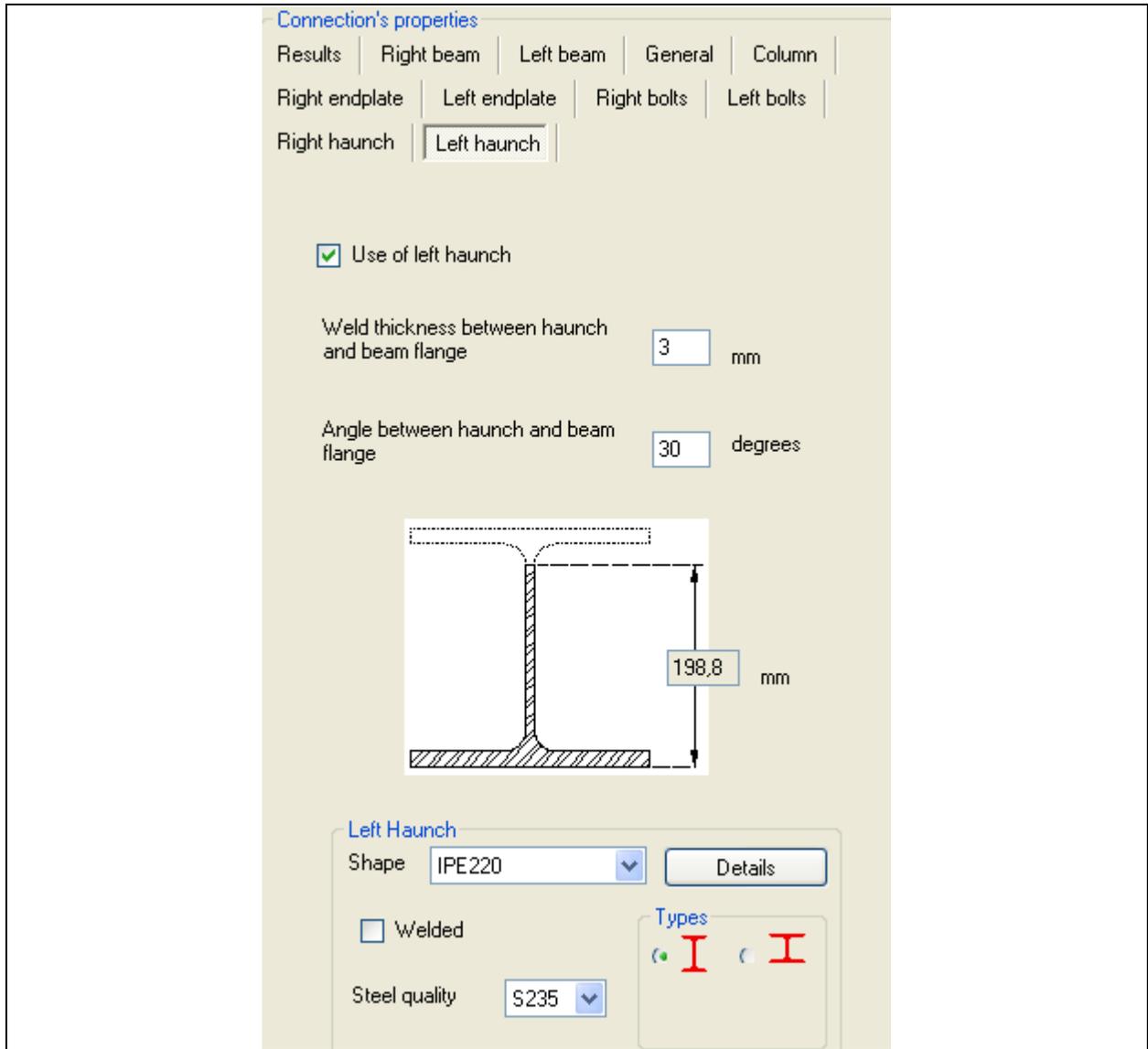


Picture 6.18

Inside, the user can define the haunch height by changing the section height. He can also modify the section dimensions as well as the section inertia characteristics.

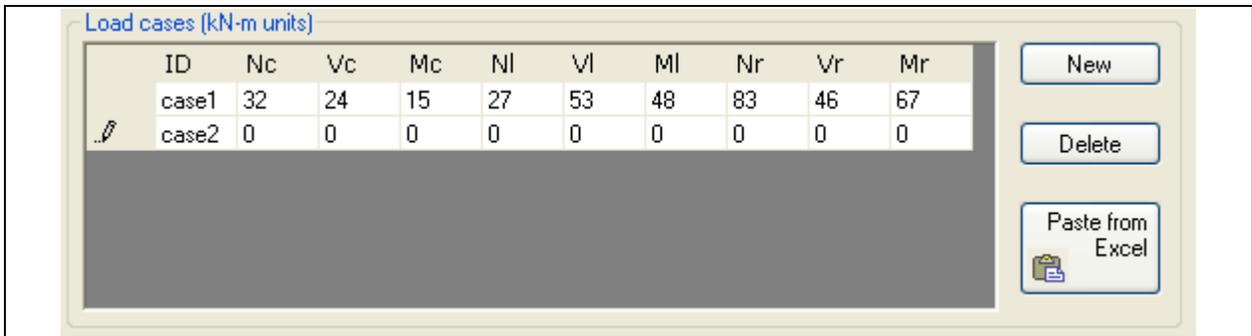
## 6.10 Left haunch

The tab Left haunch becomes active only after the user has selected the existence of the left connection in the tab General and its parameters are similar to the Right haunch tab parameters.



Picture 6.19

In the load cases window, the user defines the connection load cases.  $N_c$ ,  $V_c$ ,  $M_c$  are the column forces,  $N_l$ ,  $V_l$ ,  $M_l$  are the left beam forces and  $N_r$ ,  $V_r$ ,  $M_r$  are the right beam forces.



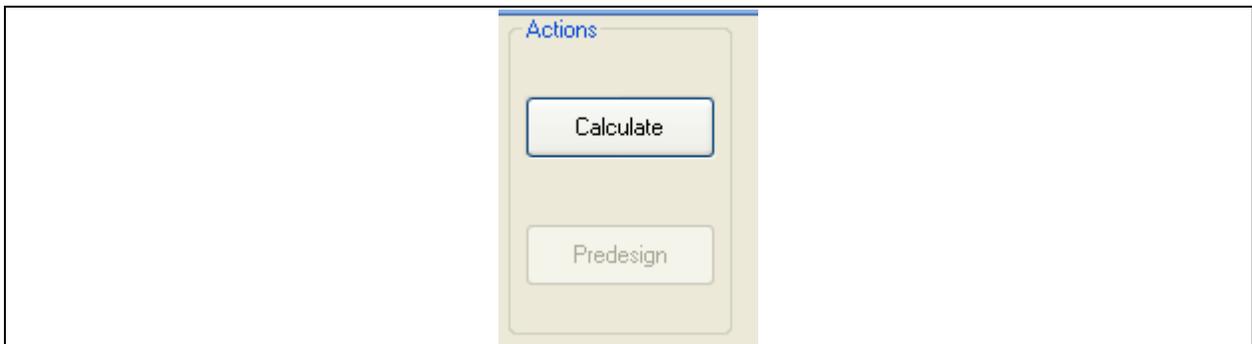
**Picture 6.20**

The user can add more load cases by clicking on New.

If the user wants to delete one or more load cases he can do so by clicking on the specific load combination and then click on Delete.

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The endplate beam column connection design starts when the user clicks on Calculate



**Picture 6.21**

The design results are shown in the tab Results.

Connection's properties

Results | Right beam | Left beam | General | Column

Right endplate | Left endplate | Right bolts | Left bolts

Right haunch | Left haunch

Load case: 1

Combinations that fail: 1

Total moment capacity: 0,134

Right connection

Axial force exceeds 5% of member's resistance: No

Moment strength: 117,577 kNm

Moment capacity: 0,851

Shear strength: 166,6 kN

Shear capacity: 0,294

Bolt tension-shear interaction capacity: 0,843

Joint rotation: 0,004688 rad

Weld capacity: 1,241

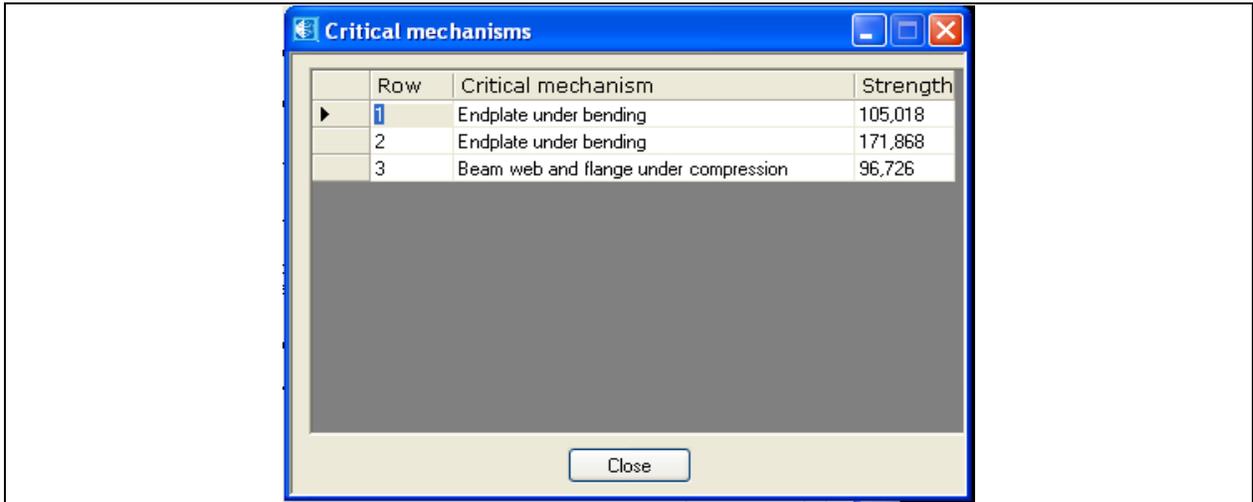
Joint classification by stiffness: Semi rigid

Joint classification by strength: Full strength

Critical mechanisms of bolt rows under tension

Picture 6.22

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations marked in red too. By clicking on the button Critical mechanisms of bolt rows under tension the following window appears where the user can see the critical mechanisms of every bolt row in tension followed by their calculated strength so in case the connection strength is exceeded the user can immediately identify the critical mechanism and act accordingly.



*Picture 6.23*

## 7 BEAM COLUMN CONNECTION WITH STEEL PLATE

The beam is connected to the column through a rectangular steel plate which is welded to the column flange and then the beam is bolted to the plate. The cross-section of the column can be either of I type or hollow (RHS, SHS). The performed checks include: bolt shear capacity, bolt bearing capacity, block tearing for both beam and column, failure of the column face (in case of hollow section).

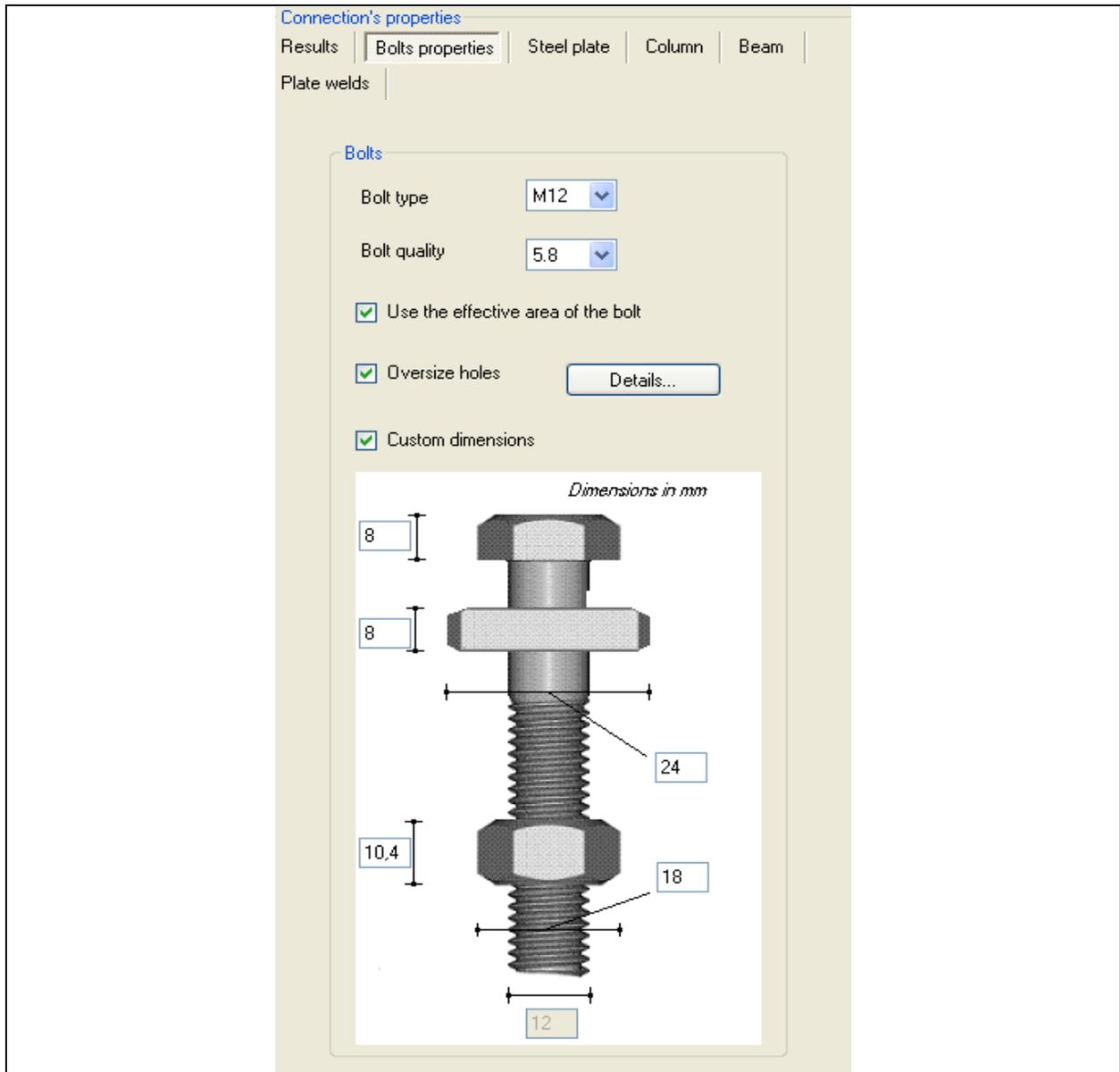
The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 7.1*

### 7.1 Bolts properties

The definition of the bolt parameters can be done by selecting the tab Bolts properties. The user selects the bolt type, the bolt quality and the use of the effective area of the bolt and/or oversize holes.

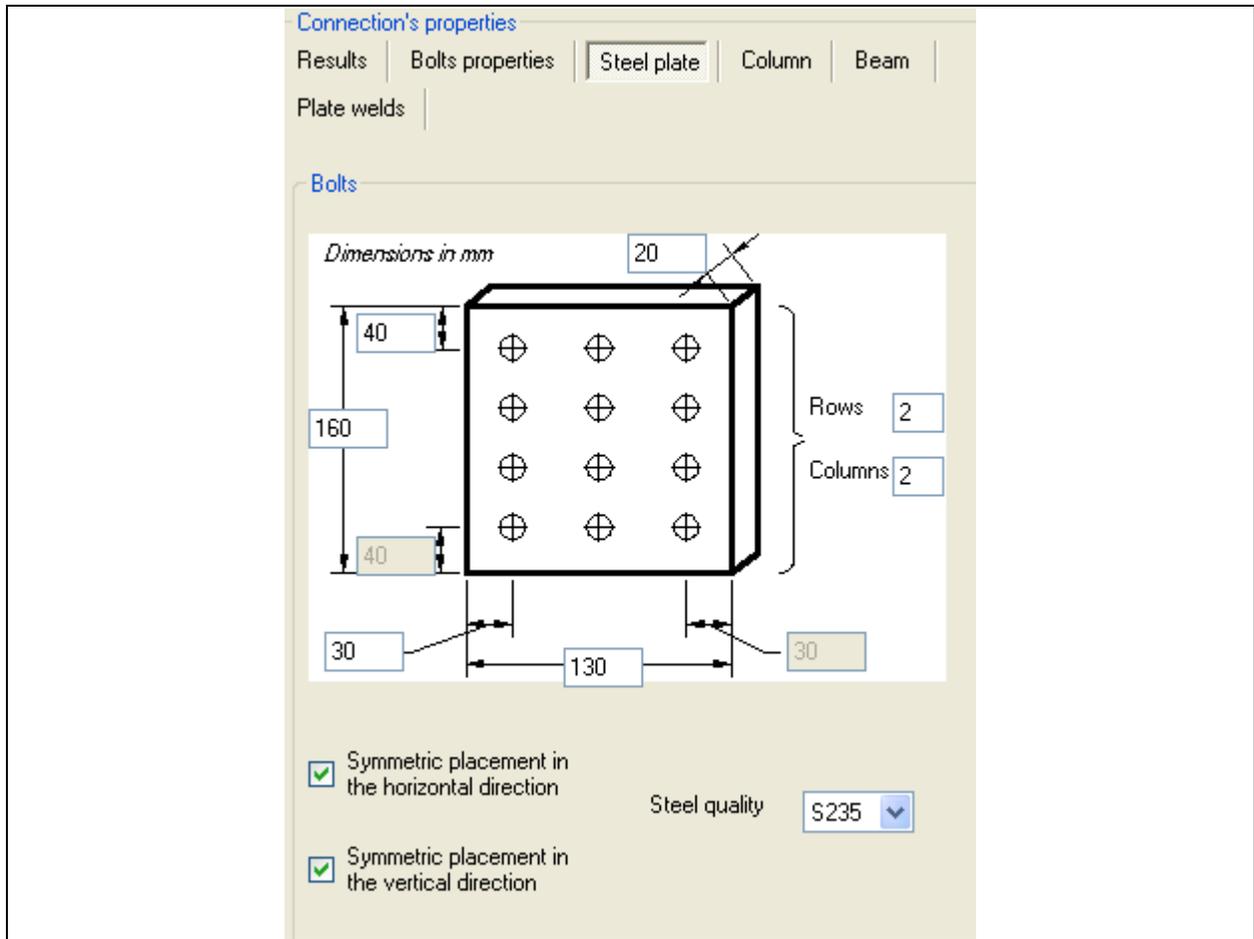


**Picture 7.2**

When the user clicks on Details the above image appears where the user can see the bolt type dimensions he defined, according to DIN 7990, DIN 7969, EN 24034, EN 24032 and DIN 6914. Clicking on Custom dimensions the user defines the bolt dimensions he prefers.

## 7.2 Steel plate

In the tab Steel plate window the user has the capability to define the bolt rows, columns and the bolts layout on the plate. When the user wants symmetric bolt placement in the horizontal direction, in the vertical direction or both, he has to check the appropriate option. The user also defines the steel plate dimensions.



Picture 7.3

### 7.3 Column

In the tab Column the user defines the shape, the type and the steel quality of the column. By clicking on Details, the user clicks can see the dimensions and the inertia characteristics of the column section he defined.

Connection's properties

Results | Bolts properties | Steel plate | **Column** | Beam

Plate welds

Column

Shape HE 300B Details

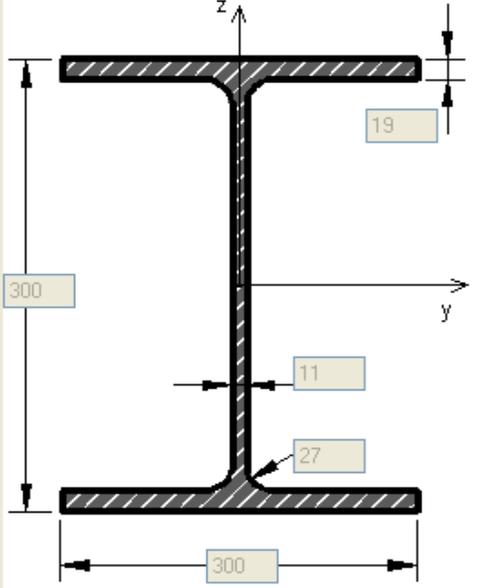
Welded

Steel quality S235

Types





*Dimensions in mm*

Inertias [mm units]

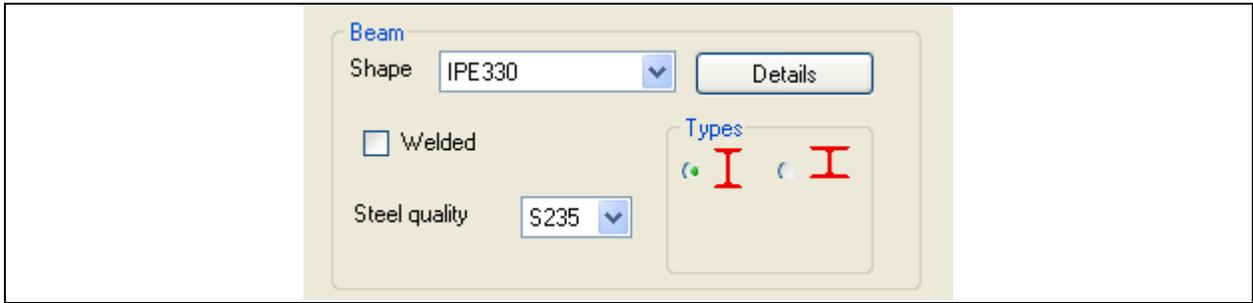
A	14900		
$I_y$	251700000	$I_z$	85630000
$W_{ely}$	1677999,9	$W_{elz}$	570866,6
$W_{ply}$	1869000	$W_{plz}$	870000
$i_y$	130	$i_z$	75,8

Picture 7.4

By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.

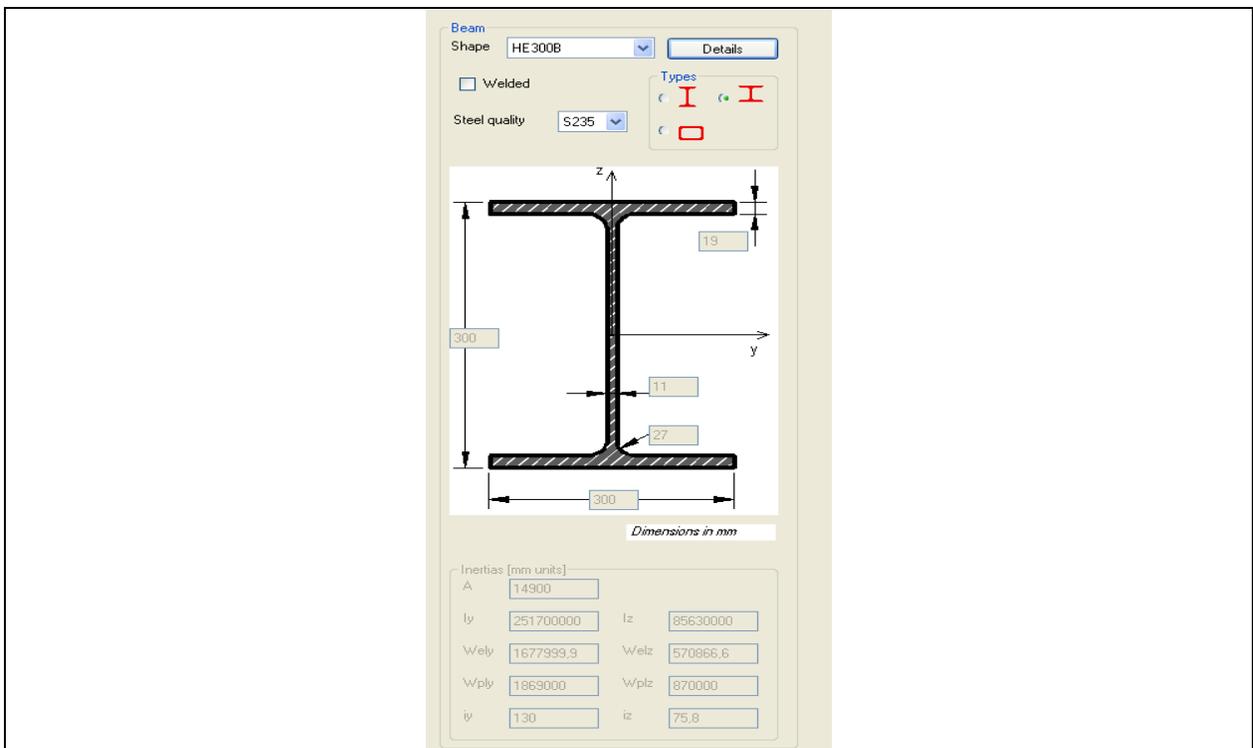
## 7.4 Beam

By clicking on the tab Beam the user can define the shape, the type and the steel quality of the beam.



Picture 7.5

When the user clicks on Details he can see the dimensions and the inertia characteristics of the beam section the user defined.

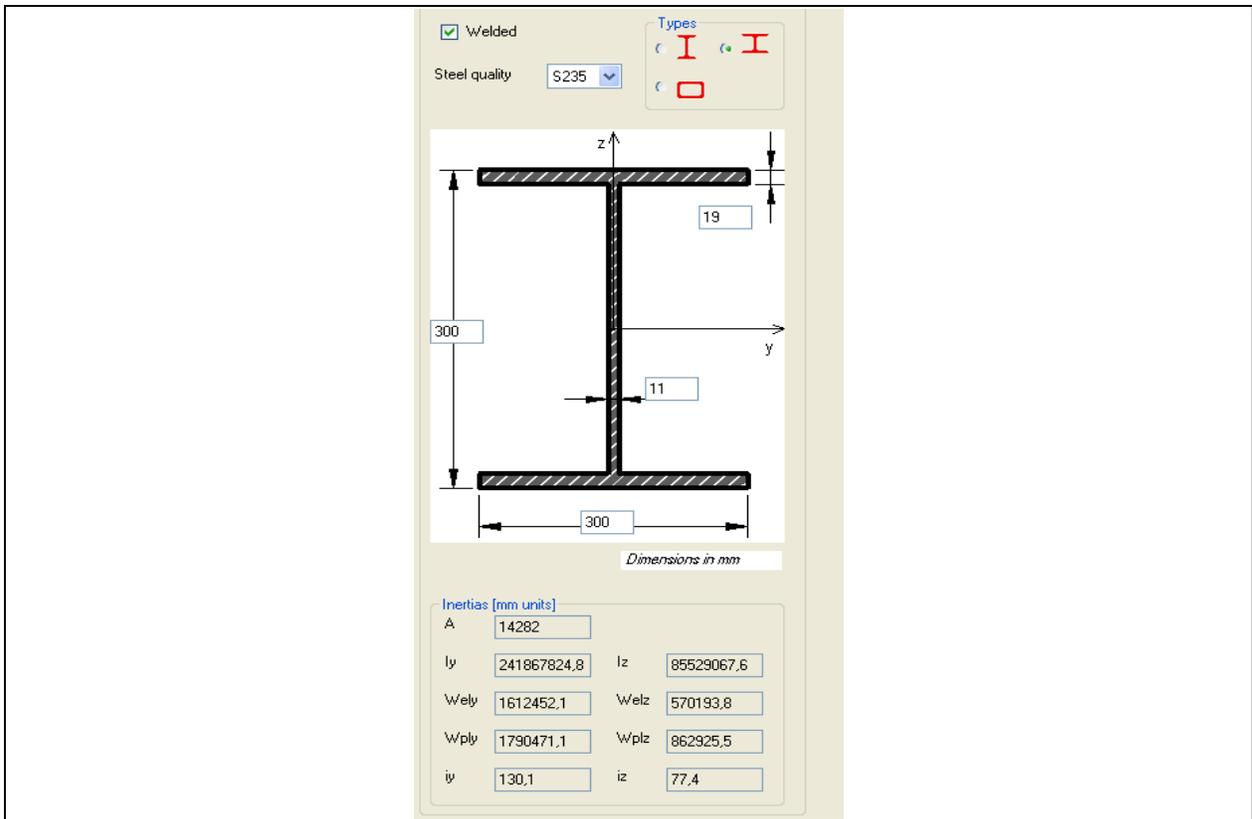


Picture 7.6



Picture 7.7

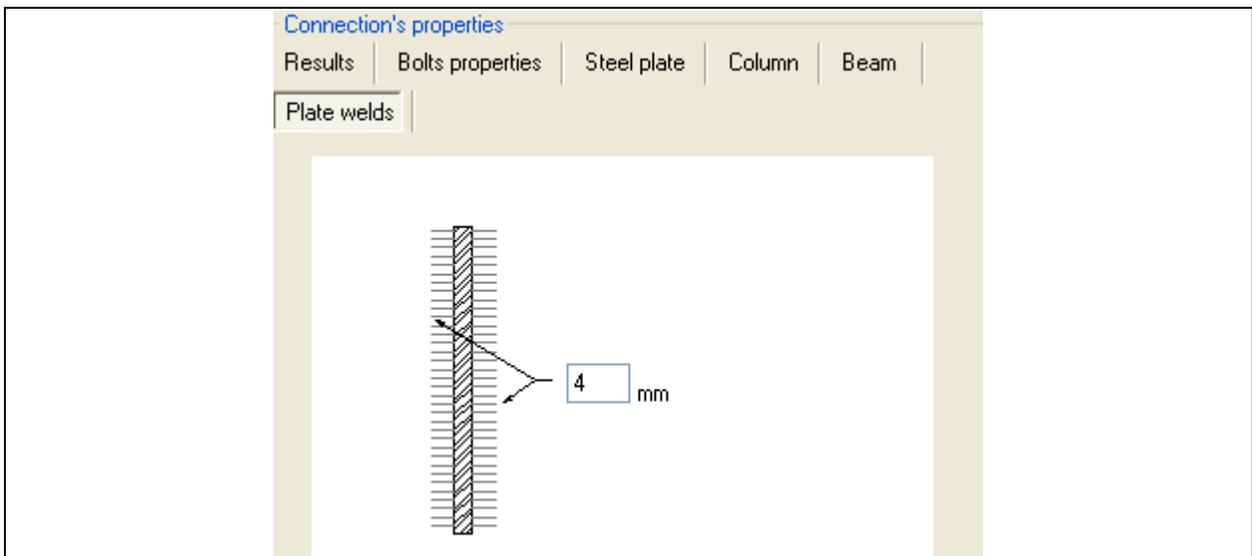
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 7.8

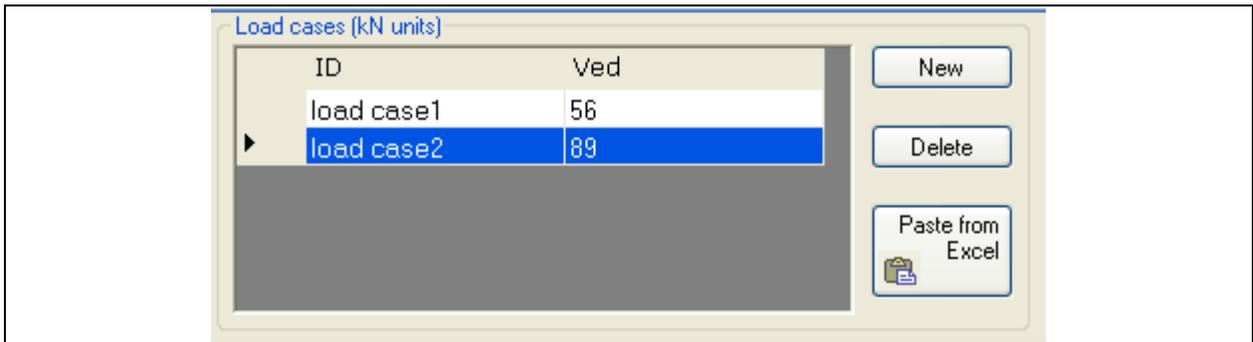
## 7.5 Plate welds

By selecting the tab Plate welds the user has the capability to define the plate welds thickness.



Picture 7.9

In the load cases window the user defines the connection load cases.



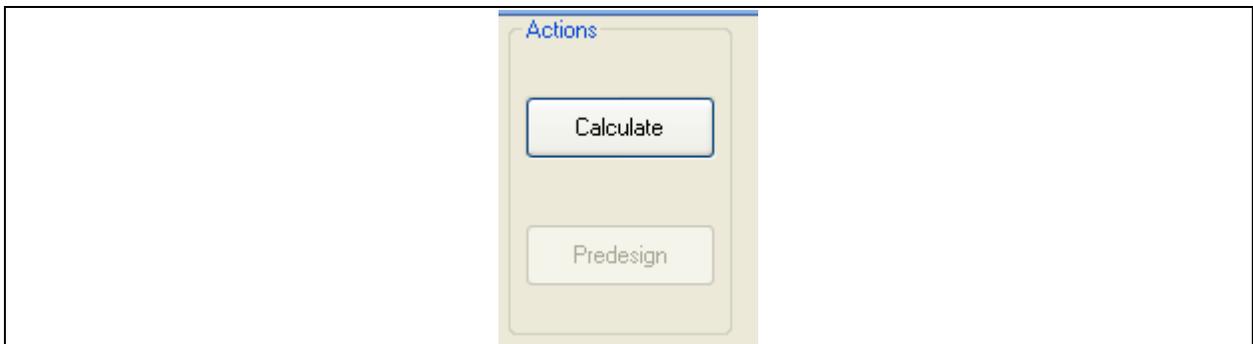
*Picture 7.10*

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined, he must click on the specific load combination and then click on Delete.

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The beam - column connection design starts when the user clicks on Calculate



*Picture 7.11*

The design results are shown in the tab Results.

Connection's properties

Results | Bolts properties | Steel plate | Column | Beam

Plate welds

Combinations that fail: load case2

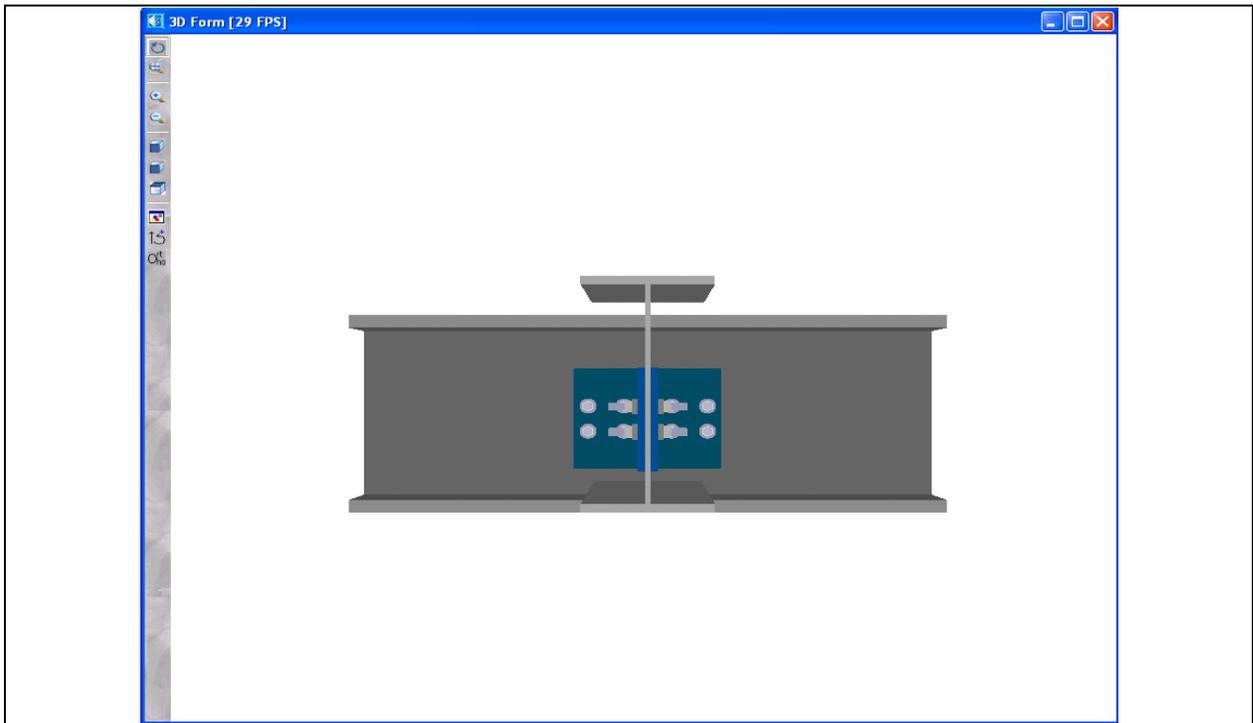
Load case	load case2	
Bolts shear strength	57,324	kN
Bolts shear capacity	1,553	
Bearing strength	185,395	kN
Bearing capacity	0,48	
Weld shear strength	36	kN / cm <sup>2</sup>
Weld shear capacity	0,941	
Weld direct strength	28,8	kN / cm <sup>2</sup>
Weld direct capacity	0,588	
Plate Divulsion strength	445,819	kN
Plate Divulsion capacity	0,2	
Beam Divulsion strength	225,697	kN
Beam Divulsion capacity	0,394	
Tubo column flange axial strength	0	kN
Tubo column flange axial capacity	0	

Picture 7.12

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations also marked in red color.

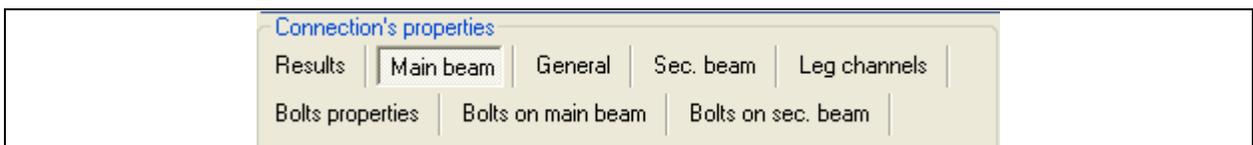
## 8 BEAM ON BEAM CONNECTION

This connection refers to a secondary beam (supported beam) connected to the web of a main beam (supporting beam). The cross section of both beams must be of I type. Both equal and unequal double angle cleats can be used for the connection, either hot rolled or welded. The user can also define whether or not there will be a cut on the top or bottom flange of the secondary beam. The performed checks include: bending and shear capacity of the angle cleats, bolts shear and bearing capacity, block shear capacity for both beams. Moreover, the program checks if the connection meets the ductility criteria of Eurocode 3.



*Picture 8.1*

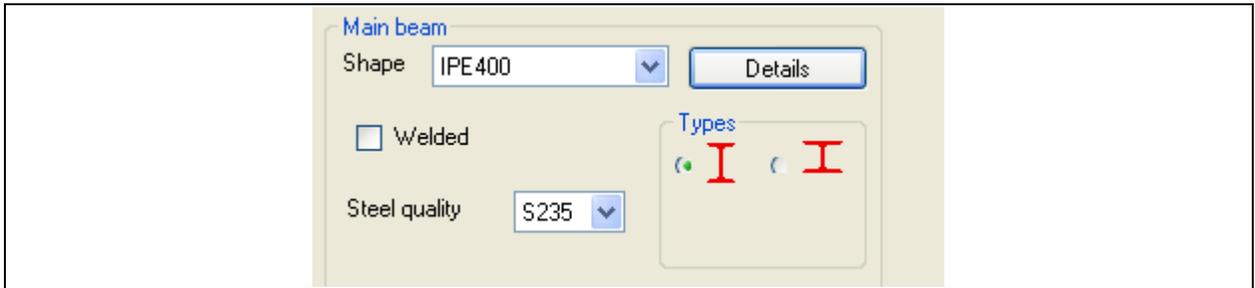
The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 8.2*

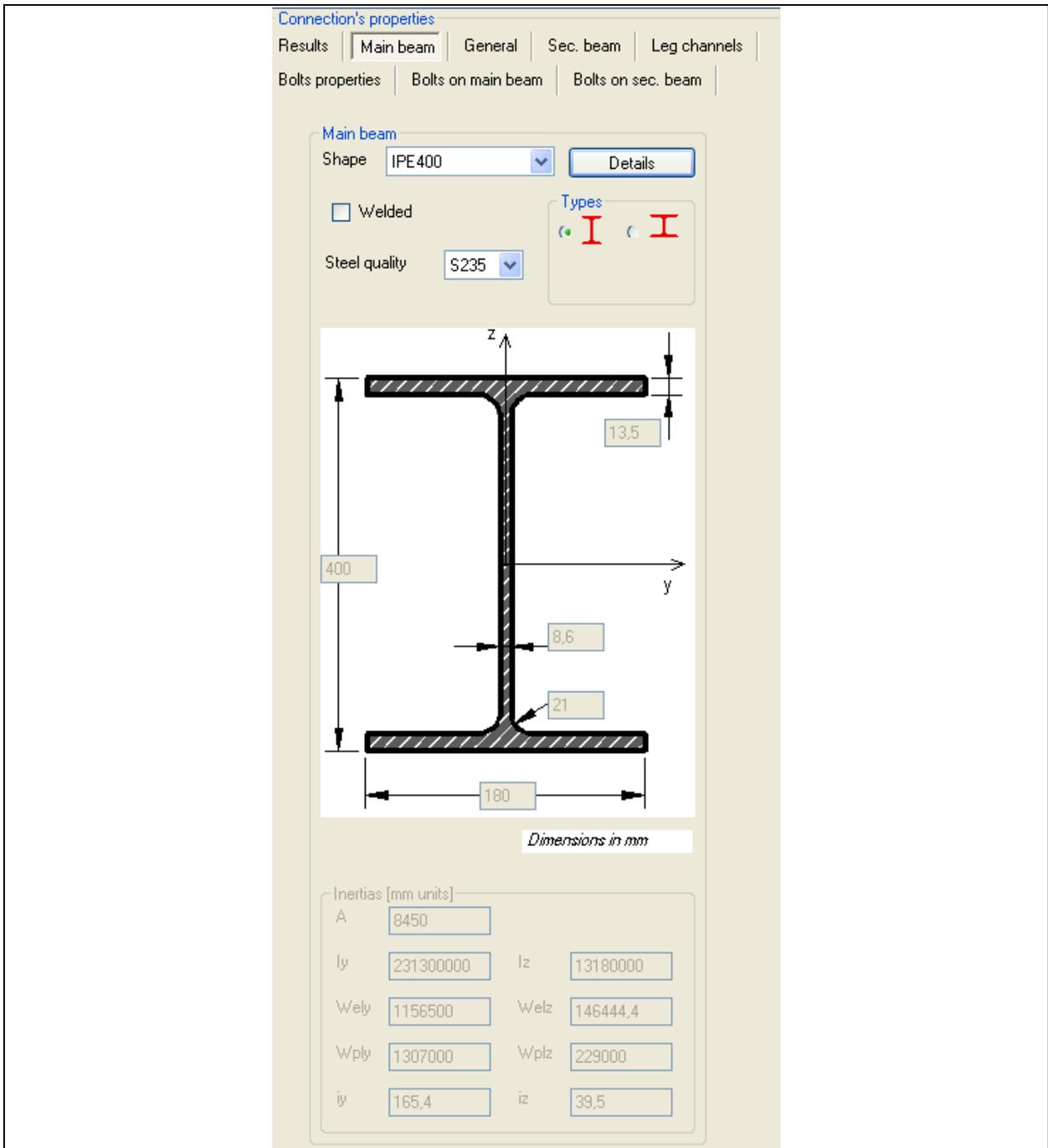
### 8.1 Main beam

By clicking on the tab Main beam the user can define the shape, the type and the steel quality of the connection main beam.



*Picture 8.3*

When the user clicks on Details has the capability to see the dimensions and the inertia characteristics of the beam section the user defined.

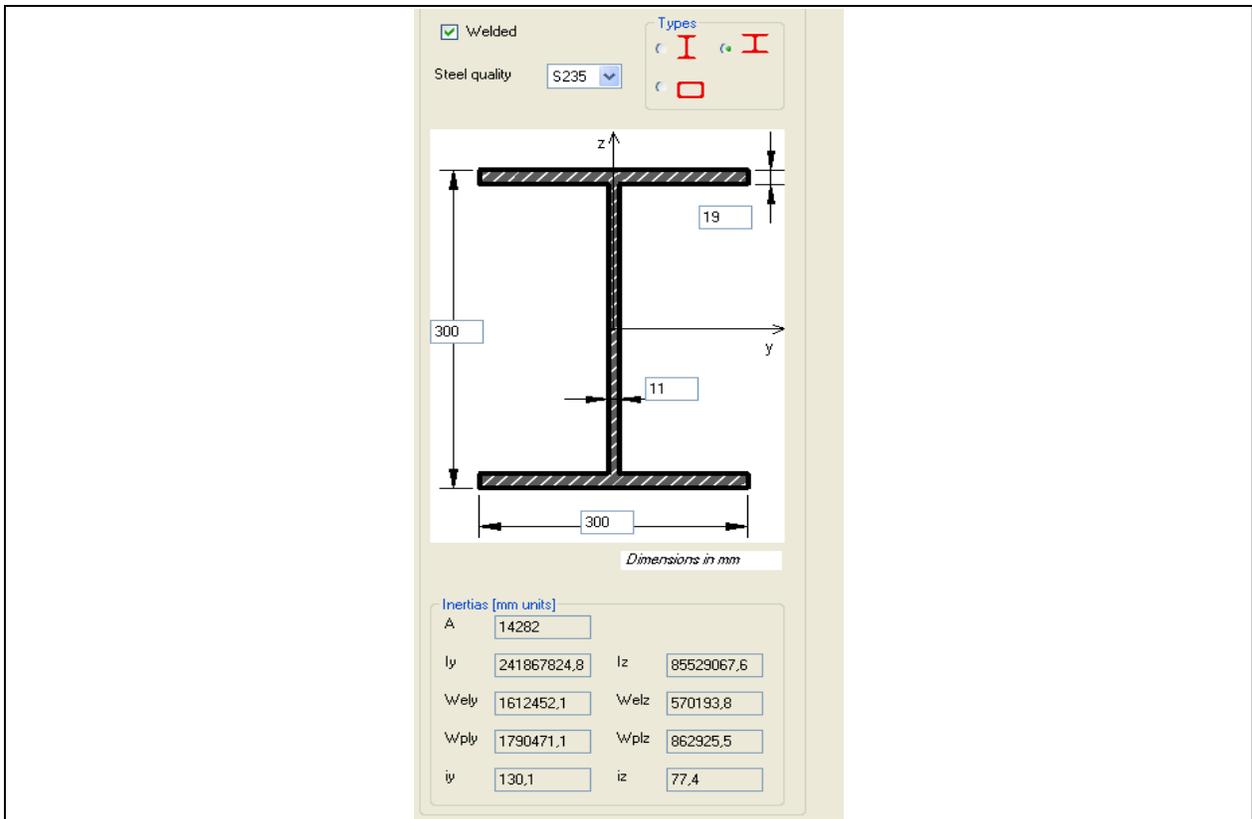


Picture 8.4



Picture 8.5

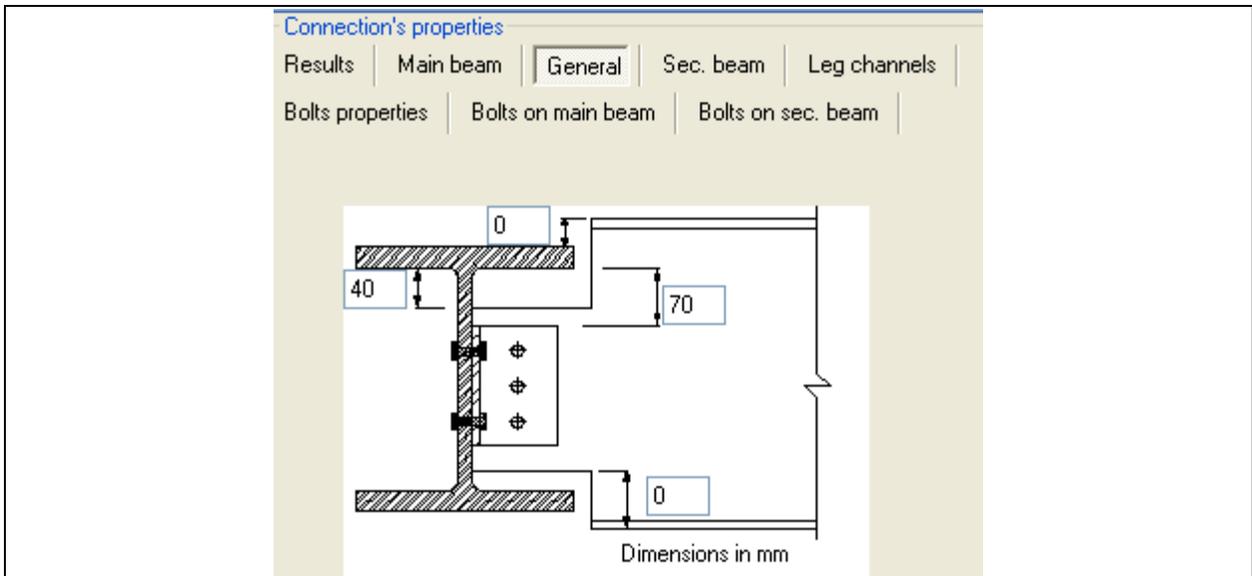
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 8.6

## 8.2 General

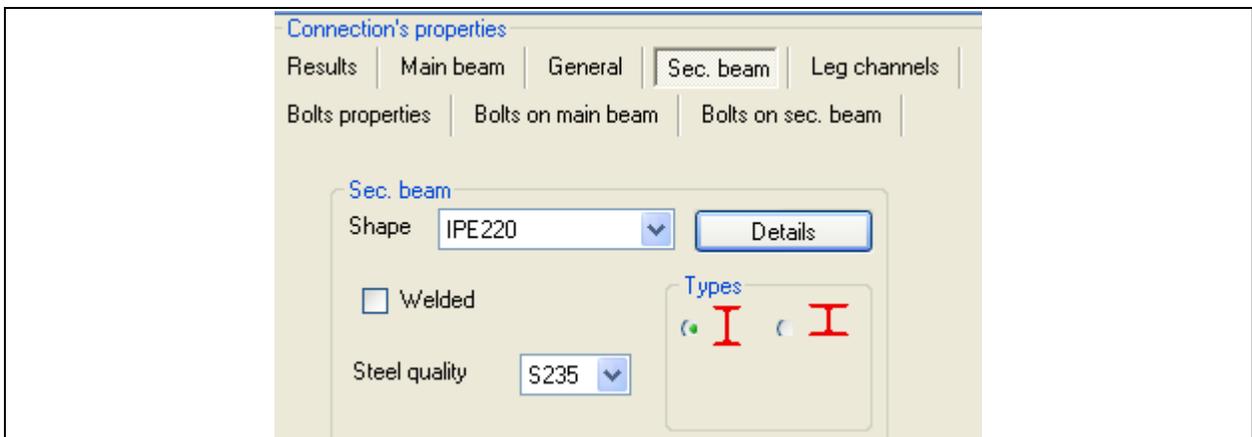
When the user selects the tab General a detail of the beam to beam connection appears. In the tab window the user can define the connection general geometry as shown below.



Picture 8.7

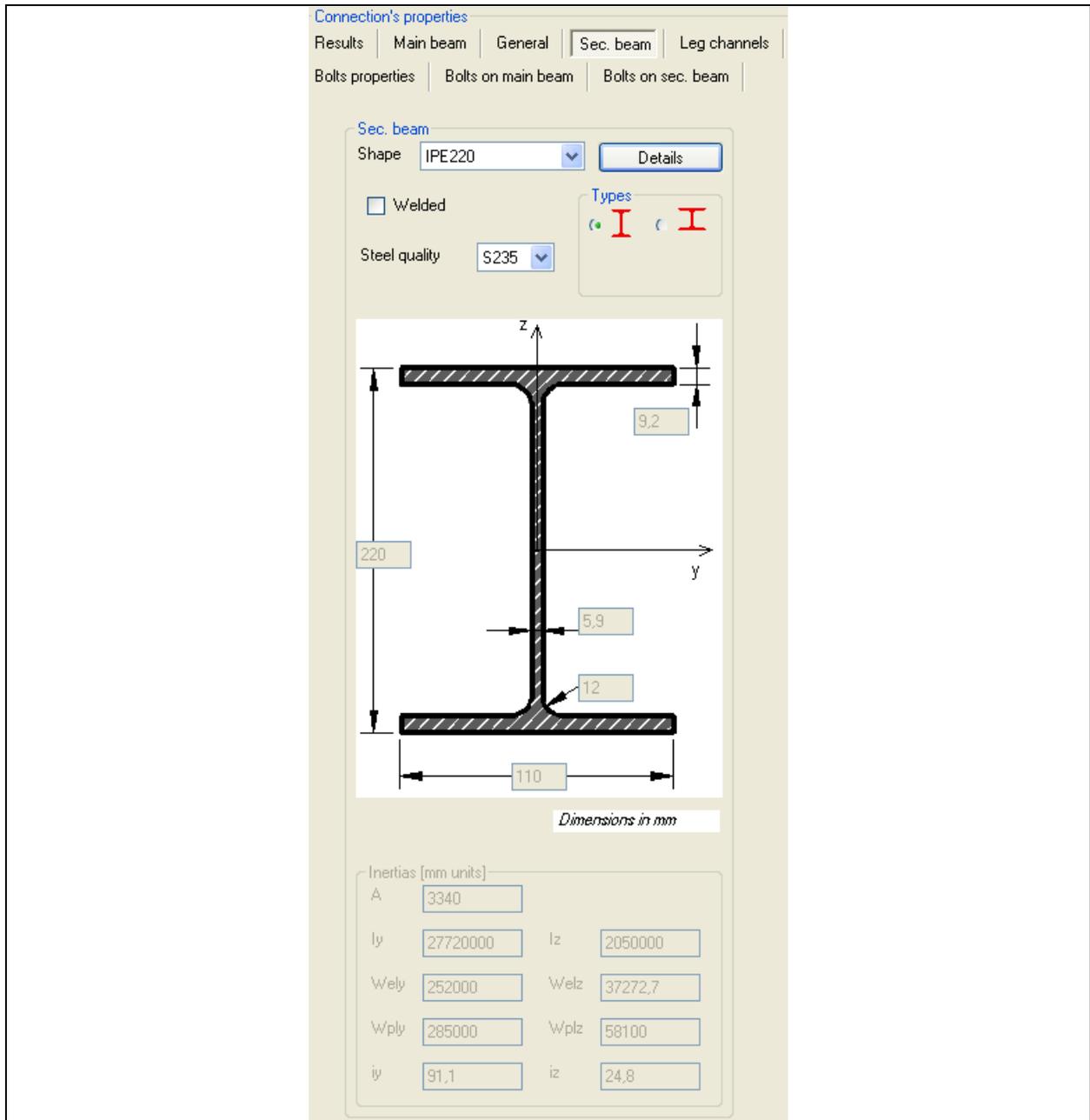
### 8.3 Secondary beam

By clicking on the tab Secondary beam the user can define the shape, the type and the steel quality of the connection secondary beam.



Picture 8.8

When the user clicks on Details has the capability to see the dimensions and the inertia characteristics of the beam section the user defined.

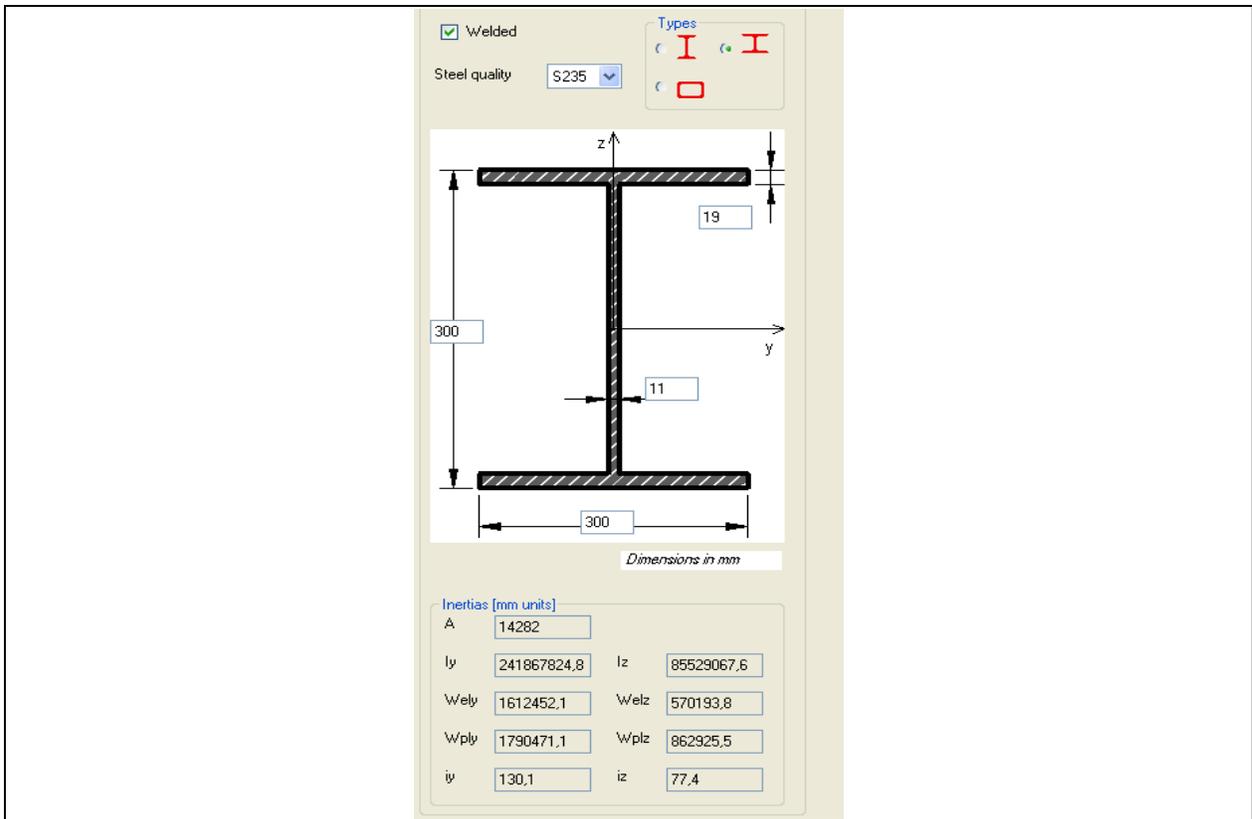


**Picture 8.9**



**Picture 8.10**

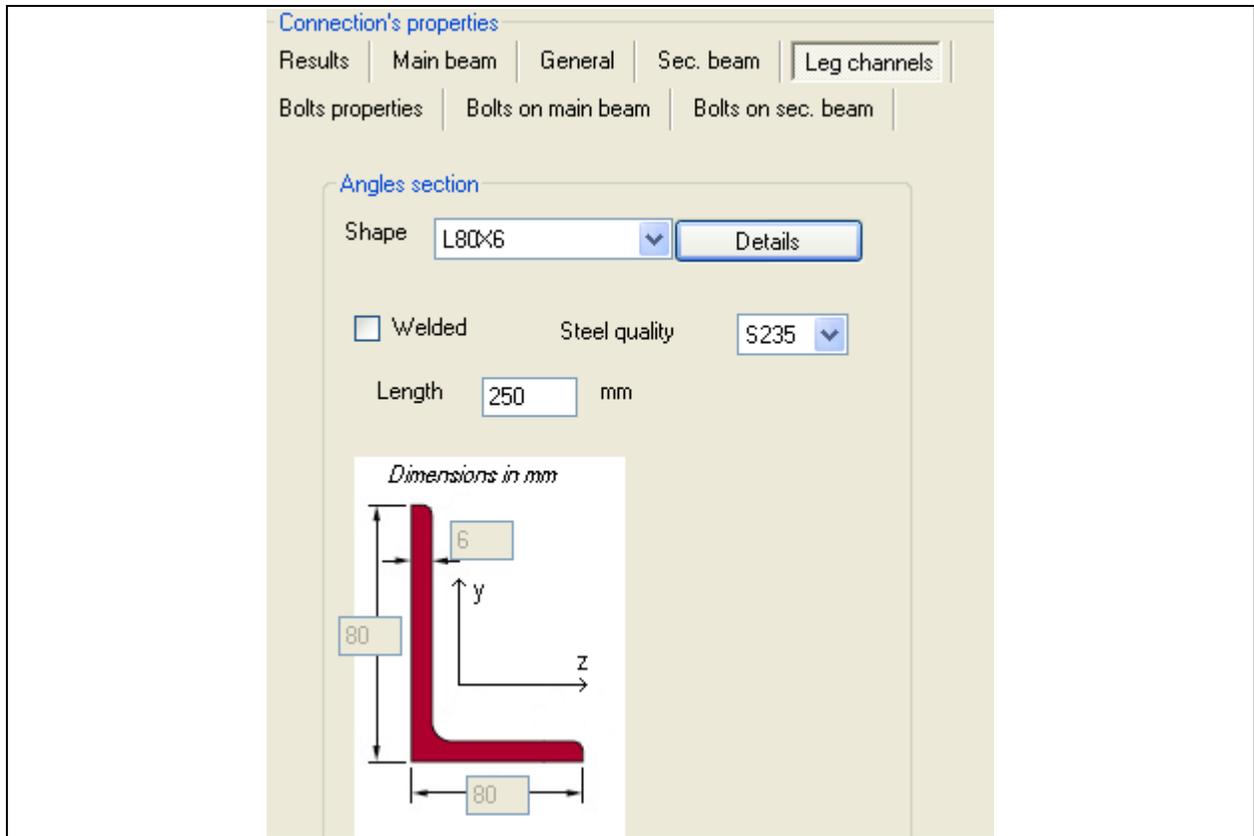
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 8.11

## 8.4 Leg channels

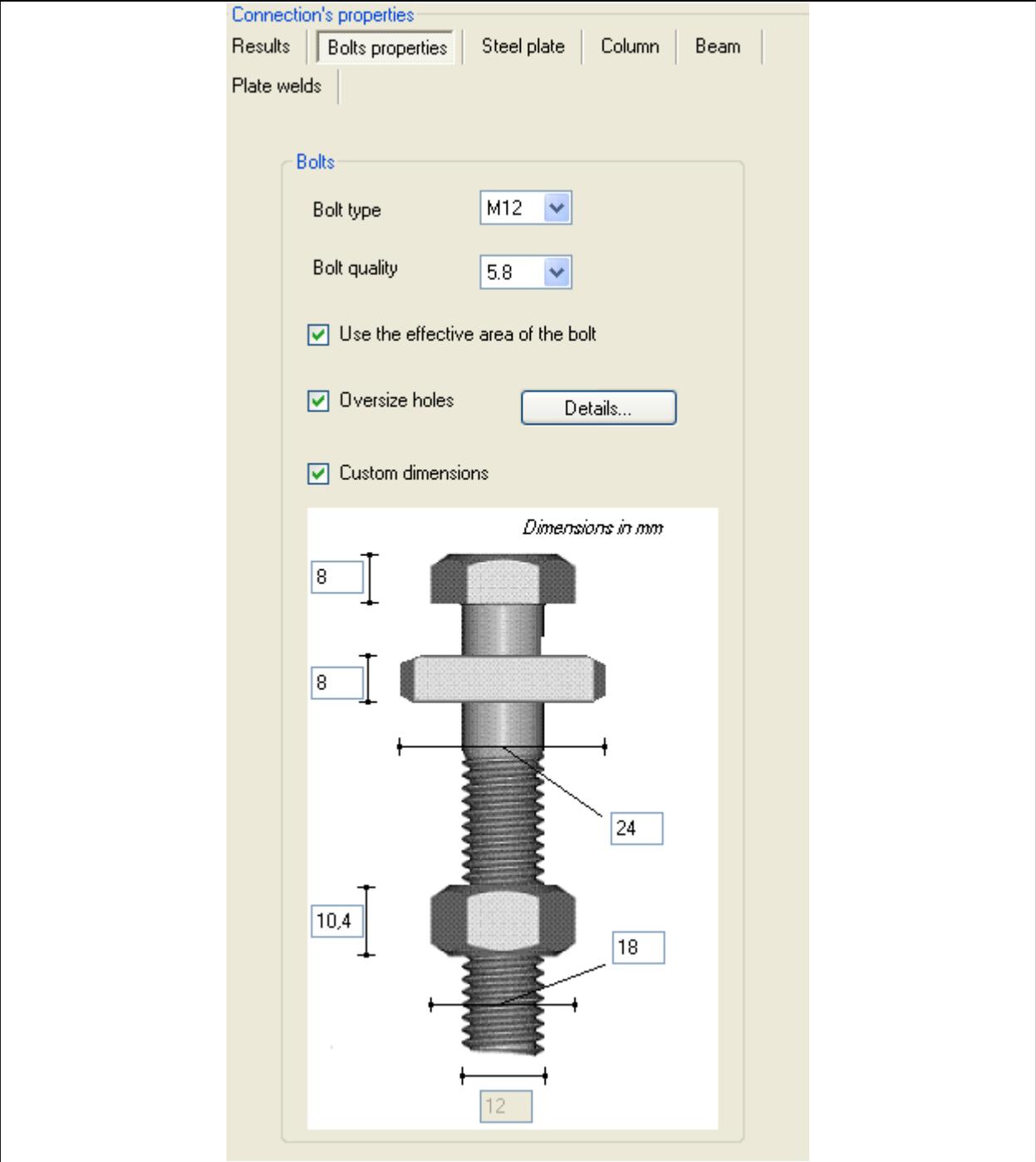
By clicking on the tab Leg channels the user can define the shape and the steel quality of the angles. The user can select either a standard or a welded angle. When the user selects a welded angle the option Shape becomes inactive and he defines the welded angle dimensions in the appropriate form. In this tab the user can also define the angles length.



Picture 8.12

## 8.5 Bolts properties

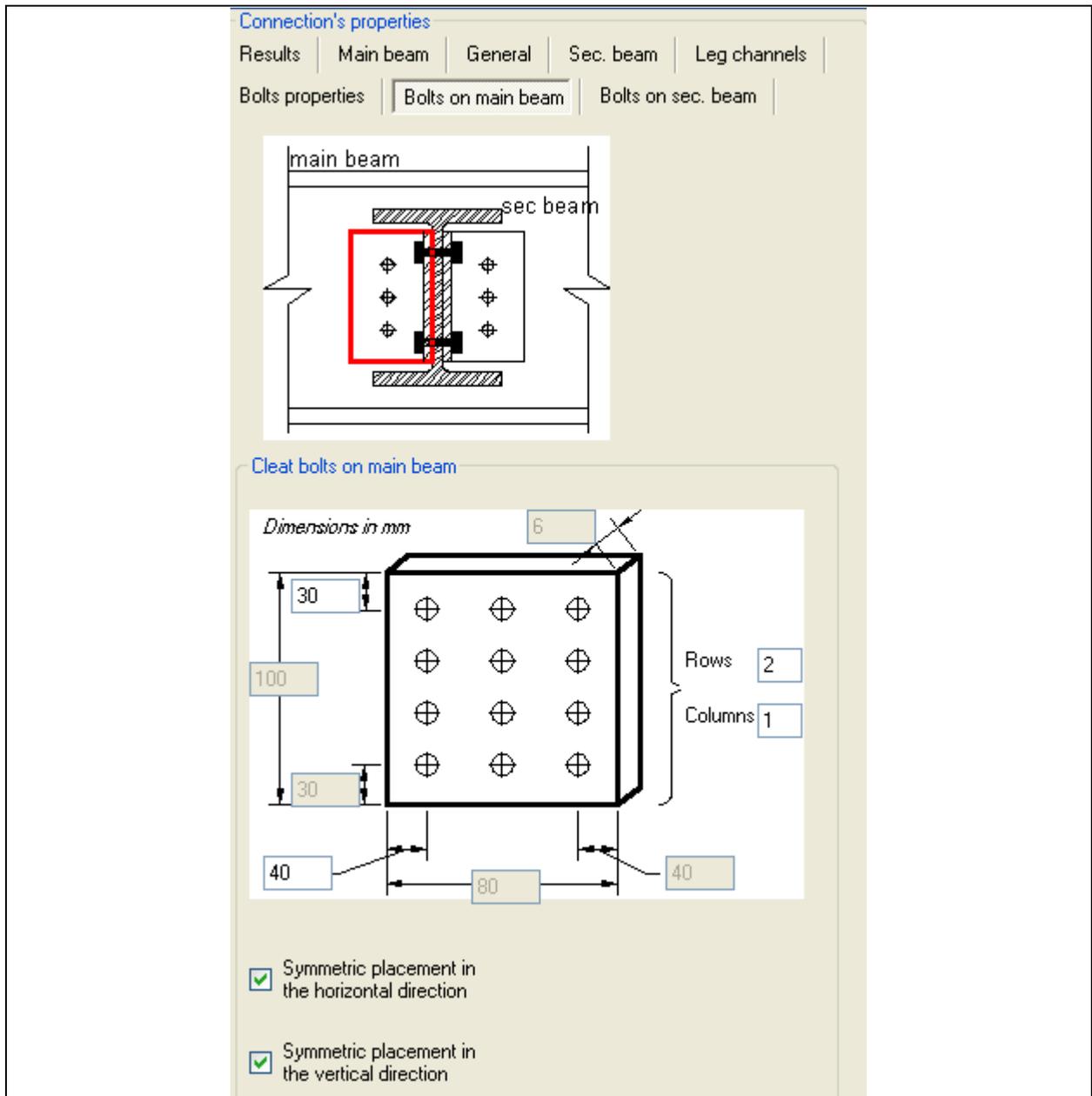
The definition of the bolt parameters can be done by selecting the tab Bolts properties. The user selects the bolt type, the bolt quality and the use of the effective area of the bolt and/or oversize holes.



When the user clicks on Details the above image appears where the user can see the bolt type dimensions he defined according to DIN 7990, DIN 7969, EN 24034, EN 24032 and DIN 6914. By clicking on Custom dimensions the user can define the bolt dimensions he prefers.

## 8.6 Bolts on main beam

When the user clicks on the tab Bolts on main beam a detail of the cleat bolts layout on the main beam appears. In that detail the user defines the rows and the columns of the bolts used in the connection. Additionally the user defines the bolts distance from the cleat edges.

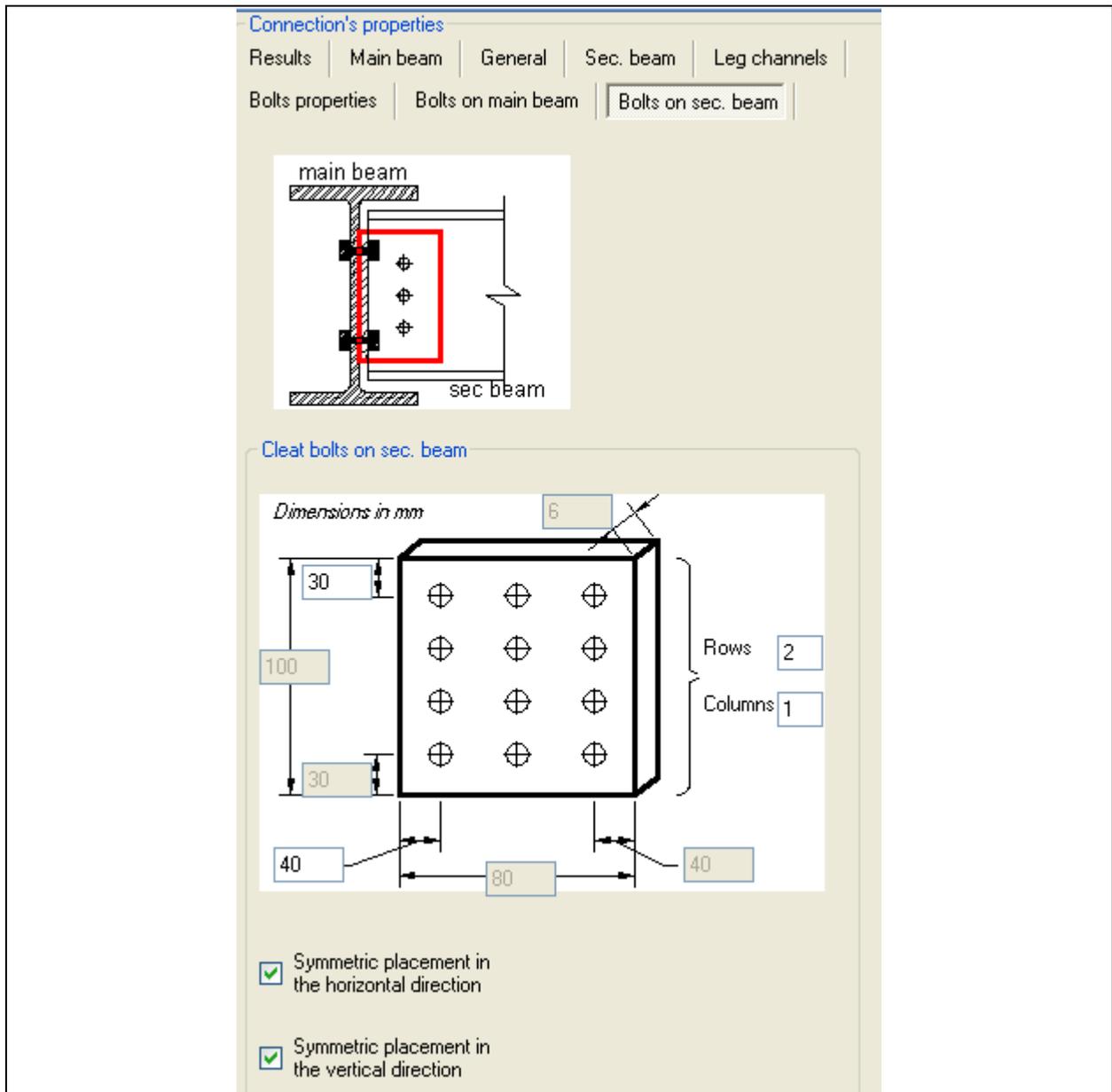


Picture 8.13

The user can also select symmetric placement in either the horizontal or vertical direction or in both, by clicking on the appropriate option.

## 8.7 Bolts on secondary beam

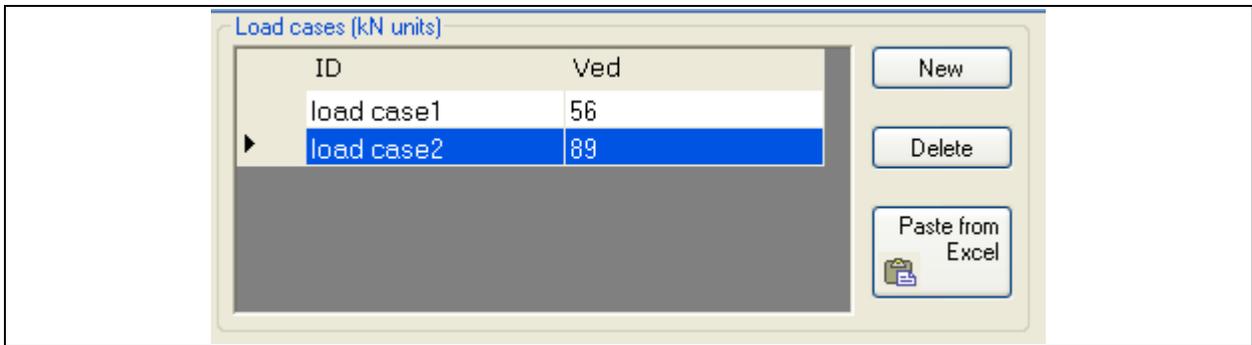
The tab Bolts on secondary beam contains a detail of the bolts layout on the secondary beam. In that detail the user defines the rows and the columns of the bolts used at the connection. Additionally the user defines the bolts distance from the cleat edges.



Picture 8.14

The user has the capability to select symmetric placement either in the horizontal or vertical direction or in both, by clicking on the appropriate option.

In the load cases window the user defines the connection load cases.



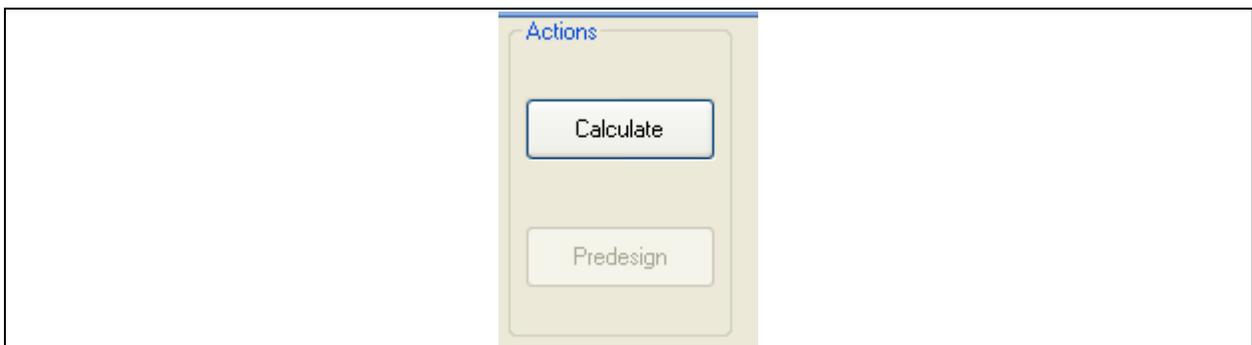
**Picture 8.15**

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined he must click on the specific load and then click on Delete.

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The beam - column connection design starts when the user clicks on Calculate.



**Picture 8.16**

The design results are shown in the tab Results.

Connection's properties

Results | Main beam | General | Sec. beam | Leg channels

Bolts properties | Bolts on main beam | Bolts on sec. beam

Load case:  1

Combinations that fail:

Main beam bolts shear strength	<input type="text" value="57,324"/>	kN
Main beam bolts shear capacity	<input type="text" value="0,785"/>	
Main beam bearing strength	<input type="text" value="108,288"/>	kN
Main beam bearing capacity	<input type="text" value="0,416"/>	
Sec. beam bolts shear strength	<input type="text" value="28,662"/>	kN
Sec. beam bolts shear capacity	<input type="text" value="1,908"/>	
Sec. beam bearing strength	<input type="text" value="53,242"/>	kN
Sec. beam bearing capacity	<input type="text" value="0,423"/>	
Cleat moment strength	<input type="text" value="3,525"/>	kNm
Cleat bending capacity	<input type="text" value="0,283"/>	
Cleat shear strength	<input type="text" value="81,406"/>	kN
Cleat shear capacity	<input type="text" value="0,276"/>	
Sec. beam divulsion strength	<input type="text" value="77,635"/>	kN
Sec. beam divulsion capacity	<input type="text" value="0,58"/>	
Angle on main beam divulsion strength	<input type="text" value="75,763"/>	kN
Angle on main beam divulsion capacity	<input type="text" value="0,29"/>	
Angle on sec. beam divulsion strength	<input type="text" value="54,163"/>	kN
Angle on sec. beam divulsion capacity	<input type="text" value="0,29"/>	

**Picture 8.17**

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations also marked in red color.

## 9 BEAM SPLICES WITH ENDPLATES CONNECTION

The connection refers to the splice of I-section beams through the use of end plates. All the components of the connection are checked according to Part 1-8 of Eurocode 3. The checks refer not only to the capacity of the connection elements but to the developed deformation of the connection (rotational capacity) as well.

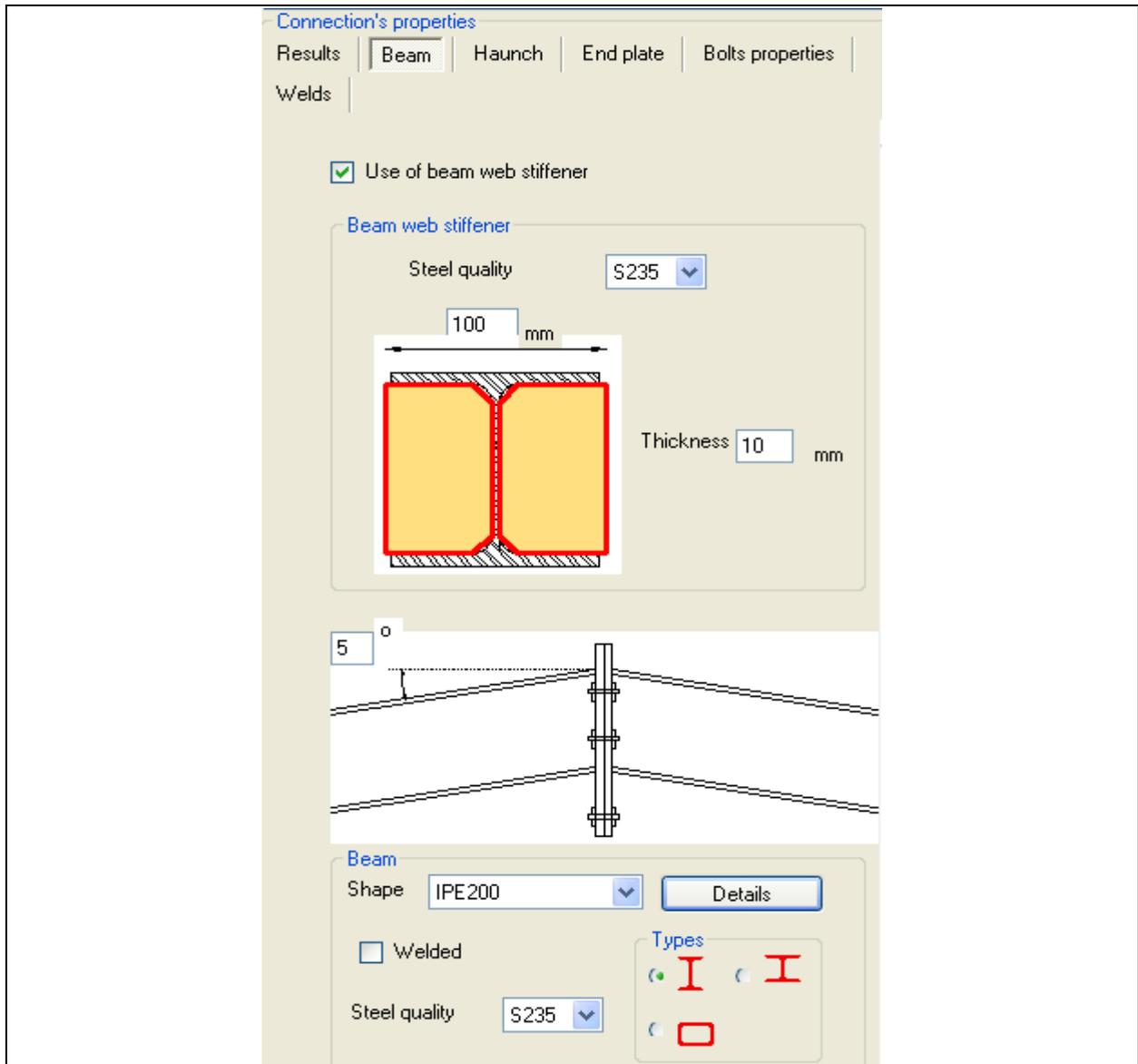
The option Connection's properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 9.1*

### 9.1 Beam

When the user selects the tab Beam a beam splice connection detail appears in the window. There the user can select the use of beam web stiffener by clicking on the appropriate option. In this case the user also defines the stiffeners length and thickness as well as its steel quality.

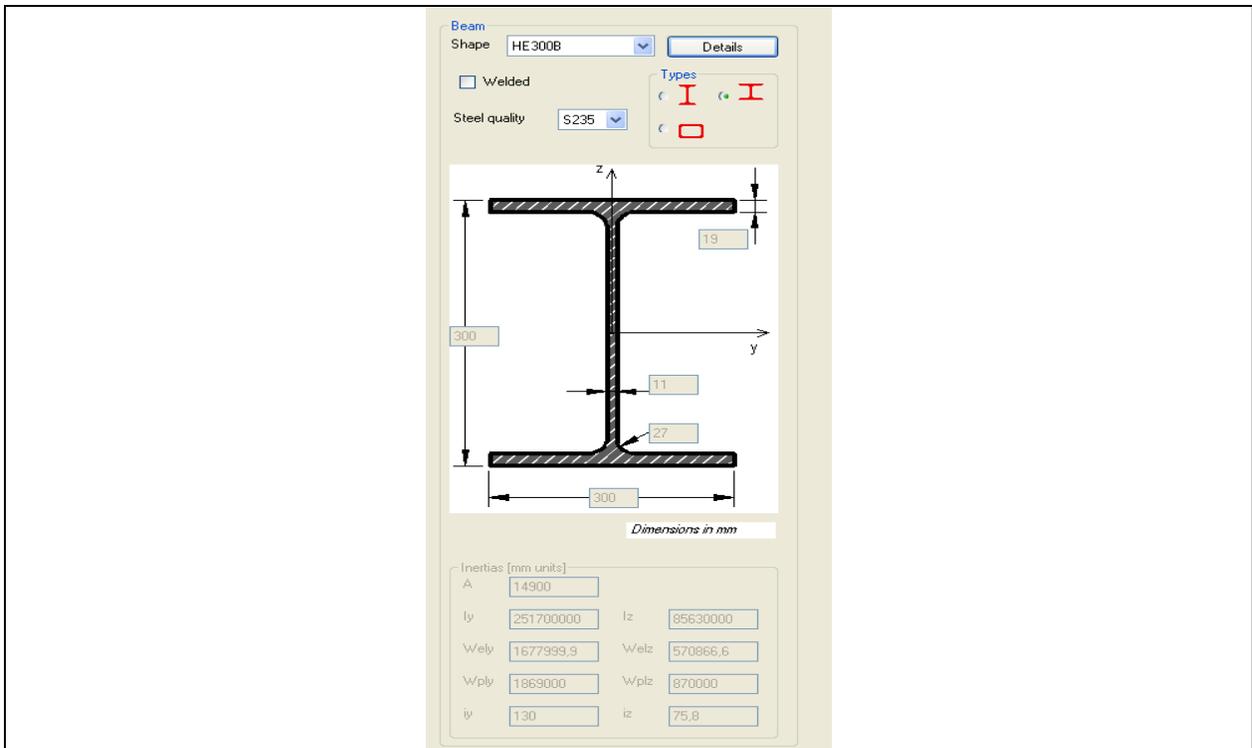


**Picture 9.2**

Additionally the user defines the angle between the beam and the horizontal.

Inside Beam box the user defines the shape, the type and the steel quality of the beam section.

When the user clicks on Details he can see the dimensions and the inertia characteristics of the beam section he defined.

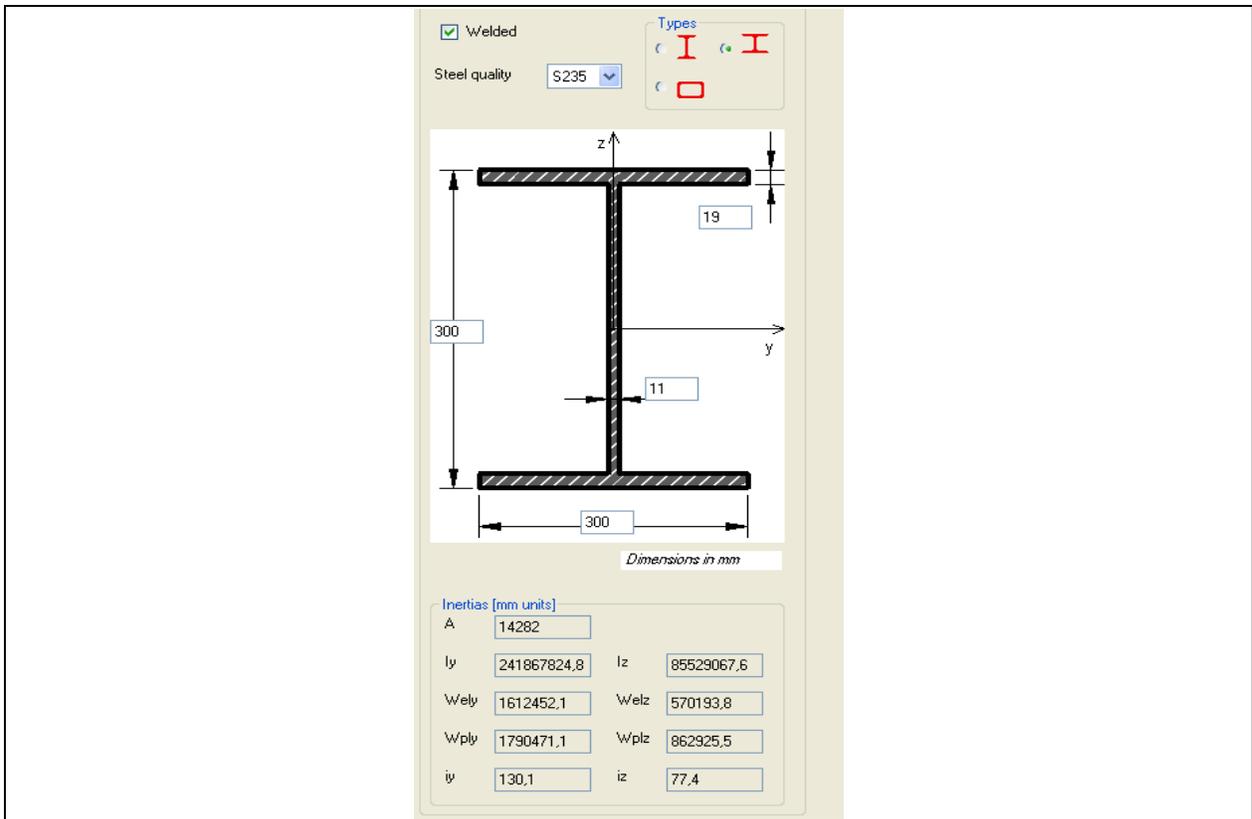


Picture 9.3



Picture 9.4

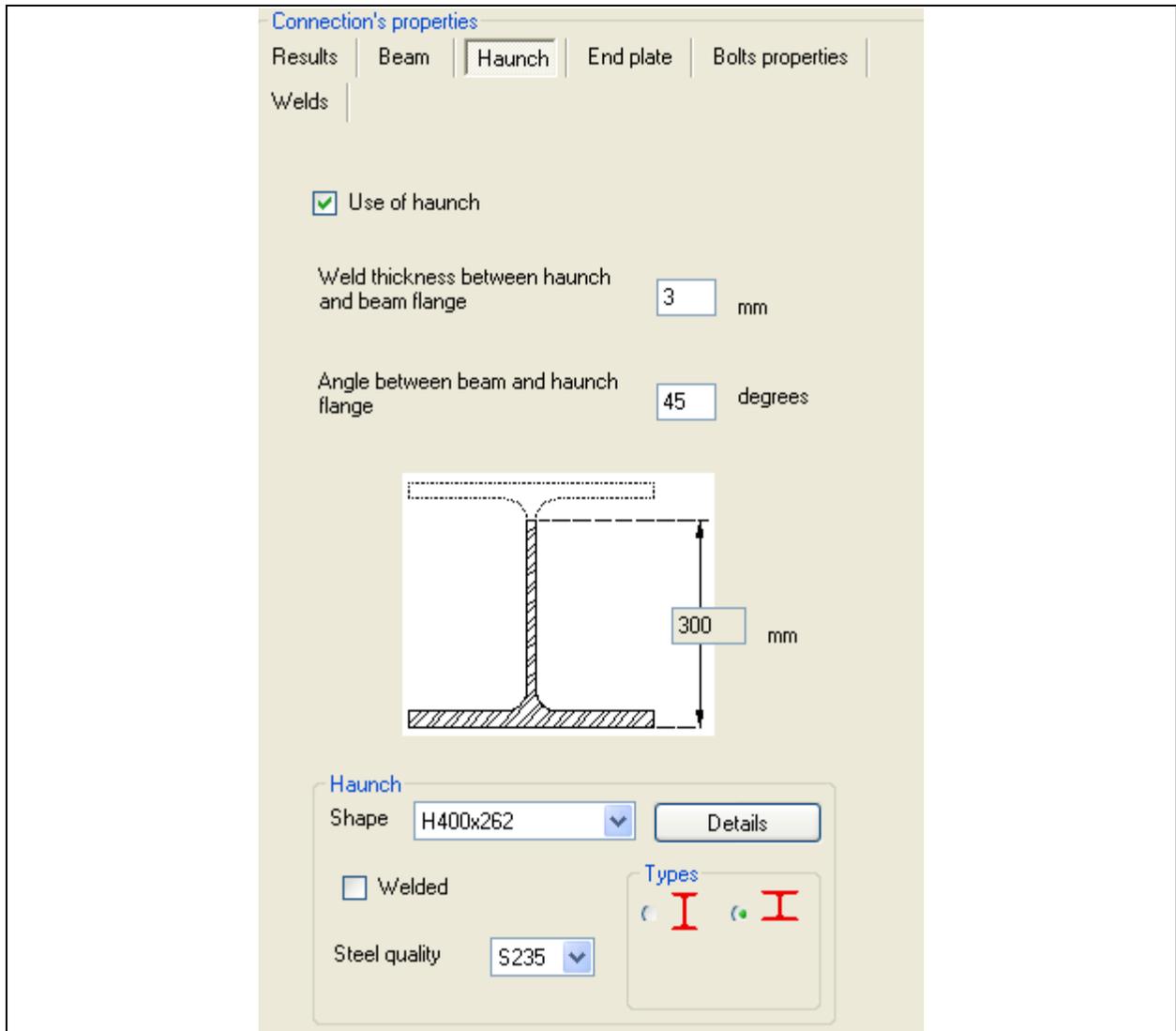
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 9.5

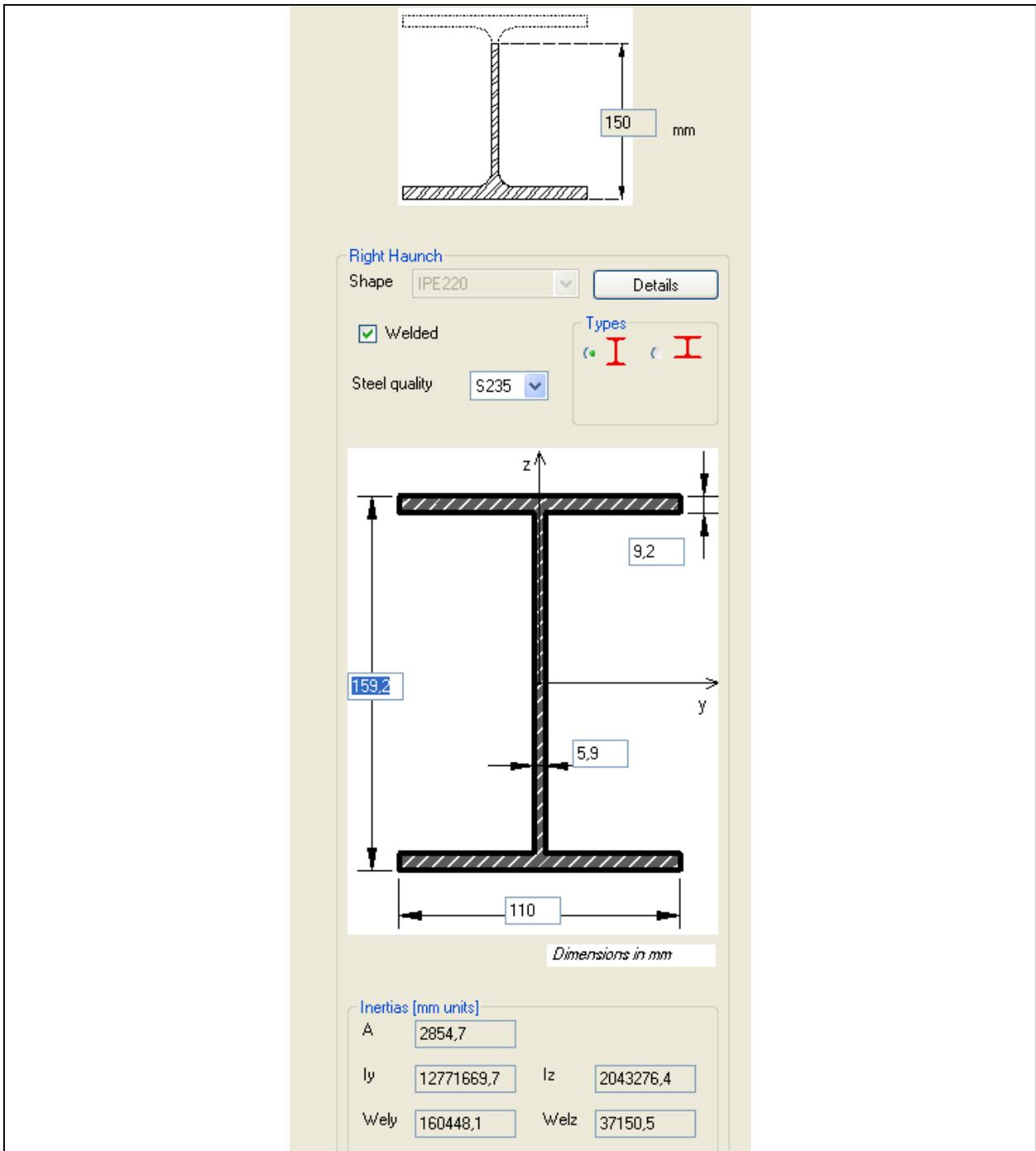
## 9.2 Haunch

The program gives the user the capability either to select the use of haunch or not by clicking on the option Use of haunch. When he does that the following window appears.



*Picture 9.6*

The user has the capability to define the weld thickness and the angle between haunch and beam flange. Then he selects the haunch shape and type as well as the section steel quality. When the user wants to define the haunch height he has to click on Welded and a haunch detail appears in the window.

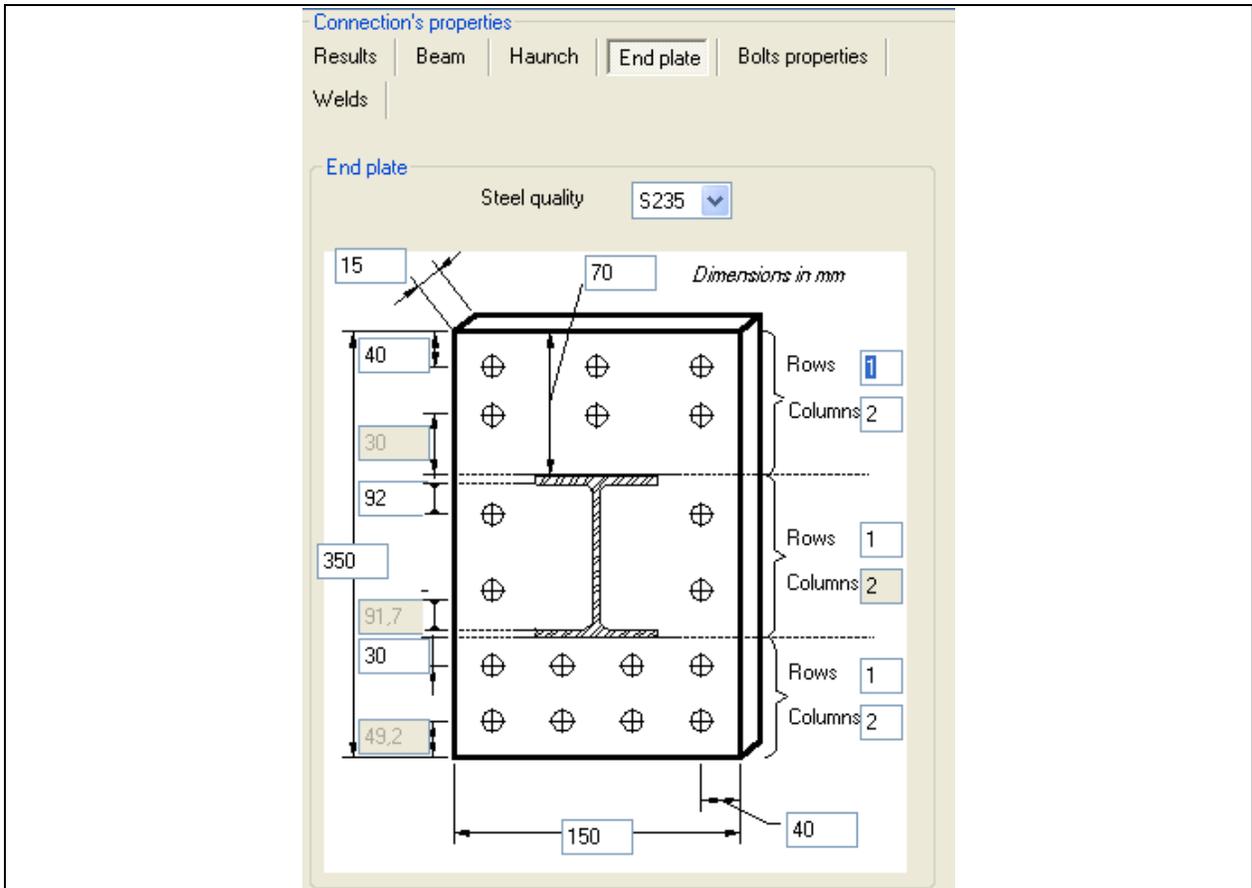


Picture 9.7

There the user defines the haunch height by changing the section height. He can also modify the remaining section dimensions as well as the section inertia characteristics.

### 9.3 Endplate

When the user selects the Endplate tab an endplate detail appears in the window.

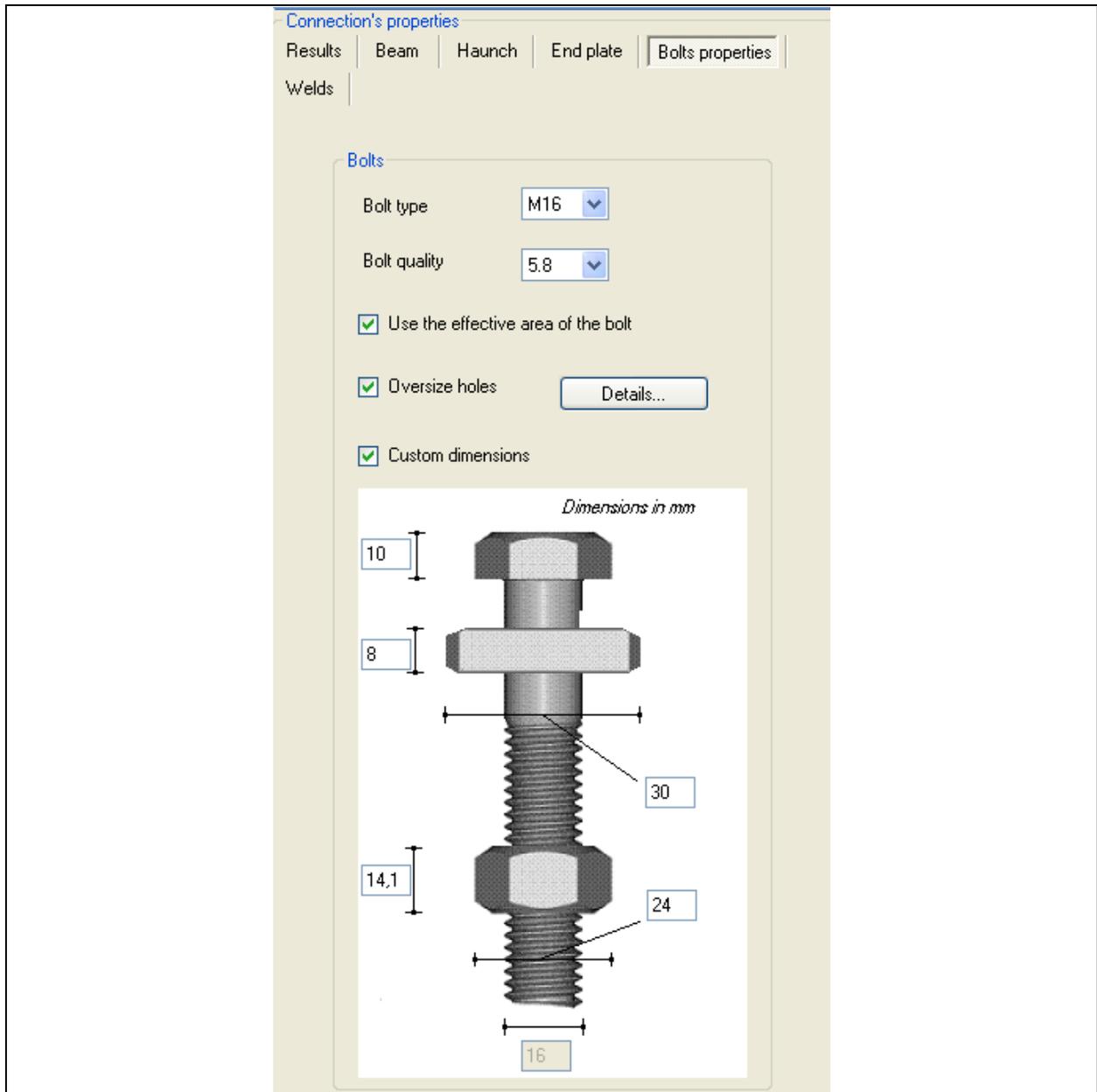


Picture 9.8

There the user can define the endplate dimensions, its thickness as well as endplate steel quality. The user can also define the number of the bolt rows and columns and the beams and bolts placement on the endplate.

### 9.4 Bolts properties

The definition of the bolt parameters can be done by selecting the tab Bolts properties. The user selects the bolt type, the bolt quality the use of the effective area of the bolt and/or oversize holes.

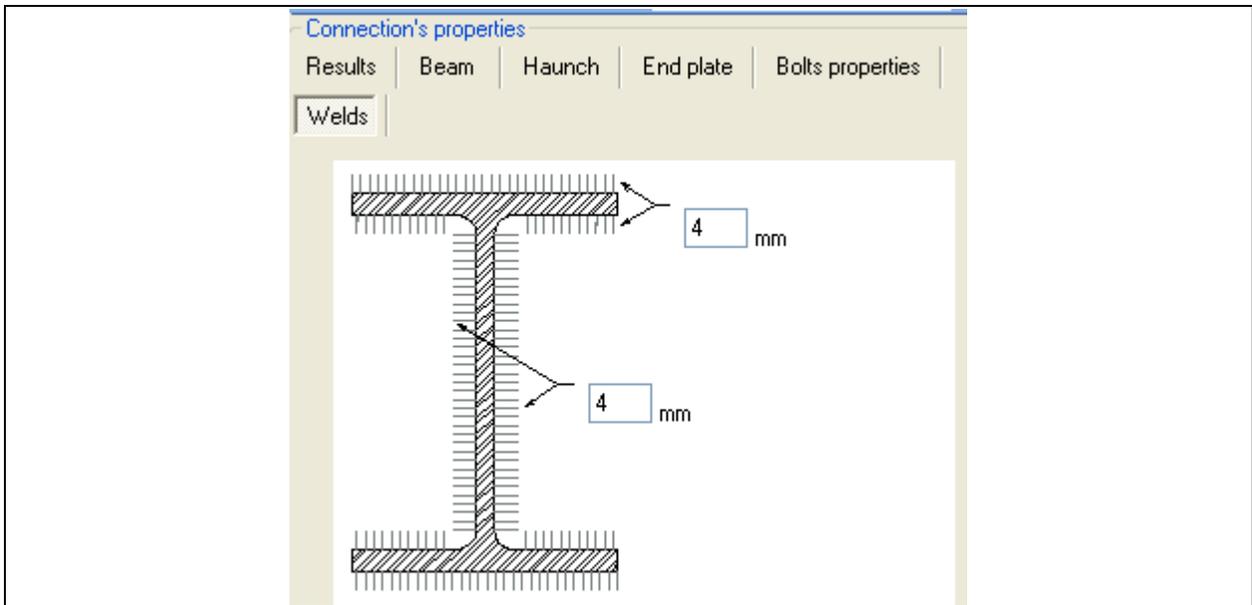


Picture 9.9

When the user clicks on Details appears the above image where the user can see the bolt type dimensions he defined according to DIN 7990, DIN 7969, EN 24034, EN 24032 and DIN 6914. Clicking on Custom dimensions the user defines the bolt dimensions he prefers.

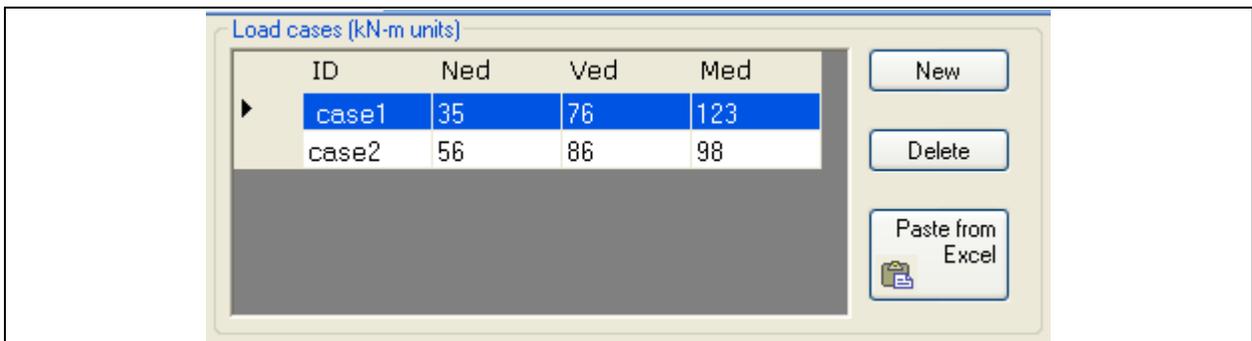
## 9.5 Welds

By selecting the tab Welds the user has the capability to define the beams weld thickness on the endplate.



Picture 9.10

In the load cases window the user defines the connection load cases.



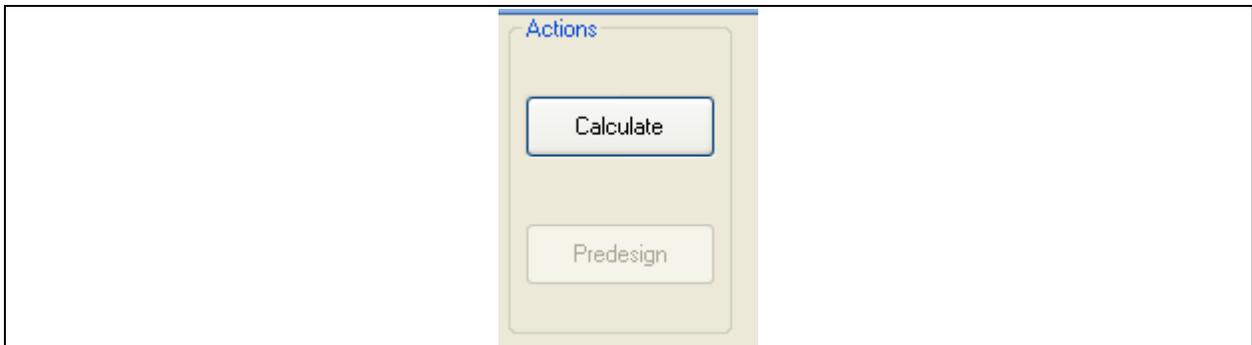
Picture 9.11

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined he must click on the specific load combination and then click on Delete.

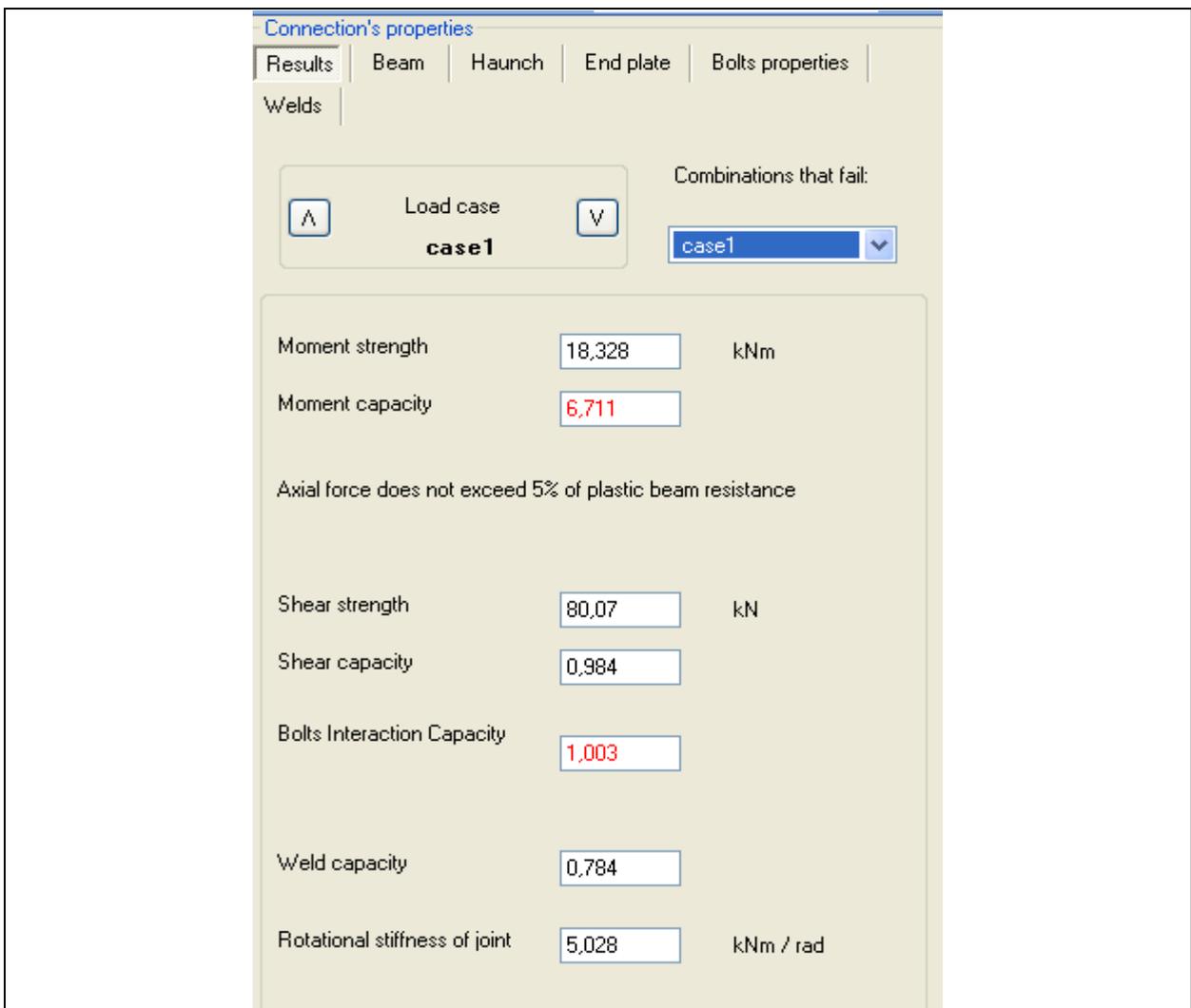
The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The beam to beam connection design starts when the user clicks on Calculate



Picture 9.12

The design results are shown in the tab Results.

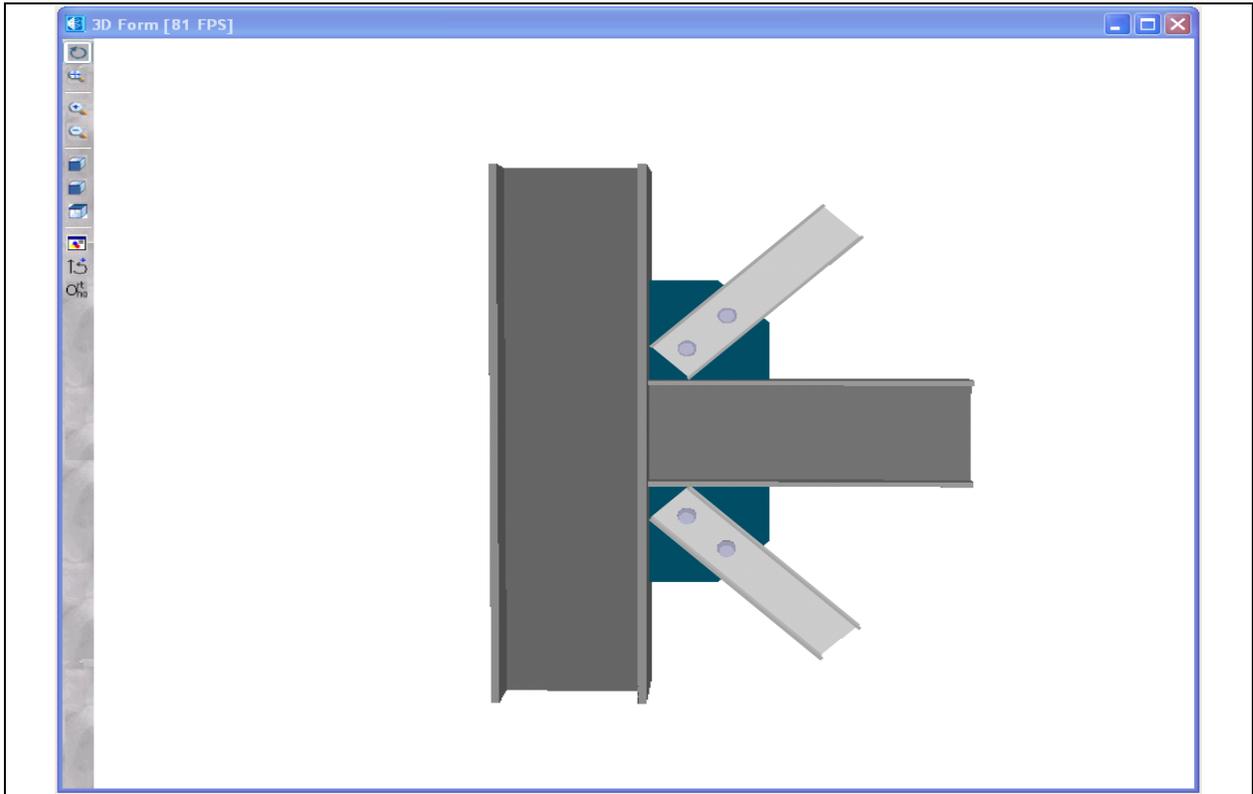


Picture 9.13

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations also marked in red color.

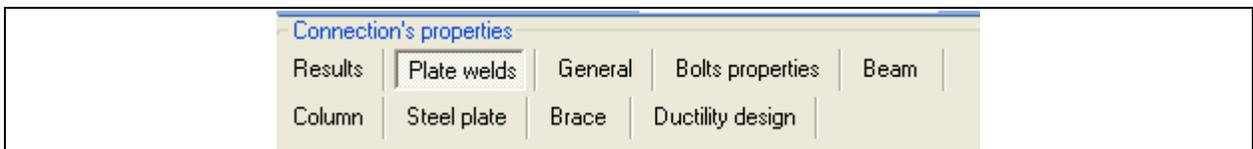
## 9.6 BRACING CONNECTION

This connection type refers to  $\Lambda$  or X shaped bracings, covering a wide variety of connection geometry. In case of X-shaped bracings the program offers the user the possibility to design the splice at the middle node. Additionally, apart from the usual checks, the user can perform ductility design of the bracing, assuming that the member in tension is ductile.



*Picture 9.14*

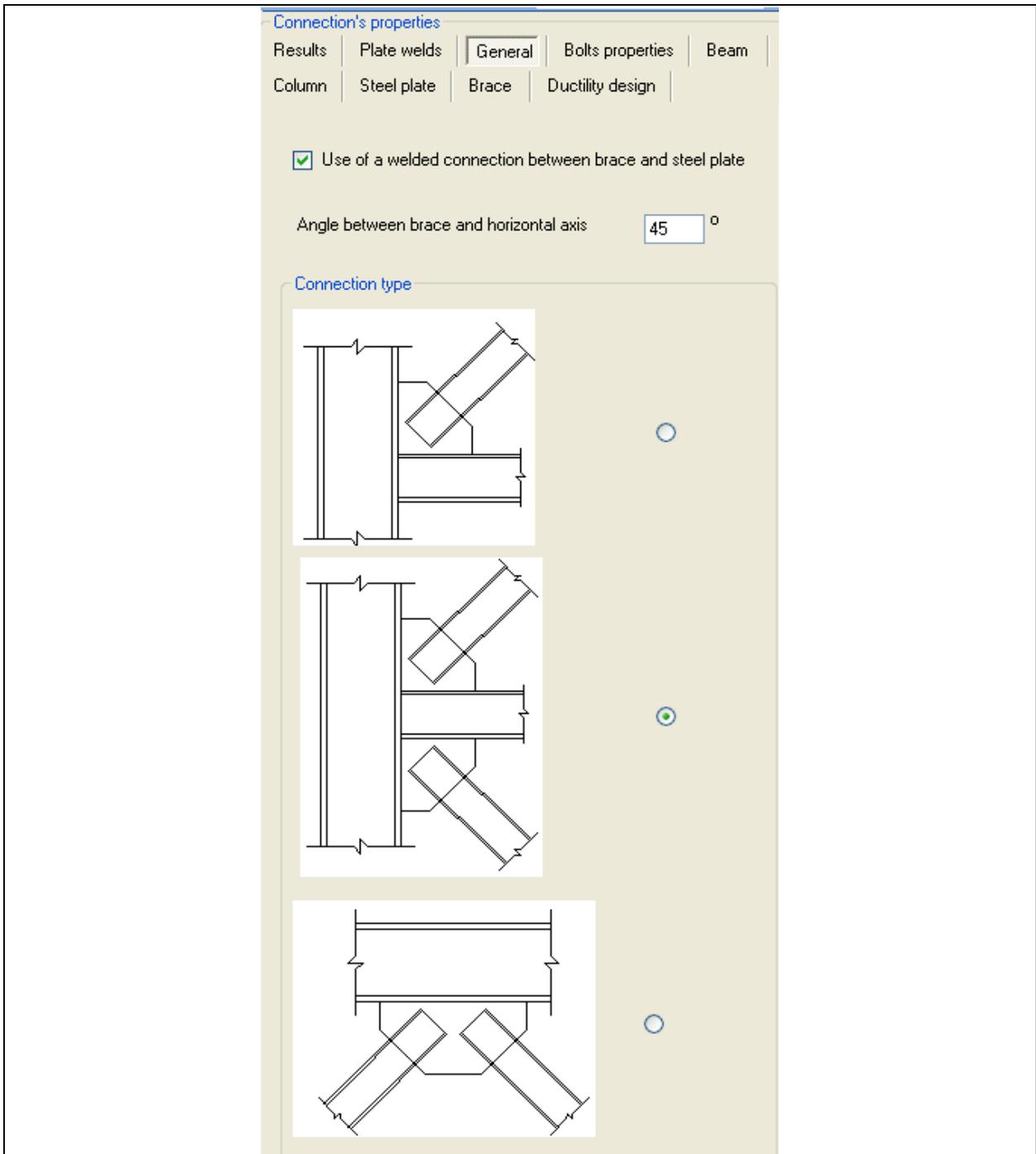
The option Connection's Properties gives the user the capability to define the connection parameters by selecting each time the appropriate tab.



*Picture 9.15*

## 9.7 Welds

When the user selects the tab General the following frame appears.

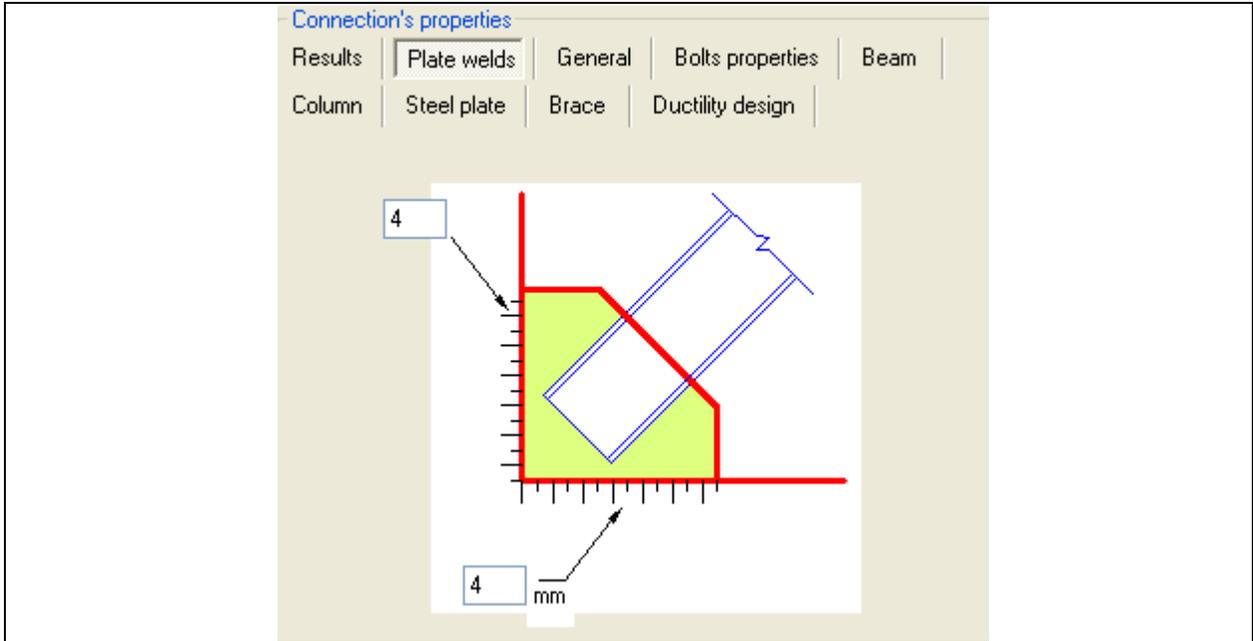


**Picture 9.16**

The user selects the bracing type of the connection by clicking on the appropriate form. The program gives the user the capability to select either the use of a welded connection between the brace and the steel plate or the use of bolts.

## 9.8 Plate welds

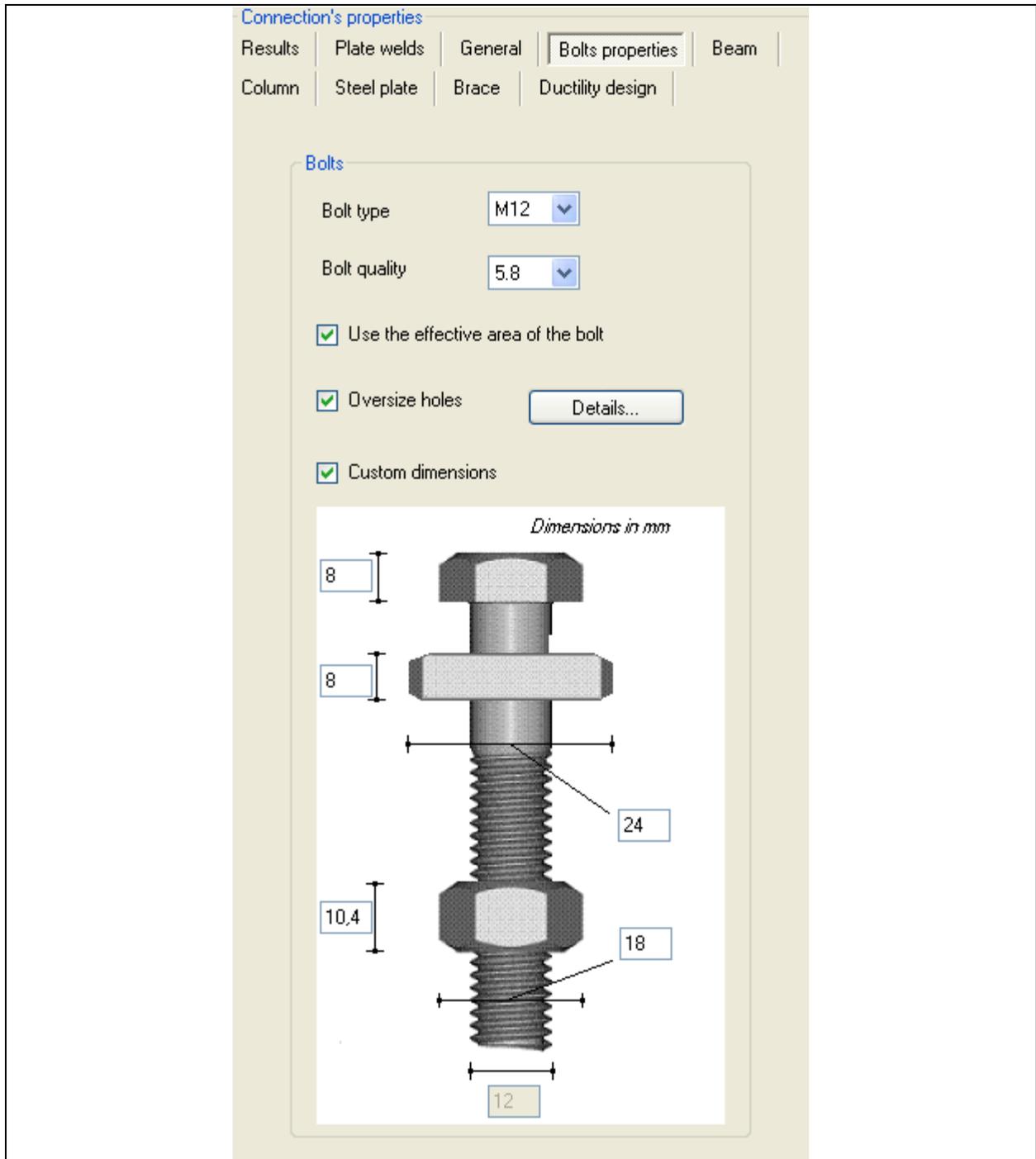
In the tab Plate welds the user defines the weld thickness between the plate and the column and between the plate and the beam.



*Picture 9.17*

## 9.9 Bolts properties

When the user has selected the use of bolts between brace and steel plate the tab Bolts properties window becomes active. Inside the user selects the bolt type, the bolt quality and the use of the effective area of the bolt and/or oversize holes.

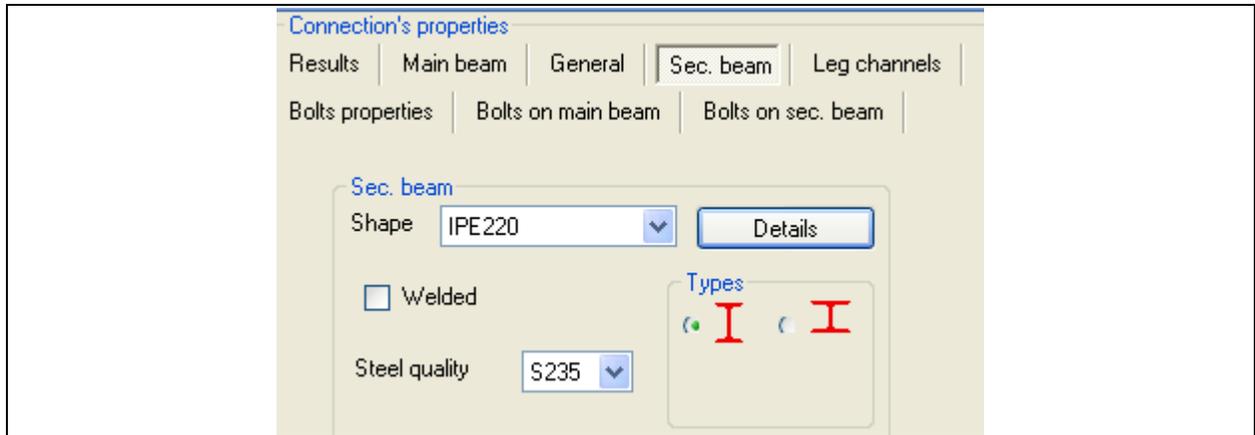


**Picture 9.18**

When the user clicks on Details the above image appears where the user can see the bolt type dimensions he defined according to DIN 7990, DIN 7969, EN 24034, EN 24032 and DIN 6914. By clicking on Custom dimensions the user defines the bolt dimensions he prefers.

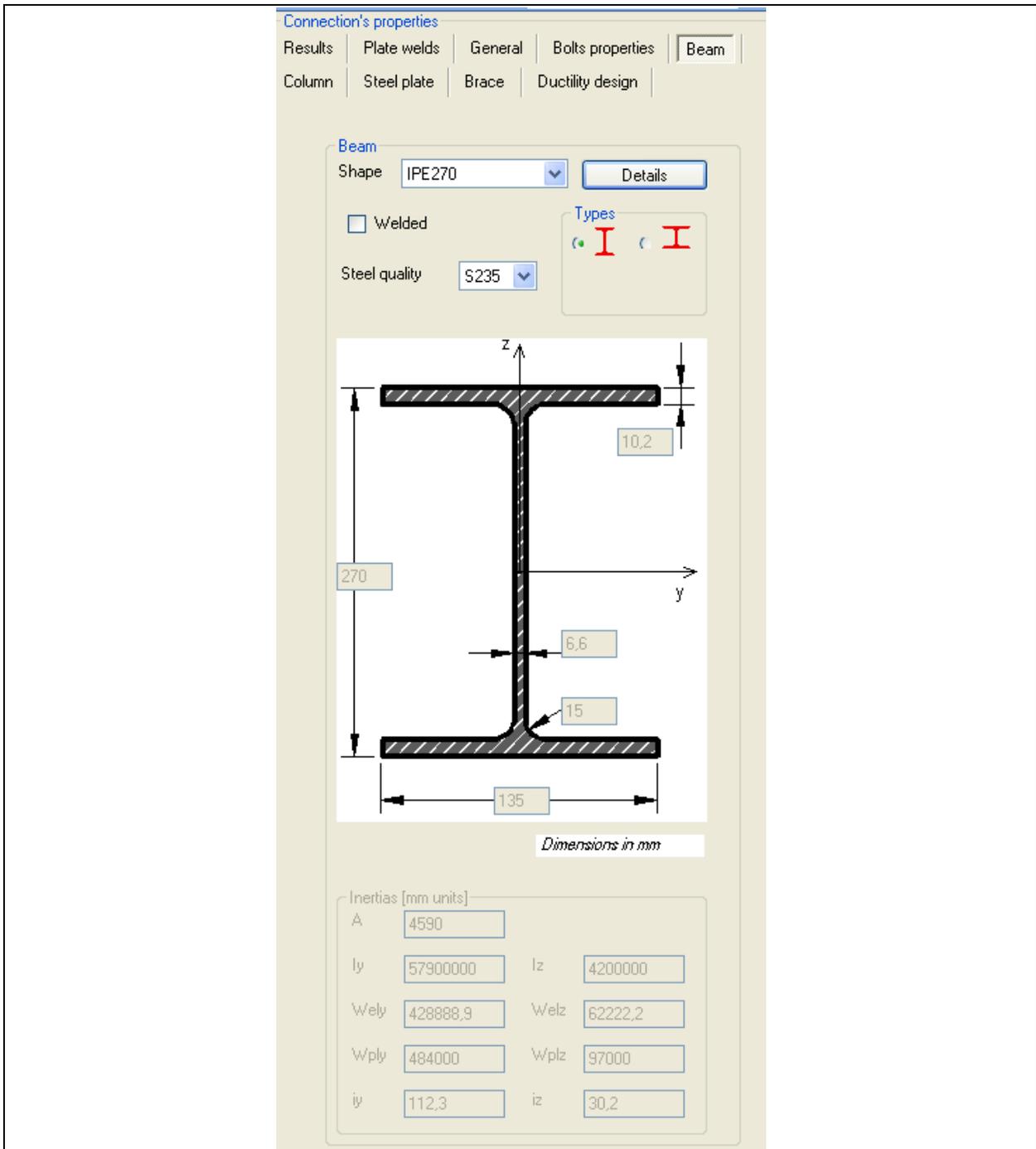
## 9.10 Beam

By clicking on the tab Beam the user can define the shape, the type and the steel quality of the connection beam.



*Picture 9.19*

When the user clicks on Details he can see the dimensions and the inertia characteristics of the beam section the user defined.

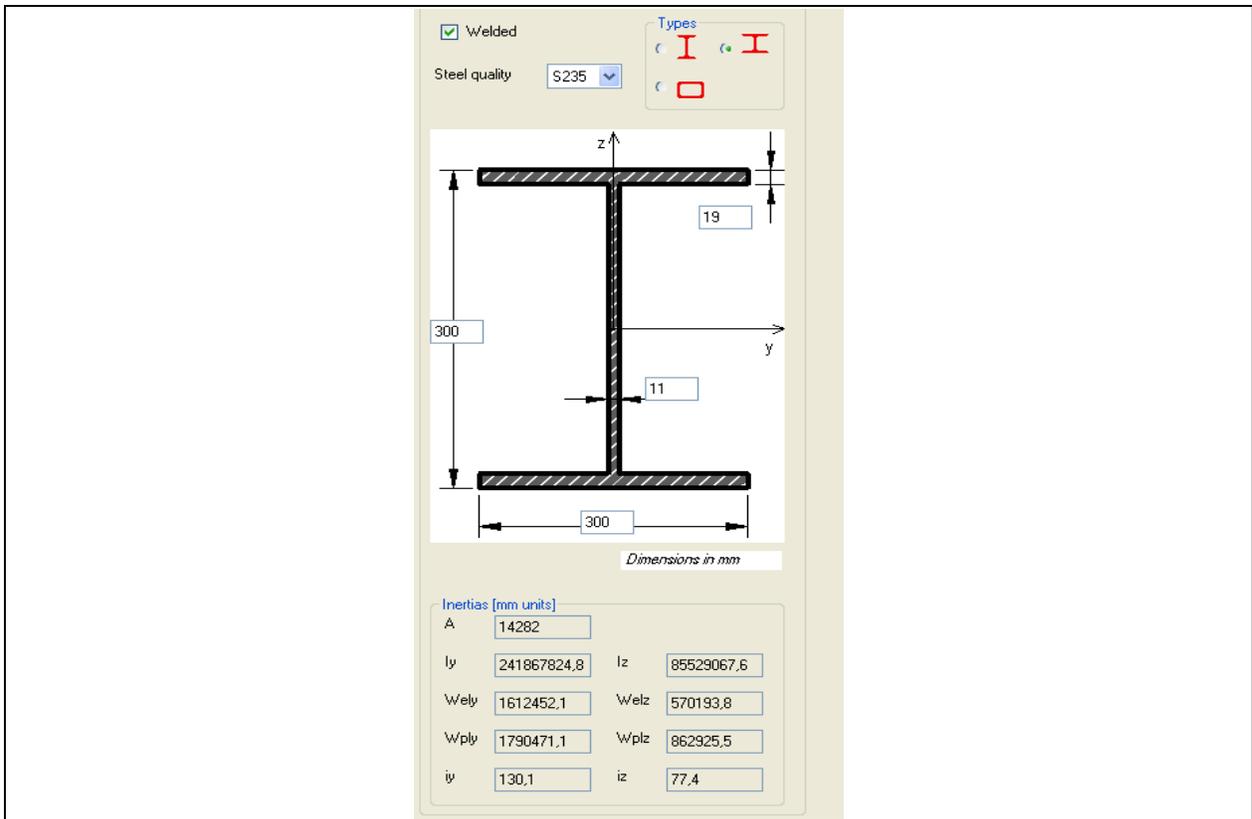


Picture 9.20



Picture 9.21

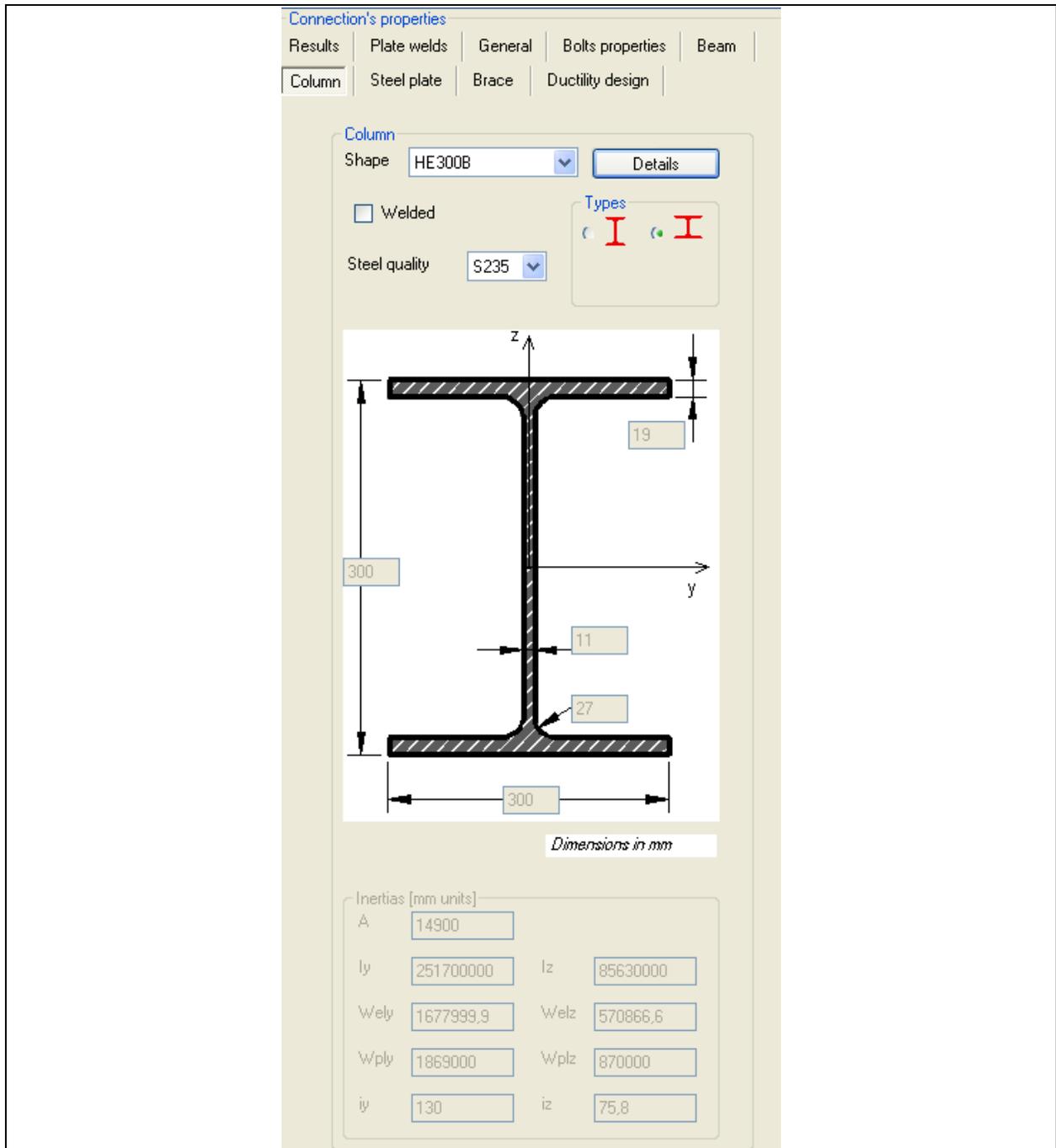
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 9.22

## 9.11 Column

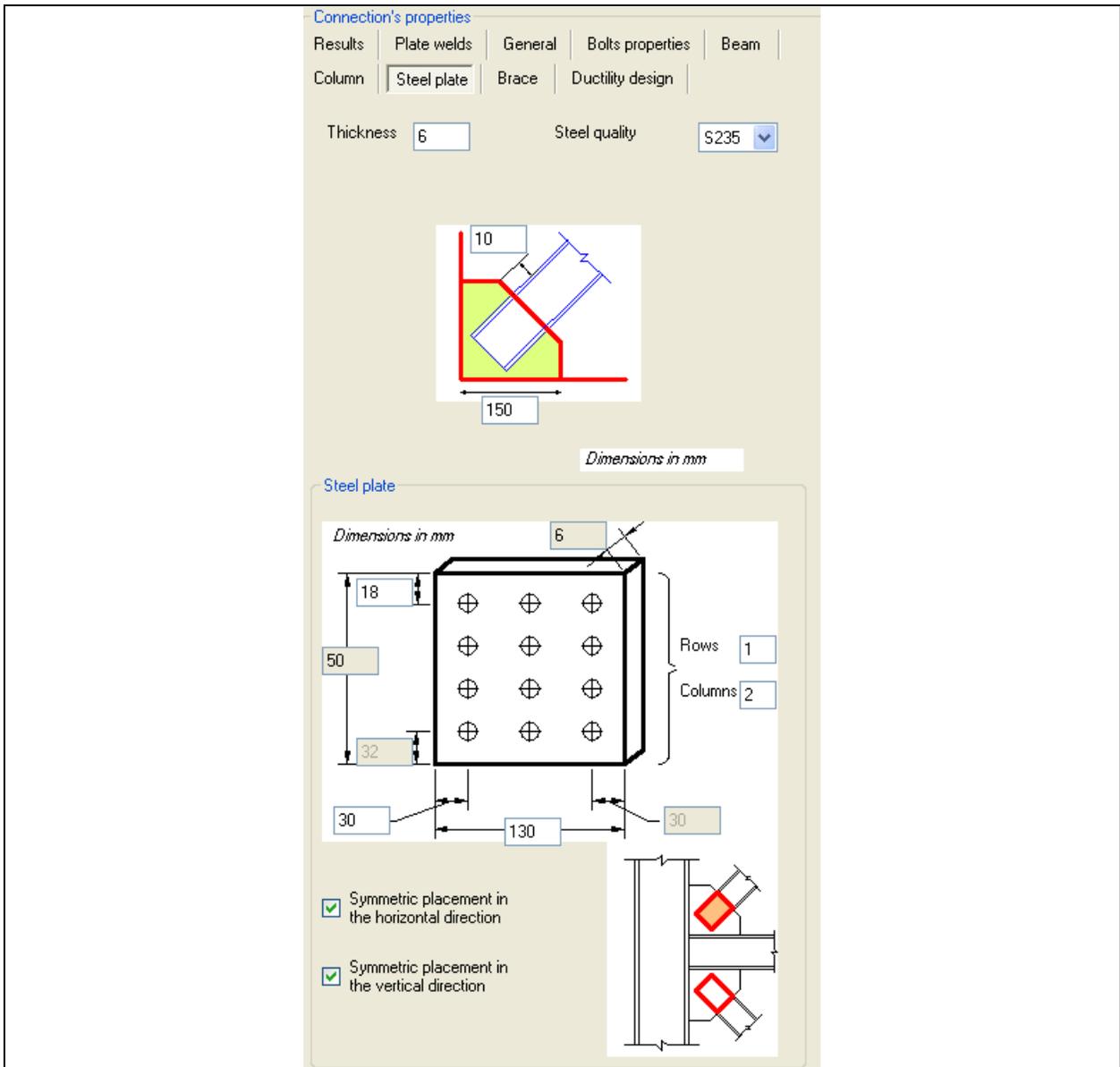
As previously, the user defines the shape, the type and the steel quality of the column. He also selects either a standard or a welded column section.



Picture 9.23

## 9.12 Steel plate

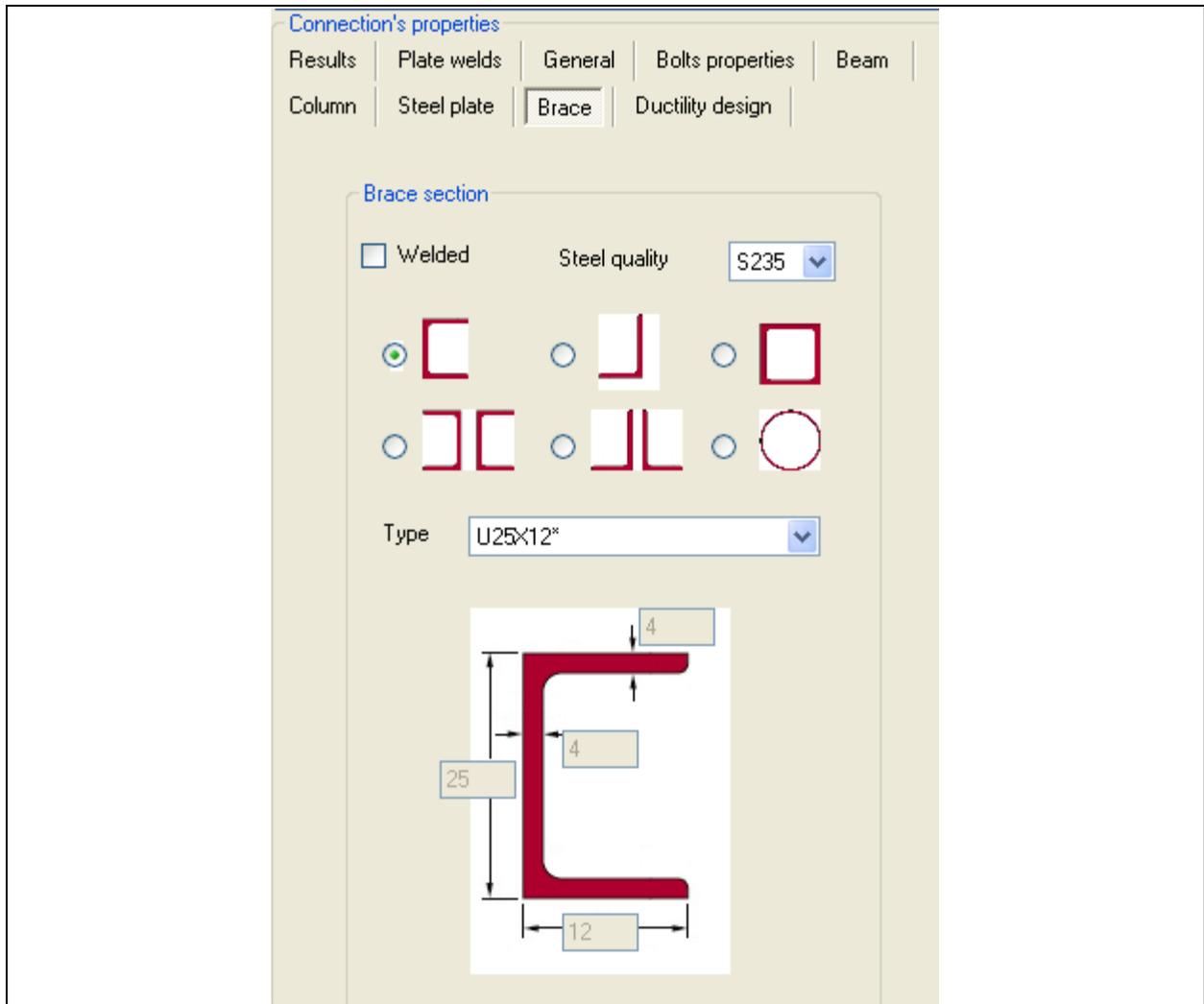
By selecting the tab Steel plate the user defines the plate dimensions and thickness as well as the bolts layout on the steel plate.



Picture 9.24

### 9.13 Brace

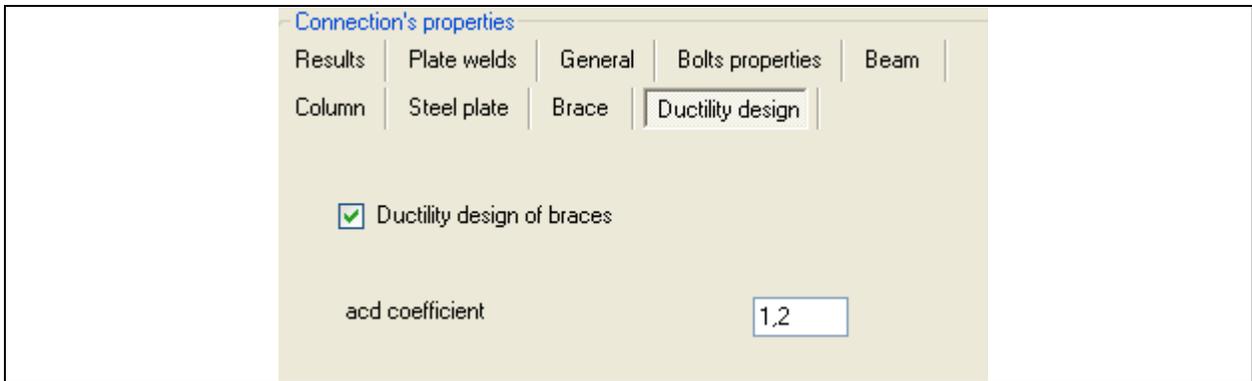
The program gives the user the capability to select the type of brace (channel, double channel, angle, double angle, SHS/RHS or CHS) by clicking on the appropriate form and then he can define either a standard or a welded brace section.



Picture 9.25

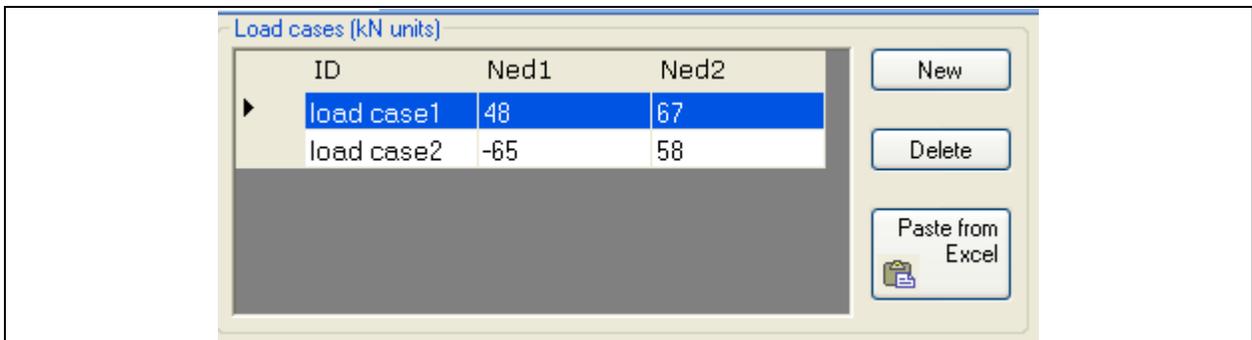
## 9.14 Ductility

The user has the capability to select the ductility design of the braces and then to define the ductility scale factor ( $\alpha_{cd}$ ). In that case the given connection load cases will be multiplied in order to perform ductility design according to Eurocode 3.



Picture 9.26

In the load cases window the user defines the connection load cases.



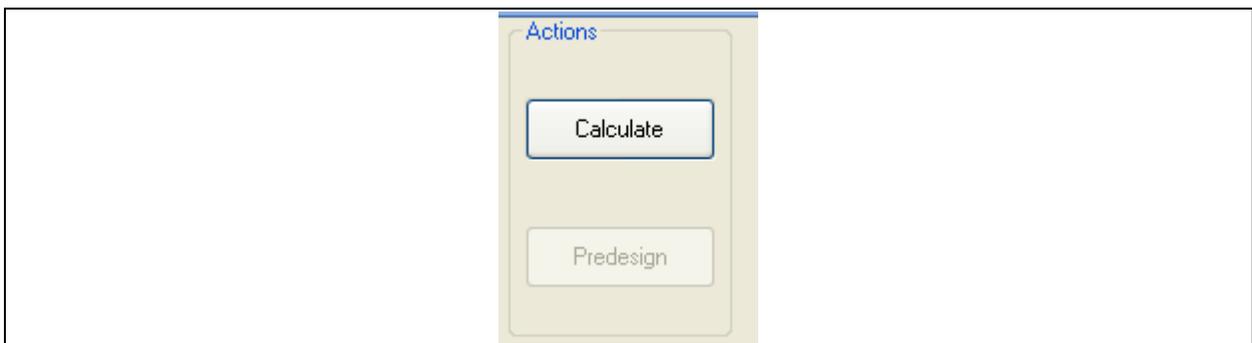
Picture 9.27

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined he must click on the specific load combination and then click on Delete.

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The connection design starts when the user clicks on Calculate.



Picture 9.28

The design results are shown in the tab Results.

The screenshot displays the 'Connection's properties' window with the 'Results' tab selected. The 'Load case' is set to 'load case1'. The 'Combinations that fail' dropdown is also set to 'load case1'. The results table shows various design parameters with their values and units. Values in red indicate that the capacity has been exceeded (capacity > 1.0).

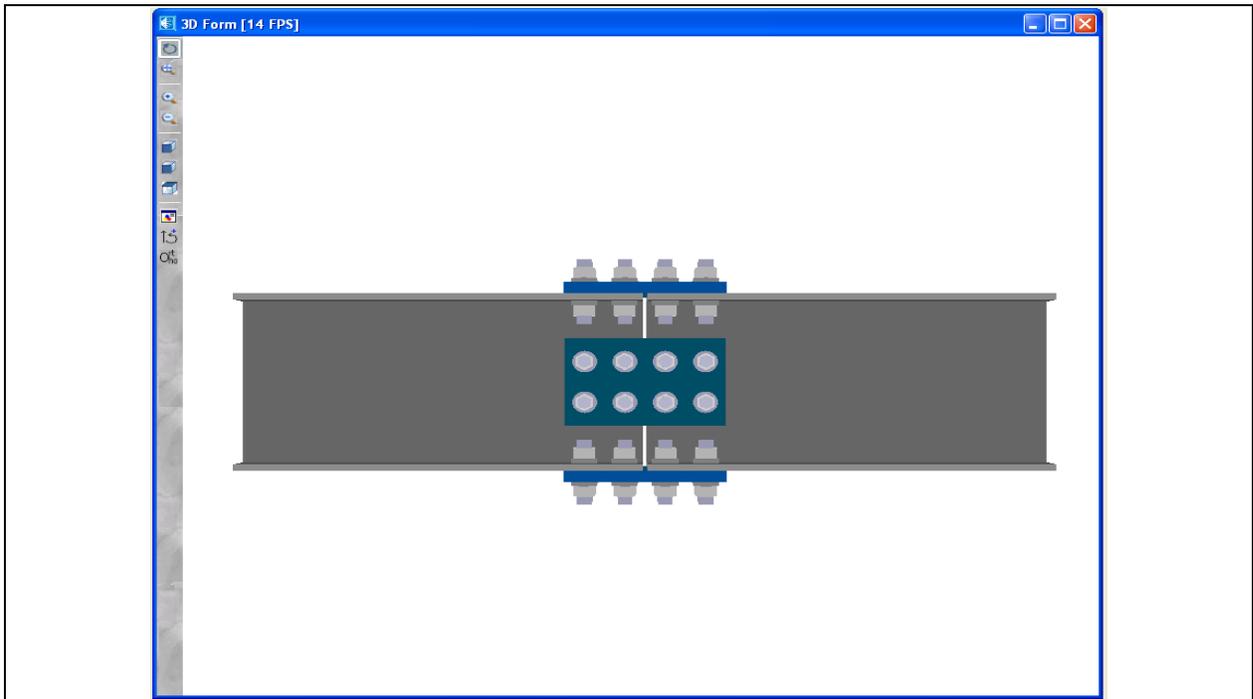
Parameter	Value	Unit
Bolts shear strength	38,453	kN
Bolts shear capacity	2,091	
Bearing strength	91,717	kN
Bearing capacity	0,877	
Brace failure ductility	Yes	
Bolts failure ductility	NO!	
Brace tension strength	212,675	kN
Brace tension capacity	0,315	
Equal stress weld strength between plate and beam	36	kN / cm <sup>2</sup>
Equal stress weld capacity between plate and beam	0,456	
Normal stress weld strength between plate and beam	28,8	kN / cm <sup>2</sup>
Normal stress weld capacity between plate and beam	0	
Equal stress weld strength between plate and column	36	kN / cm <sup>2</sup>
Equal stress weld capacity between plate and column	0,456	
Normal stress weld strength between plate and column	28,8	kN / cm <sup>2</sup>
Normal stress weld capacity between plate and column	0	
Stress weld strength between plate and brace	0,36	kN / cm <sup>2</sup>
Stress weld capacity between plate and brace	0,351	

Picture 9.29

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations also marked in red color.

## 10 FLANGE AND WEB PLATES BEAM CONNECTION

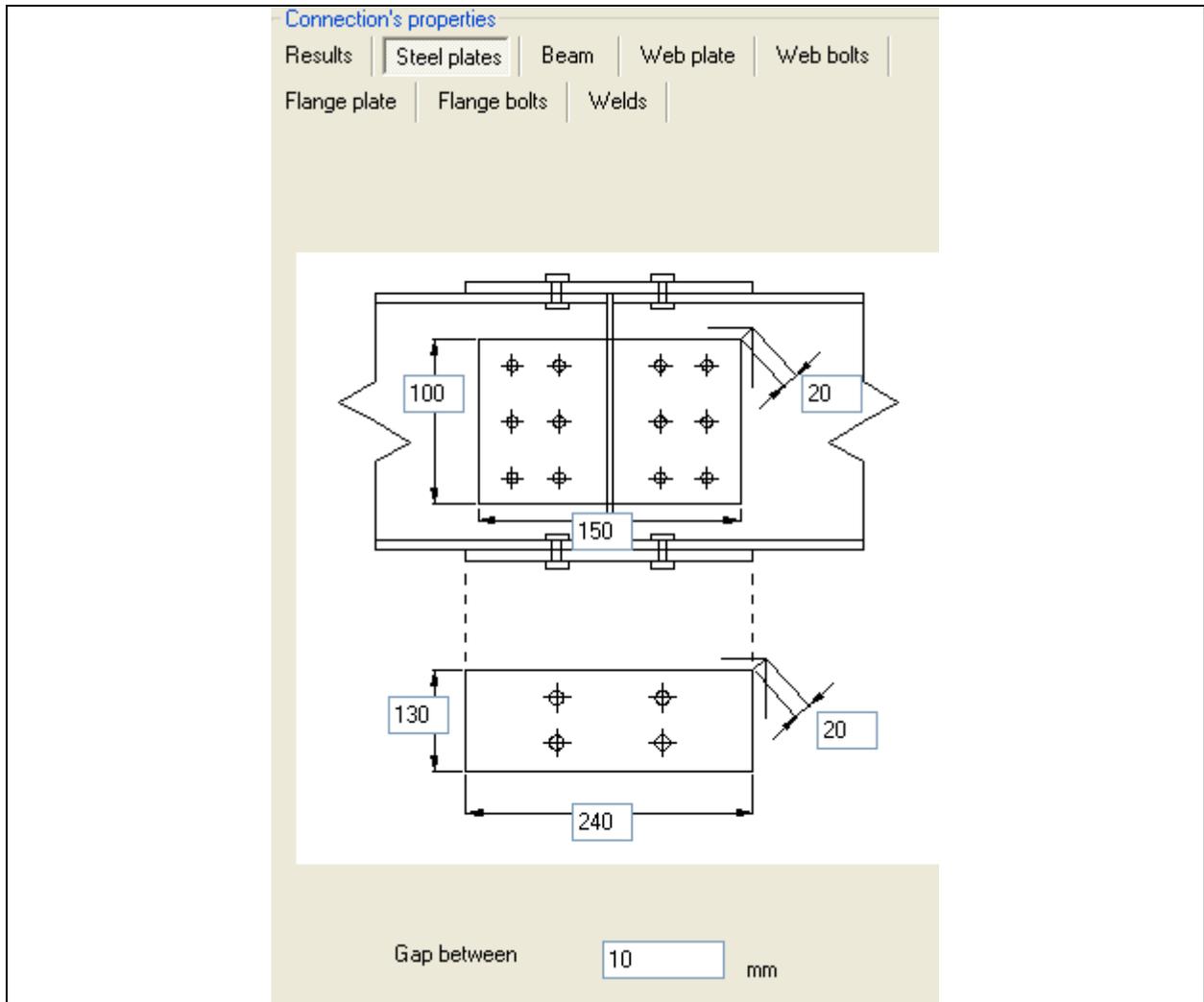
The connection refers to the splice of I-section beams through the use of steel plates. The steel plates can be attached to the web and flanges of the beams either with bolts or with a combination of welds and bolts. Besides the capacity of the connection elements, the program checks if the connection meets the ductility criteria of Eurocode 3, to ensure that brittle failure modes are avoided.



*Picture 10.1*

### 10.1 Steel plates

In the window of the tag Steel plates the user can define the dimensions and thickness of the web and flange plates. The user also defines the gap between the connected beams.



Picture 10.2

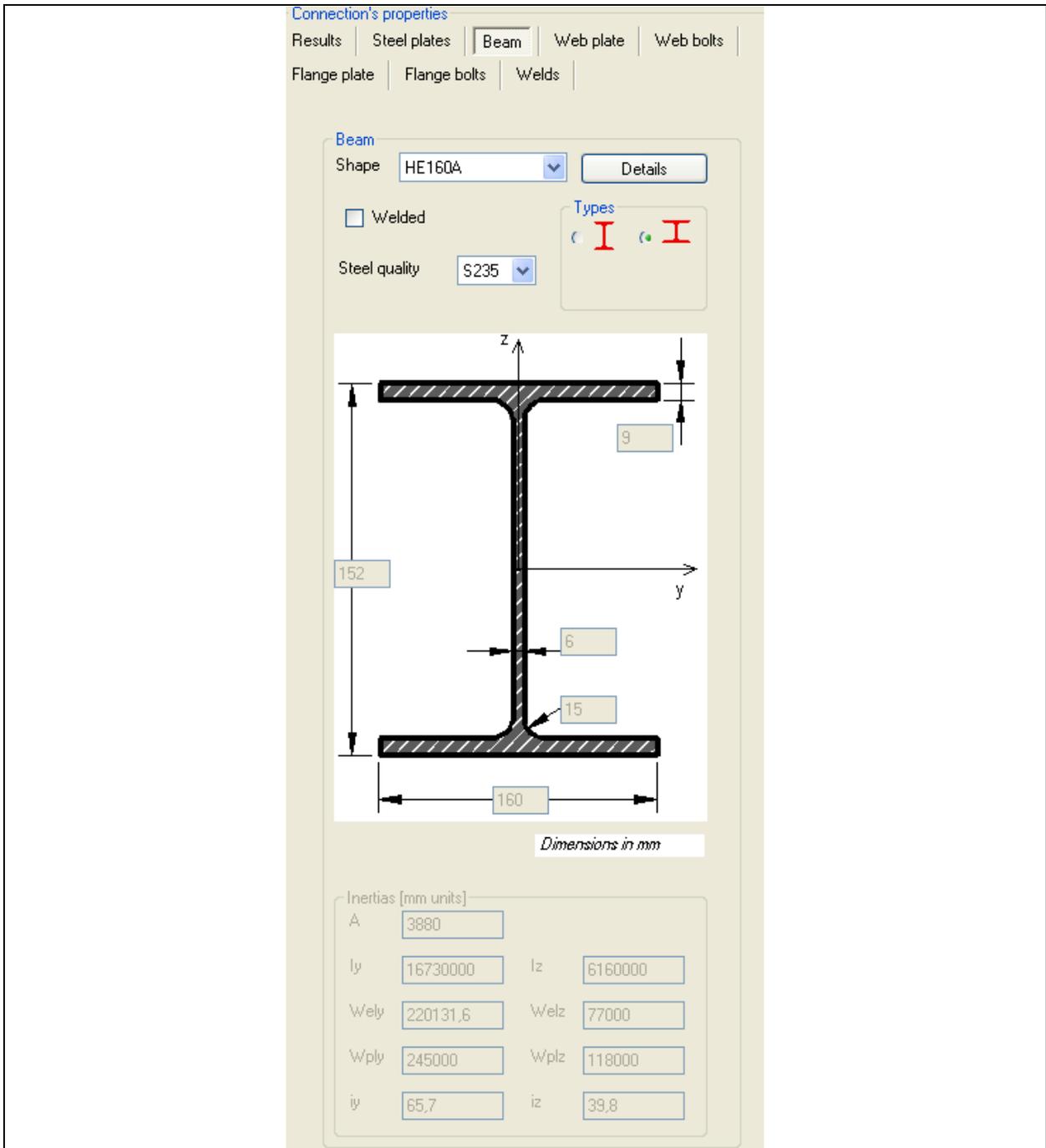
## 10.2 Beam

By clicking on the tab Beam the user can define the shape, the type and the steel quality of the connection beams.



**Picture 10.3**

When the user clicks on Details has the capability to see the dimensions and the inertia characteristics of the beam section the user defined.

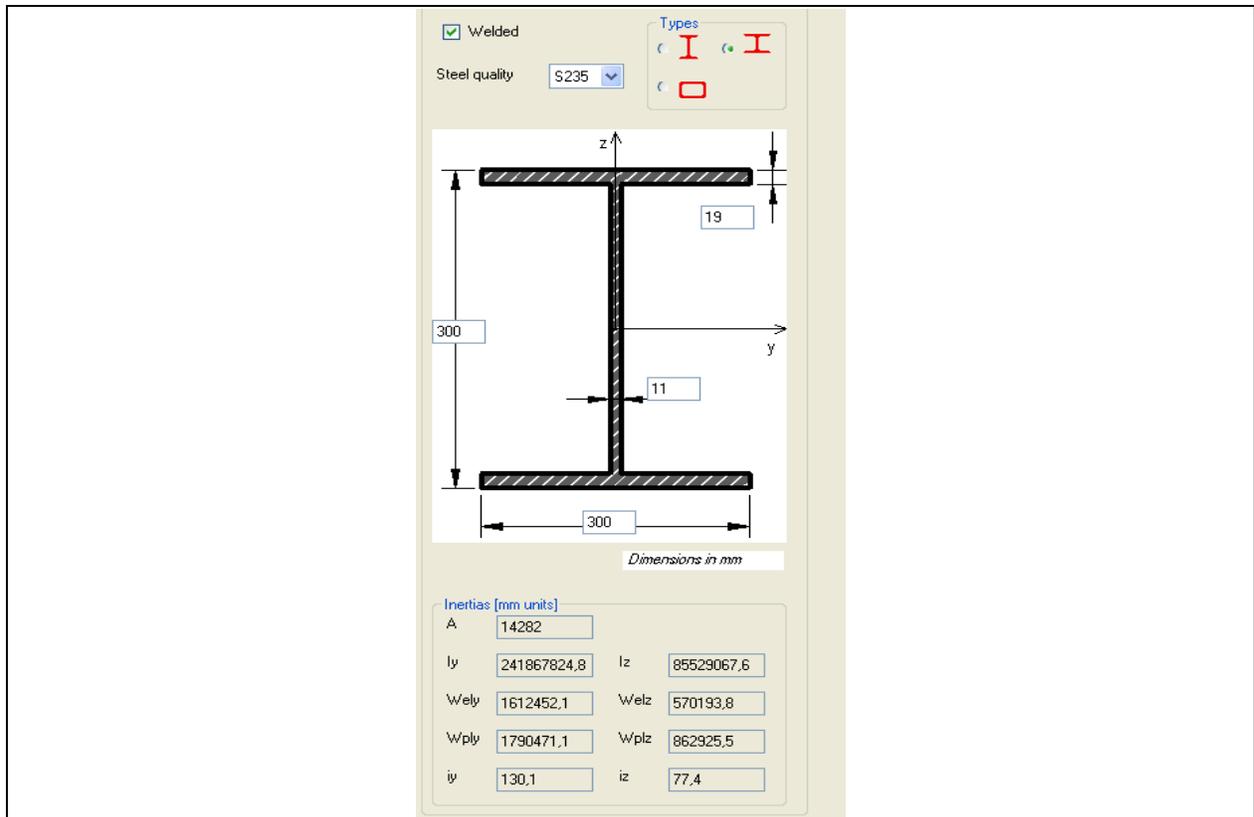


Picture 10.4



Picture 10.5

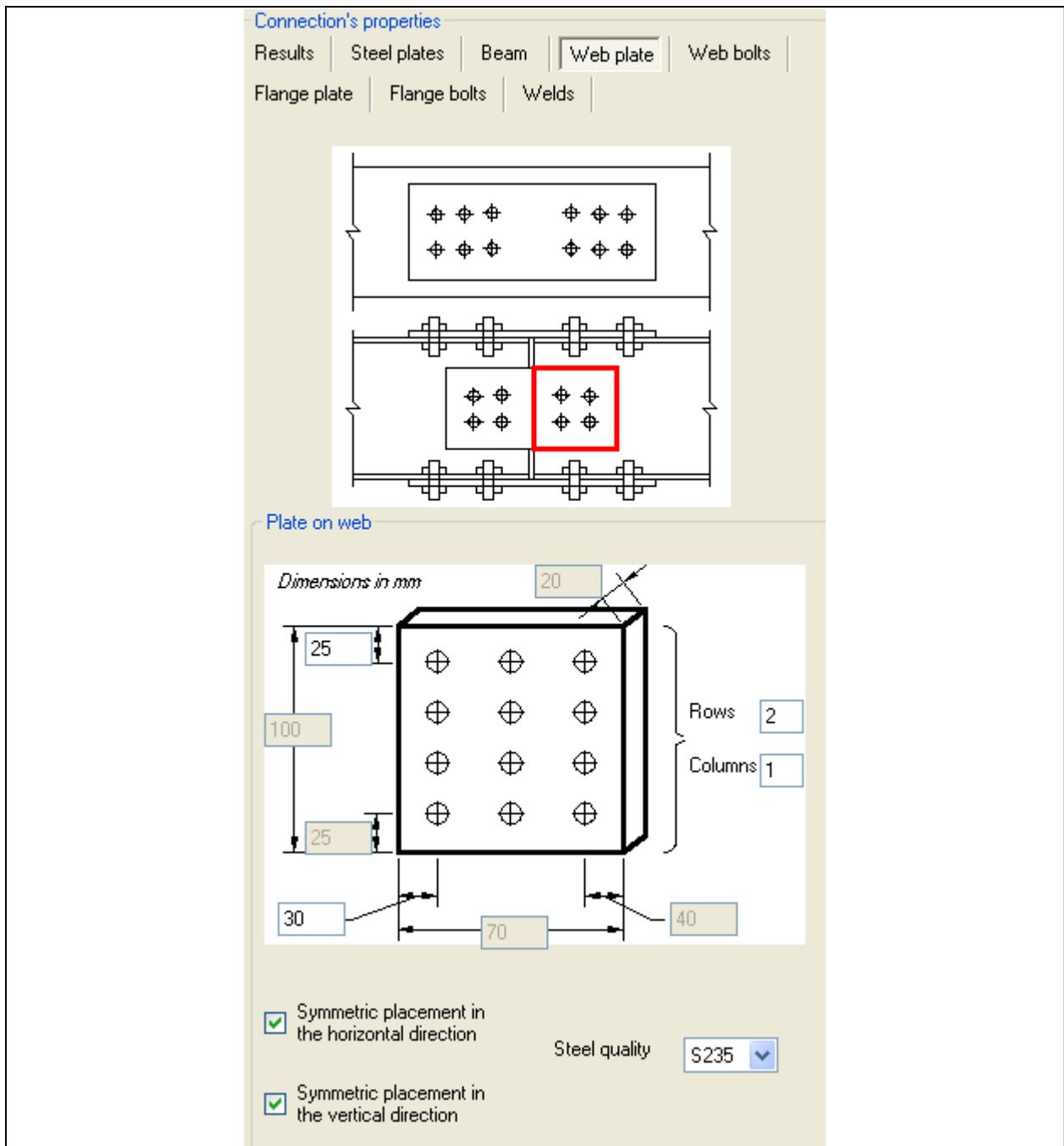
By clicking on the option Welded the user can define the dimensions of the welded section and then the program automatically calculates the section inertia characteristics.



Picture 10.6

### 10.3 Web plate

When the user clicks on the tab Web plate a plate detail appears. There is also a web plate view. On that detail the user defines the rows and the columns of the bolts used in the connection. Additionally the user defines the bolts distance from the plate edges.

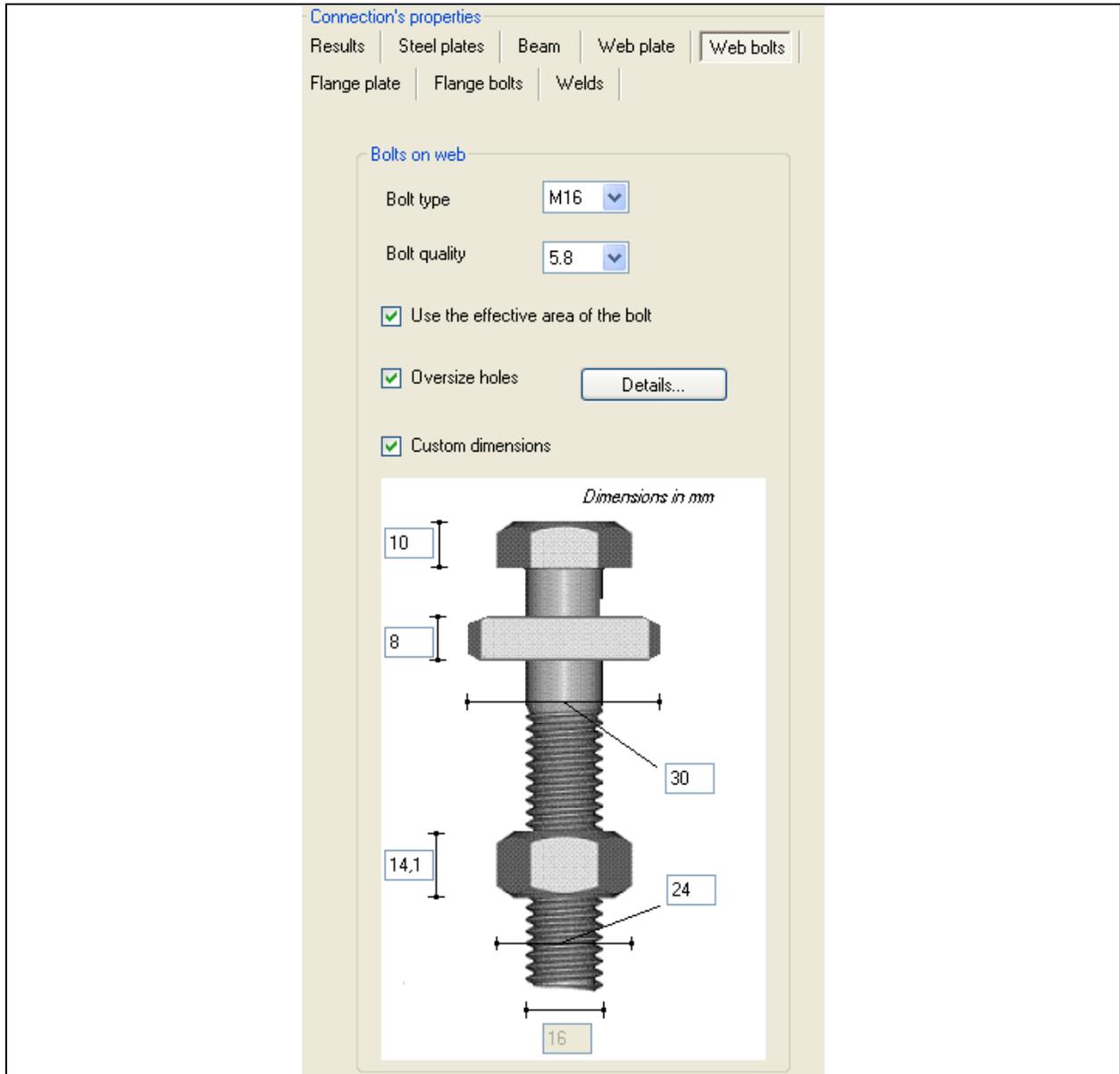


Picture 10.7

The user has the capability to select symmetric placement in the horizontal or in the vertical direction or in both directions, by clicking on the appropriate option.

## 10.4 Web bolts

The definition of the bolts parameters (of those placed on the web) can be done by selecting the tab Web bolts. The user selects the bolt type, the bolt quality and the use of the effective area of the bolt and/or oversized holes.



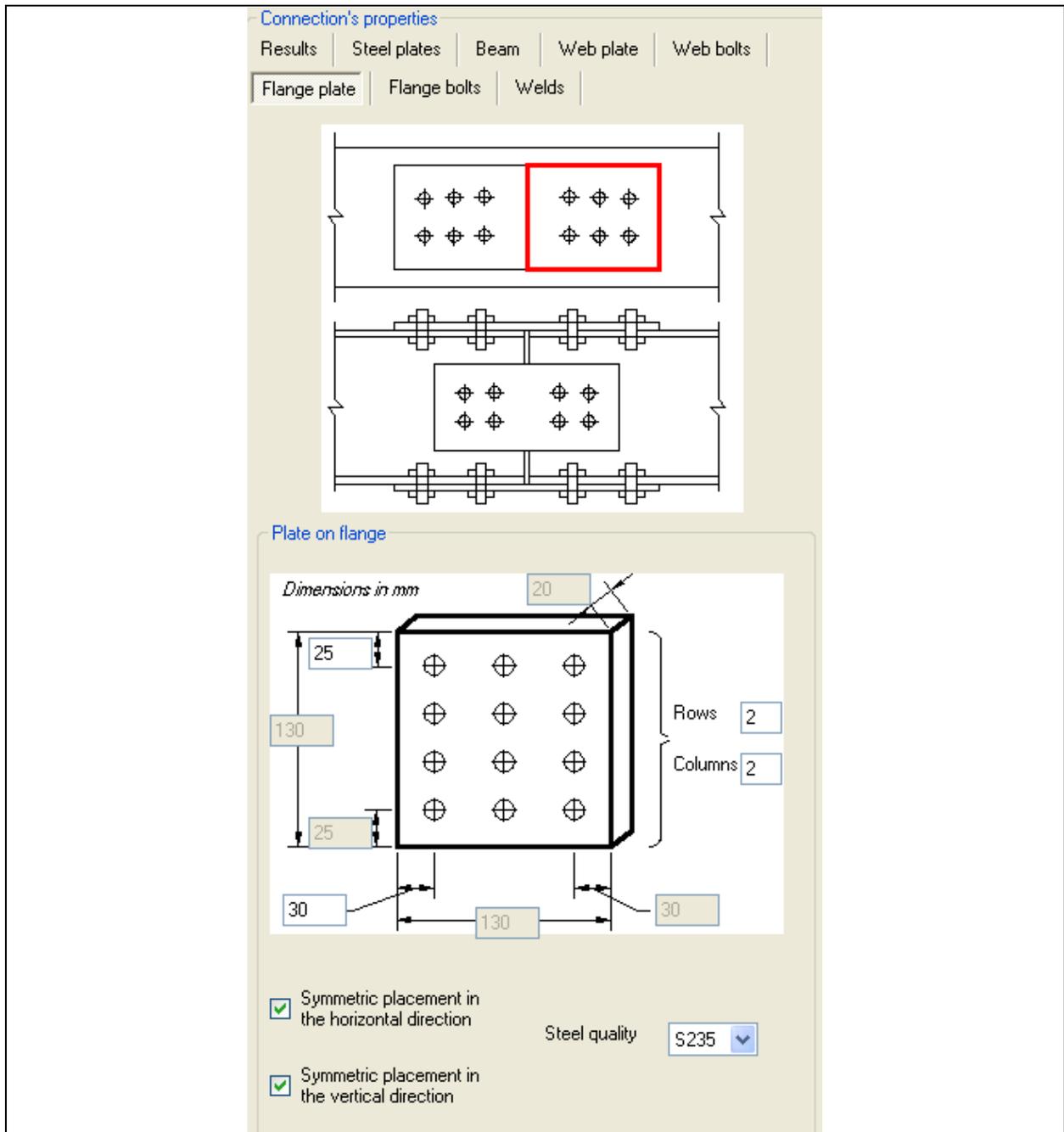
Picture 10.8

When the user clicks on Details the above image appears where the user can see the bolt type dimensions he defined according to DIN 7990, DIN 7969, EN 24034, EN 24032 and DIN 6914.

By clicking on Custom dimensions the user defines the bolt dimensions he prefers.

## 10.5 Web plate

When the user clicks on the tab Flange plate a plate detail appears. There is also a flange plate view. On that detail the user defines the rows and the columns of the bolts used in the connection. Additionally the user defines the bolts distance from the plate edges.



Picture 10.9

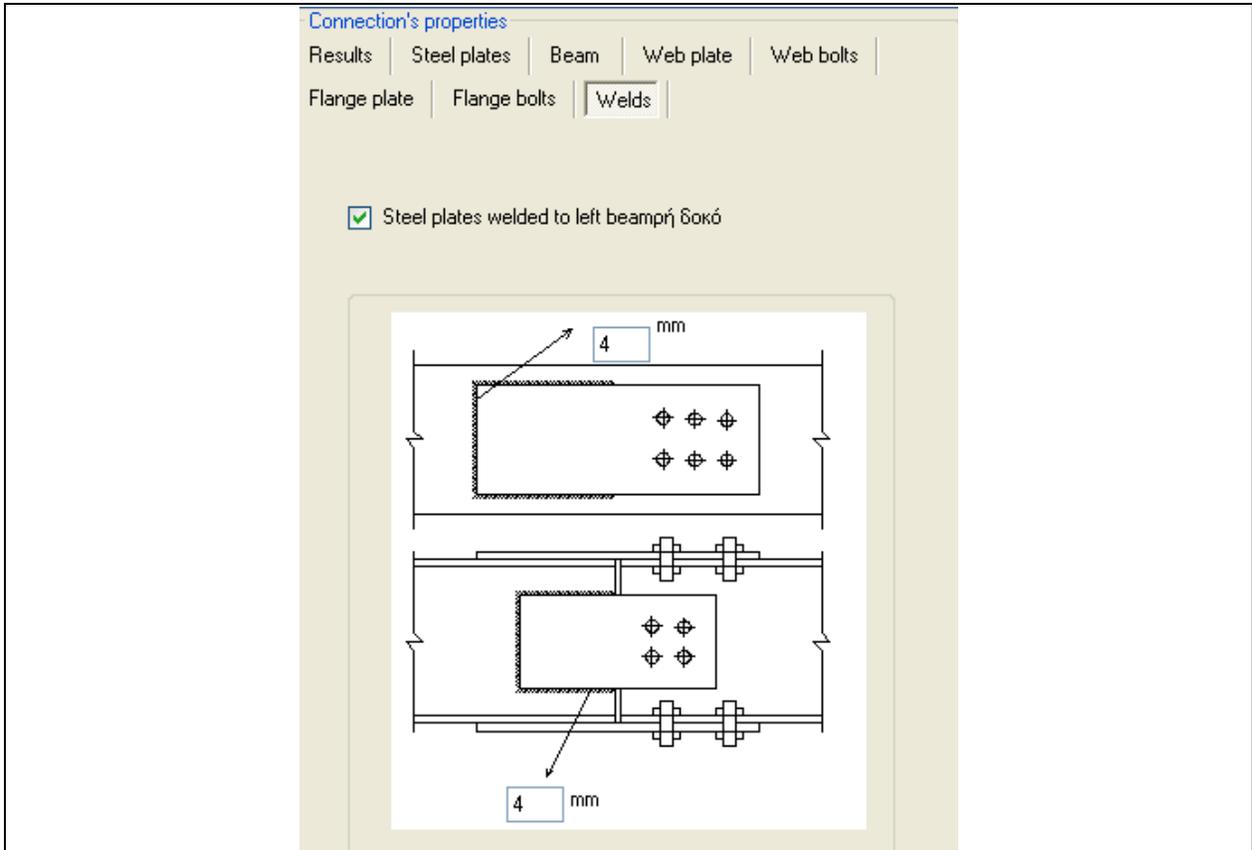
The user has the capability to select symmetric placement in the horizontal or in the vertical direction or in both directions by clicking on the appropriate option.

## 10.6 Flange bolts

The user acts the same way he did when he selected the tab Web bolts.

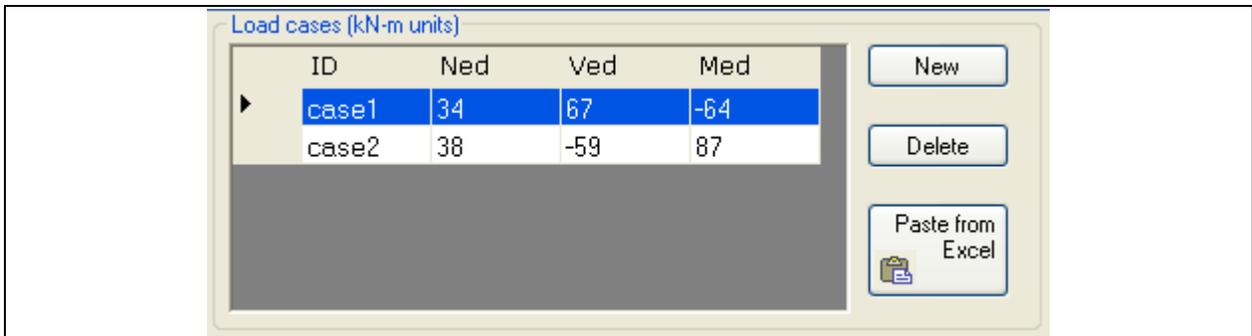
## 10.7 Welds

The program gives the user the capability to select welded flange and web plates to the left connection beam by clicking on Steel plates welded to left beam. When he does that he can also define the weld thickness of both plates.



**Picture 10.10**

In the load cases window the user defines the connection load cases.



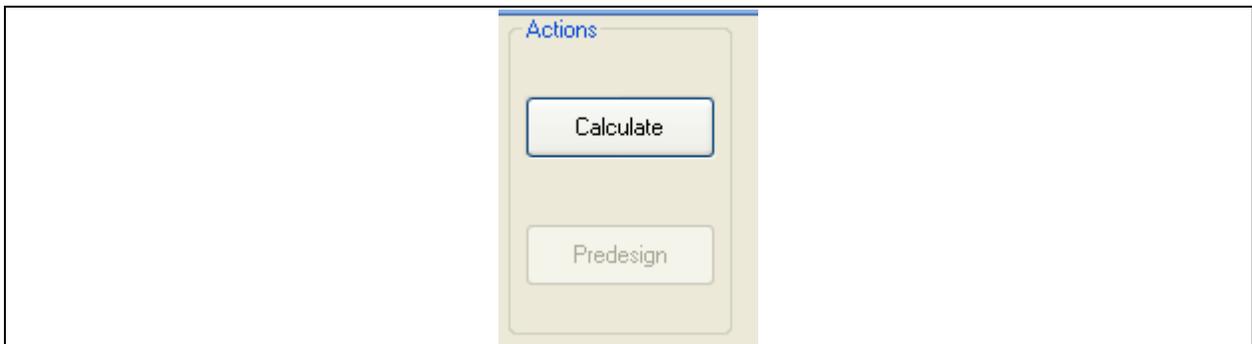
**Picture 10.11**

The user can add more than one load cases by clicking on New.

If the user wants to delete one or more load cases he has already defined he must click on the specific load combination and then click on Delete.

The user can also import the connection loads from an Excel spreadsheet by clicking on Paste from Excel.

The beam connection design starts when the user clicks on Calculate



**Picture 10.12**

The design results are shown in the tab Results.

Connection's properties

Results | Steel plates | Beam | Web plate | Web bolts |  
 Flange plate | Flange bolts | Welds

Load case: **case1**      Combinations that fail: case1

Checkings	Strengths	Capacities
Beam in bending	50,168 kNm	1,276
Beam in shear	96,125 kN	0,697
Flange bolts in shear	136,722 kN	2,575
Flange plate bearing	282,419 kN	1,246
Flange plate in axial force	487,296 kN	0,722
Web plate in axial force	311,04 kN	0,024
Web bolts in shear	53,38 kN	9,737
Web plate bearing	39,813 kN	13,055
Flange welds	20,785 kN / cm <sup>2</sup>	1,841
Web welds	20,785 kN / cm <sup>2</sup>	0,312

Picture 10.13

The text in red means that the capacity is exceeded (capacity > 1.0). The user can also see the critical combinations also marked in red.