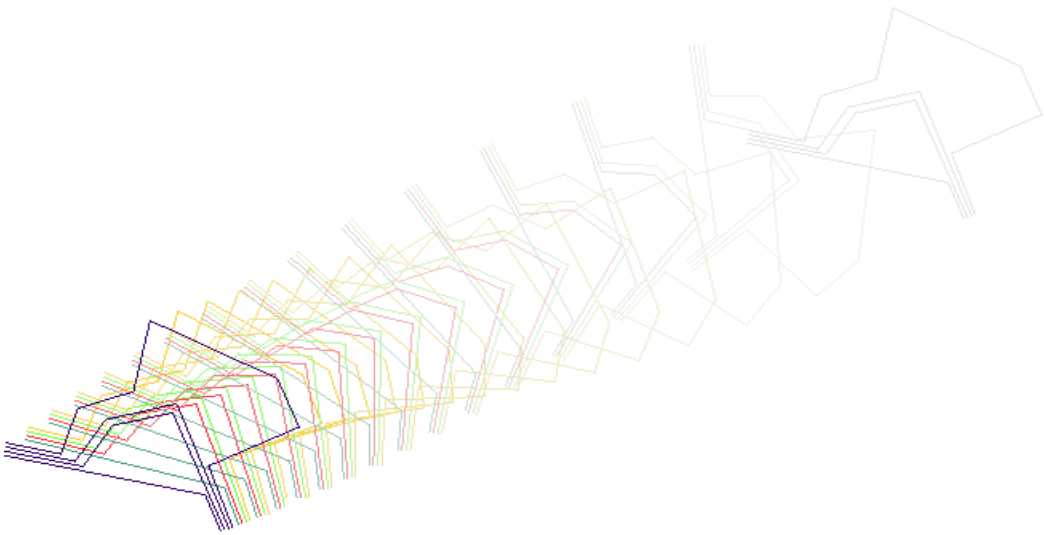
CSA⁴ MANUAL

Cross Section Analyzer is a tool for automatic creation and calculation of various cross sectional design concepts.

Cross sections are generated basing on user-defined design variables. The software enables the definition of material, thickness and length design variables.

One of the greatest advantages of the Cross Section Analyzer is the speed of calculations.
Now it is possible to calculate thousands of design variants in seconds!

Search for the optimal solution with the usage of results filtering functionality. Set the range of acceptable results values and find the most suitable cross-sectional designs.

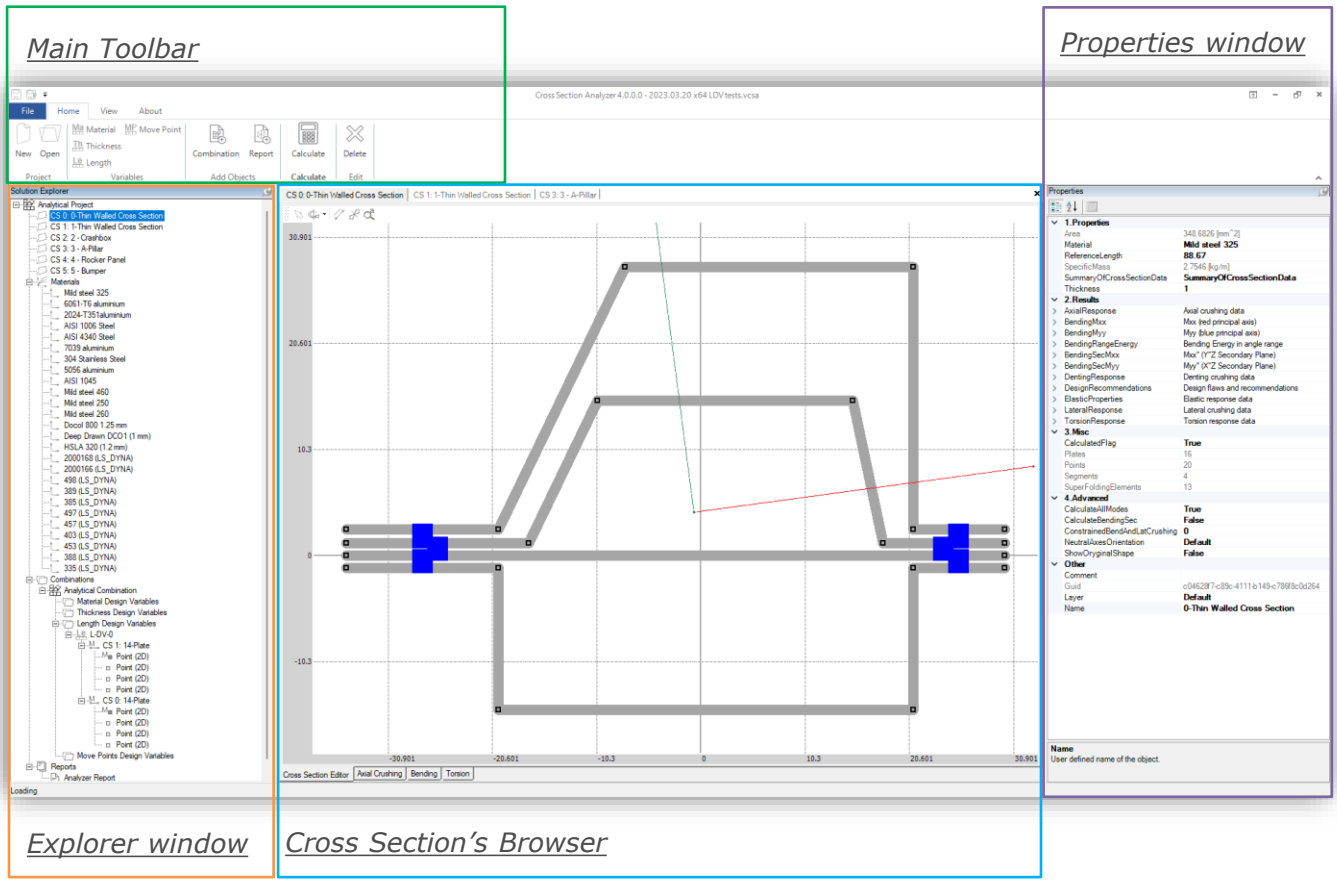


CSA – MANUAL

cross section analyzer

CROSS SECTION ANALYZER – MAIN VIEW

CSA main view is divided into 3 main areas: Explorer window, Cross section 2D view and Properties Window.



Explorer window
The Explorer window includes the basic cross section, list of imported materials, all defined design variables and results reports. All elements of a CSA solution are grouped in appropriate folders in the Explorer tree.

Cross Section's Browser
In the cross section 2D view the geometry of an analyzed cross section is presented. It is equipped with the selection and area selection tools which enable the user to select specific elements of the cross section and assign them to chosen design variables.
Moreover, charts for axial response, bending response, torsion response etc. are available after clicking on an appropriate bookmark at the bottom of the 2D view window.

Properties window
In the Properties window the user can view properties of any selected object of the Analyzer's solution. Results of the basic cross section can be checked as well as detailed parameters of any plate or segment.
In case of materials, detailed characteristic of a selected material can be viewed
In case of a selected design variable the user can view, define and edit desired parameters.

Main Toolbar
Main toolbar located above the Explorer window guaranties easy access to main functionalities of the CSA.
Detailed description of CSA tools and functionalities will be given in later parts of this manual.

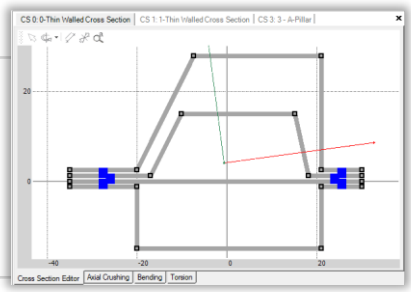
MAIN VIEW – Explorer Window

The Explorer tree enables easy access to all elements of an analytical project.
All objects can be found in appropriate expandable folders.

- Analytical Project
  - CS 0: 0 - Crashbox
  - CS 1: 1 - A-Pillar
  - CS 2: 2 - Upper Rail
  - CS 3: 3 - Rocker Panel
  - CS 4: 4 - Roof Cross Member
  - CS 5: 5 - Circle
  - CS 6: 6 - Bumper
  - Materials
    - 2000168 (LS_DYNA)
    - 2000166 (LS_DYNA)
    - 297 (LS_DYNA)
    - 360 (LS_DYNA)
    - 397 (LS_DYNA)
    - 450 (LS_DYNA)
  - Common Combinations
    - Analytical Combination
      - Material Design Variables
        - M-DV-3
          - CS 1: 1 - A-Pillar 6 - Plate
          - CS 1: 1 - A-Pillar 7 - Plate
          - CS 0: 0 - Crashbox 0 - Plate
      - Thickness Design Variables
        - T-DV-2
          - CS 0: 0 - Crashbox 4 -Plate
          - CS 3: 3 - Rocker Panel 4 - Plate
          - CS 1: 1 - A-Pillar 6 - Plate
          - CS 1: 1 - A-Pillar 7 - Plate
      - Length Design Variables
        - L-DV-3
          - CS 3: 3 - Rocker Panel 16 - Plate
            - 3 - Rocker Panel 15 - Point
          - CS 0: 0 - Crashbox 3 -Plate
            - 0 - Crashbox 7 - Point
      - Move Points Design Variables
        - MP-DV-0
          - CS 0: 0 - Crashbox 7 - Point
          - CS 0: 0 - Crashbox 4 - Point
  - Reports
    - Analyzer Report

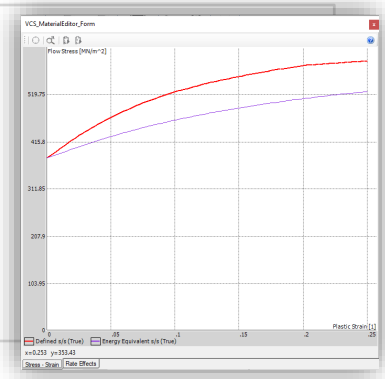
Imported Cross Section

Double click on a Cross Section to open it in the Cross Section's Browser window.



Imported materials

Double click on a material to open the Material Editor window.
Detailed definition of a selected material can be viewed in the properties window.



Analytical Combination – set of design variables.

Within the "Analytical Combinations folder the user can find separate folders for each available design variable. All elements of a cross section assigned to a design variable will be listed in the explorer tree.

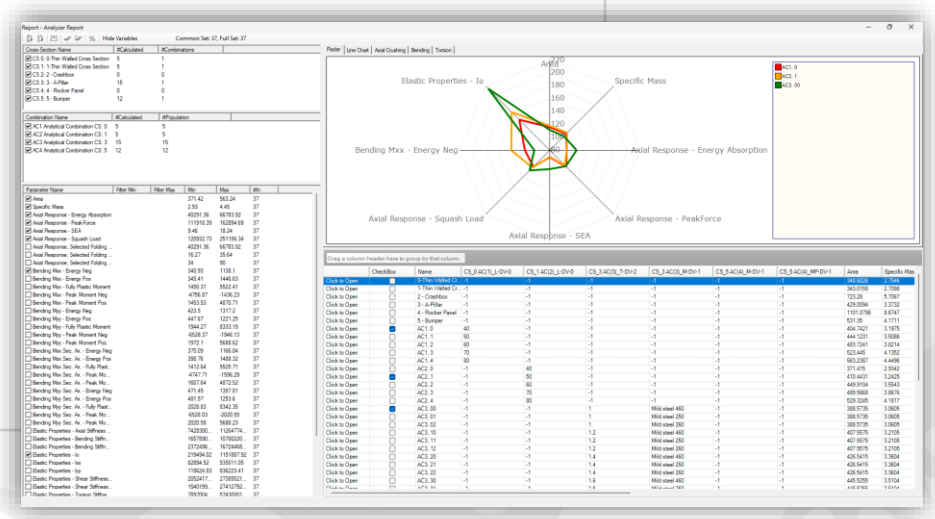
- *Material DV*
- *Thickness DV*
- *Length DV*
- *Move Point DV*

Results Report

At the vary bottom of the Explorer tree the Analyzer Report can be found.

Double click to open the report window in which results can be displayed and filtered.

** Calculate Analytical Project to display results!*

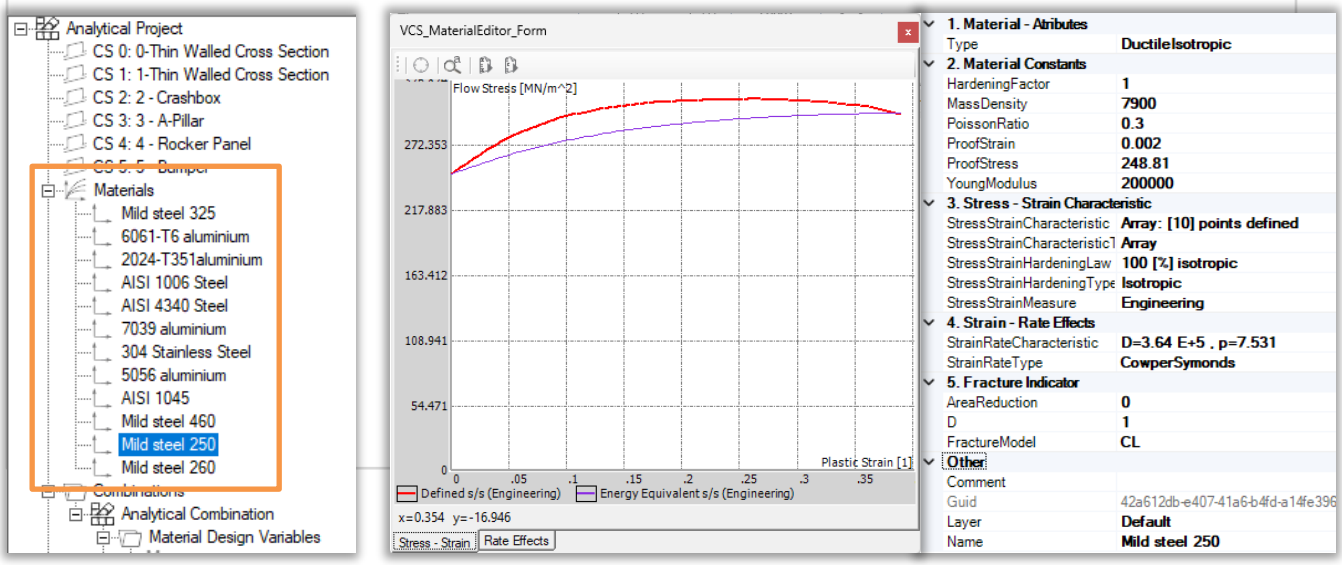


cross section analyzer

Material Editor

Double click on a chosen material in the Explorer window to open the Material Editor window. In the Material Editor the stress-strain curve is displayed. Additionally, after selecting the appropriate bookmark, the strain rate characteristic can be displayed.

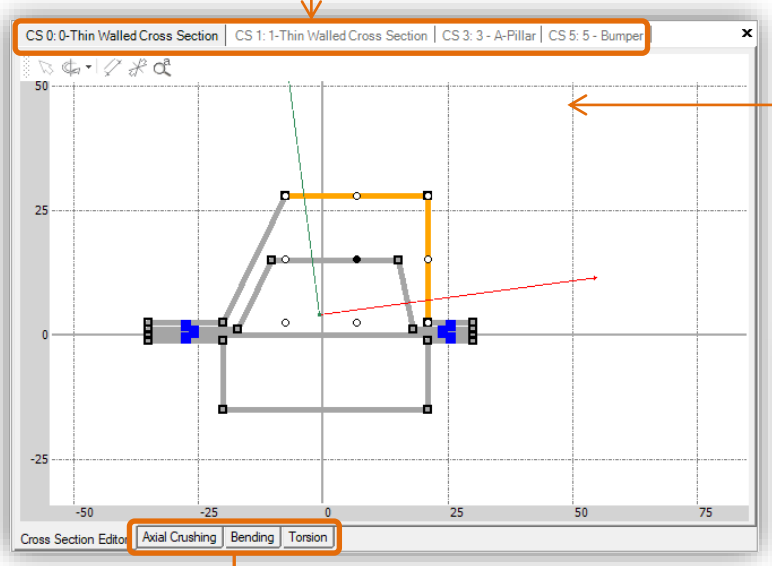
Detailed definition of a material can be viewed in the Properties window



MAIN VIEW – Cross Section's Browser

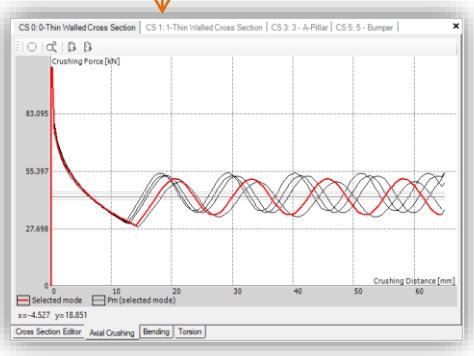
Double click on a Cross Section in the Explorer tree, to open it in the Cross Section's Browser window. In the cross section 2D view the geometry of the base cross section is displayed. The window is equipped with selection tool – the user can easily select plates and points of the cross section, view their definition in the properties window and assign selected objects to a chosen design variable.

User can open multiple cross sections in browser

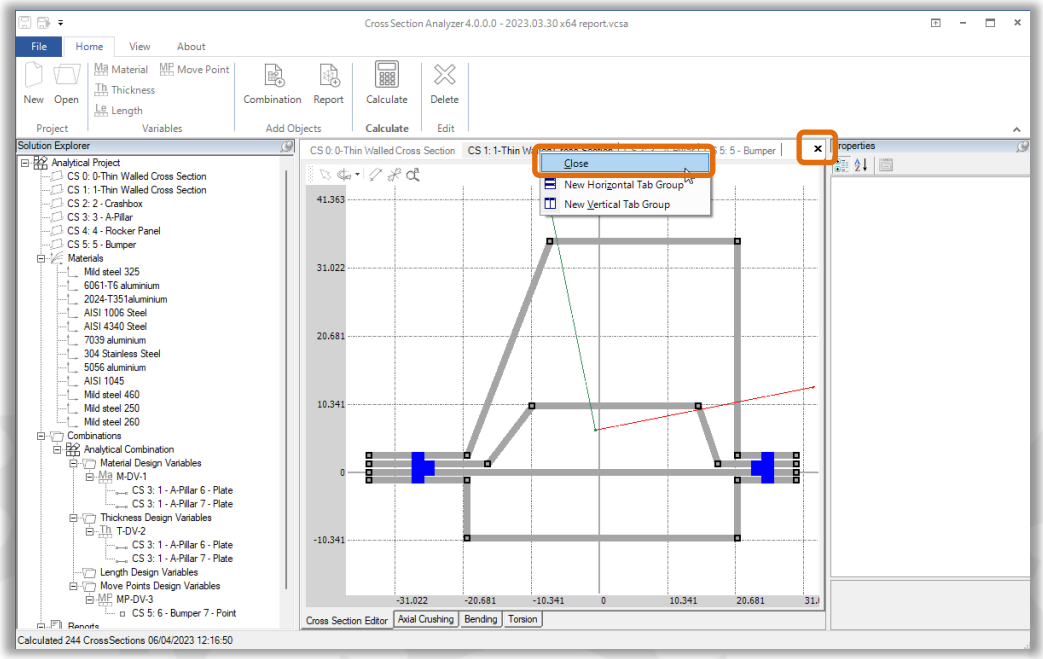


Select Plates and Points of the cross section.

Display result charts for mechanical response of the cross section. Click on an appropriate bookmark at the bottom of the 2D view window.



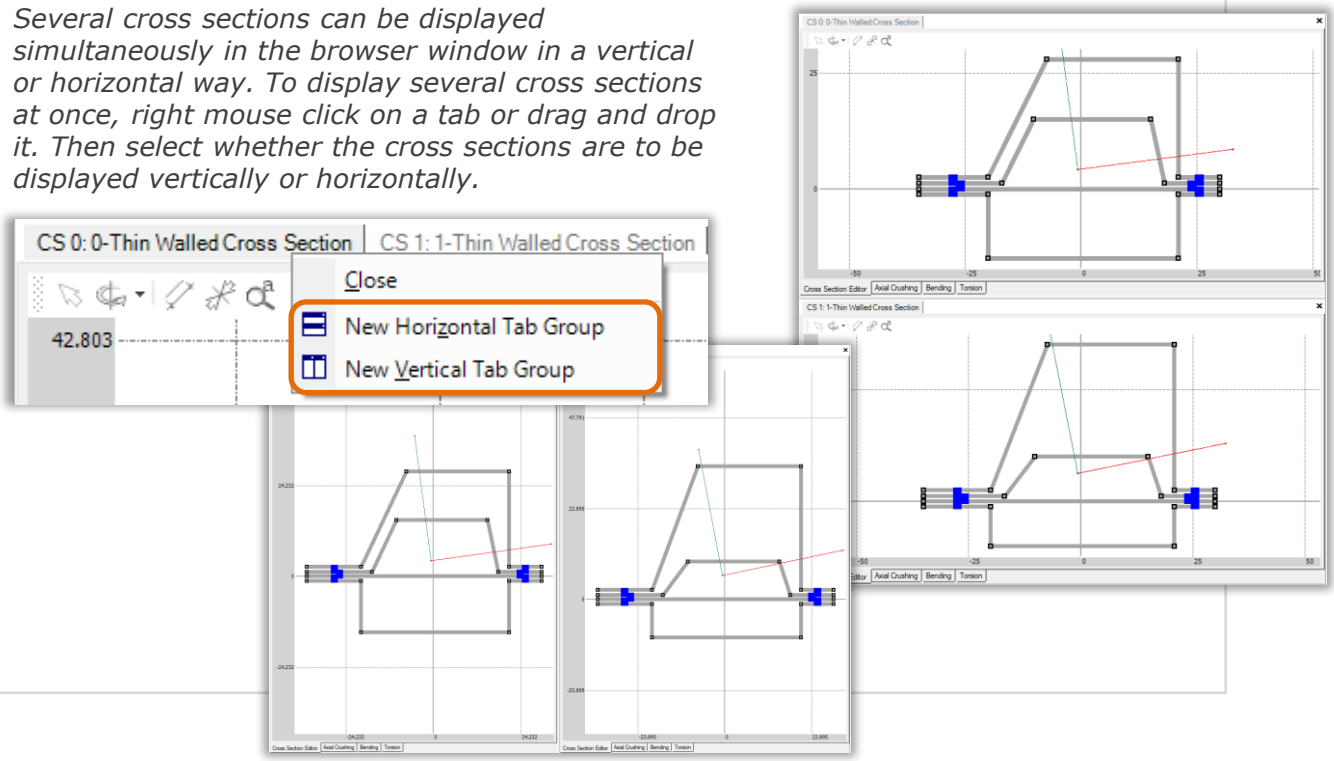
Each opened cross section is visible as separate tab. To switch to other cross section just click on its tab. To close cross section, click on the "X" in the upper right corner of the browser or right mouse click on tab that are to be closed and select Close button.



cross section analyzer

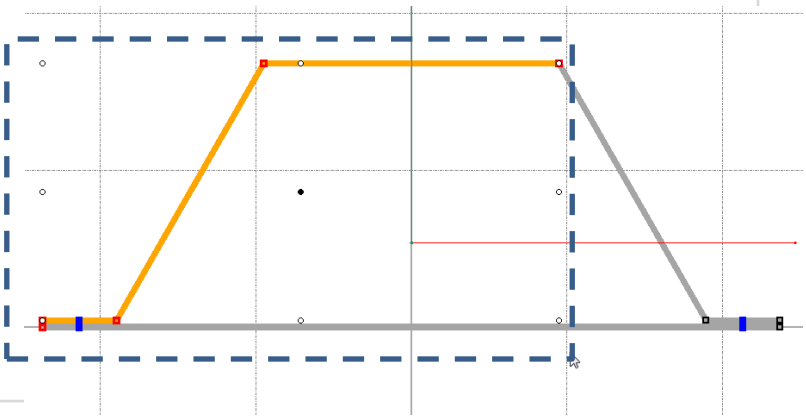
MAIN VIEW – Cross Section's Browser

Several cross sections can be displayed simultaneously in the browser window in a vertical or horizontal way. To display several cross sections at once, right mouse click on a tab or drag and drop it. Then select whether the cross sections are to be displayed vertically or horizontally.



Area Selection

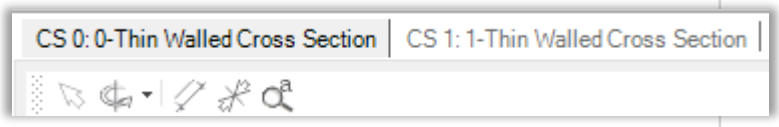
The user can select several plates and points of a cross section simultaneously by means of the area selection tool.
Please note that all selected plates will be marked in orange color, all selected points will be marked in red color.

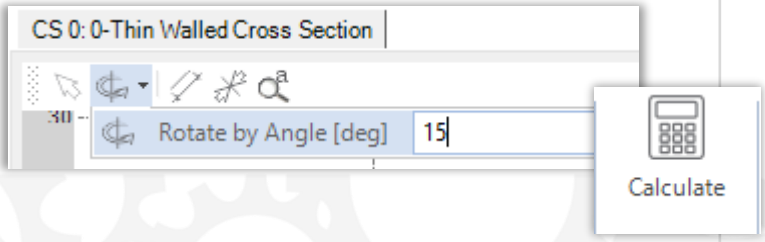


Cross Section Editor toolbar

Each cross section editor contain its toolbar with Select, Rotate, Show Length, Show Thickness and Zoom to all tools.

To rotate the cross section enter the angle value and press enter button on the keyboard.
To recalculate rotated cross section select it in the explorer tree and click on the calculate button.





2D VIEW – Cross Section in Macro Element Method

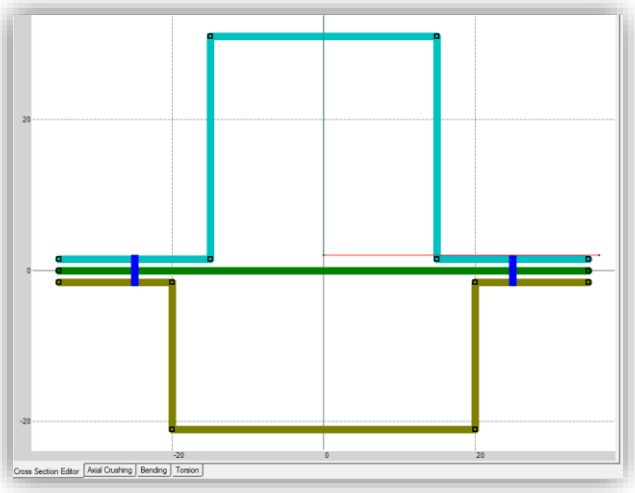
Accordingly, to the Macro Element Method (MEM) the VCS software enables the creation of a simplified cross section model build of plates and segments based on Points.

All Cross Sections created in MEM consist of :

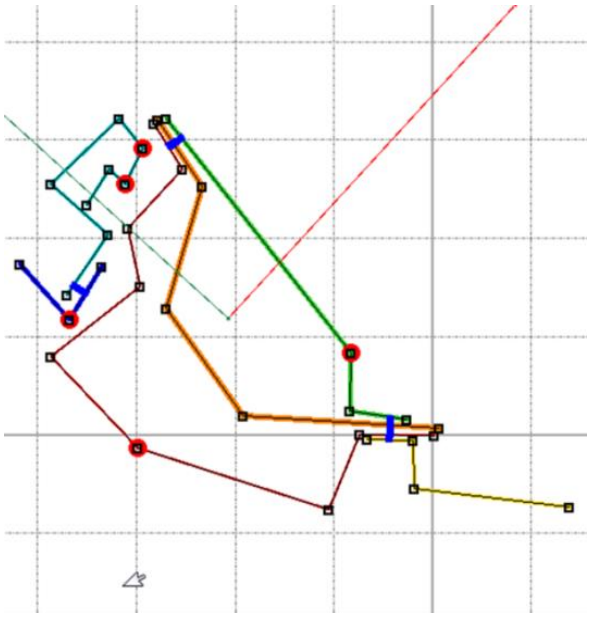
- *Points*
- *Plates – created by connecting two Points*
- *Segments – build of Plates*
- *Super Folding Elements*

and possibly

- *Connections*



IMPORTANT NOTICE
Please note that a cross section purposed for analysis in the CSA needs to be defined with accordance to the Macro Element Method.
Incorrect or too dense discretization of a cross section can affect the overall results.

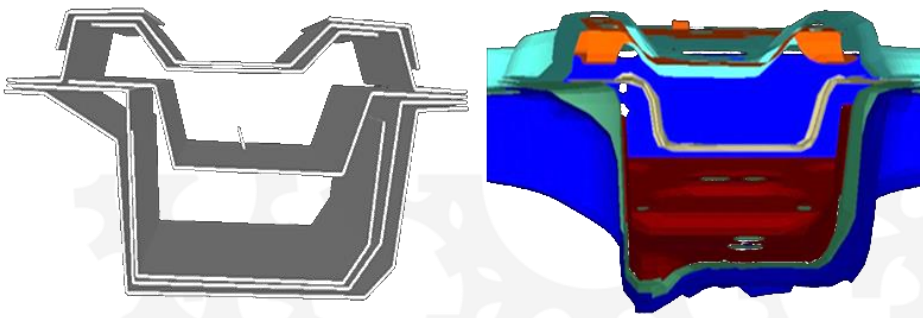


In the picture on the left an example of a Cross Section modelled in MEM can be seen. Please note that each segment has been marked in different color.

*A Macro Element model is a **simplified model**, where details of the cross-sectional geometry should be neglected.*

The problem of radius modelling at the Cross Section level is related to the definition of Super Folding Element (SFE) and corresponding modelling methodology (quite different then in FE programs). The energy absorption in corner area can be significantly increased only for radii that guarantee development of full plastic folds like in the case of circular or hexagonal column.

In the picture on the right, the comparison of a simplified MEM model (gray) and a typical model created in accordance with the FE methodology can be seen.



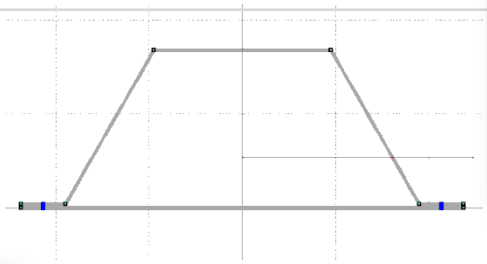
cross section analyzer

MAIN VIEW – Properties Window

In the Properties window the user can view detailed definition of any selected object from a current CSA solution.

After selecting any object in the Explorer window all its properties will be automatically displayed.
In case of a cross section, the Properties window includes not only information about the geometry and assigned material but also detailed results.*

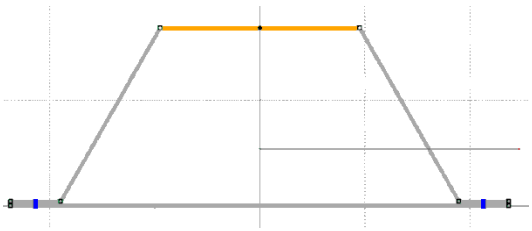
** More information available in "VCS – Cross Section Editor Manual".*

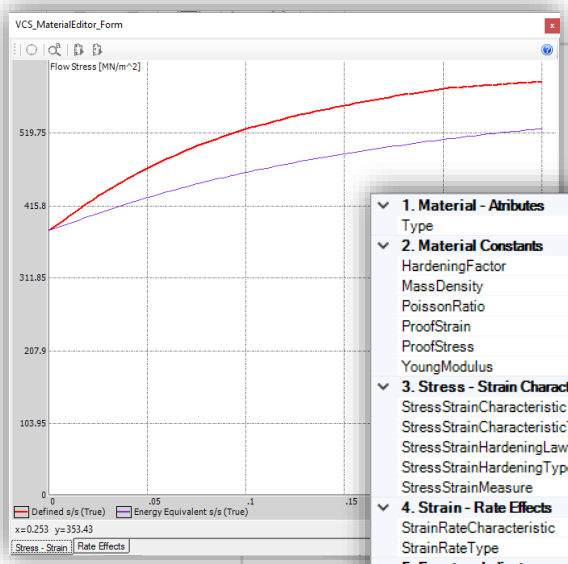


1.Properties	
Area	308 [mm^2]
Material	2000121 (LS_DYNA)
ReferenceLength	108.77
SpecificMass	2.4301 [kg/m]
SummaryOfCrossSectionDatı	SummaryOfCrossSectionData
Thickness	1
2.Results	
AxialResponse	Axial crushing data
BendingMxx	Mxx (red principal axis)
BendingMyy	Myy (blue principal axis)
BendingRangeEnergy	Bending Energy in angle range
BendingSecMxx	Mxx" (Y"Z Secondary Plane)
BendingSecMyy	Myy" (X"Z Secondary Plane)
DentingResponse	Denting crushing data
DesignRecommendations	Design flaws and recommendations
ElasticProperties	Elastic response data
LateralResponse	Lateral crushing data
TorsionResponse	Torsion response data
3.Misc	
CalculatedFlag	True
Plates	11
Points	14
Segments	3
SuperFoldingElements	9
4.Advanced	
CalculateAllModes	True
CalculateBendingSec	False
ConstrainedBendAndLatCrusl	0
NeutralAxesOrientation	Default
ShowOryginalShape	False
Other	
Comment	
Guid	0faf4e73-e3dd-4dc0-82e5-ed99ac8b65
Layer	Default
Name	0-Hexagonal hat

0. Basic Properties	
Material	2000121 (LS_DYNA)
Thickness	1.1
1. Apperance	
Color	165, 165, 165
Visible	True
2.Properties	
DirectionVector	(1, 0, 0)
End	(15, 31)
Start	(-15, 31)
Width	30
WidthEffective	43.62
3.Design Recommendations	
MaximalWidth	43.62 [mm] (OK)
RequiredWidth	11 [mm]
4.Misc	
Name	0-Plate
PlateType	Web
Other	
Comment	
Guid	9741932f-3d49-4513-8bbd-7ffa6f89a10
Layer	Default

For any selected plate, information concerning thickness, assigned material and length are available. Those data can be treated as reference when defining design variables.





1. Material - Atributes	
Type	DuctileIsotropic
2. Material Constants	
HardeningFactor	1
MassDensity	7890
PoissonRatio	0.3
ProofStrain	0.002
ProofStress	380
YoungModulus	200000
3. Stress - Strain Characteristic	
StressStrainCharacteristic	Array: [10] points defined
StressStrainCharacteristicTy	Array
StressStrainHardeningLaw	100 [%] isotropic
StressStrainHardeningType	Isotropic
StressStrainMeasure	True
4. Strain - Rate Effects	
StrainRateCharacteristic	D=8 E+3 , p=8
StrainRateType	CowperSymonds
5. Fracture Indicator	
AreaReduction	0
D	1
FractureModel	SurfaceStrains
Other	
Comment	
Guid	97934834-0803-4333-9f95-d69dfa03e4
Layer	Default
Name	2000121 (LS_DYNA)

In CSA it is possible to work with ductile isotropic materials which can be defined in form of elastic-plastic piecewise characteristic.

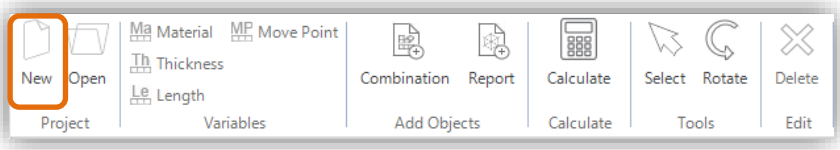
The Material is described by five groups of data available in the Properties window:

- *Material Constants*
- *Stress Strain Characteristic*
- *Strain Rate Characteristic*
- *Hardening Factor*
- *Fracture Indicator*

** Detailed information available in "VCS – Material Editor Manual".*

cross section analyzer

CREATE NEW ANALYTICAL PROJECT

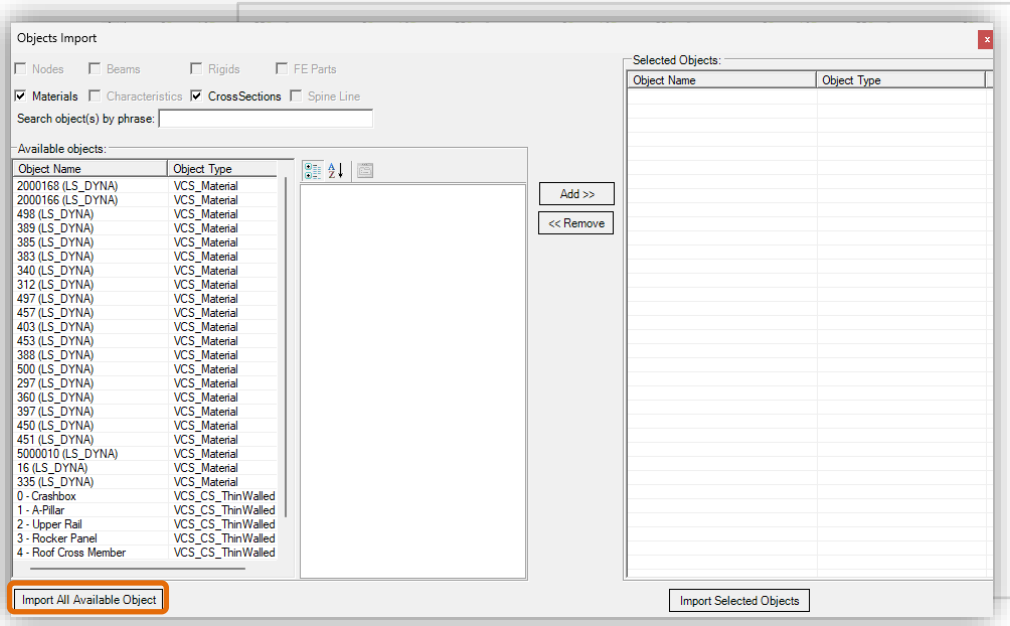


Choose cross sections for analysis

*To create new analytical project, Thin-Walled Cross Sections need to be imported. Click "**New**" button and select VCS file with cross sections that are to be analysed.*

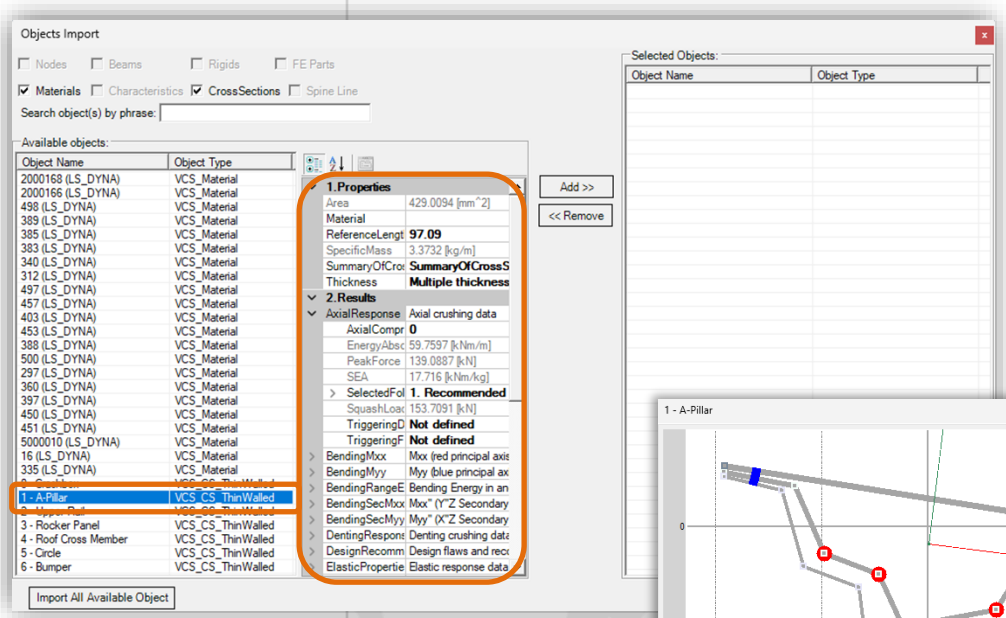
** Note that only calculated cross sections can be imported.*

*** Cross section needs to be defined accordingly to the Macro Element Method requirements.*



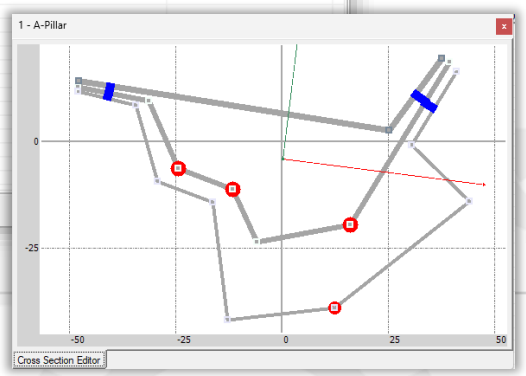
In the "Object Import" window on the left-hand side there is a list with a complete set of cross sections and materials available in the selected file.

*Click "**Import All Available Objects**" button to import all cross sections and materials available in the file.*



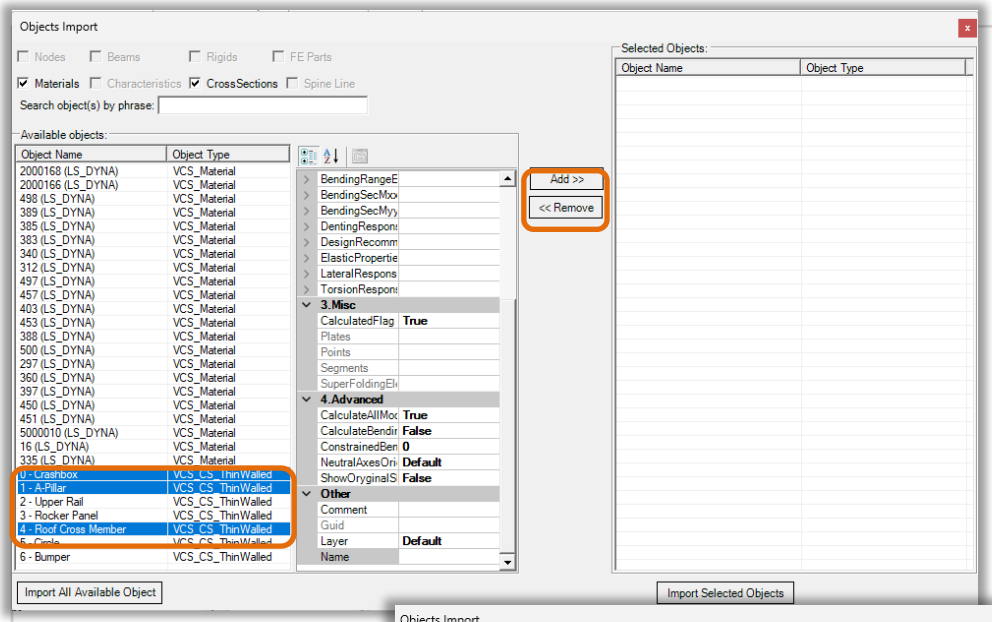
After clicking on specific object from the list, you can display its properties.

Double click enables to preview the cross section.

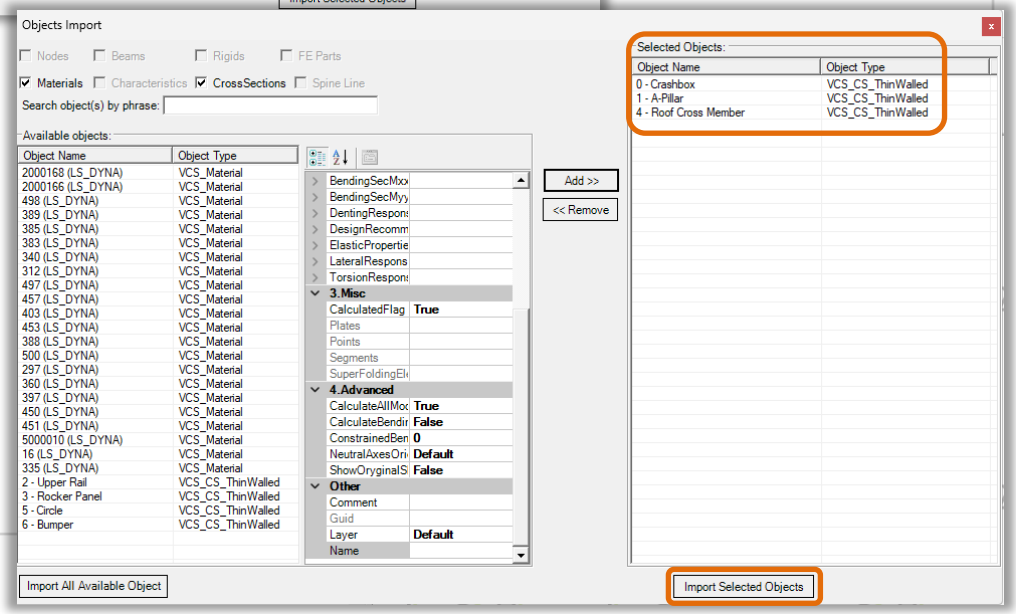


cross section analyzer

CREATE NEW ANALYTICAL PROJECT



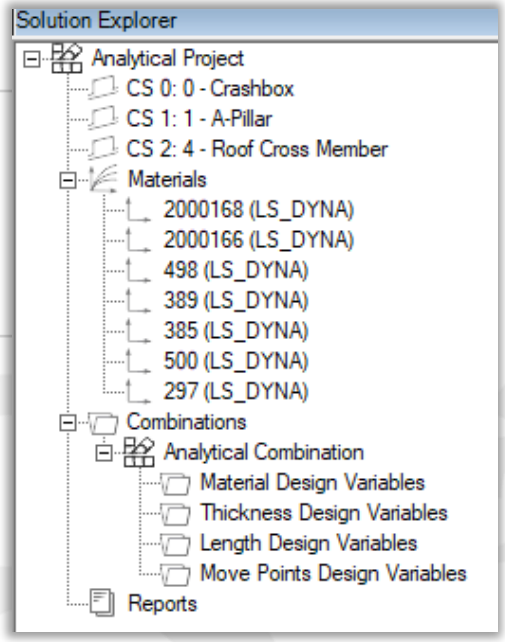
*You can import only selected objects as you wish. After selecting them from the 'Available objects' list (use CTRL button to select multiple objects), click on the **Add** button to add them to Selected Objects list. To delete unnecessarily added objects select them from the Selected Objects list and click on the **Remove** button.*



*When selection is finished click on the **Import Selected Objects** button.*

(*) Objects related with selected ones (e.g., materials assigned to selected cross sections) will be imported automatically.

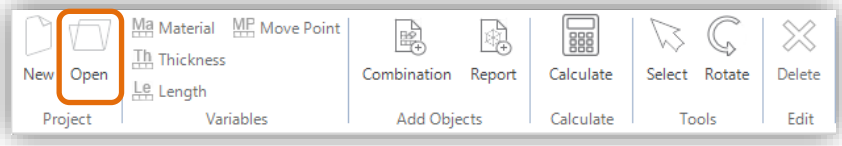
After the import is completed, the cross sections and materials are added to the Solution Explorer tree and placed in appropriate folder.

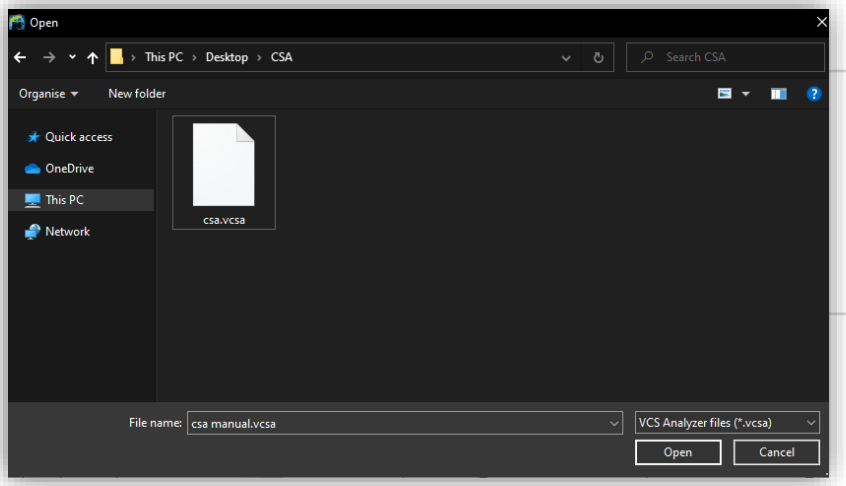


cross section analyzer

OPEN EXISTING ANALYTICAL PROJECT

*Select "**Open**" button to open previously created CSA analytical project.*
Please note that CSA files have .vcsa extensions.

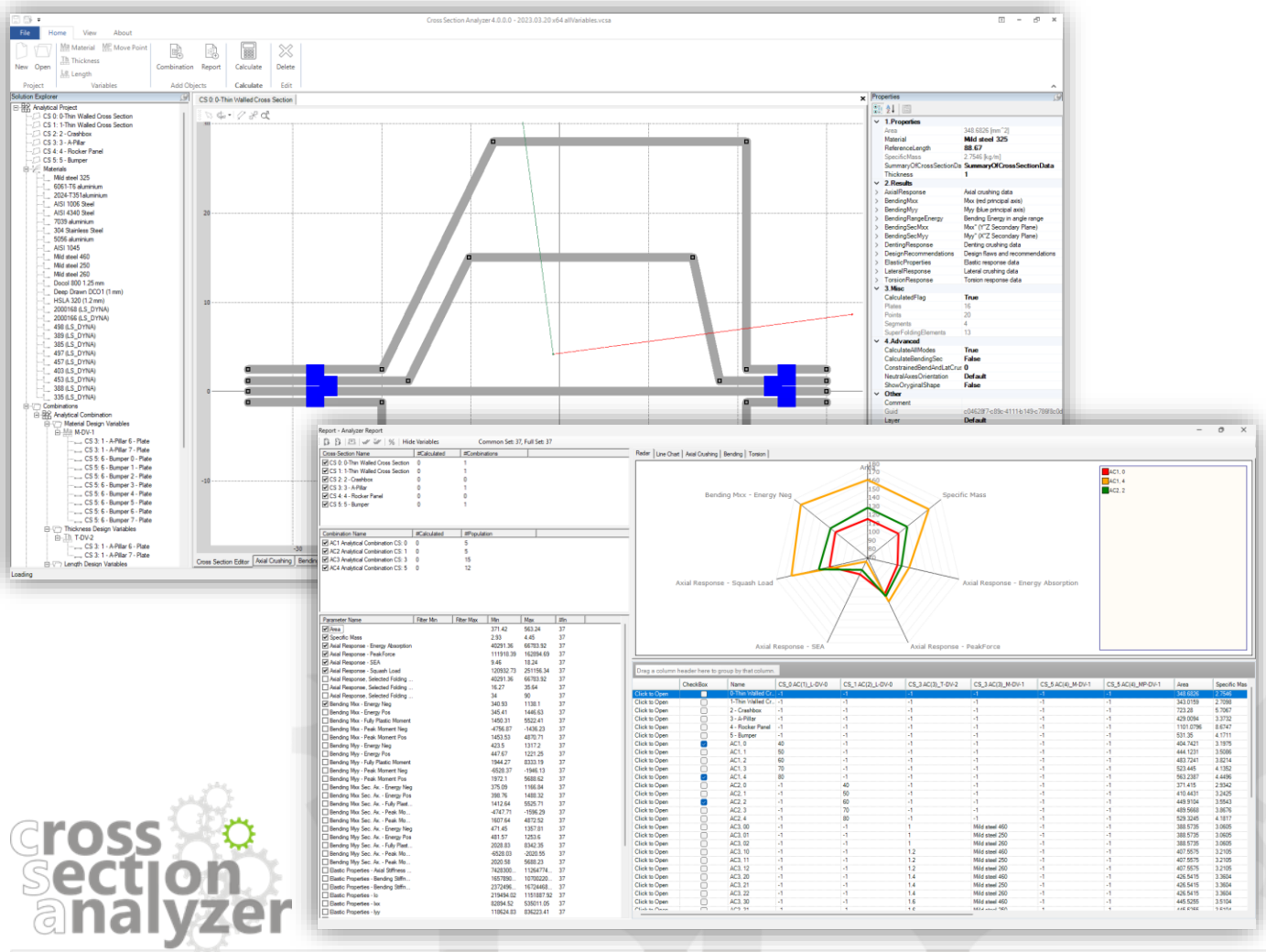




Select the file to open.

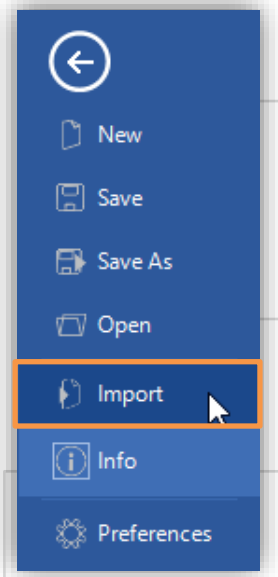
Confirm by "Open" button.

The project is opened and ready to use. If the folder with project's results is available, then project don't need recalculation to display Report. If the results folder is not available, recalculate project to be able to use all report functionalities.



cross section analyzer

IMPORT CROSS SECTIONS/ MATERIALS



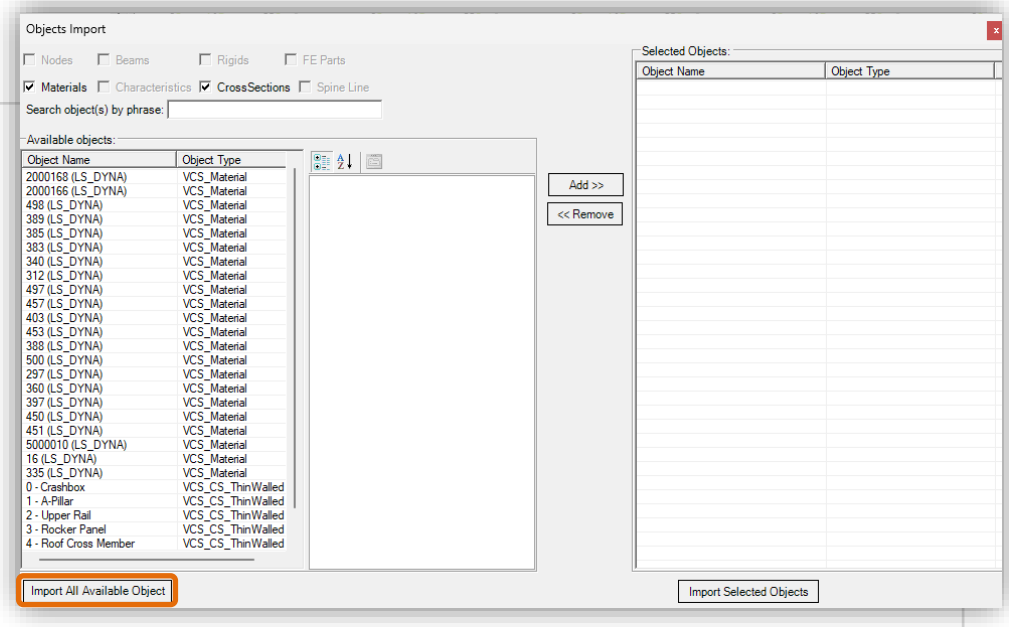
Additional cross sections and materials can be imported at any time.

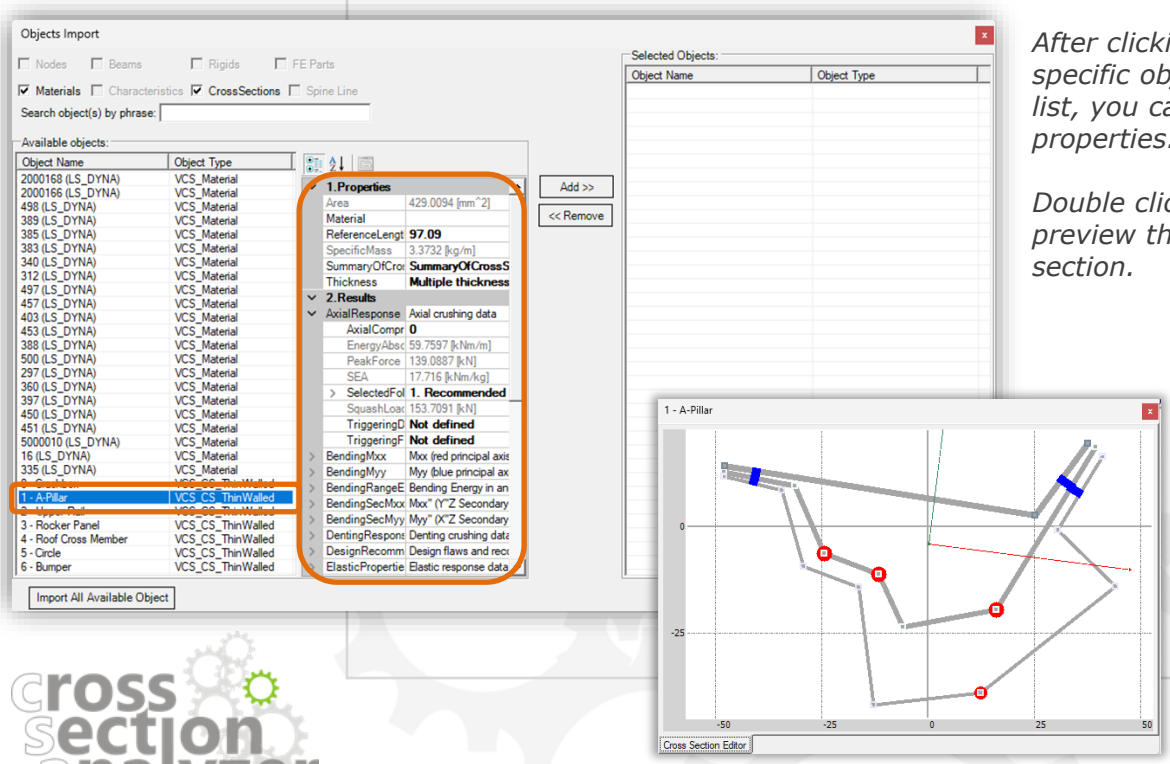
In order to import objects, click on File and select the "Import" option.

Select a VCS file from which you wish to import objects and press Open.

In the "Object Import" window on the left-hand side there is a list with a complete set of cross sections and materials available in the selected file.

*Click "**Import All Available Objects**" button to import all cross sections and materials available in the file.*



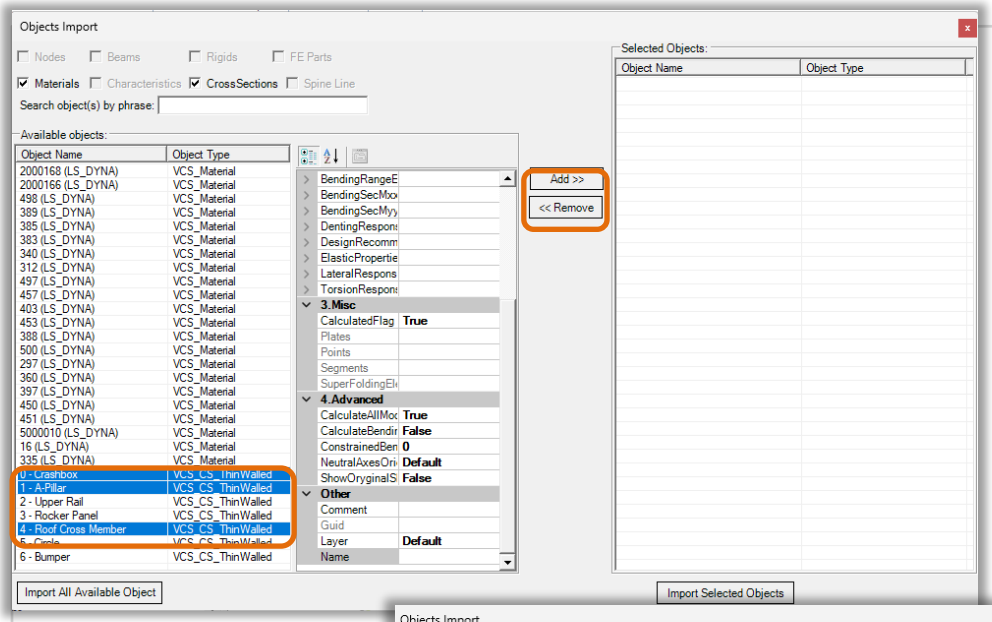


After clicking on specific object from the list, you can display its properties.

Double click enables to preview the cross section.

cross section analyzer

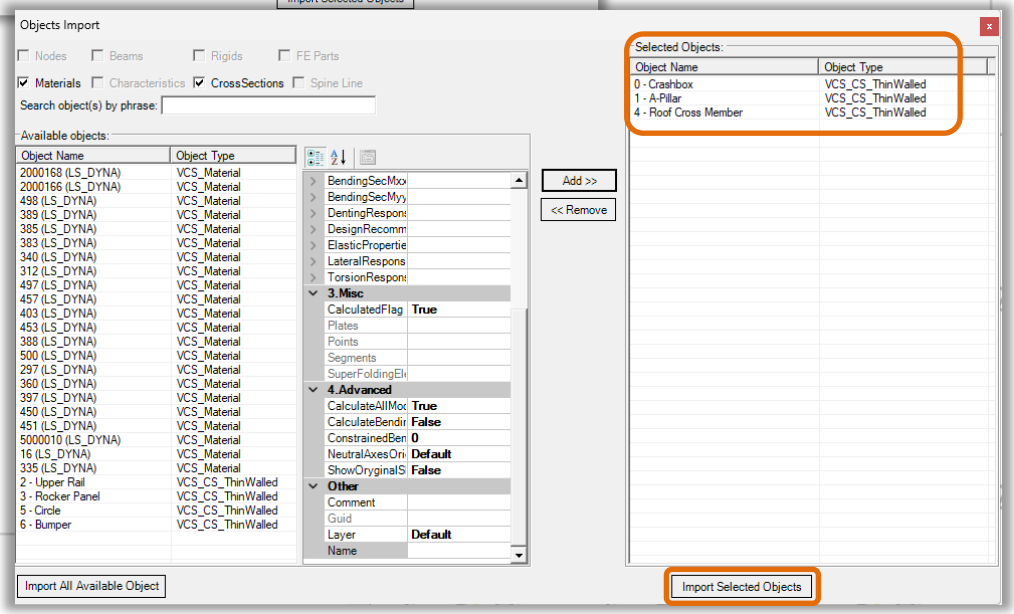
IMPORT CROSS SECTIONS/ MATERIALS



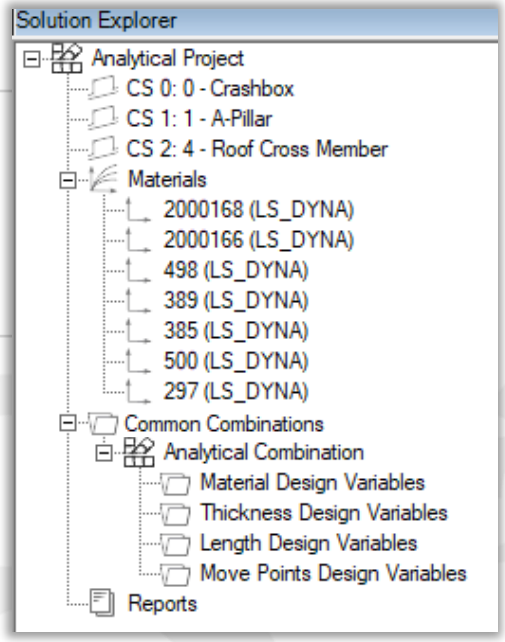
*You can import only selected objects as you wish. After selecting them from the 'Available objects' list (use CTRL button to select multiple objects), click on the **Add** button to add them to Selected Objects list. To delete unnecessarily added objects select them from the Selected Objects list and click on the **Remove** button.*

*When selection is finished click on the **Import Selected Objects** button.*

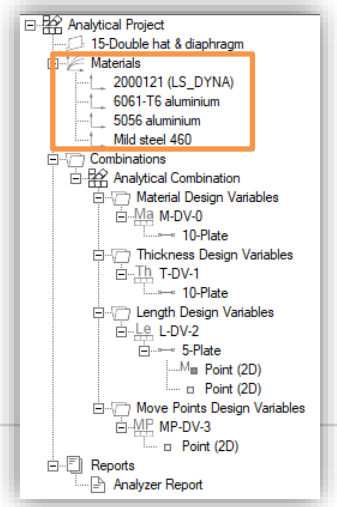
(*) Objects related with selected ones (e.g., materials assigned to selected cross sections) will be imported automatically.

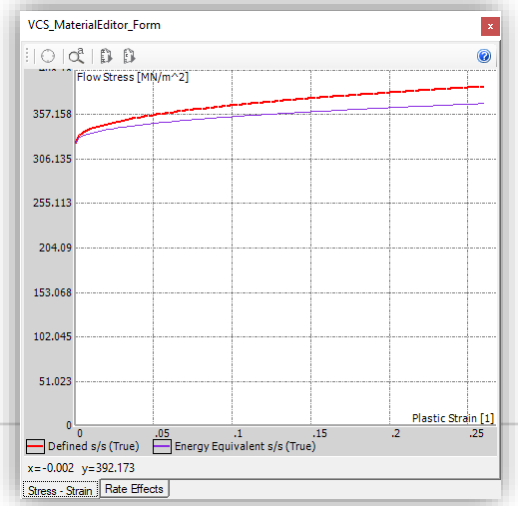


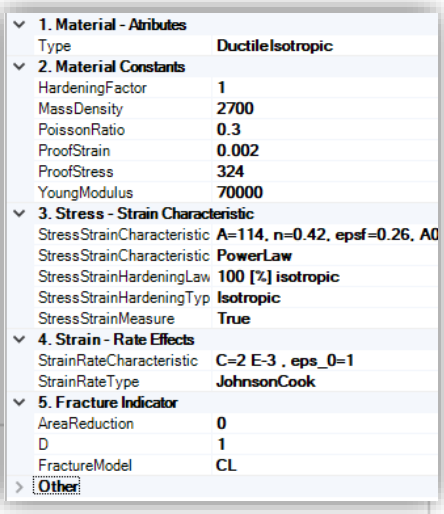
After the import is completed, the cross sections and materials are added to the Solution Explorer tree and placed in appropriate folder.



cross section analyzer







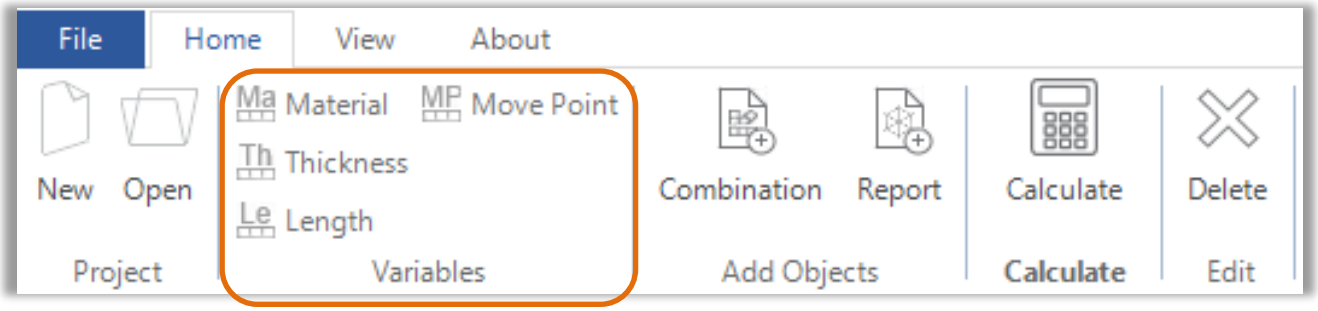
All imported objects can be found in the Explorer window.

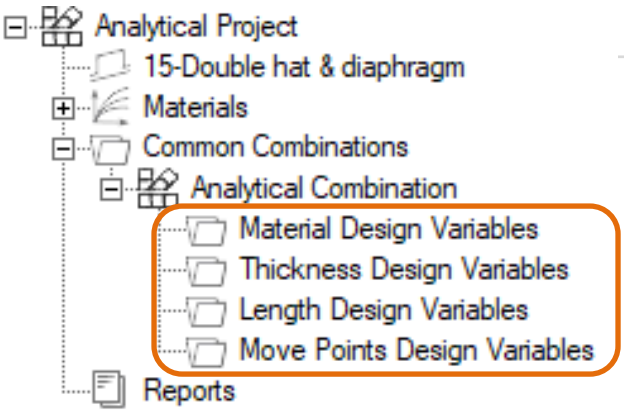
Detailed definition of a material can be viewed in the Properties window.

Double click on a selected material to open the Material Editor window in which stress-strain and strain rate characteristics are displayed.

DEFINE SET OF DESIGN VARIABLES

For each "Analytical Combination" user can define four types of design variables: material, thickness, length and move point.





Design variables folders are located under the "Analytical Combinations" branch of the Explorer tree.

In order to open and define a chosen design variable select the appropriate folder in the Explorer window. Afterwards click on the design variable icon available in the CSA main toolbar.

Newly created design variable will be added to the fitting folder in the Explorer window.

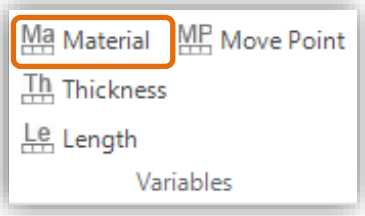
Material Design Variable	*Assign various materials to a selected plate or a group of plates*
Thickness Design Variable	*Assign various thickness values within the defined range to a selected plate or a group of plates.*
Length Design Variable	*Assign various length values within the defined range to a selected plate or a group of plates. Additionally define moving and/or restricted points of the cross section*
Move Point Design Variable	*Change coordinates of selected points along a predefined vector. Analyze various geometry variants*

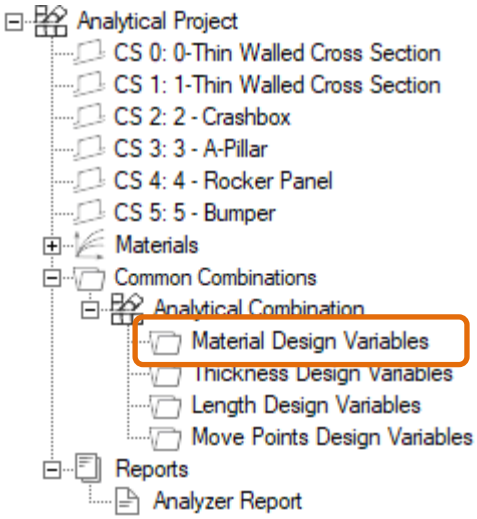
1. Create material design variable

The Material Design Variable enables to assign various materials to a selected plate or a group of plates from different cross sections.

In order to define a design variable, select the Analytical Combination branch in the Explorer window.

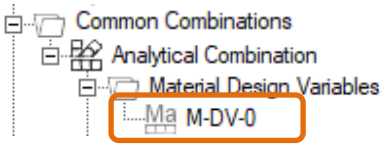
Afterwards click on the design variable icon available in the main toolbar.

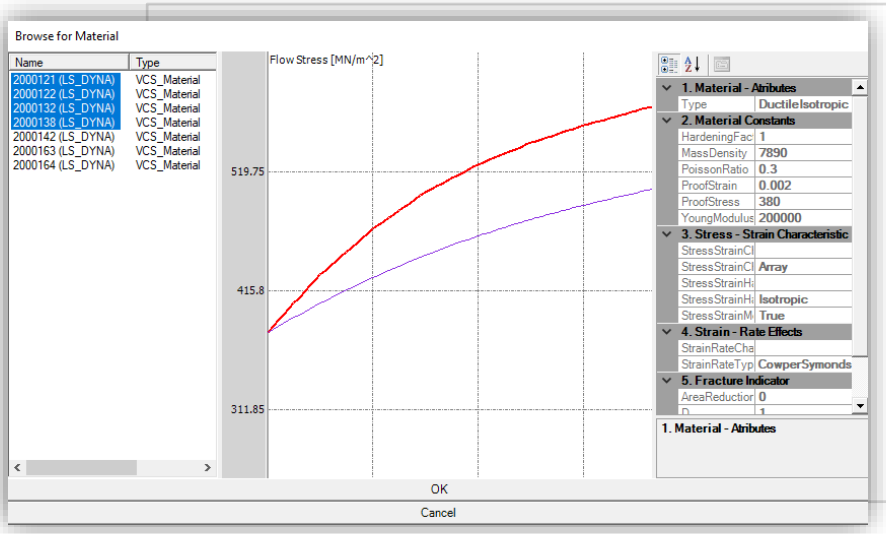




2. Set material design variable

Automatically a new Material Design Variable will appear in the Explorer tree. Double click on it to open "Browse for material" and set the materials.





"Browse for Material" window includes a list of all imported materials.

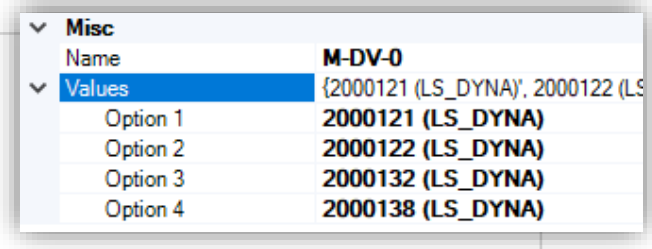
For each selected material, the user can view its stress-strain chart and properties.

Select number of materials for analysis and confirm by "OK".

Multiple materials can be selected with CTRL.

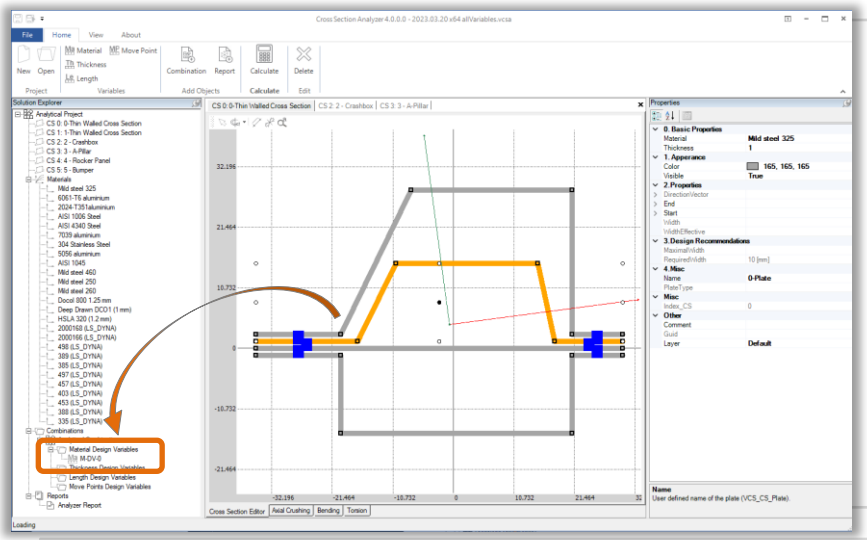
Select material design variable in the explorer tree to preview its settings.
In the "Values" section of the Properties window all defined material options are listed.

Selected materials can be changed at any time.



cross section analyzer

3. Assign Plates to previously defined design variable



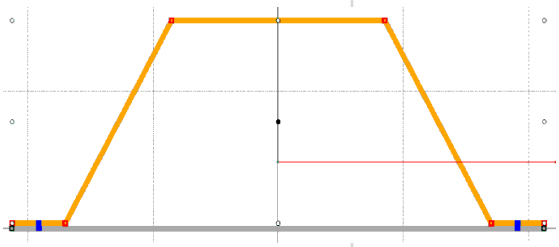
Select required plate or number of plates and afterwards drag and drop them in the appropriate design variable (in the Explorer window).

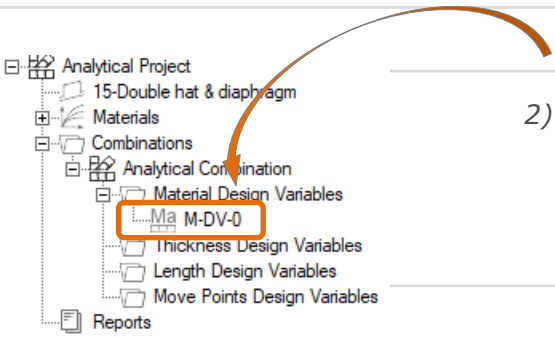
(*) Please note that you can add plates from different cross sections. Double click on cross section to open its window.

Step-by-step instruction on how to add plates to a variable is given below:

1) *Select required plate or number of plates in the 2D view. Use the CTRL button or area selection option to select multiple plates.*
All selected elements will be marked in orange.

(*) Please note that points are also automatically selected when using the area selection. They will however not be assigned to material nor thickness design variable.

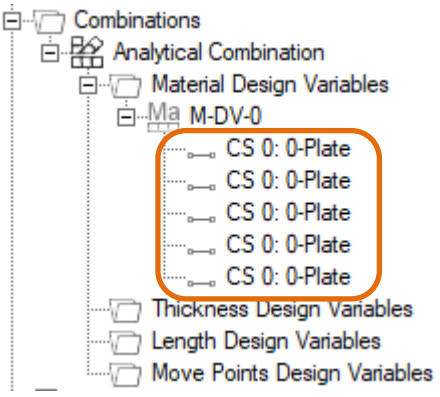




2) *After selecting plates, drag and drop them in the appropriate design variable in the Explorer tree.*

3) *All assigned plates will be automatically added to the design variable in the Explorer tree. Note that the plates contain information about the cross-section they come from.*

(*) After selecting a design variable in the Explorer window all plates assigned to it will be highlighted in orange in the 2D view window.



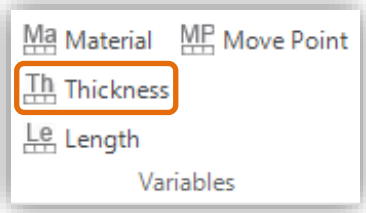
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

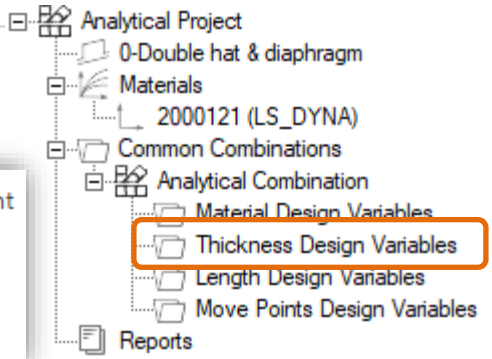
Thickness Design Variable

1. Create thickness design variable

The Thickness Design Variable enables to assign various thickness values within the defined range to a selected plate or a group of plates from different cross sections.

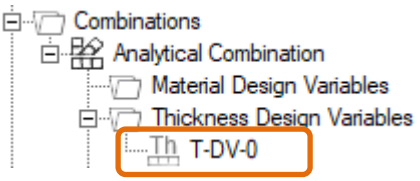
In order to define a design variable, select the Analytical Combination branch in the Explorer window. Afterwards click on the design variable icon available in the main toolbar.

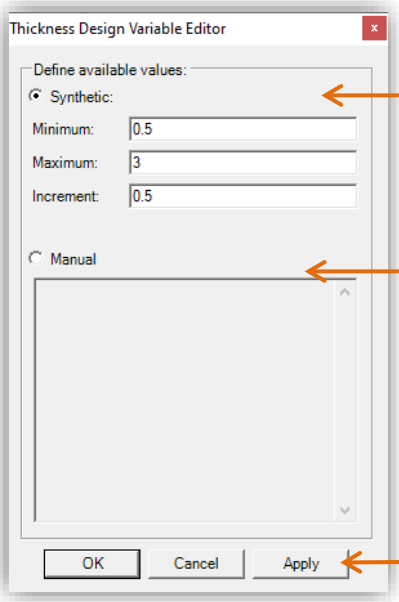




2. Set thickness design variable

Automatically a new Thickness Design Variable will appear in the Explorer tree. Double click on it to open "Thickness Design Variable Editor" and set the thicknesses.





In the "Thickness Design Variable Editor" the minimum and maximum value of plates thicknesses can be set. Additionally, the increment needs to be defined.

Alternatively, after checking the "Manual" option, it is possible to input set of user defined thickness values.

The design variable definition procedure ends by clicking on the "Apply" button.

Useful keyboard shortcuts:
*Key: **L** – show lengths*
*Key: **T** – show thickness*

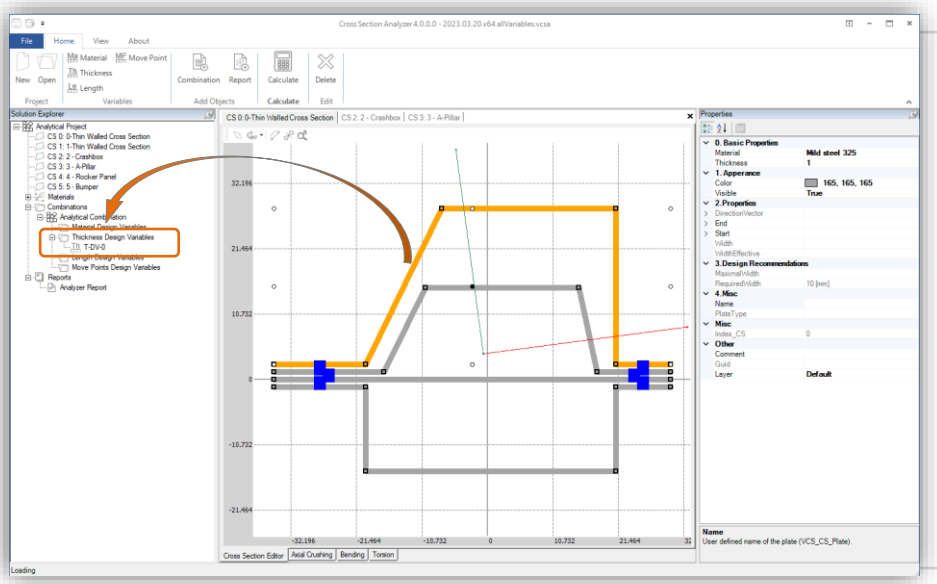
Click on the cross section 2D view and use one of the presented keyboard shortcuts in order to display plates thicknesses and / or lengths.

Basing on the design variables definition the software will automatically create cross sectional design variants, where prior selected plates will be given various thickness values.

Select specific design variable in the explorer tree to preview its settings. In the "Values" section of the Properties window all defined thickness options are listed.

Misc	
Increment	0.5
Manual	(Collection)
Maximum	3
Minimum	0.5
Name	T-DV-1
Synthetic	True
Values	{0.5', 1', 1.5', 2', 2.5', 3'}
Option 1	0.5
Option 2	1
Option 3	1.5
Option 4	2
Option 5	2.5
Option 6	3

3. Assign Plates to previously defined design variable



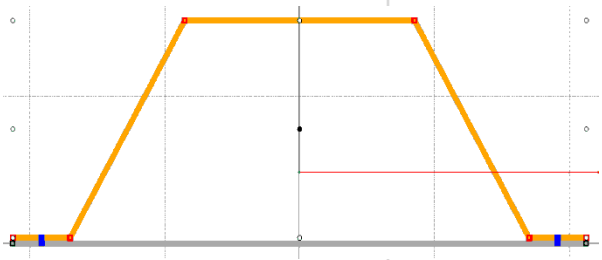
Select required plate or number of plates and afterwards drag and drop them in the appropriate design variable (in the Explorer window).

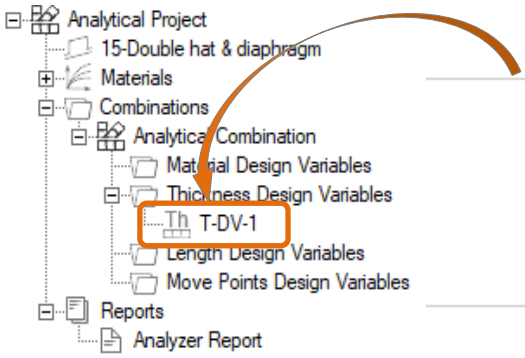
(*) Please note that you can add plates from different cross sections. Double click on cross section to open its window.

Step-by-step instruction on how to add plates to a variable is given below:

1) *Select required plate or number of plates in the 2D view. Use the CTRL button or area selection option to select multiple plates.*
All selected elements will be marked in orange.

(*) Please note that points are also automatically selected when using the area selection. They will however not be assigned to material nor thickness design variable.

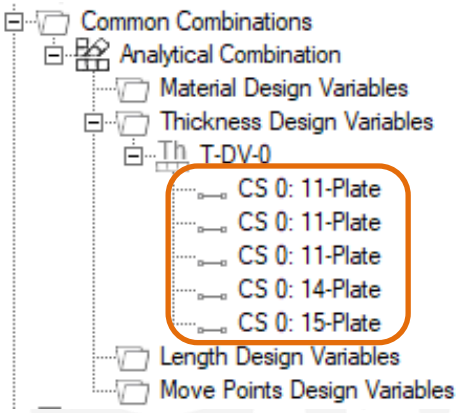




2) *After selecting plates, drag and drop them in the appropriate design variable in the Explorer tree.*

3) *All assigned plates will be automatically added to the design variable in the Explorer tree. Note that the plates contain information about the cross-section they come from.*

(*) After selecting a design variable in the Explorer window, all plates assigned to it will be highlighted in orange in the 2D view window.

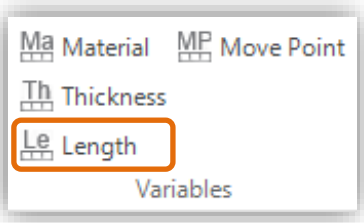


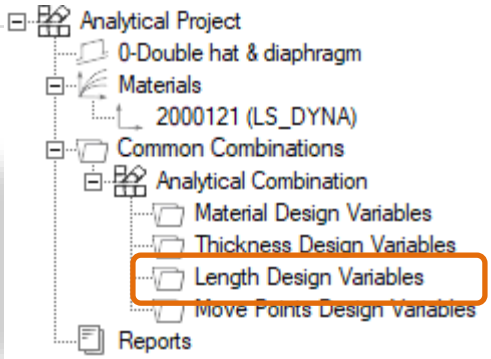
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

1. Create length design variable

The Length Design Variable enables to assign various length values within the defined range to a selected plate or a group of plates from different cross sections.

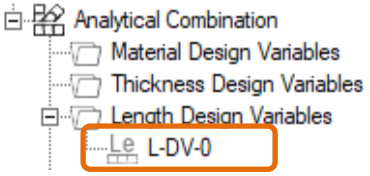
In order to define a design variable, select the Analytical Combination branch in the Explorer window. Afterwards click on the design variable icon available in the main toolbar.

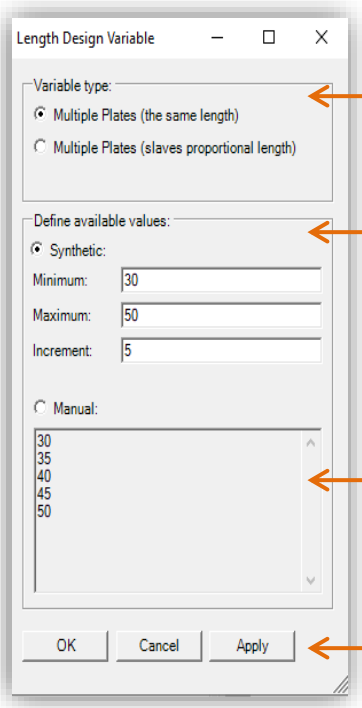




2. Set length design variable

Automatically a new Length Design Variable will appear in the Explorer tree. Double click on it to open "Length Design Variable Editor" and set the thicknesses.





The Length Design Variable offers two definition options:
- *Multiple Plates (the same length)*
- *Multiple Plates (slaves proportional length)*

In the "Length Design Variable" window the minimum and maximum length value for chosen plate or number of plates can be set.
Additionally, the increment needs to be defined.

Alternatively, after checking the "Manual" option, it is possible to enter set of user defined length values.

The design variable definition procedure ends by clicking on the "Apply" button.

Useful keyboard shortcuts:
*Key: **L** – show lengths*
*Key: **T** – show thickness*

Click on the cross section 2D view and use one of the presented keyboard shortcuts in order to display plates thicknesses and / or lengths.

3. Assign Plates and Points to previously defined design variable

After the definition of Length Design Variable is completed a plate or number of plates need to be assigned to it, as well as a set of master and slave points.

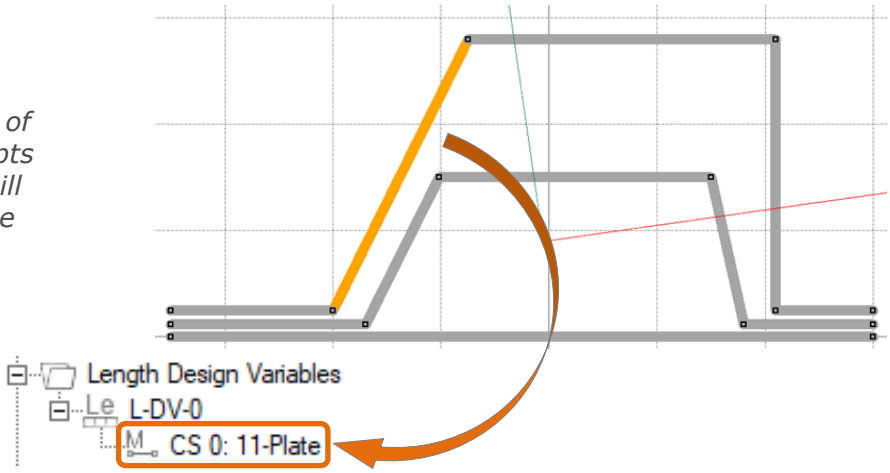
(*) Please note that you can add plates from different cross sections, but proportional plates length is implemented only within one section. Double click on cross section to open its window.

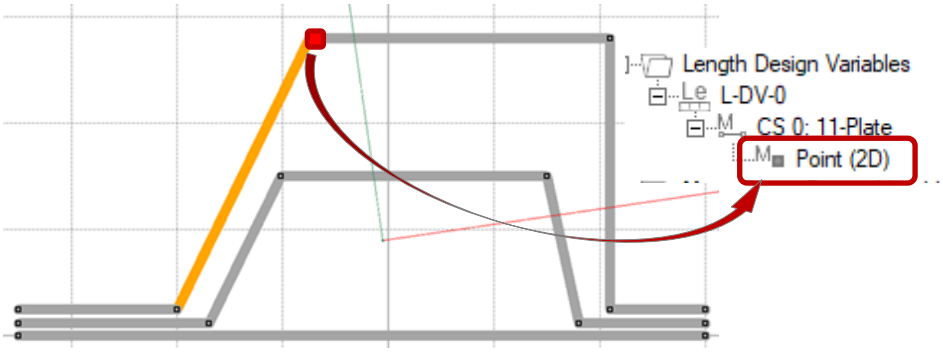
Sample procedures for assigning plates to design variables are described below:

Case 1: Single Plate

1) *Select Plate – during the analysis process CSA will automatically create number of cross-sectional design concepts in which this plate's length will be changed accordingly to the design variable's definition.*

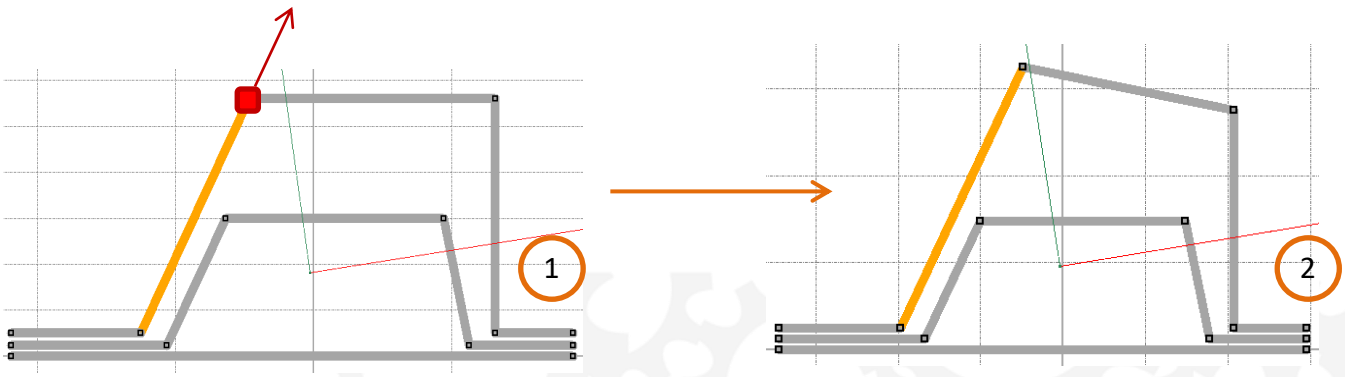
2) *Drag and drop the plate to previously defined **Length Design Variable** in the Explorer window.*
Note that the plates contain information about the cross-section they come from.





3) *Select Master Point (moving point) – plate's length will be changed in the direction of the selected point. In other words, only this selected point will be "moved".*

4) *Drag and drop selected Master Point to **Plate** in the Explorer tree*



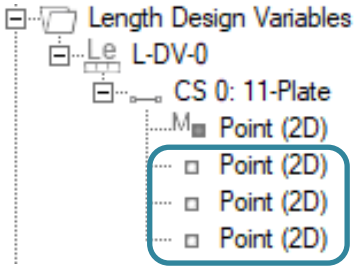
Case 2: Multiple Points

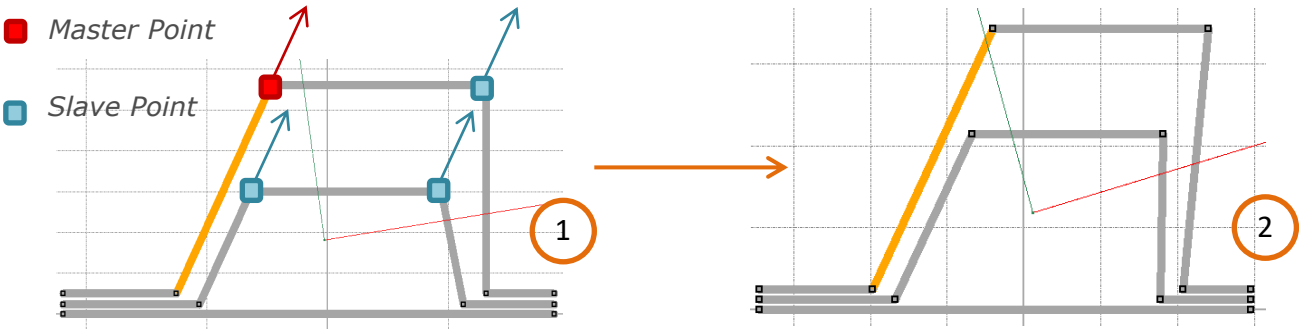
To each plate within a length design variable Slave Points can be assigned. Those points will be moved proportionally to the movement of the master point.

*Drag and drop selected Slave Points to **Plate** in the Explorer tree in the same way as the master point.*

Note that the first Point added to the Explorer tree is the master point. All points added below will be slave points.

The slave point will be moved along a vector parallel to the master plate.

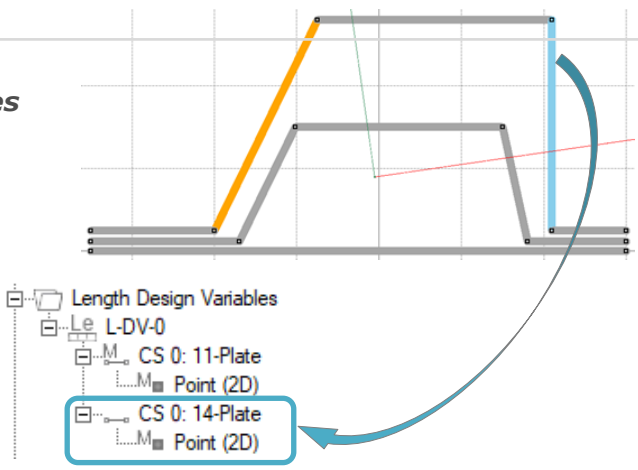




Case 3: Multiple Plates

To one Length Design Variable several plates can be assigned.

To each plate a moving point needs to be selected.

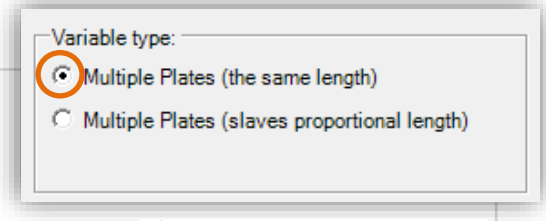


The Length Design Variable offers two options of multiple plate movement definition:

1. *Multiple plates – the same length*
2. *Multiple plates – slaves proportional length*

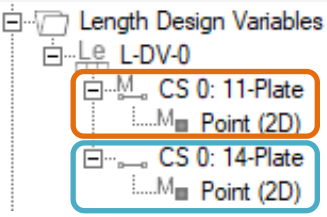
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

Case 3.1: Multiple plates – the same length

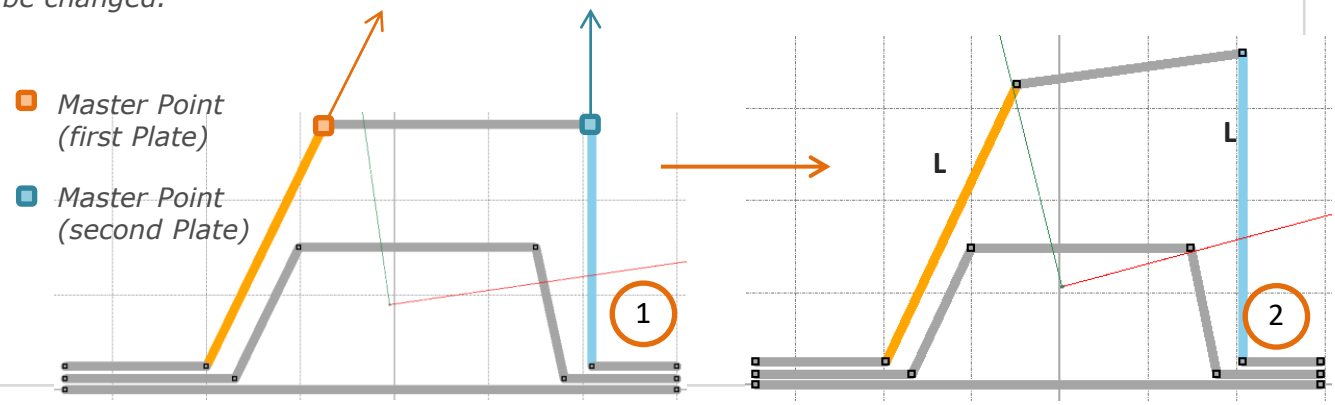


In case of the "the same length" option all plates assigned to the design variable will share the same length value.

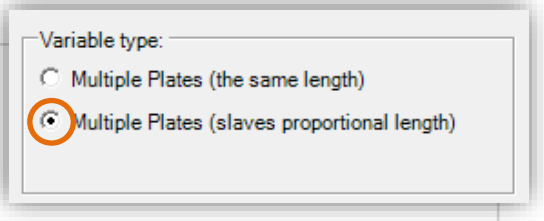
To each plate a moving point needs to be selected.
All moving Points (marked below in orange and blue) will change its position along a line tangent to its original plate (see below).



In consequence of such plate-length change in the presented example, the angles between plates of the cross section will be changed.

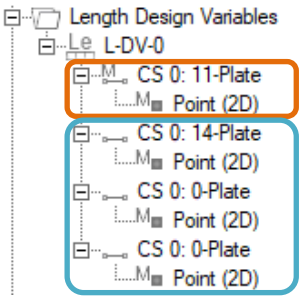


Case 3.2: Multiple plates – slaves proportional length



In case of the "slaves proportional length" the plate "defined" as a slave plate will change its length proportionally to the master plate.

Note that the first Plate added to the Explorer tree is the master plate. All plates added below will be slave plates.

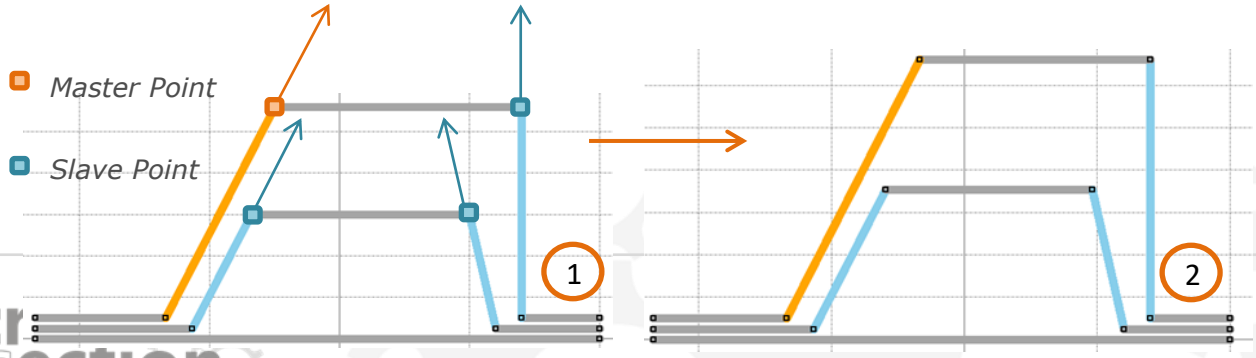


In the pictures below, the master plate is marked in orange and slave plates in blue.

To each plate a moving point needs to be selected.

The slave points (marked below in blue) will change their position along a line tangent to their original plates (see below), but they will not share a common length value. The length value will change proportionally to the master plate

In consequence of such plate-length change in the presented example, the angles between plates of the cross section will remain the same.

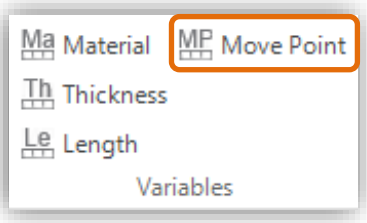


Move Point Design Variable

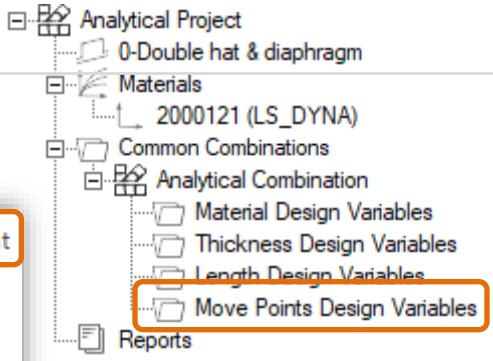
1. Create move point design variable

The Move Points Design Variable enables to assign various point vector values to a selected point or a group of points from different cross sections.

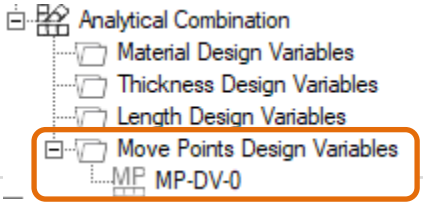
In order to define a design variable, select the Analytical Combination branch in the Explorer window.



Afterwards click on the design variable icon available in the main toolbar.



Automatically a new Move Point Design Variable (MP-DV) will appear in the Explorer tree.

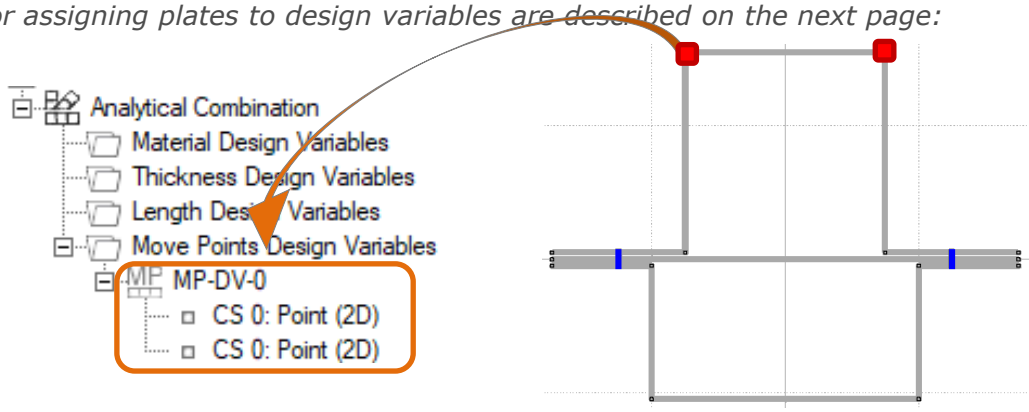


2. Assign points to the move point design variable

After the definition of Move Point Design Variable is completed, a points need to be assigned to it. Select required points or number of points and afterwards drag and drop them in the appropriate design variable (in the Explorer window).

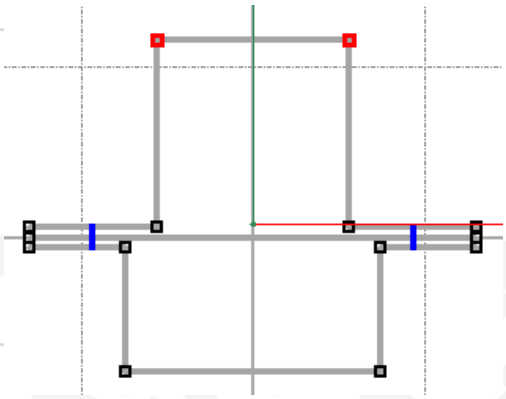
(*) Please note that you can add plates from different cross sections. Double click on cross section to open its window.

Sample procedures for assigning plates to design variables are described on the next page:



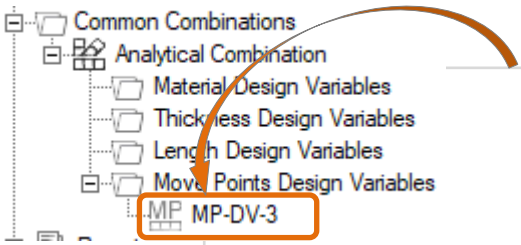
1) *Select required point or number of points in the 2D view. Use the CTRL button or area selection option to select multiple points. All selected elements will be marked in red.*

   (*) Please note that points are also automatically selected when using the area selection. They will however not be assigned to material nor thickness design variable.



Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

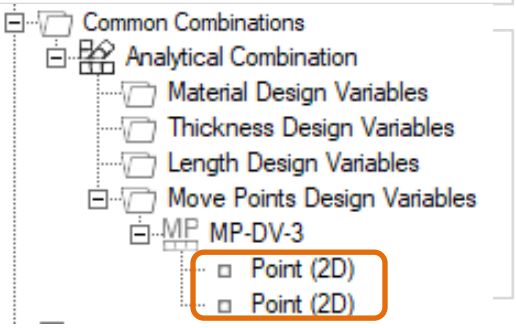
Move Point Design Variable



2) *After selecting plates, drag and drop them in the appropriate design variable in the Explorer tree.*

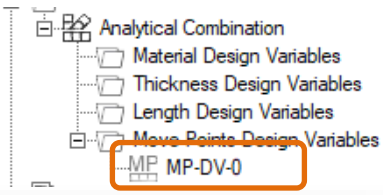
3) *All assigned plates will be automatically added to the design variable in the Explorer tree.*

(*) After selecting a design variable in the Explorer window, all plates assigned to it will be highlighted in orange in the 2D view window.



3. Set move point design variable

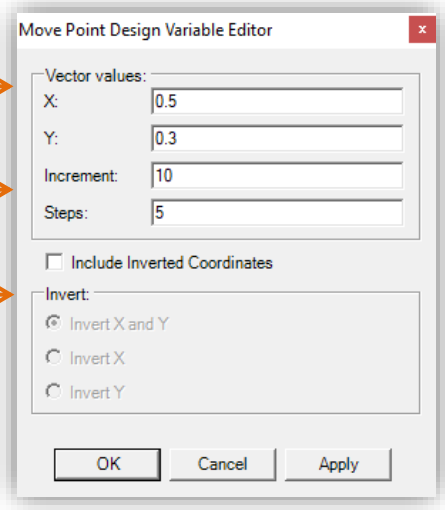
Automatically a new Move Point Design Variable will appear in the Explorer tree. Double click on it to open "Move Point Design Variable Editor" and set values.



Define the vector values (X and Y coordinates)

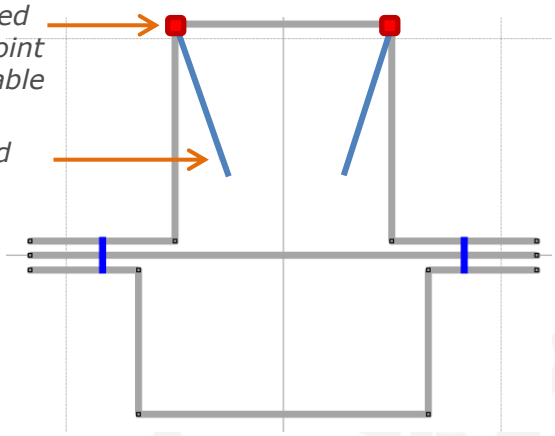
Define increment and number of steps

Define additional vector in selected direction



Point assigned to a Move Point Design Variable

User defined vector



Move point design variable can be previewed at any time.

After clicking on a Move Point Design Variable in the explorer tree all points assigned to it will be marked in red and vectors are displayed as blue lines.

Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

Inverted vectors

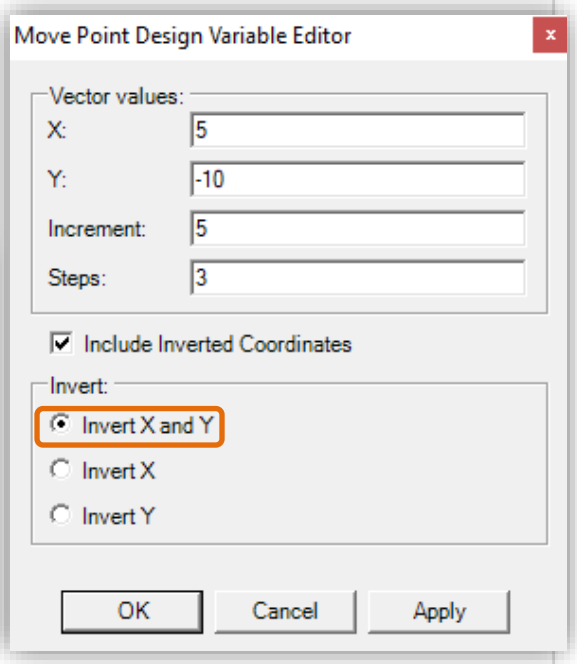
Move Point Design Variable gives the possibility to create additional inverted vector. Three options of inversion are described below:

Invert X and Y

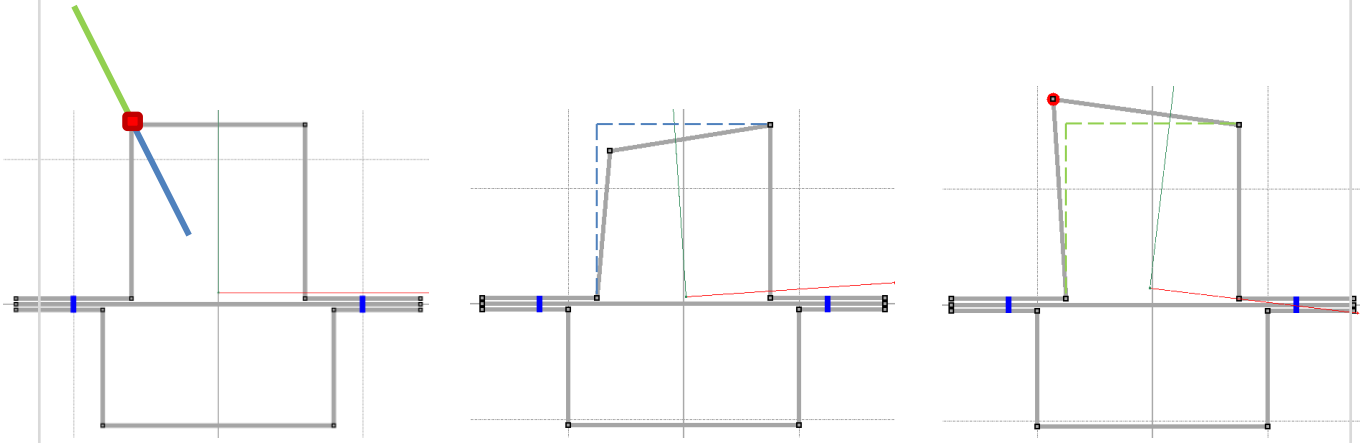
This option enables creation of additional vector in an inverted X and Y direction (marked in green in the picture below).
In the Properties window of Move Point Design Variable, the defined options can be previewed.

As a result of a fully defined move point design variable the CSA will automatically generate number of cross-sectional design variants.

Misc	
IncludeReverseVector	**True**
IncrementStep	**5**
MoveVectorX	**5**
MoveVectorY	**-10**
Name	**MP-DV-0**
Reverse_X	**True**
Reverse_Y	**True**
Steps	**3**
Values	{-10', -5', 0', 5', 10'}
Option 1	**-10**
Option 2	**-5**
Option 3	**0**
Option 4	**5**
Option 5	**10**



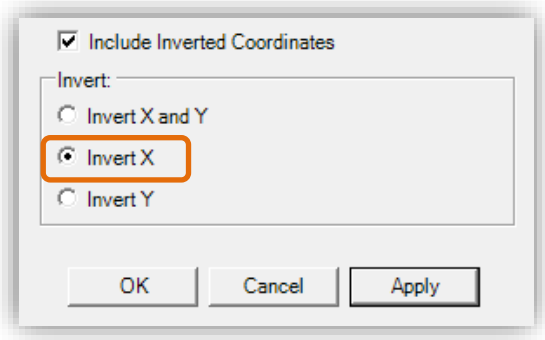
Coordinates of assigned points will be changed along the defined vectors.
Please see the example below:



Original cross section

Examples of automatically generated variants of cross-sectional geometry.

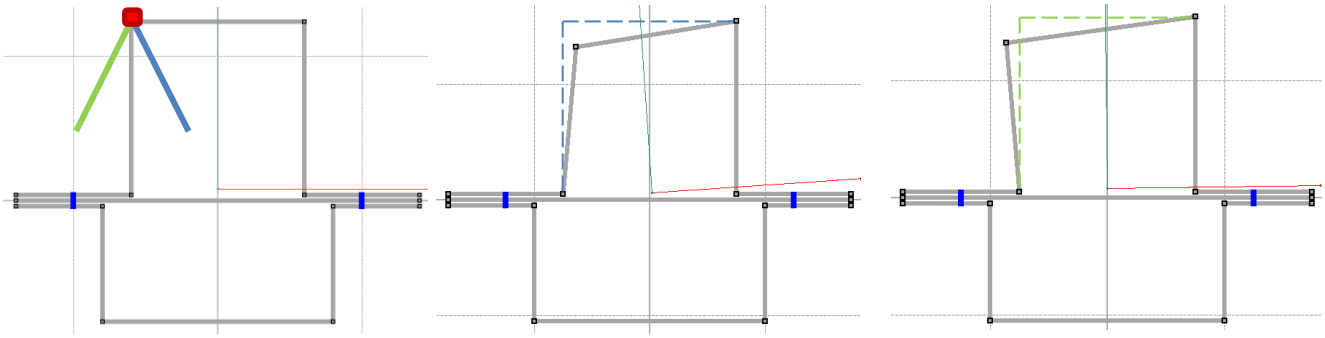
Invert X



*This option enables the creation of additional vector in **inverted X direction** (marked in green in the picture below).*

In the Properties window of Move Point Design Variable, the defined options can be previewed.

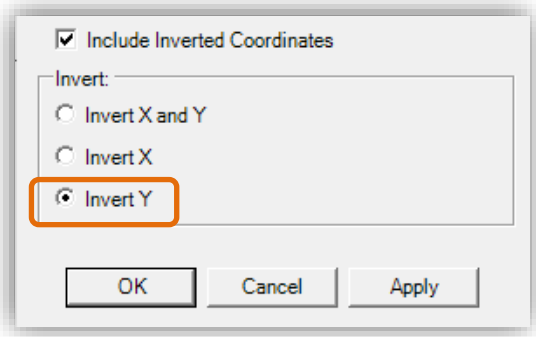
Coordinates of assigned points will be changed along the defined vectors.
Please see the example below:



Original cross section

Examples of automatically generated variants of cross-sectional geometry.

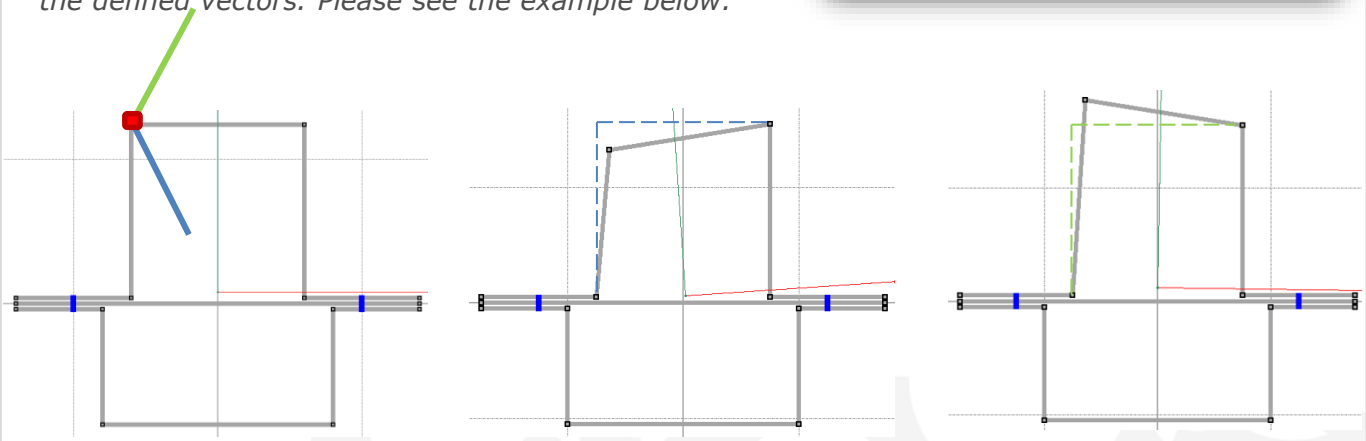
Invert Y



*This option enables the creation of additional vector in inverted **Y direction** (marked in green in the picture below).*

In the Properties window of Move Point Design Variable, the defined options can be previewed.

Coordinates of assigned points will be changed along the defined vectors. Please see the example below:

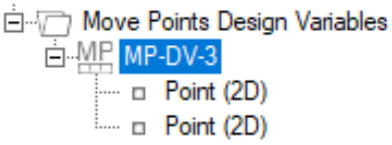


Original cross section

Examples of automatically generated variants of cross-sectional geometry.

Move Point Design Variable

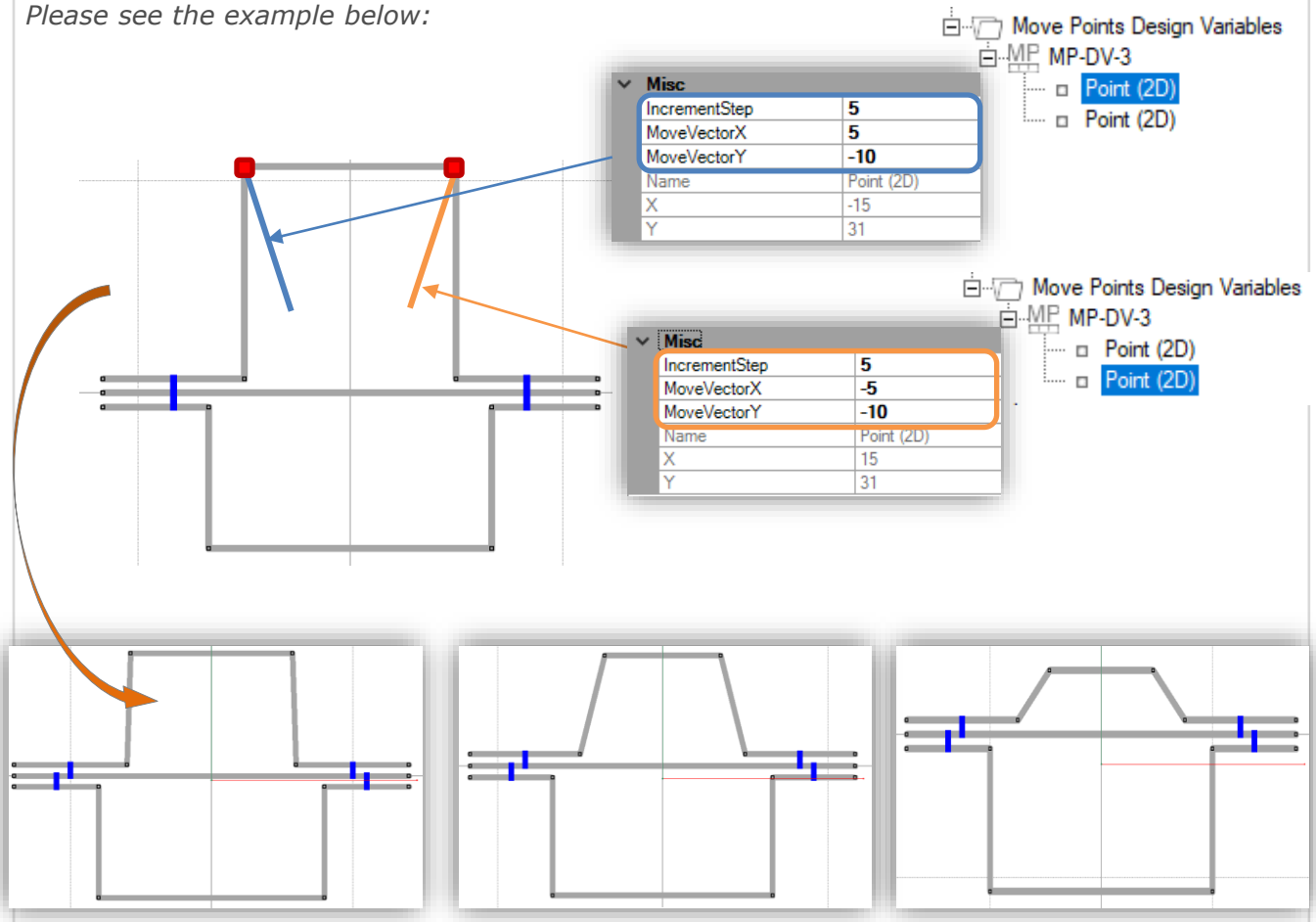
Note that Move Point Design Variable settings can be viewed and edited in the Properties window. Inverted vector settings also can be changed in the Properties window.



Misc	
IncludeReverseVector	**False**
IncrementStep	**5**
MoveVectorX	**5**
MoveVectorY	**-10**
Name	**MP-DV-0**
Reverse_X	**False**
Reverse_Y	**False**
Steps	**3**
Values	{0', 5', 10'}

Independent vectors

Note that the Move Point Design Variable can be edited for each point independently in the Properties window. The change of vector setting can be made after selecting a specific point in the Explorer Tree.
Coordinates of assigned points will be changed along the defined vectors.
Please see the example below:



Original cross section

Examples of automatically generated variants of cross-sectional geometry.

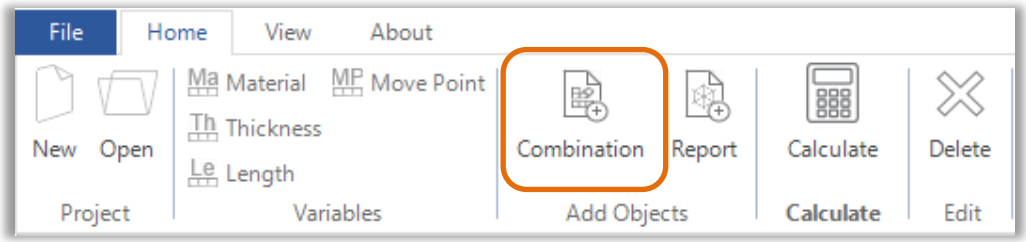
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

CREATE NEW ANALYTICAL COMBINATION

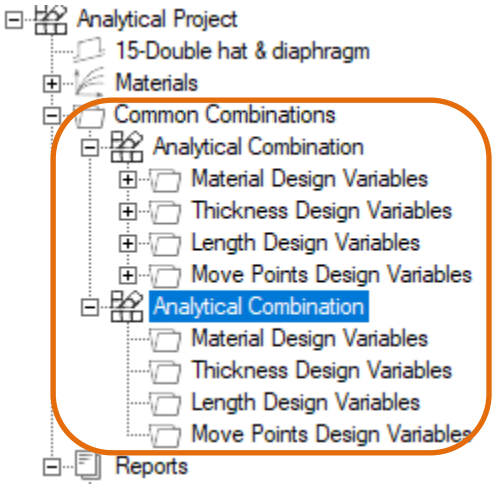
User can create number of analytical combinations within a single Analyzer Project. This enables to analyze even more design option within one Analyzer Project.

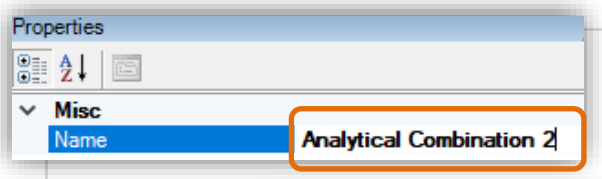
User can have common Analytical Combination for all cross sections or an Analytical Combination for each cross section separately.

In order to create additional Analytical Combination, select place to be added and simply click on the icon in CSA main menu.



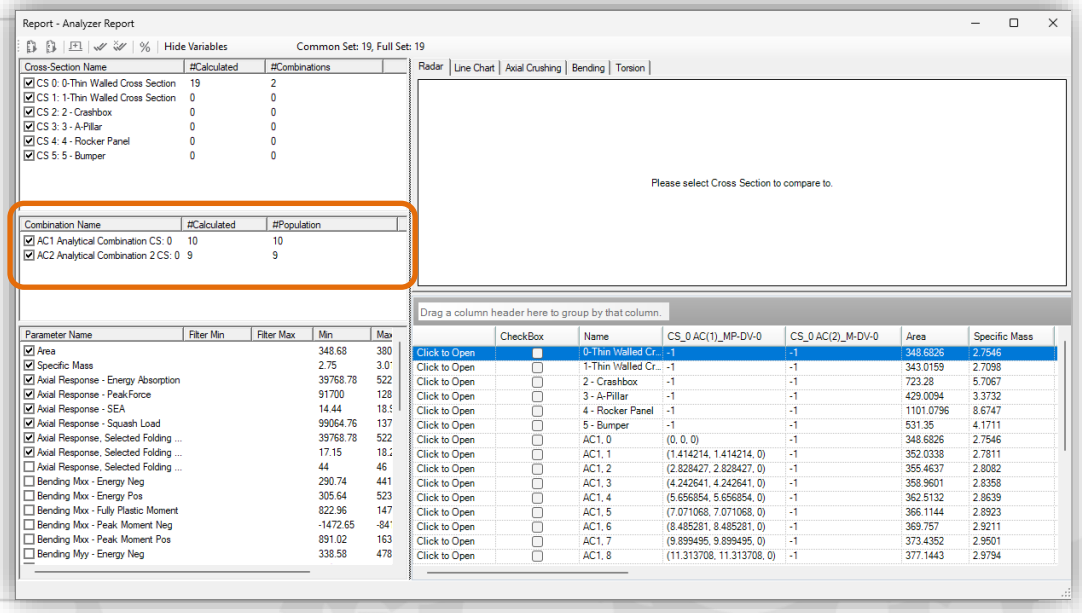
New Analytical Combination branch will be added to the Explorer tree together with a set of folders for four types of design variables.





Name of the Analytical Combination can be changed in the Properties window.

All Analytical Combinations are visible in the Analyzer Report window.

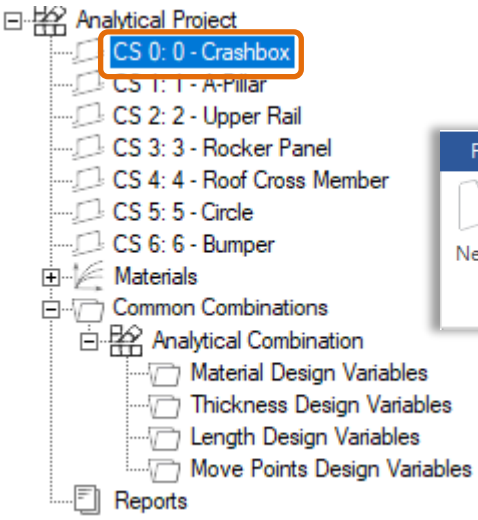


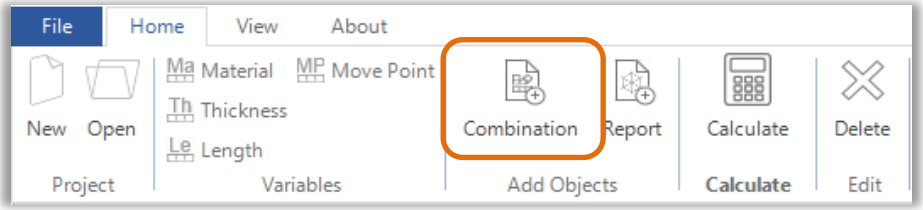
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

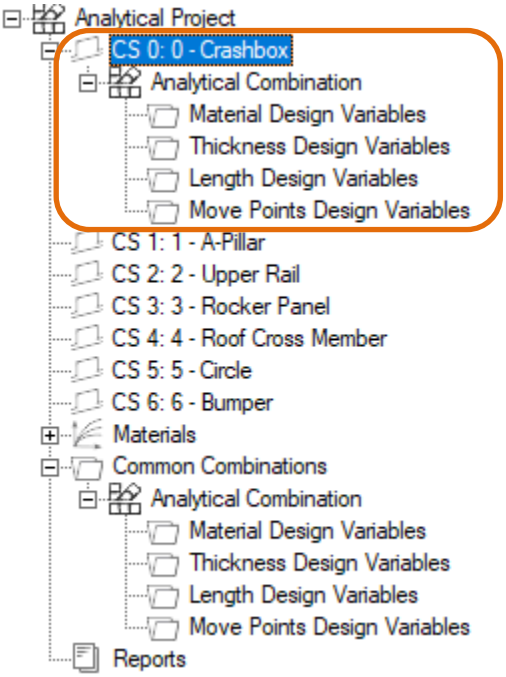
CREATE NEW ANALYTICAL COMBINATION

Alternatively, you can create an internal Analytical Combination for each cross section.

In this case, select requested cross section and click Combination button. After that internal analytical combination will be added to the cross section and will be ready to create variables.







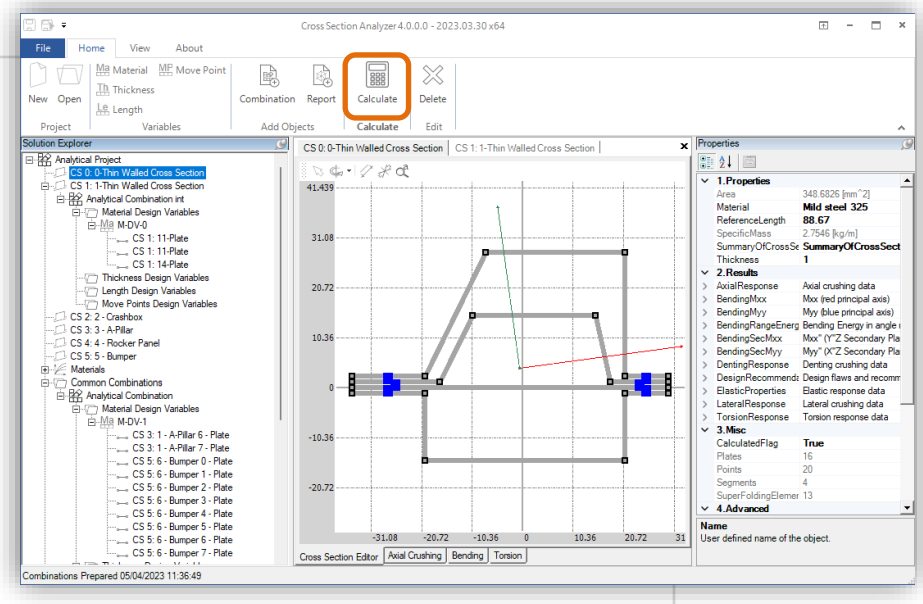
Each object can be removed from the CSA project after clicking on the "Delete" icon in the main toolbar or delete button on the keyboard.

CALCULATE

The Cross Section Analyzer automatically creates and calculates cross sectional design variants (combinations) basing on the previously defined design variables.

The user can choose to calculate

- *the entire Analytical Project,*
- *solely Internal Analytical Combinations created within one cross-sectional folder*
- *Common Combinations.*

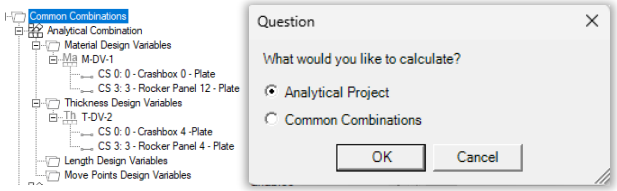


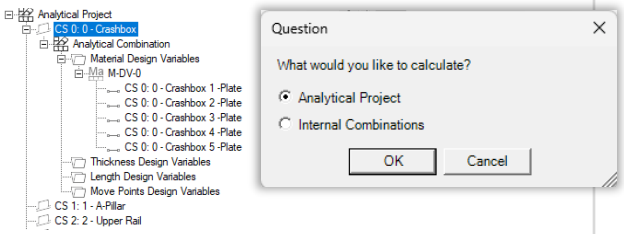
In order to start the calculation routine, indicate in the Explorer tree what is to be calculated , click on the "Calculate" icon in the main toolbar.

Calculation of the entire Analytical project is always possible regardless of the object currently selected in the Explorer tree. After selecting Calculate button, question window appears. Select the Analytical Project radio button and confirm by "OK".

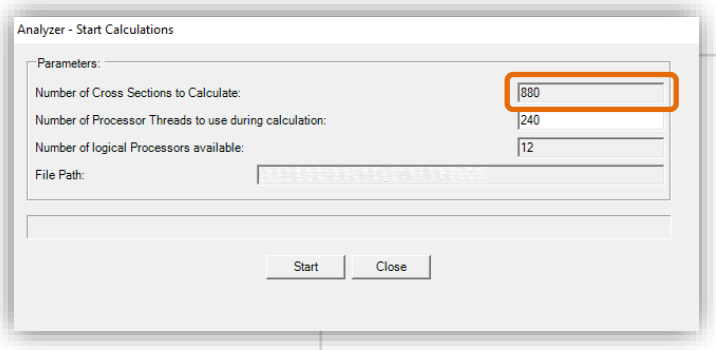
In order to calculate only Common Combinations, before selecting Calculate button, user needs to indicate the Common Combination or any elements of the "Common Combination" folder. In the question window select the proper radio button and confirm by "OK".

In order to calculate only Internal Combinations of a specific cross section, before selecting Calculate button, user needs to indicate the cross section that is to be calculated or any element within its folder, select proper radio button in the question window and confirm by "OK".

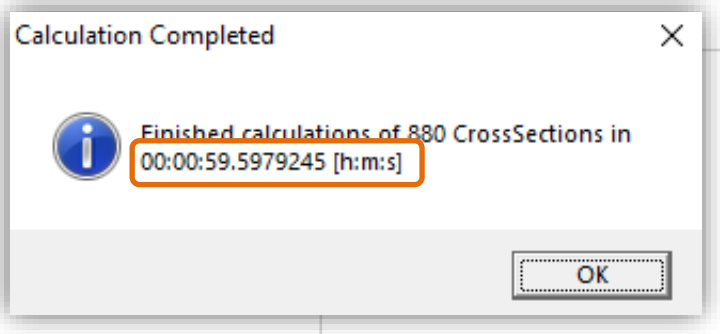




Important notice:
CSA project needs to be saved before the calculations.

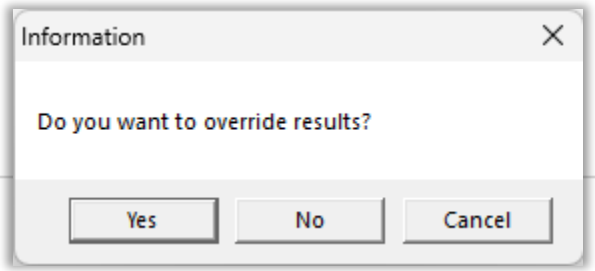


In the "Analyzer – Start Calculations" window user can preview the number of cross sections that are to be calculated. In the given example the software created 880 cross sections

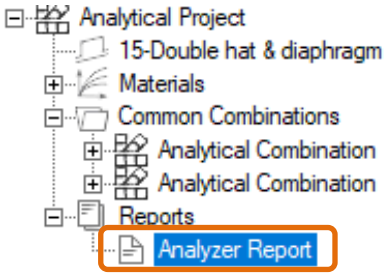


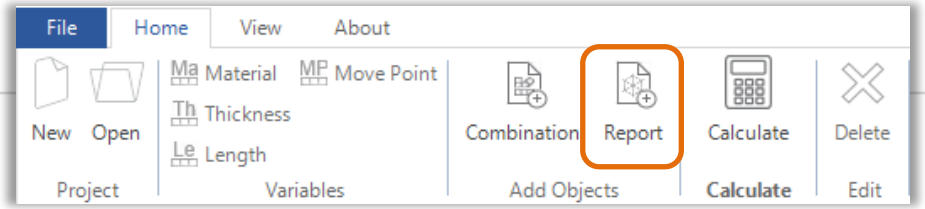
One of the greatest advantages on the Analyzer software is the speed of calculations.
In the given example calculation of 880 cross sections took slightly over 59 seconds.

If you start a calculation but a file with that name already exists, you will be asked whether to overwrite the results or save the project as a new file. Select the appropriate action.



Results of the cross-sectional analysis are available in the "Analyzer Report" window.





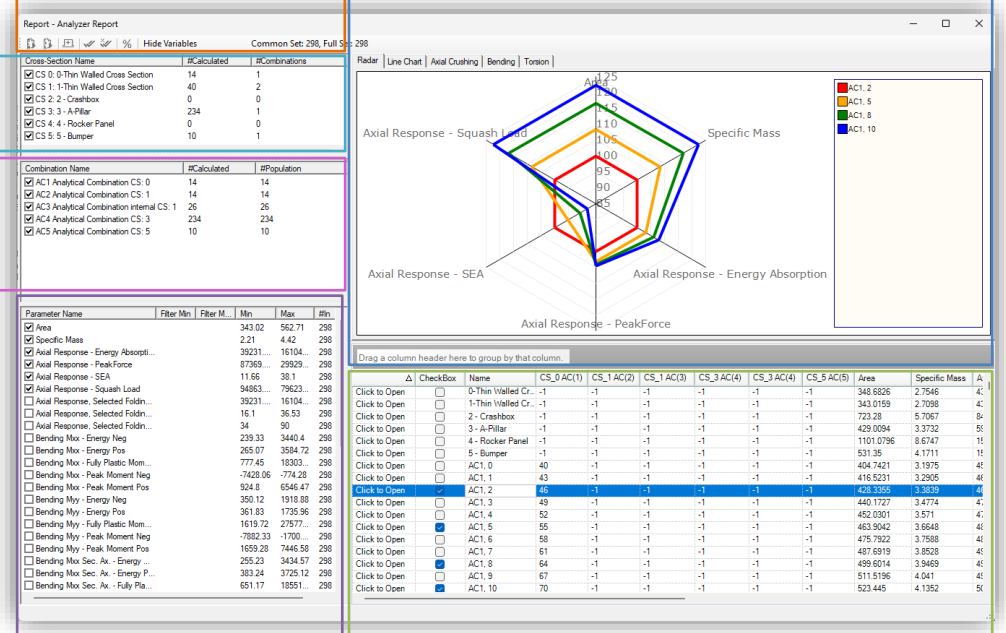
Click on the "Report" icon in CSA main toolbar after the calculations are done. A new "Analyzer Report" will be automatically added to the explorer tree.
Double click on it to view calculation results in the Analyzer Report window. You can add any number of analytical reports with different settings and filters.
Note, that all reports refer to the latest conducted calculation. If you wish to save a Report, you need to save the entire CSA solution.

Report toolbar
A set of tools to work in the report window.

The "Radar" window
In this window graphs illustrating the comparison of selected cross-sections can be displayed (only chosen results are taken into account).

Cross Sections zone
You can select Cross Sections to be displayed.

Combinations zone
You can select Analytical Combinations to be displayed.



Parameters zone
In this zone you can select Parameters to be displayed and find the minimum and maximum values of specific results. You can also define filters here.

List of Results
Displays all cross-sectional design variants which fulfill the user selections and filtering limitations if applicable.
For each selected cross section, results in Radar window are shown.

cross section analyzer

RESULTS REPORT – Cross Sections Zone

In the cross sections zone, user can find a list of available Cross Sections. The user can display all available cross sections or choose several that are meaningful to him.

In this zone user can also find information about number of calculated variants of specific cross sections and number of combinations related to them.

Cross-Section Name	#Calculated	#Combinations
CS 0: 0-Thin Walled Cross Section	14	1
CS 1: 1-Thin Walled Cross Section	40	2
CS 2: 2 - Crashbox	0	0
CS 3: 3 - A-Pillar	234	1
CS 4: 4 - Rocker Panel	0	0
CS 5: 5 - Bumper	10	1

Combination Name	#Calculated	#Population
AC1 Analytical Combination CS: 0	14	14
AC2 Analytical Combination CS: 1	14	14
AC3 Analytical Combination internal CS: 1	26	26
AC4 Analytical Combination CS: 3	234	234
AC5 Analytical Combination CS: 5	10	10

To hide irrelevant cross sections, uncheck them.

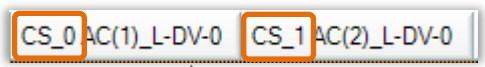
Please note that after unchecking the cross section its combinations disappear from the Combinations zone and from the list of results.

Cross-Section Name	#Calculated	#Combinations
CS 0: 0-Thin Walled Cross Section	0	0
CS 1: 1-Thin Walled Cross Section	40	2
CS 2: 2 - Crashbox	0	0
CS 3: 3 - A-Pillar	234	1
CS 4: 4 - Rocker Panel	0	0
CS 5: 5 - Bumper	0	0

Combination Name	#Calculated	#Population
AC2 Analytical Combination CS: 1	14	14
AC3 Analytical Combination internal CS: 1	26	26
AC4 Analytical Combination CS: 3	234	234

Each Analytical Combination contain index of cross section with which is related.

The corresponding columns in the list of results contain cross-section indexes.



	CheckBox	Name	CS_0 AC(1)_L-DV-0	CS_1 AC(2)_L-DV-0	CS_1 AC(3)_M-DV-0	CS_3 AC(4)_T-DV-2	CS_3 AC(4)_M-DV-1	CS_5 AC(5)_MP-DV-0	Area	Spe
Click to Open	☐	0-Thin Walled Cr...	-1	-1	-1	-1	-1	-1	348.6826	2.75
Click to Open	☐	1-Thin Walled Cr...	-1	-1	-1	-1	-1	-1	343.0159	2.70
Click to Open	☐	2 - Crashbox	-1	-1	-1	-1	-1	-1	723.28	5.70
Click to Open	☐	3 - A-Pillar	-1	-1	-1	-1	-1	-1	429.0094	3.37
Click to Open	☐	4 - Rocker Panel	-1	-1	-1	-1	-1	-1	1101.0796	8.67
Click to Open	☐	5 - Bumper	-1	-1	-1	-1	-1	-1	531.35	4.17
Click to Open	☐	AC1, 0	40	-1	-1	-1	-1	-1	404.7421	3.19
Click to Open	☐	AC1, 1	43	-1	-1	-1	-1	-1	416.5231	3.29
Click to Open	☑	AC1, 2	46	-1	-1	-1	-1	-1	428.3355	3.38
Click to Open	☐	AC1, 3	49	-1	-1	-1	-1	-1	440.1727	3.47
Click to Open	☐	AC1, 4	52	-1	-1	-1	-1	-1	452.0301	3.57
Click to Open	☑	AC1, 5	55	-1	-1	-1	-1	-1	463.9042	3.66
Click to Open	☐	AC1, 6	58	-1	-1	-1	-1	-1	475.7922	3.75
Click to Open	☐	AC1, 7	61	-1	-1	-1	-1	-1	487.6919	3.85
Click to Open	☑	AC1, 8	64	-1	-1	-1	-1	-1	499.6014	3.94

RESULTS REPORT – Combinations Zone

In the combination zone, user can find a list of available Analytical Combinations. The user can display all available combinations or choose several that are meaningful to him.

In this zone user can also find information about number of population of specific combination and info if they are calculated in the current opening.

Cross-Section Name	#Calculated	#Combinations
☑ CS 0: 0-Thin Walled Cross Section	14	1
☑ CS 1: 1-Thin Walled Cross Section	40	2
☑ CS 2: 2 - Crashbox	0	0
☑ CS 3: 3 - A-Pillar	234	1
☑ CS 4: 4 - Rocker Panel	0	0
☑ CS 5: 5 - Bumper	10	1

Combination Name	#Calculated	#Population
☑ AC1 Analytical Combination CS: 0	14	14
☑ AC2 Analytical Combination CS: 1	14	14
☑ AC3 Analytical Combination internal CS: 1	26	26
☑ AC4 Analytical Combination CS: 3	234	234
☑ AC5 Analytical Combination CS: 5	10	10

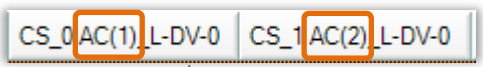
Please note that after unchecking the cross section its combinations disappear from the Combinations zone.

Cross-Section Name	#Calculated	#Combinations
☐ CS 0: 0-Thin Walled Cross Section	0	0
☑ CS 1: 1-Thin Walled Cross Section	40	2
☑ CS 2: 2 - Crashbox	0	0
☑ CS 3: 3 - A-Pillar	234	1
☑ CS 4: 4 - Rocker Panel	0	0
☐ CS 5: 5 - Bumper	0	0

Combination Name	#Calculated	#Population
☑ AC2 Analytical Combination CS: 1	14	14
☑ AC3 Analytical Combination internal CS: 1	26	26
☑ AC4 Analytical Combination CS: 3	234	234

Each Analytical Combination contain index of cross section with which is related.

The corresponding columns in the list of results contain analytical combination indexes.



	CheckBox	Name	CS_0 AC(1)_L-DV-0	CS_1 AC(2)_L-DV-0	CS_1 AC(3)_M-DV-0	CS_3 AC(4)_T-DV-2	CS_3 AC(4)_M-DV-1	CS_5 AC(5)_MP-DV-0	Area	Spe
Click to Open	☐	0-Thin Walled Cr...	-1	-1	-1	-1	-1	-1	348.6826	2.75
Click to Open	☐	1-Thin Walled Cr...	-1	-1	-1	-1	-1	-1	343.0159	2.70
Click to Open	☐	2 - Crashbox	-1	-1	-1	-1	-1	-1	723.28	5.70
Click to Open	☐	3 - A-Pillar	-1	-1	-1	-1	-1	-1	429.0094	3.37
Click to Open	☐	4 - Rocker Panel	-1	-1	-1	-1	-1	-1	1101.0796	8.67
Click to Open	☐	5 - Bumper	-1	-1	-1	-1	-1	-1	531.35	4.17
Click to Open	☐	AC1, 0	40	-1	-1	-1	-1	-1	404.7421	3.19
Click to Open	☐	AC1, 1	43	-1	-1	-1	-1	-1	416.5231	3.29
Click to Open	☑	AC1, 2	46	-1	-1	-1	-1	-1	428.3355	3.38
Click to Open	☐	AC1, 3	49	-1	-1	-1	-1	-1	440.1727	3.47
Click to Open	☐	AC1, 4	52	-1	-1	-1	-1	-1	452.0301	3.57
Click to Open	☑	AC1, 5	55	-1	-1	-1	-1	-1	463.9042	3.66
Click to Open	☐	AC1, 6	58	-1	-1	-1	-1	-1	475.7922	3.75
Click to Open	☐	AC1, 7	61	-1	-1	-1	-1	-1	487.6919	3.85
Click to Open	☑	AC1, 8	64	-1	-1	-1	-1	-1	499.6014	3.94

List of all available parameters.

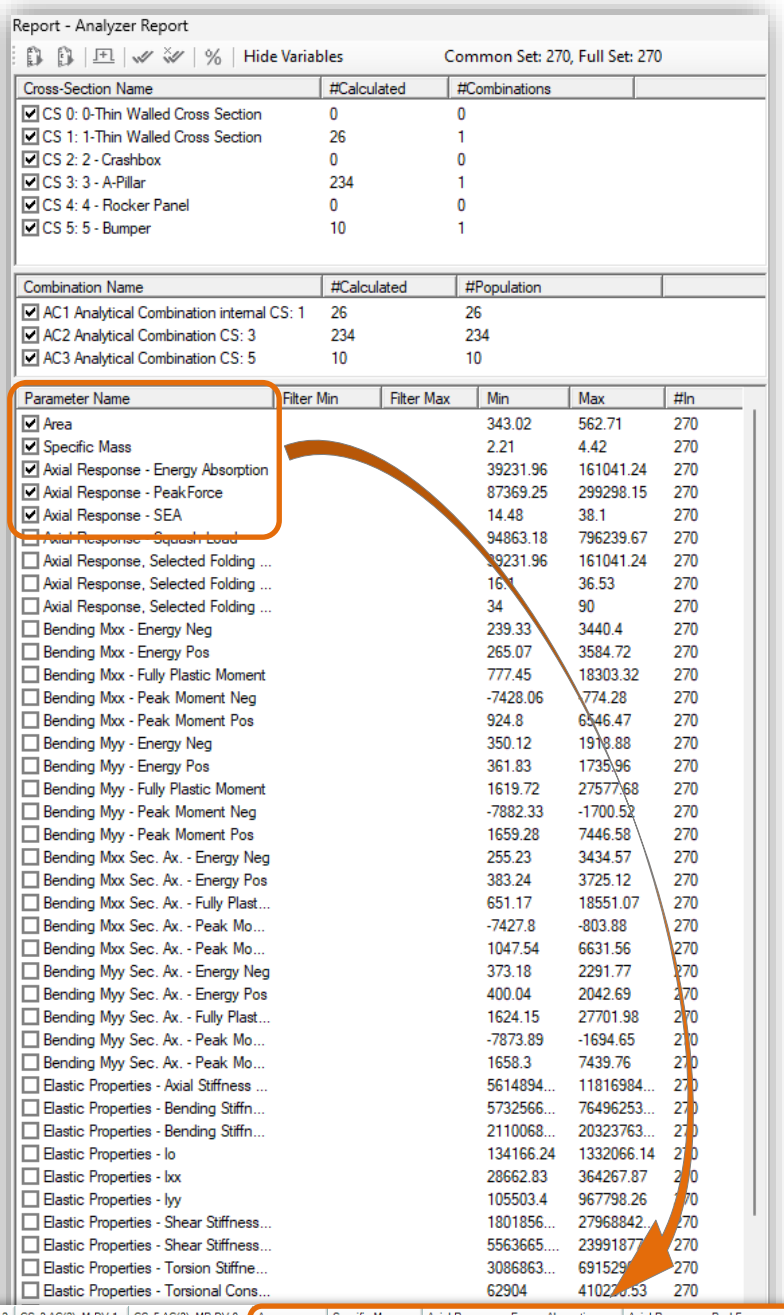
The user can choose several types of results that are meaningful to him.

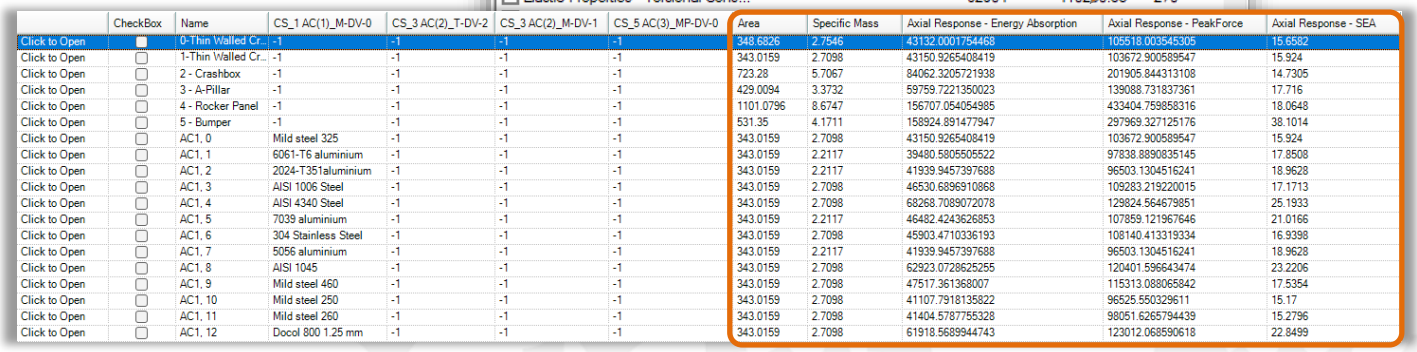
When the specific parameter is selected, its values will be added to the cross-section list and to the Radar window.

In appropriate columns user can find the minimum and maximum values of specific results detected after calculation.

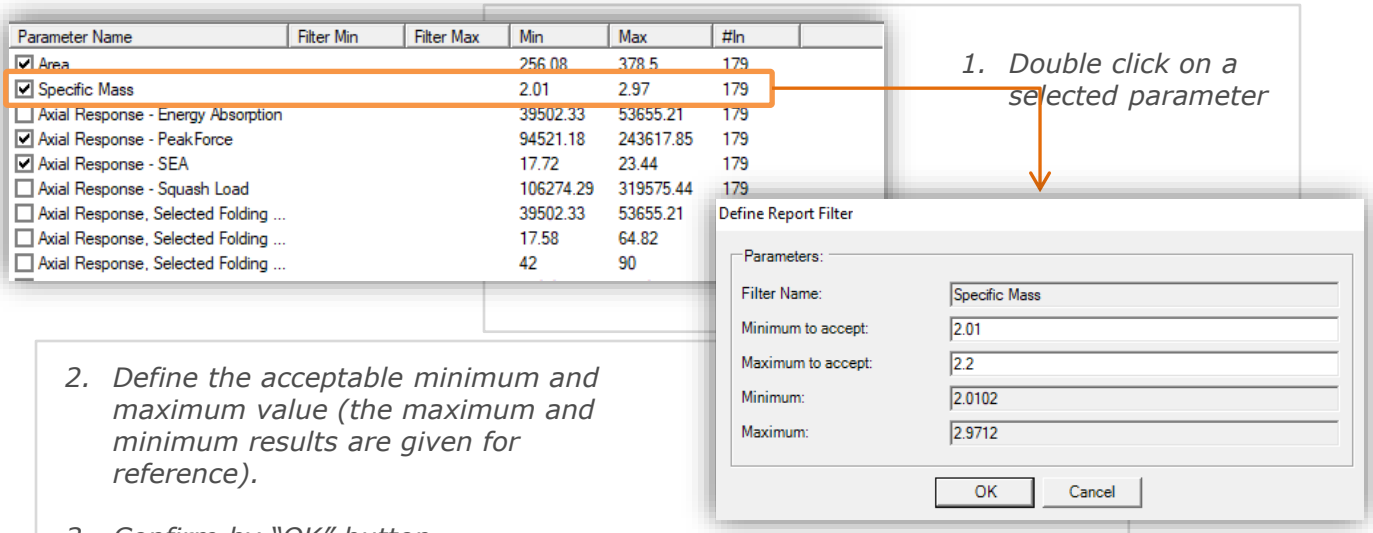
Filters limiting the maximum and / or minimum value of a parameter can be applied here.

** Detailed information on the parameters is available in the "VCS - Cross Section Editor Manual".*





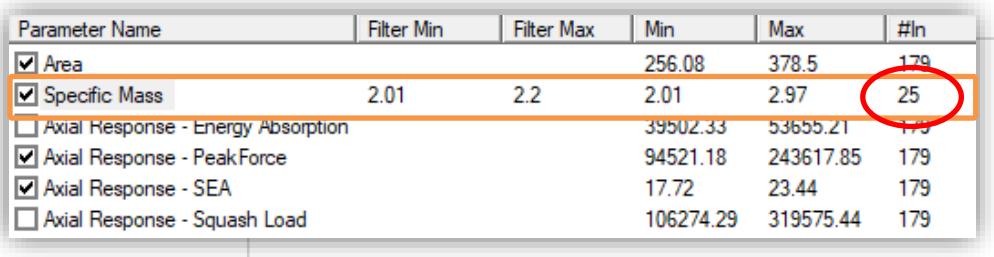
Double click on a selected parameter to define the results filter



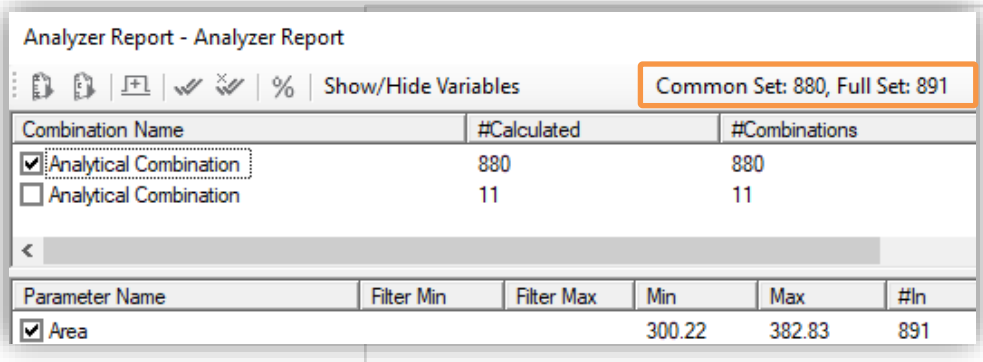
2. *Define the acceptable minimum and maximum value (the maximum and minimum results are given for reference).*

3. *Confirm by "OK" button*

The filter is now defined. You can see the number of cross sections within the filter's range in the "In#" column (see below).
In the "List of calculated cross sections" window only those cross sections which fulfill the filter's conditions will be listed (as long, as the filtered parameter is checked).



Number of cross section which are contained within the filter's range.



On the top of the report window additional information about common set of cross sections is displayed.
"Common set" gives the number of cross sections which fulfil the requirements of all defined filters.

In the example presented above 2 filters were defined (for specific mass and SEA).
From the total number of 179 calculated cross sections 25 fit in the range of both filters.

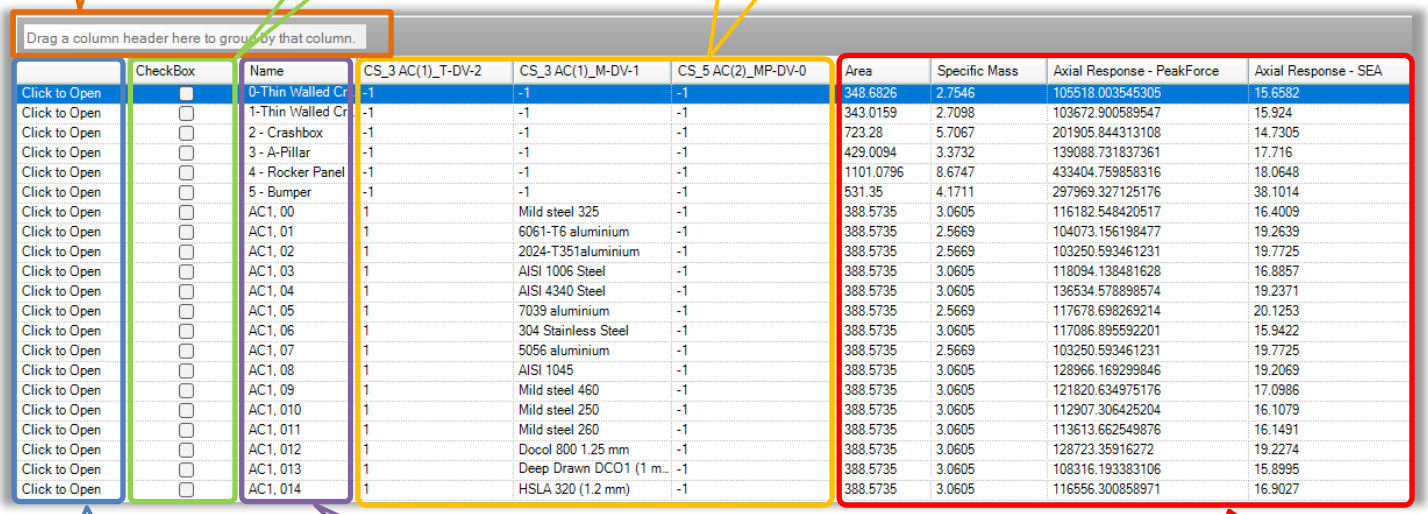
cross section analyzer

***List containing** all cross-sectional design variants which fulfill the filtering limitations, or all calculated variants if no filter has been defined.*

Grouping by data content functionality.

Check-boxes allow to export and compare cross-sections.

Column group that contains information about each assigned design variable for all analytical combinations.



Drag a column header here to group by that column.

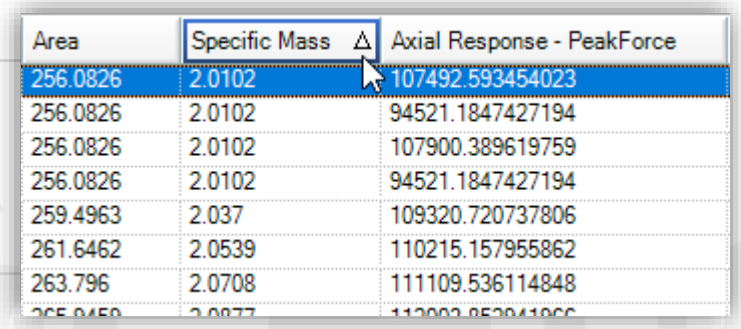
	CheckBox	Name	CS_3 AC(1)_T-DV-2	CS_3 AC(1)_M-DV-1	CS_5 AC(2)_MP-DV-0	Area	Specific Mass	Axial Response - PeakForce	Axial Response - SEA
Click to Open	☐	0-Thin Walled Cr	-1	-1	-1	348.6826	2.7546	105518.003545305	15.6582
Click to Open	☐	1-Thin Walled Cr	-1	-1	-1	343.0159	2.7098	103672.900589547	15.924
Click to Open	☐	2 - Crashbox	-1	-1	-1	723.28	5.7067	201905.844313108	14.7305
Click to Open	☐	3 - A-Pillar	-1	-1	-1	429.0094	3.3732	139088.731837361	17.716
Click to Open	☐	4 - Rocker Panel	-1	-1	-1	1101.0796	8.6747	433404.759858316	18.0648
Click to Open	☐	5 - Bumper	-1	-1	-1	531.35	4.1711	297969.327125176	38.1014
Click to Open	☐	AC1, 00	1	Mild steel 325	-1	388.5735	3.0605	116182.548420517	16.4009
Click to Open	☐	AC1, 01	1	6061-T6 aluminium	-1	388.5735	2.5669	104073.156198477	19.2639
Click to Open	☐	AC1, 02	1	2024-T351aluminium	-1	388.5735	2.5669	103250.593461231	19.7725
Click to Open	☐	AC1, 03	1	AISI 1006 Steel	-1	388.5735	3.0605	118094.138481628	16.8857
Click to Open	☐	AC1, 04	1	AISI 4340 Steel	-1	388.5735	3.0605	136534.578898574	19.2371
Click to Open	☐	AC1, 05	1	7039 aluminium	-1	388.5735	2.5669	117678.698269214	20.1253
Click to Open	☐	AC1, 06	1	304 Stainless Steel	-1	388.5735	3.0605	117086.895592201	15.9422
Click to Open	☐	AC1, 07	1	5056 aluminium	-1	388.5735	2.5669	103250.593461231	19.7725
Click to Open	☐	AC1, 08	1	AISI 1045	-1	388.5735	3.0605	128966.169299846	19.2069
Click to Open	☐	AC1, 09	1	Mild steel 460	-1	388.5735	3.0605	121820.634975176	17.0986
Click to Open	☐	AC1, 010	1	Mild steel 250	-1	388.5735	3.0605	112907.306425204	16.1079
Click to Open	☐	AC1, 011	1	Mild steel 260	-1	388.5735	3.0605	113613.662549876	16.1491
Click to Open	☐	AC1, 012	1	Docol 800 1.25 mm	-1	388.5735	3.0605	128723.35916272	19.2274
Click to Open	☐	AC1, 013	1	Deep Drawn DC01 (1 m...	-1	388.5735	3.0605	108316.193383106	15.8995
Click to Open	☐	AC1, 014	1	HSLA 320 (1.2 mm)	-1	388.5735	3.0605	116556.300858971	16.9027

"Click to Open" button enables to open cross-section's individual CSE window.

Column containing the names of cross-sectional variants with info about combination number.

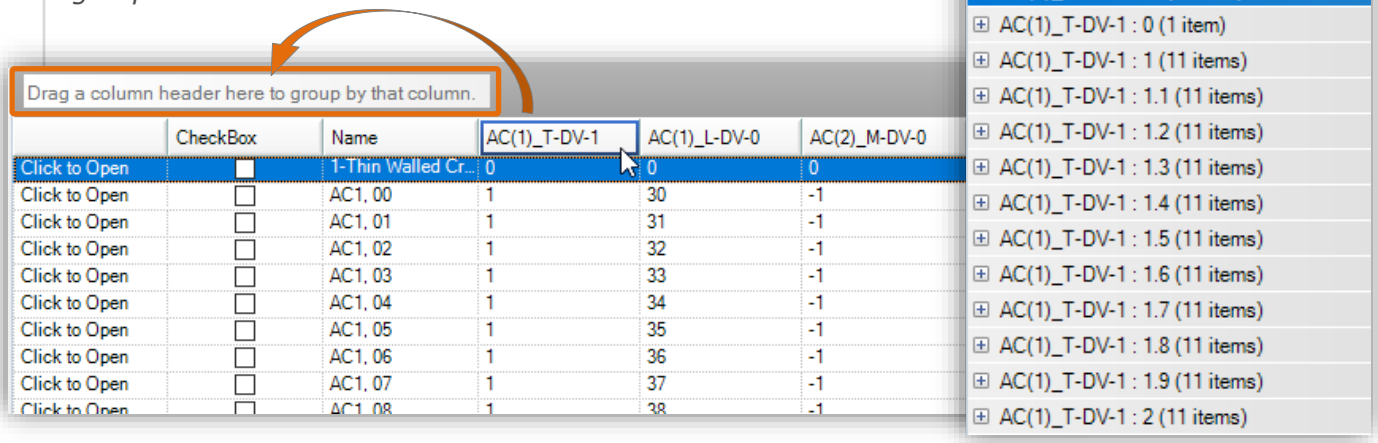
Column group containing values of parameters selected from the list of results.

Please note that the data can be sorted by smallest or largest values after clicking on the header of selected column.

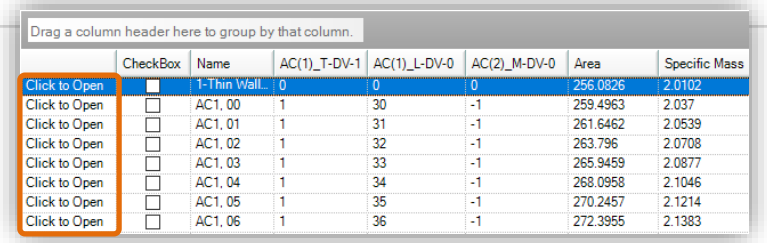


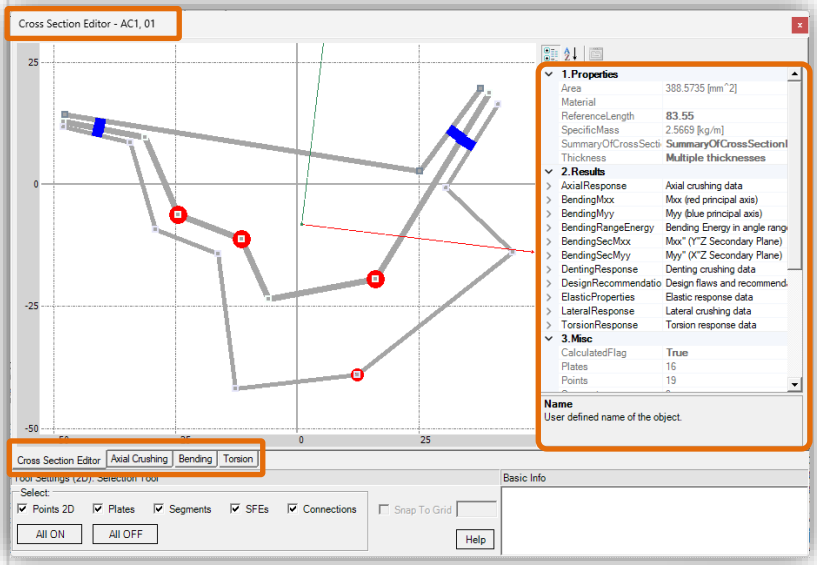
Area	Specific Mass △	Axial Response - PeakForce
256.0826	2.0102	107492.593454023
256.0826	2.0102	94521.1847427194
256.0826	2.0102	107900.389619759
256.0826	2.0102	94521.1847427194
259.4963	2.037	109320.720737806
261.6462	2.0539	110215.157955862
263.796	2.0708	111109.536114848

To group cross-sections by data content, drag and drop the specific header of the column according to which they are to be grouped.



"Click to Open" button enable to open cross-section's individual Cross Section Editor window

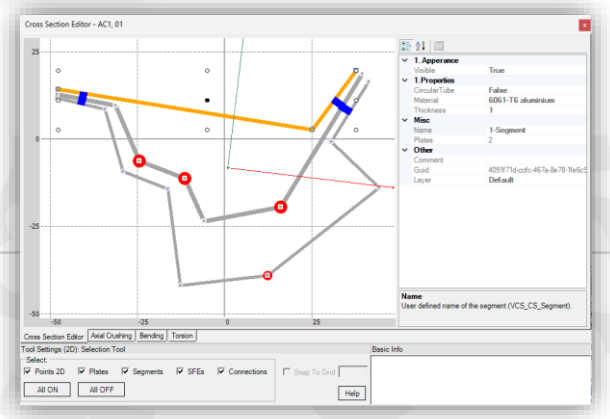




- *View the geometry of the selected variant.*
- *All results are available in the Properties part of the window*
- *Additionally result charts are available under appropriate bookmarks.*

Useful tip:
To display all results of selected cross-section, click its name in the upper left corner of the CSE.

Moreover, properties of any selected element of the cross section can be displayed.



cross section analyzer

Column group containing information about each assigned design variable for all analytical combinations.

Combination Name	#Calculated	#Population
☑ AC1 Analytical Combination CS: 3	234	234
☑ AC2 Analytical Combination CS: 5	10	10

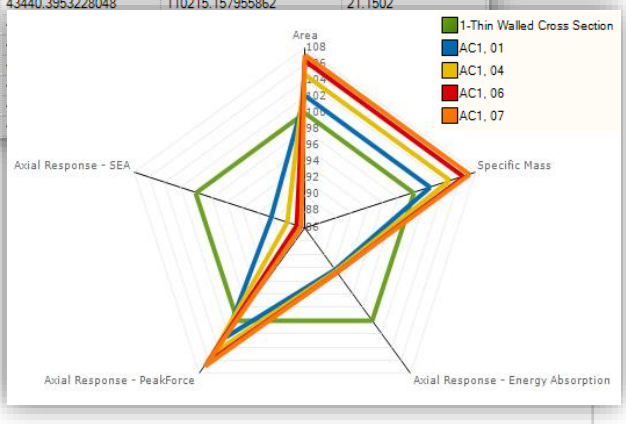
	CheckBox	Name	CS_3 AC(1)_T-DV-2	CS_3 AC(1)_M-DV-1	CS_5 AC(2)_MP-DV-0	Area	Specific Mass	Axial Res
Click to Open	☐	0-Thin Walled Cr...	-1	-1	-1	348.6826	2.7546	105518.00
Click to Open	☐	1-Thin Walled Cr...	-1	-1	-1	343.0159	2.7098	103672.90
Click to Open	☐	2 - Crashbox	-1	-1	-1	723.28	5.7067	201905.84
Click to Open	☐	3 - A-Pillar	-1	-1	-1	429.0094	3.3732	139088.73
Click to Open	☐	4 - Rocker Panel	-1	-1	-1	1101.0796	8.6747	433404.75
Click to Open	☐	5 - Bumper	-1	-1	-1	531.35	4.1711	297969.32
Click to Open	☐	AC1, 00	1	Mild steel 325	-1	388.5735	3.0605	116182.54
Click to Open	☐	AC1, 01	1	6061-T6 aluminium	-1	388.5735	2.5669	104073.15
Click to Open	☐	AC1, 02	1	2024-T351aluminium	-1	388.5735	2.5669	103250.59
Click to Open	☐	AC1, 03	1	AISI 1006 Steel	-1	388.5735	3.0605	118094.13
Click to Open	☐	AC1, 04	1	AISI 4340 Steel	-1	388.5735	3.0605	136534.57
Click to Open	☐	AC1, 05	1	7039 aluminium	-1	388.5735	2.5669	117678.69
Click to Open	☐	AC1, 06	1	304 Stainless Steel	-1	388.5735	3.0605	117086.89
Click to Open	☐	AC1, 07	1	5056 aluminium	-1	388.5735	2.5669	103250.59
Click to Open	☐	AC1, 08	1	AISI 1045	-1	388.5735	3.0605	128966.16
Click to Open	☐	AC1, 09	1	Mild steel 460	-1	388.5735	3.0605	121820.63

The number in brackets informs about the analytical combination it relates to.

The individual design variables can be identified by their symbol:
T - Thickness DV
M - Material DV
L - Length DV
MP - Move Point DV

*At any time, the group of columns with variables can be hidden using **Hide Variables** button.*

	CheckBox	Name	AC(1)_T-DV-1	AC(1)_L-DV-0	AC(2)_M-DV-0	Area	Specific Mass	Axial Response - Energy	Axial Response - PeakForce	Axial Response - SEA
Click to Open	☑	1-Thin Wa...	0	0	0	256.0826	2.0102	47100.4059132553	107492.593454023	23.4307
Click to Open	☐	AC1, 00	1	30	-1	259.4963	2.037	43393.0229005406	109320.720737806	21.3024
Click to Open	☑	AC1, 01	1	31	-1	261.6462	2.0539	43440.3953228048	110215.157955862	21.1502
Click to Open	☐	AC1, 02	1	32	-1	263.796	2.0708			
Click to Open	☐	AC1, 03	1	33	-1	265.9459	2.0877			
Click to Open	☑	AC1, 04	1	34	-1	268.0958	2.1046			
Click to Open	☐	AC1, 05	1	35	-1	270.2457	2.1214			
Click to Open	☑	AC1, 06	1	36	-1	272.3955	2.1383			
Click to Open	☑	AC1, 07	1	37	-1	274.5454	2.1552			



Indicate check-boxes of cross-sections that are to be added to comparison. The graph appears in the "Radar" window.

*To check or uncheck all available cross-sections click on **Select All** / **Deselect All** button from the toolbar.*

cross section analyzer

RESULTS REPORT – "Radar" window

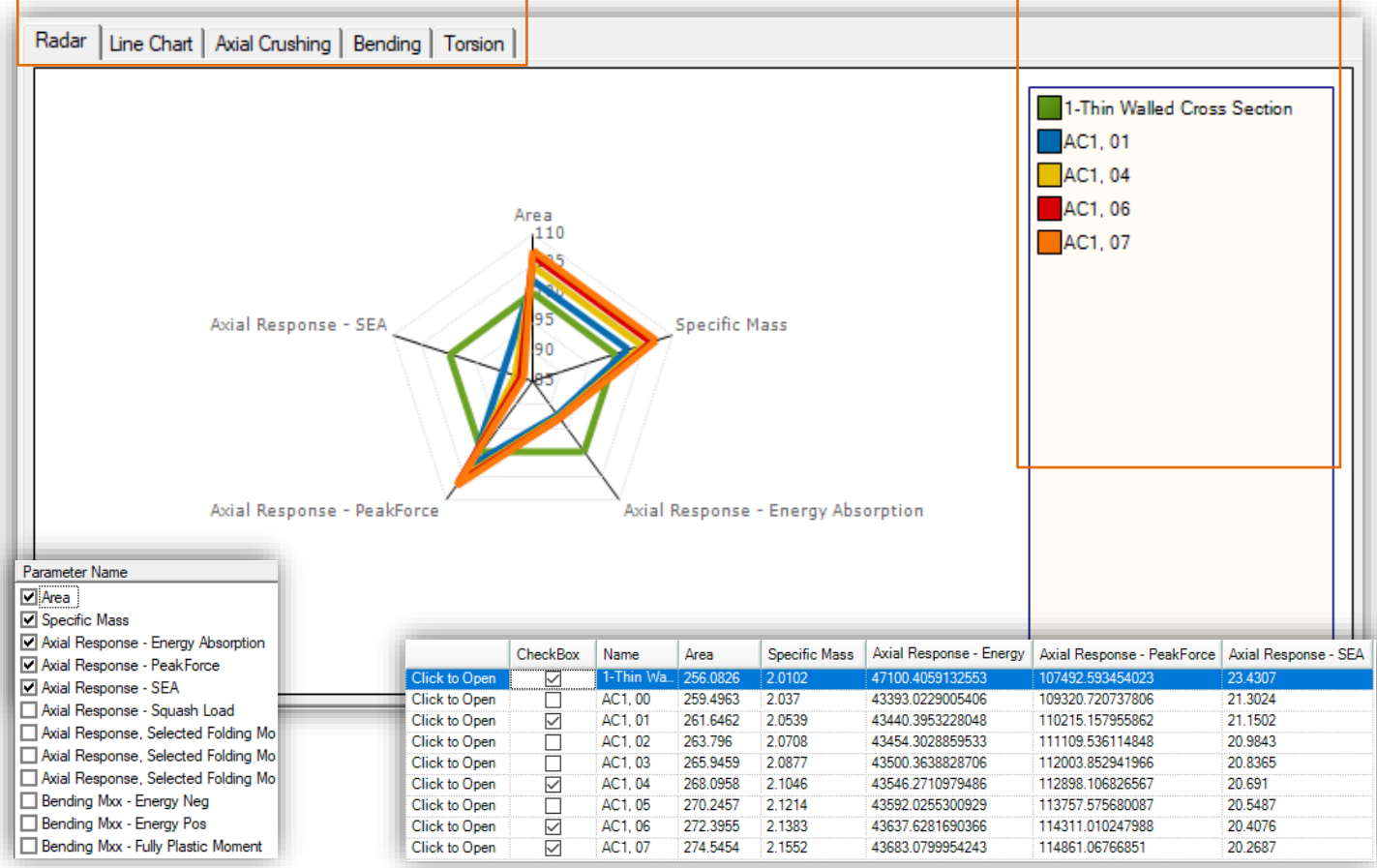
The "Radar" window allows to compare the different results of the selected cross-sections.

In the main Radar window, a radar graph illustrating the comparison of selected cross sections in percentage rate is displayed (only chosen results are taken into account).

Additionally, the graphs with line chart and axial, bending, torsion response can be displayed here.

Graphs available for display

Legend of colors that represent results for prior selected response



	CheckBox	Name	Area	Specific Mass	Axial Response - Energy	Axial Response - PeakForce	Axial Response - SEA
Click to Open	☑	1-Thin Wa...	256.0826	2.0102	47100.4059132553	107492.593454023	23.4307
Click to Open	☐	AC1, 00	259.4963	2.037	43393.0229005406	109320.720737806	21.3024
Click to Open	☑	AC1, 01	261.6462	2.0539	43440.3953228048	110215.157955862	21.1502
Click to Open	☐	AC1, 02	263.796	2.0708	43454.3028859533	111109.536114848	20.9843
Click to Open	☐	AC1, 03	265.9459	2.0877	43500.3638828706	112003.852941966	20.8365
Click to Open	☑	AC1, 04	268.0958	2.1046	43546.2710979486	112898.106826567	20.691
Click to Open	☐	AC1, 05	270.2457	2.1214	43592.0255300929	113757.575680087	20.5487
Click to Open	☑	AC1, 06	272.3955	2.1383	43637.6281690366	114311.010247988	20.4076
Click to Open	☑	AC1, 07	274.5454	2.1552	43683.0799954243	114861.06766851	20.2687

To display Radar graph:

1. Select parameters that are to be included.

2. Add or remove a cross-sections to the comparison. Simply check or uncheck it in the "List of calculated cross sections" window.

Important notice
The selected cross-section (marked in blue) is treated as a reference point to which other values are compared (in percentage rate).

RESULTS REPORT – "Radar" window

*Apart from the "Radar" functionality the Results report includes the **Line Chart** bookmark which enables more detailed analysis of selected cross sections.*

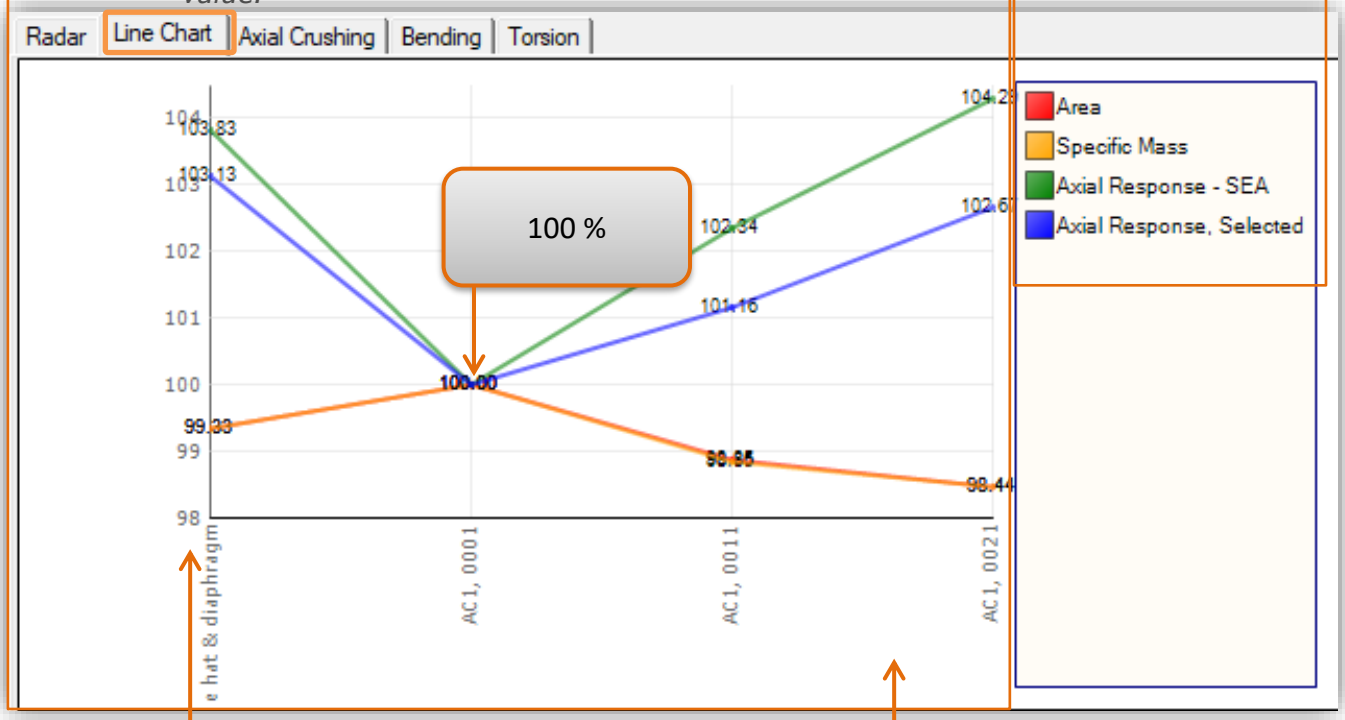
In the center of the "line chart" view lines representing results for number of selected cross sections are displayed.

In the example presented below:

- *Blue line represents results for axial response – peak force.*
- *Results are given for 4 selected cross sections.*
- *One selected cross section is treated as a reference point to which other values are compared (in percentage rate). In the given example the third cross section is selected for reference, and therefore its results are given 100% value.*

Colorful lines represent results for prior selected response.

In the given example lines for 6 results are displayed.

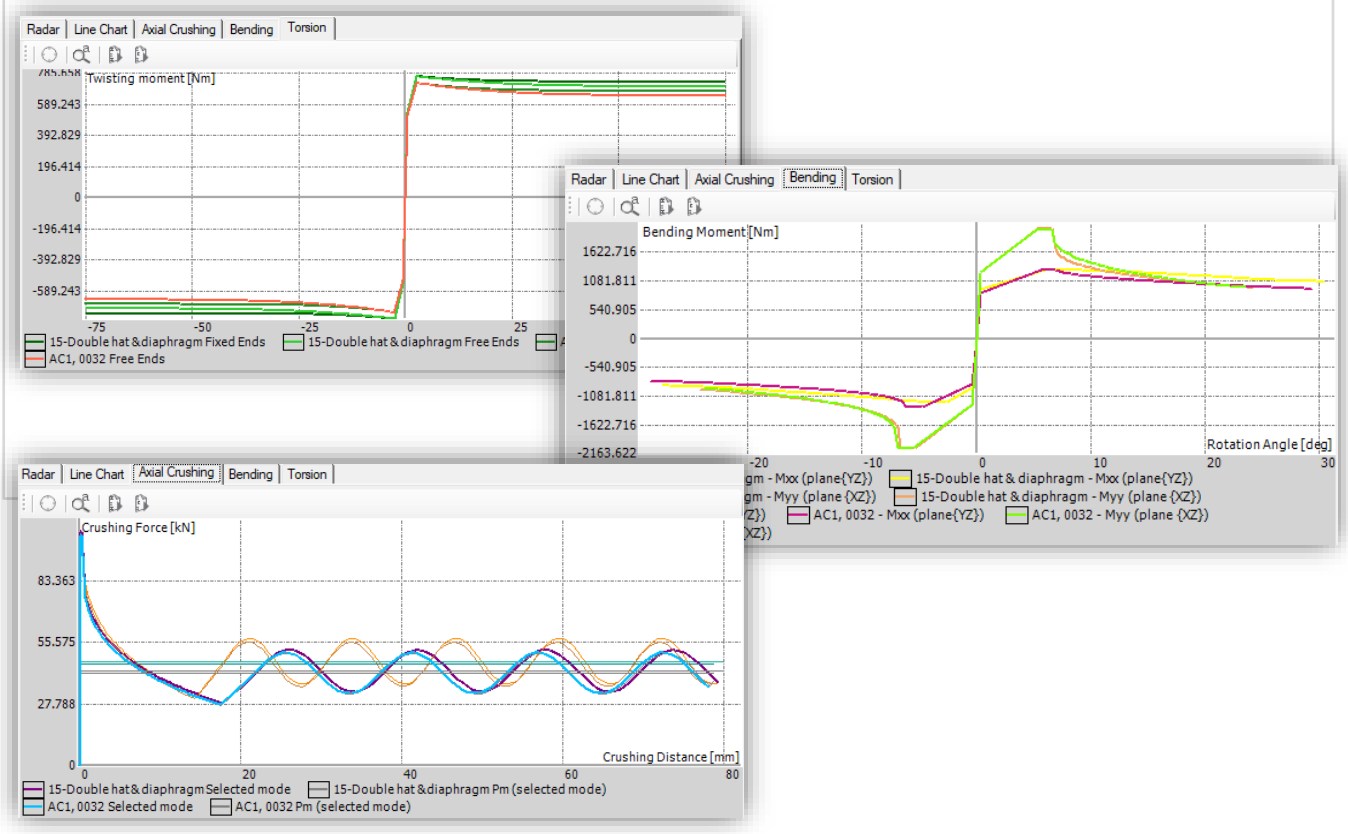


On the "Y" axis percentage values are given.

Chosen cross sections are listed on the "X" axis.
In order to add or remove a cross section simply check or uncheck it in the "List of calculated cross sections" window.

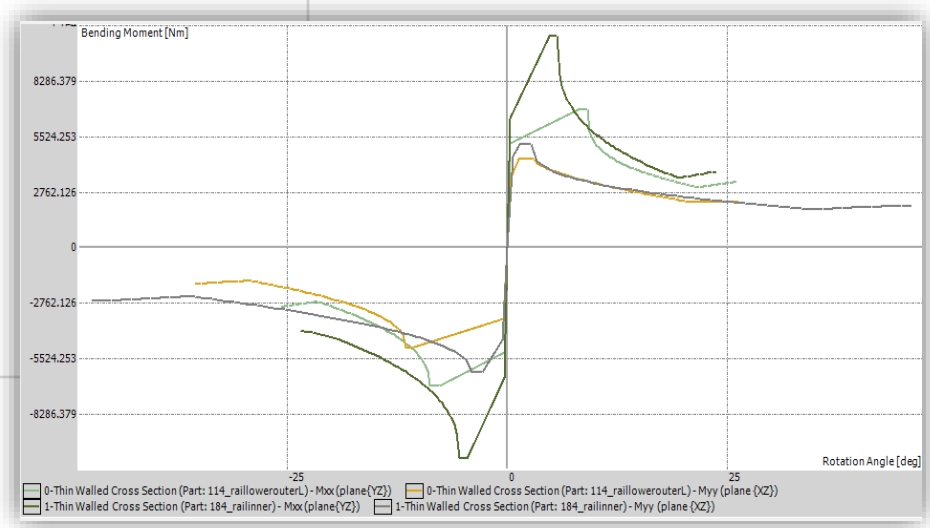
RESULTS REPORT – "Radar" window

*Additionally, the results report is enhanced with the functionality of curve comparison. The user can compare charts for **Axial, Bending or Torsion** response of number of selected cross sections.*



Each line represents response curve of one selected cross section.

In order to add or remove a cross section simply check or uncheck it in the "List of calculated cross sections" window.



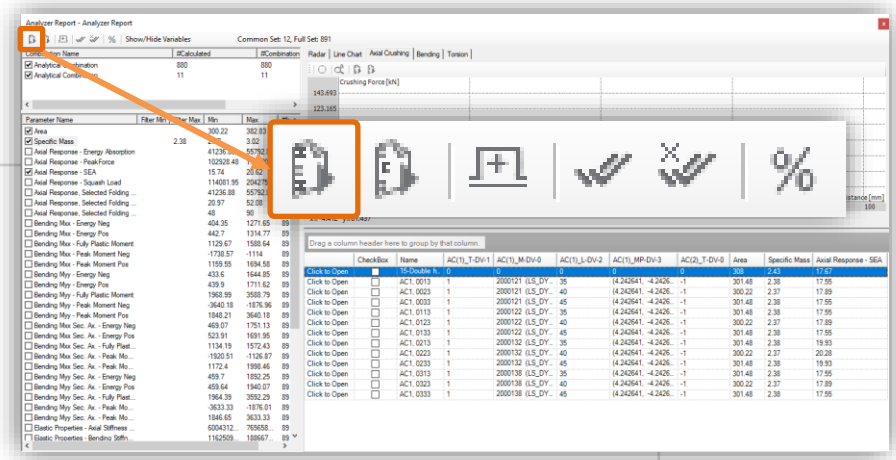
All results of the Analyzer Report can by easily exported to PDF and Excel file.

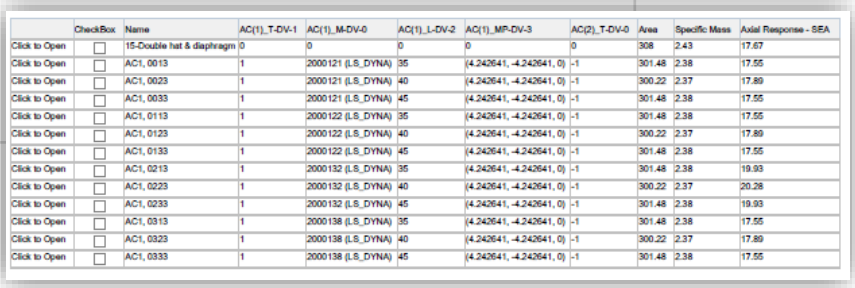
Export to PDF

The user can save obtained results as PDF document.

Click on the "Export Report" icon to export results.

Only data visible on the list of cross section which fulfill the filtering limitations will be included in the exported PDF document.





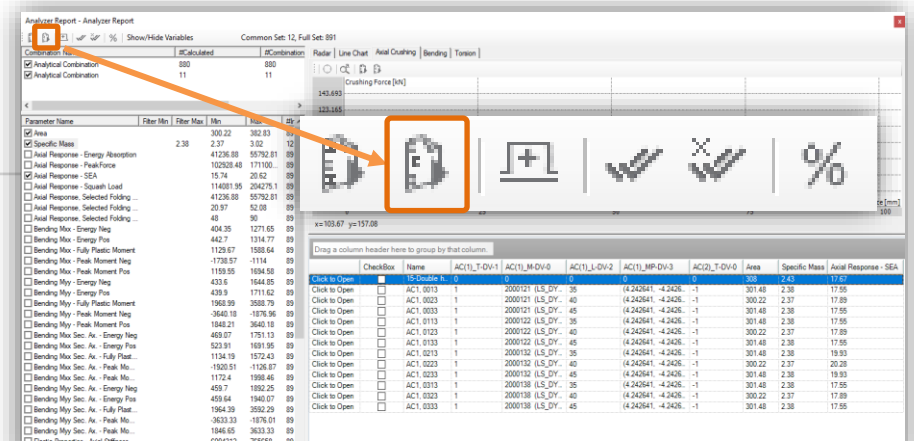
	CheckBox	Name	AC(1)_T-DV-1	AC(1)_M-DV-0	AC(1)_L-DV-2	AC(1)_MP-DV-3	AC(2)_T-DV-0	Area	Specific Mass	Axial Response - SEA
Click to Open	☐	15-Double hat & diaphragm	0	0	0	0	0	308	2.43	17.67
Click to Open	☐	AC1, 0013	1	2000121 (LS_DYNA)	35	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55
Click to Open	☐	AC1, 0023	1	2000121 (LS_DYNA)	40	(4.242641, -4.242641, 0)	-1	300.22	2.37	17.89
Click to Open	☐	AC1, 0033	1	2000121 (LS_DYNA)	45	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55
Click to Open	☐	AC1, 0113	1	2000122 (LS_DYNA)	35	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55
Click to Open	☐	AC1, 0123	1	2000122 (LS_DYNA)	40	(4.242641, -4.242641, 0)	-1	300.22	2.37	17.89
Click to Open	☐	AC1, 0133	1	2000122 (LS_DYNA)	45	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55
Click to Open	☐	AC1, 0213	1	2000132 (LS_DYNA)	35	(4.242641, -4.242641, 0)	-1	301.48	2.38	19.93
Click to Open	☐	AC1, 0223	1	2000132 (LS_DYNA)	40	(4.242641, -4.242641, 0)	-1	300.22	2.37	20.28
Click to Open	☐	AC1, 0233	1	2000132 (LS_DYNA)	45	(4.242641, -4.242641, 0)	-1	301.48	2.38	19.93
Click to Open	☐	AC1, 0313	1	2000138 (LS_DYNA)	35	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55
Click to Open	☐	AC1, 0323	1	2000138 (LS_DYNA)	40	(4.242641, -4.242641, 0)	-1	300.22	2.37	17.89
Click to Open	☐	AC1, 0333	1	2000138 (LS_DYNA)	45	(4.242641, -4.242641, 0)	-1	301.48	2.38	17.55

Export to Excel

The user can save obtained results as .xls file type.

Click on the "Export to Excel" icon to export results.

Only data visible on the list of cross section which fulfill the filtering limitations will be included in the exported excel file.



	CheckBox	Name	AC(1)_T-DV-1	AC(1)_M-DV-0	AC(1)_L-DV-2	AC(1)_MP-DV-3	AC(2)_T-DV-0	Area	Specific Mass	Axial Response - SEA
Click to Open	False	15-Double hat & dia	0	0	0	0	0	308	2.43	17.67
Click to Open	False	AC1, 0013	1	2000121 (LS_DYNA)	35	(4.242641, -4.242641, (-1		301.48	2.38	17.55
Click to Open	False	AC1, 0023	1	2000121 (LS_DYNA)	40	(4.242641, -4.242641, (-1		300.22	2.37	17.89
Click to Open	False	AC1, 0033	1	2000121 (LS_DYNA)	45	(4.242641, -4.242641, (-1		301.48	2.38	17.55
Click to Open	False	AC1, 0113	1	2000122 (LS_DYNA)	35	(4.242641, -4.242641, (-1		301.48	2.38	17.55
Click to Open	False	AC1, 0123	1	2000122 (LS_DYNA)	40	(4.242641, -4.242641, (-1		300.22	2.37	17.89
Click to Open	False	AC1, 0133	1	2000122 (LS_DYNA)	45	(4.242641, -4.242641, (-1		301.48	2.38	17.55
Click to Open	False	AC1, 0213	1	2000132 (LS_DYNA)	35	(4.242641, -4.242641, (-1		301.48	2.38	19.93
Click to Open	False	AC1, 0223	1	2000132 (LS_DYNA)	40	(4.242641, -4.242641, (-1		300.22	2.37	20.28
Click to Open	False	AC1, 0233	1	2000132 (LS_DYNA)	45	(4.242641, -4.242641, (-1		301.48	2.38	19.93
Click to Open	False	AC1, 0313	1	2000138 (LS_DYNA)	35	(4.242641, -4.242641, (-1		301.48	2.38	17.55
Click to Open	False	AC1, 0323	1	2000138 (LS_DYNA)	40	(4.242641, -4.242641, (-1		300.22	2.37	17.89
Click to Open	False	AC1, 0333	1	2000138 (LS_DYNA)	45	(4.242641, -4.242641, (-1		301.48	2.38	17.55

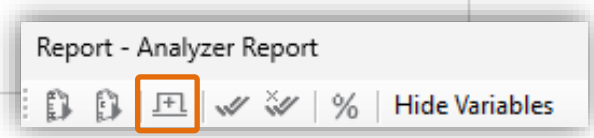
EXPORT – CROSS SECTION

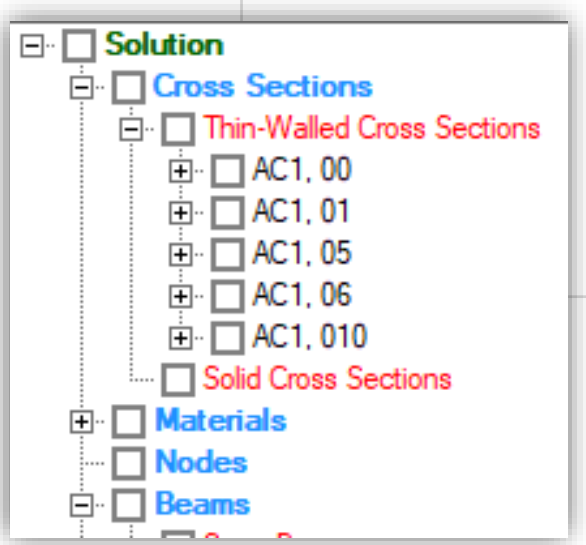
Each cross section generated during the analytical procedure can be saved and afterwards opened in VCS solution.

	CheckBox	Name	CS_3 AC(1)_T-DV-2	CS_3 AC(1)_M-DV-1	CS_5 AC(2)_MP-DV-0	Area	Specific Mass
Click to Open	☐	0-Thin Walled Cr...	-1	-1	-1	348.6826	2.7546
Click to Open	☐	1-Thin Walled Cr...	-1	-1	-1	343.0159	2.7098
Click to Open	☐	2 - Crashbox	-1	-1	-1	723.28	5.7067
Click to Open	☐	3 - A-Pillar	-1	-1	-1	429.0094	3.3732
Click to Open	☐	4 - Rocker Panel	-1	-1	-1	1101.0796	8.6747
Click to Open	☐	5 - Bumper	-1	-1	-1	531.35	4.1711
Click to Open	☑	AC1, 00	1	Mild steel 325	-1	388.5735	3.0605
Click to Open	☑	AC1, 01	1	6061-T6 aluminium	-1	388.5735	2.5669
Click to Open	☐	AC1, 02	1	2024-T351aluminium	-1	388.5735	2.5669
Click to Open	☐	AC1, 03	1	AISI 1006 Steel	-1	388.5735	3.0605
Click to Open	☐	AC1, 04	1	AISI 4340 Steel	-1	388.5735	3.0605
Click to Open	☑	AC1, 05	1	7039 aluminium	-1	388.5735	2.5669
Click to Open	☑	AC1, 06	1	304 Stainless Steel	-1	388.5735	3.0605
Click to Open	☐	AC1, 07	1	5056 aluminium	-1	388.5735	2.5669
Click to Open	☐	AC1, 08	1	AISI 1045	-1	388.5735	3.0605
Click to Open	☐	AC1, 09	1	Mild steel 460	-1	388.5735	3.0605
Click to Open	☑	AC1, 010	1	Mild steel 250	-1	388.5735	3.0605
Click to Open	☐	AC1, 011	1	Mild steel 260	-1	388.5735	3.0605
Click to Open	☐	AC1, 012	1	Docol 800 1.25 mm	-1	388.5735	3.0605

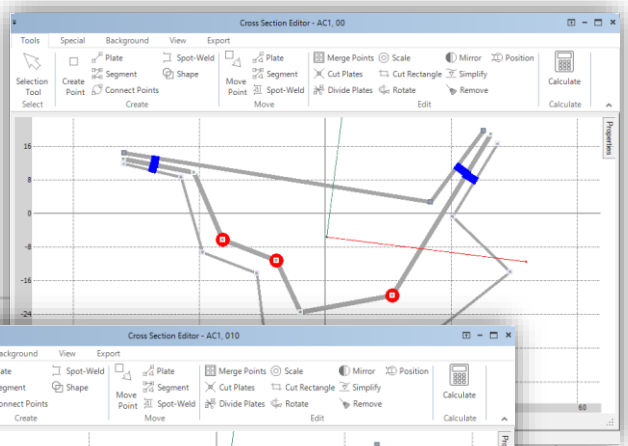
1. Select all cross sections that are to be saved in VCS file. Several cross sections can be exported simultaneously.

2. Click the "Save Selected Cross Sections" button (available in the main toolbar of the Analyzer Report).



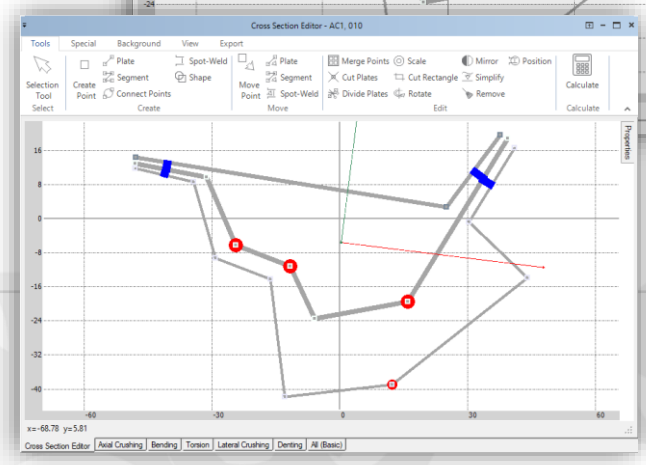


After opening the saved VCS file, all previously selected cross sections are visible in the Solution Explorer tree.
Additionally, all materials available in the analytical project will be automatically added to the solution.



Double click on a chosen cross section to open it in the Cross Section Editor and to view its definition in the properties window.

The exported cross-sections can be easily used for further simulations in VCS.



cross section analyzer