

# manual workspace 8

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# VCS – ALL INN ONE ENVIRONMENT

VISUAL CRASH STUDIO (VCS) is an all-in-one environment for early design, virtual testing and optimization of complex crashworthy structures.

It includes the functionalities of the 2D environment for analyzing and design of thin-walled prismatic members as well as a complex 3D virtual design space for modeling and testing of individual beams, subassemblies and complete structures.

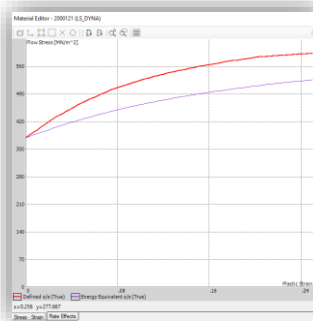
## VCS – MAIN FUNCTIONALITIES

### MATERIAL EDITOR

All Materials used in the VCS Solution can be defined by means of the Material Editor window.

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

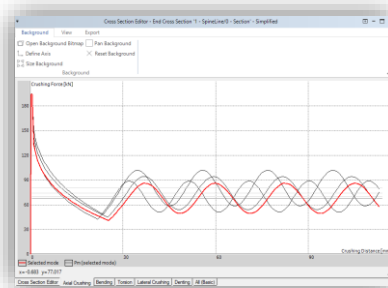
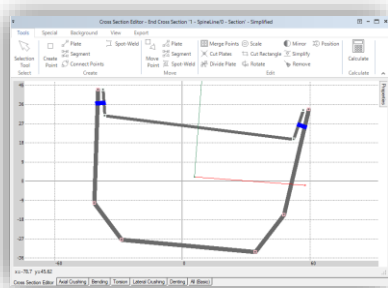
- Material Constants
- Stress Strain Characteristic
- Strain Rate Characteristic
- Hardening Factor
- Fracture Indicator



1. Material - Anisotropic	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
StressStrainCharacteristicType	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	
Layer	Default
Name	Steel - 380 MPa - 2000122 (LS_DYNA)

### CROSS SECTION EDITOR

All Cross Sections created in VCS consist of Points, Plates – created by connecting two Points, Segments – build of Plates, Super Folding Elements and possibly Connections.

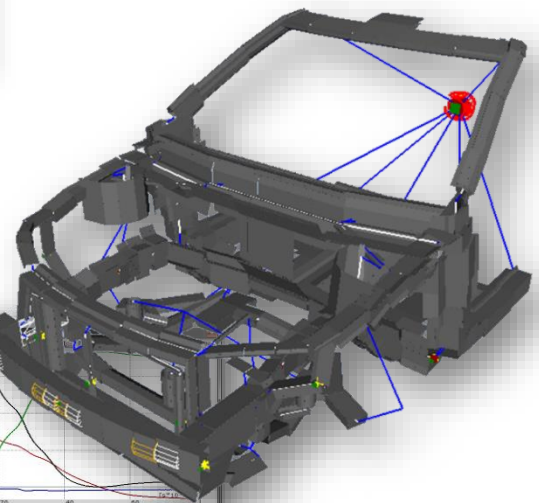
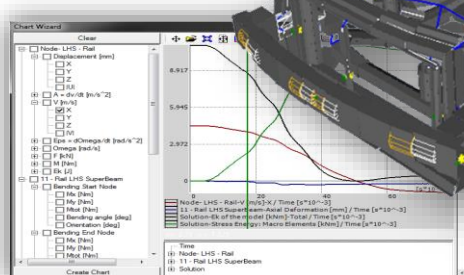


Results of calculations for a cross section are grouped in 7 expandable containers in the section Results of the properties window

### 3D ENVIRONMENT

3D virtual design space is used for modeling and testing of subassemblies and structures based on Super Beams.

All objects creating a VCS 3D model are build of nodes, on which the user can define beams and rigid bodies. Results of a 3D simulation can be displayed in the Chart Wizard window



# WELCOME SCREEN

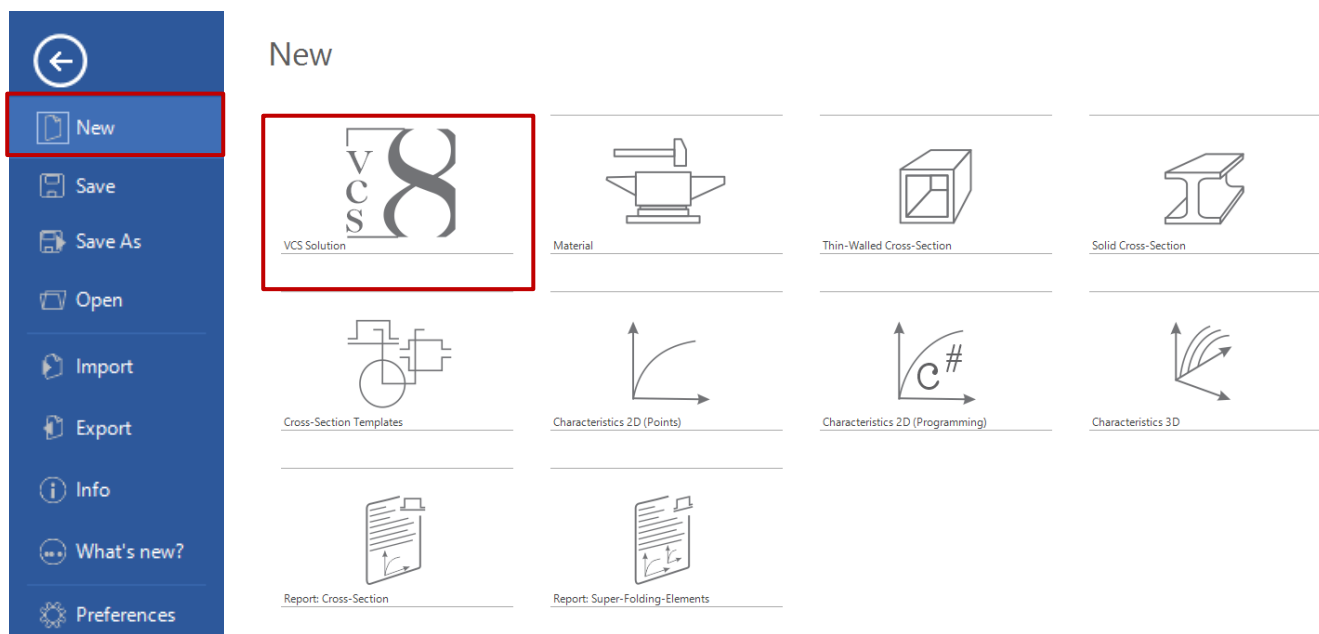
After opening a new VCS Solution, you will find the Welcome Screen. The welcome window grants easy access to recently opened projects. You can easily open the recently used Solution or create a new one. The Welcome Screen can be blocked by unmarking the "Show On Startup" field in the down left corner of the welcome screen.



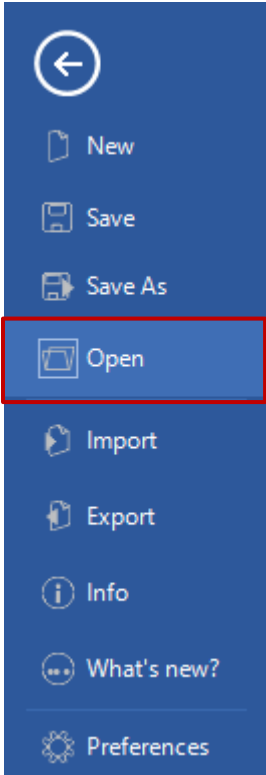
# NEW SOLUTION

After entering the File menu you can create a new VCS Solution. This procedure allows you to create a macro element model from scratch.

Similarly, a new material, characteristic, cross section or report can be created.



# NEW SOLUTION



## Recent Documents

13\_Bumper\_TimeSettings.vcsx

SELECTED OBJECTS EXPORT.vcsx

SELECTED OBJECTS EXPORT.vcsx

13\_Bumper\_TimeSettings.vcsx

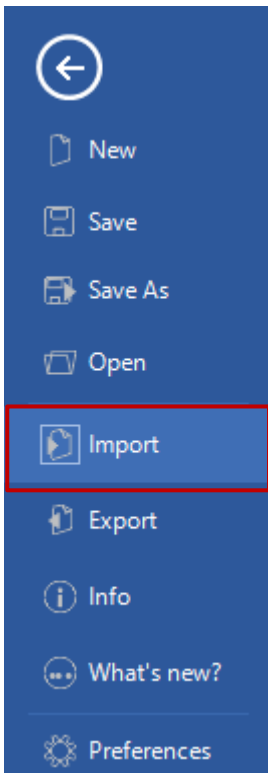
13\_Bumper\_TimeSettings.vcsx

13\_Bumper\_TimeSettings.vcsx

\_Bumper\_TimeSettings.vcsx

Clear Recent Files

*The list of recently opened and used Solutions is also available under the File menu.*



## Import

Materials

FE Model

Geometry

Objects from other VCS file

Old file format

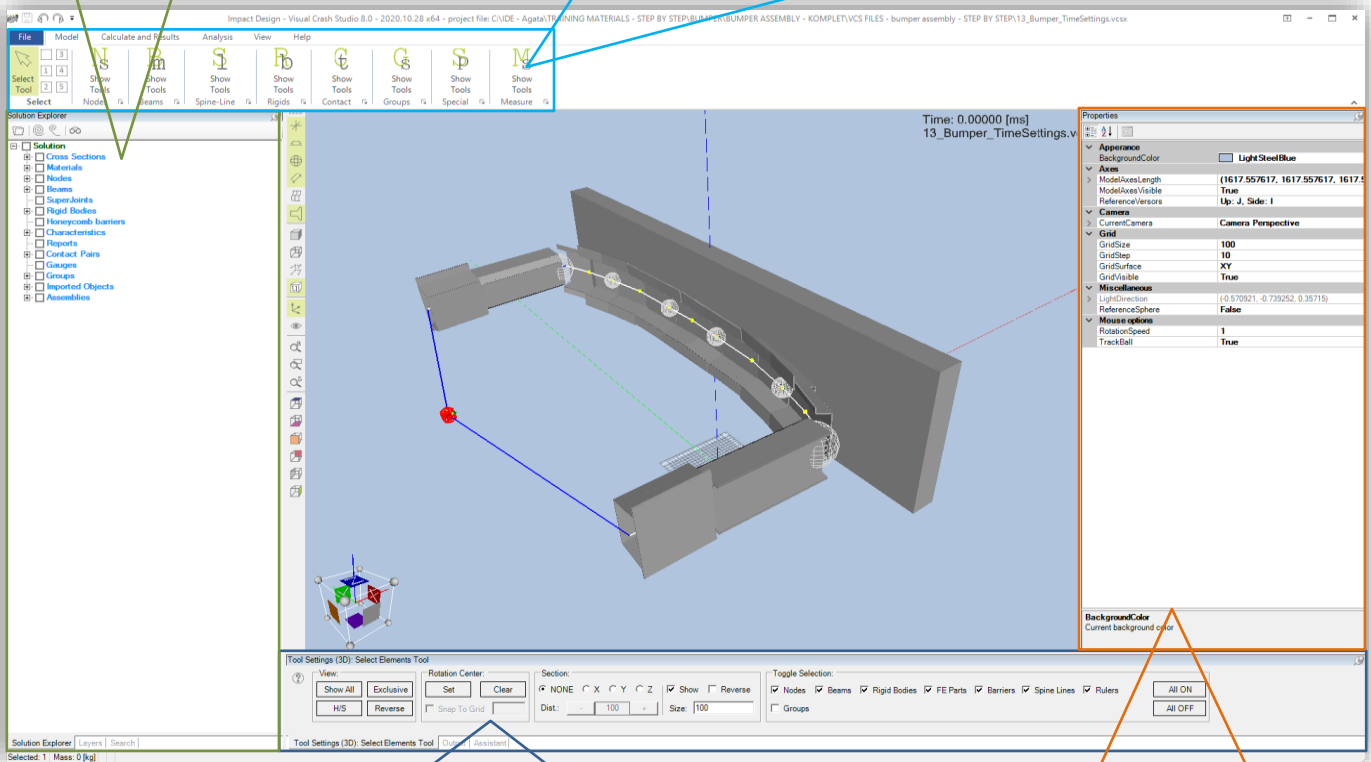
*Easy access to variety of import options gives the possibility to create a VCS model on basis of an imported geometry.*



# VCS MAIN VIEW

## SOLUTION EXPLORER

## MAIN TOOLBAR



- TOOL SETTINGS WINDOW
- DYNAMIC ENGINEERING ASSISTANT
- OUTPUT WINDOW

## PROPERTIES WINDOW

On the top of the screen you can find the **Main Toolbar** where you have easy access to most of the VCS main features.

On the left side of the central view window you will find **3D view tools** dedicated for the edition of the 3D view. Those icons will enable you to control appearance of the main 3D view

In the **Solution Explorer** window you will find folders containing each and every object created in the Solution. Each object like Cross Section, Material, Beam or Rigid Body is ascribed to a separate folder on the explorer tree.

The **Properties** window gives the possibility to edit an object. In the properties window you will also find the properties and results for the currently selected object.

At the bottom of the screen The **Tool Settings Window** can be found. In the same location, after clicking on an appropriate bookmark you can view the **Dynamic Engineering Assistant**, **Output** window and solution's **history**.

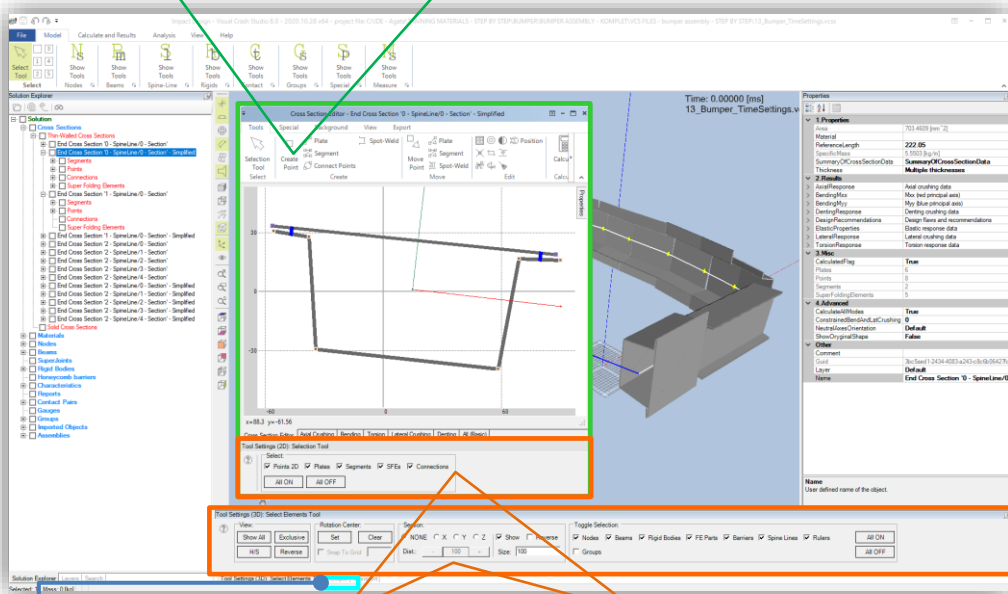
(\*) Please note that the location of Explorer window, Properties window and Tool Settings window can be freely changed by the user



# VCS MAIN VIEW - 2

## CROSS SECTION EDITOR:

The Cross Section Editor is used to design, calculate and design Thin Walled Cross-Sections for best crash performances.



## TOOL SETTINGS WINDOW

Facilitates the usage of the majority of VCS tools  
Tool Settings window is also available for tools of the Cross Section Editor.

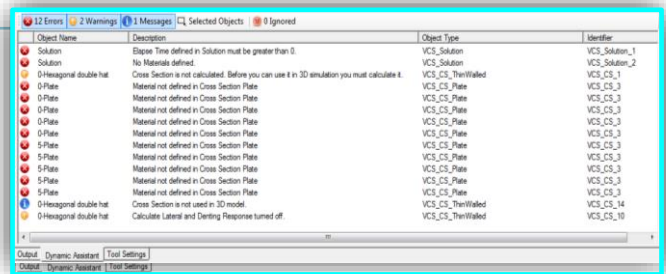
Easy access to ALL additional functionalities of a tool

Definition off all needed parameters and settings

Basic info about tool status.  
Help information available

## DYNAMIC ENGINEERING ASSISTANT

Dynamic Engineering Assistant (DEA) provides information about all errors and inaccuracies detected in the currently opened VCS Solution.



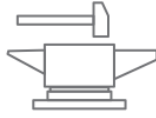
**Error** - crucial for proper model, calculations **warning** and **message** – useful modelling tips

Help information is available for each detected error and inaccuracy.

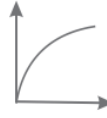
DEA can automatically find an object in which an error or inaccuracy has been detected.



# VCS OBJECTS



Material

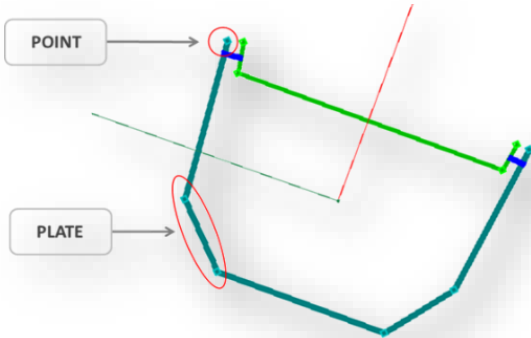


Characteristics 2D (Points)



Thin-Walled Cross-Section

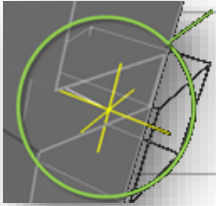
New material, characteristic and cross sections are created in separate editor's windows (Characteristic Editor, Material Editor & Cross Section Editor).  
In order to open a new Editor window, select an appropriate option from the File menu



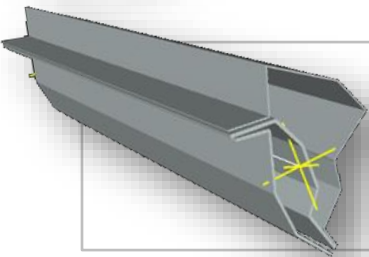
According to the Macro Element Method VCS software enables the creation of a simplified thin-walled cross section model build of Plates and Segments based on Points.

Each plate of across section can be defined with different material and thickness.

All objects of the VCS 3D environment are created after clicking on an appropriate icon in the main toolbar. Tree basic types of objects used in modeling of a simplified beam structure are:



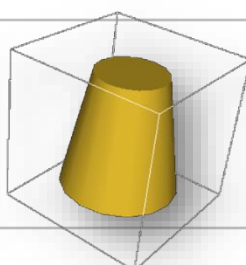
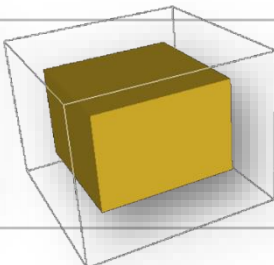
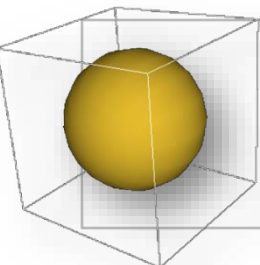
The **Node** is used as a spatial reference point for all VCS objects. The Node encompasses number of data necessary for dynamic simulation.



**Super Beam** - Defined by 2 Thin Walled Cross Sections

**Solid Beam** - Defined by a single Solid Cross Section

**User Defined Beam** - The mechanical response of the Beam defined by 2D Characteristics

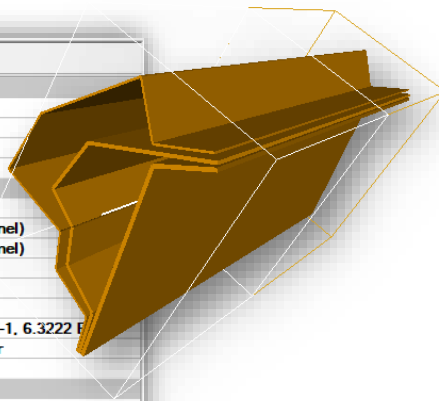
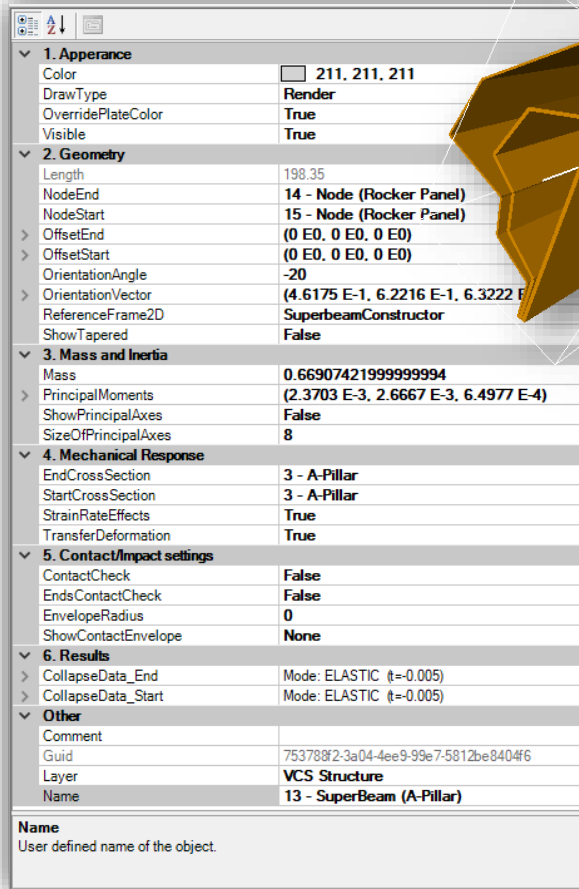


**Rigid bodies:** sphere, cone, cylinder and box (cube) are created as objects attached to a Node.





# VCS OBJECT'S PROPERTIES WINDOW



For each Object created in VCS Solution a separate **Properties window** is available.

In an Object's Properties window you will find detailed information concerning various properties of the Object.

Moreover, the Properties window enables the User to edit the existing Object (you can easily edit the coordinates of an Object, its visibility, and several other parameters).

Additionally, in case of Cross Sections the Properties window contains Results of the calculation process as well as design recommendations for progressive axial crushing design (for more information see: VCS Manual – Cross Sections).

# VCS OBJECT IN SOLUTION EXPLORER

All Object created in VCS are automatically catalogued in the **Solution Explorer** window.

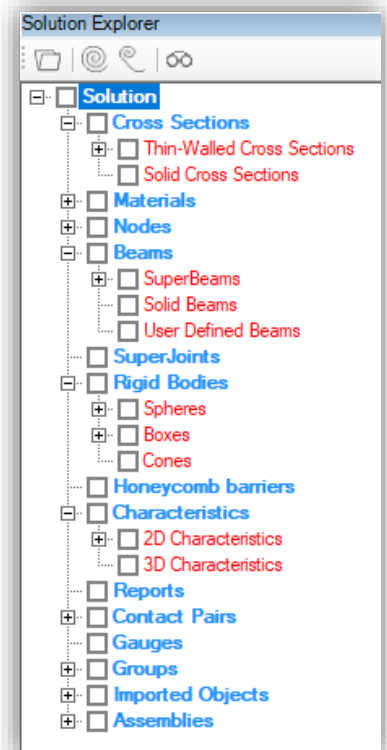
In the Solution Explorer window you will find separate folders for each group of VCS objects (for example Cross Sections, Beams or Material).

You can easily find each Object you have created.

After selecting an object in the Solution Explorer window, it will be simultaneously marked in the 3D view.

Number of VCS tool is accessible through the Solution Explorer window.

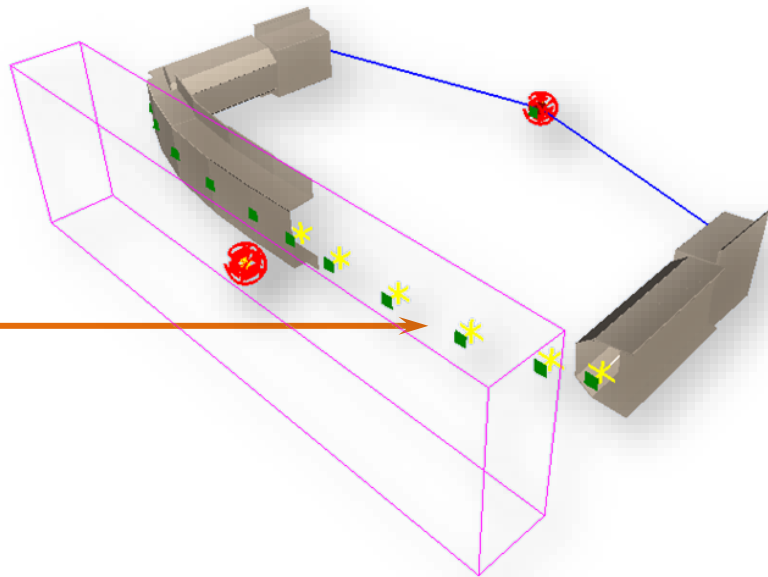
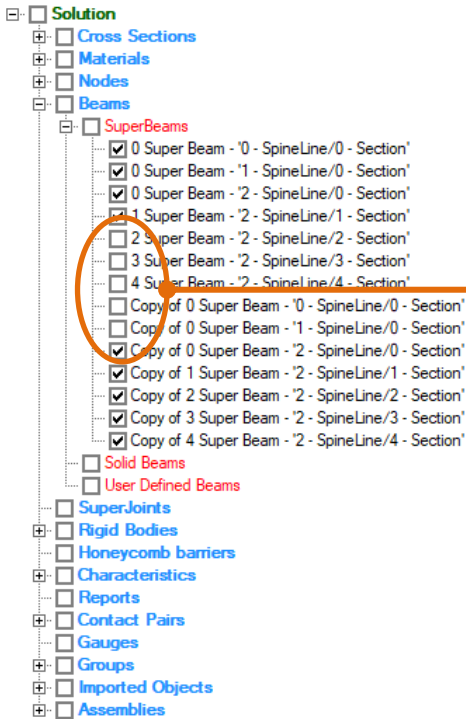
After selecting an Object in the Solution Explorer folded right click on it. A drop-down list containing several tools and functionalities available for this Object will be shown.



# OBJECT'S VISIBILITY CHANGE IN EXPLORER WINDOW

In VCS the user can change the object's visibility directly in the Solution Explorer window.

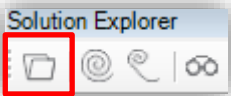
On the left side of each object a visibility checkbox can be found.



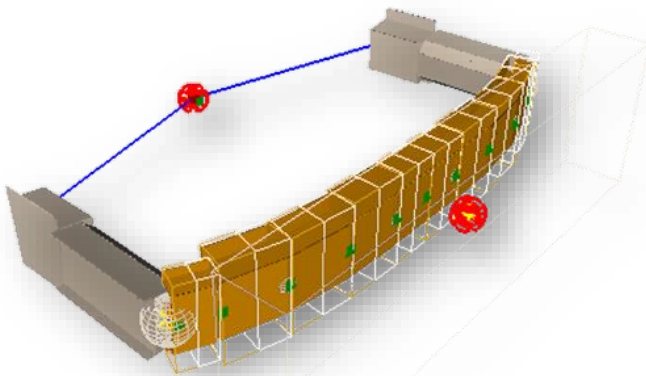
In the presented example visibility of several super beams of the bumper assembly have been unchecked.

Those objects are not displayed in the VCS 3D view.

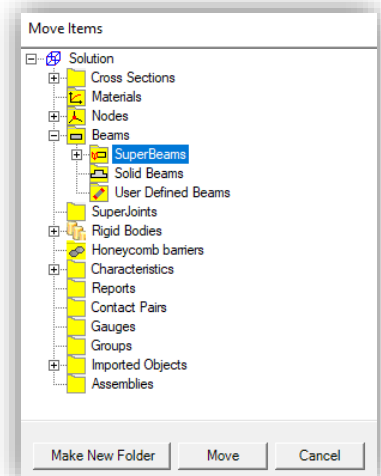
# MOVE TO FOLDER TOOL



The "Move to Folder" tool enables the user to easily change the localization of an object in the Solution Explorer tree. After selecting an object or number of objects click on the presented icon.

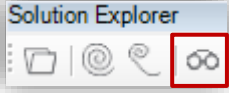


In the "Move items" window select the requested folder in which you wish to place the selected elements.



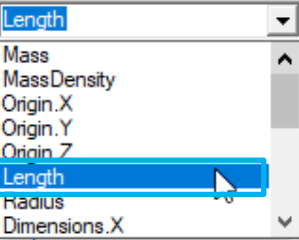
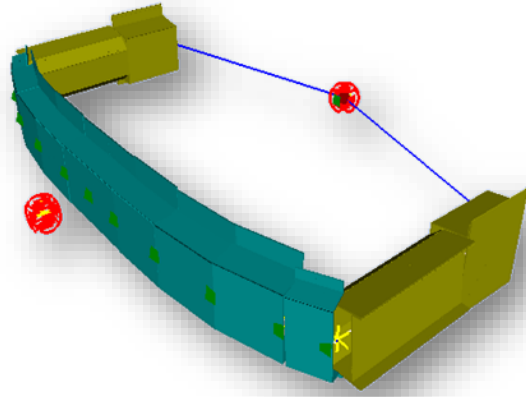


# "Advanced Search" tool



"Advanced Search" icon can be found in the Solution Explorer's toolbar

The advanced search functionality enables the user to filter and select object of a VCS model basing on a selected parameter and its value range.  
In the presented example of a bumper model a search for beams of specific length has been carried out.

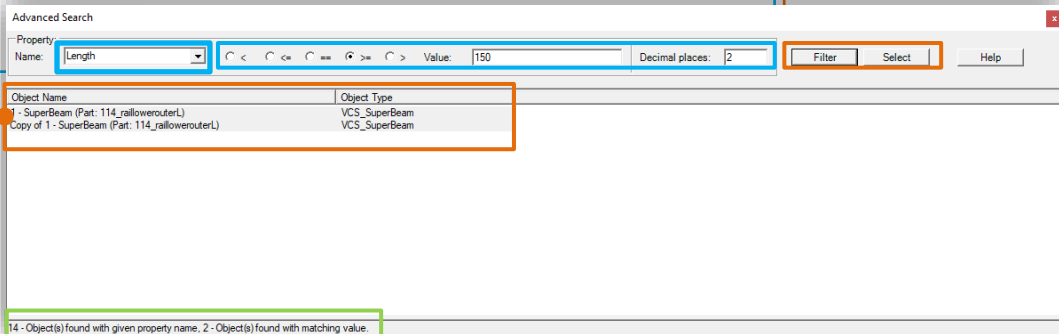


- 1) From the "name" drop down list select the requested object's property basing on which the search will be made.
- 2) Indicated the parameter's value range.

(\* ) Apart from the listed properties, any property name copied from the Properties window can be entered (identical spelling is required).

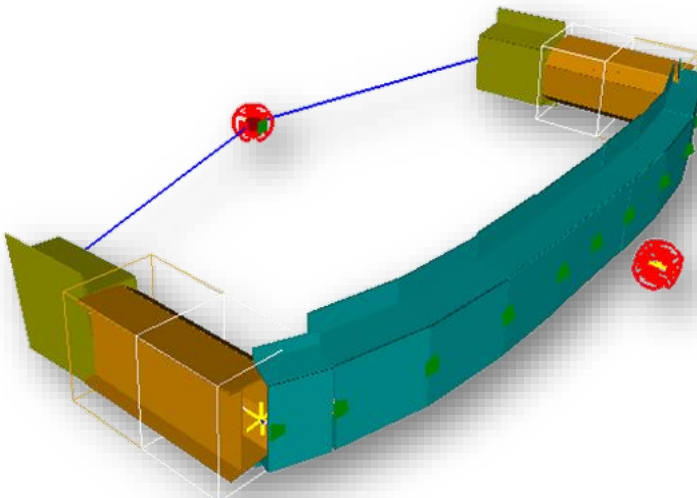
After defining the properties value range click of the "Filter" icon.

From the displayed objects list select all wanted elements of the model. Click the "Select" icon



14 - Object(s) found with given property name, 2 - Object(s) found with matching value.

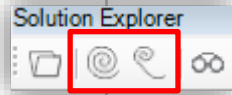
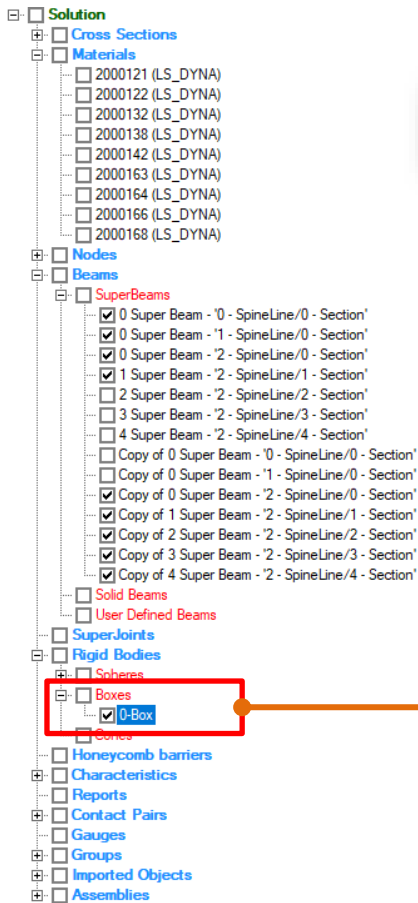
At the bottom of the "Advanced Search" window you can find the number of all objects present in the current VCS model and the number of elements found with a value matching the one defined in the properties section



All selected objects will be marked in orange in the VCS 3D view.

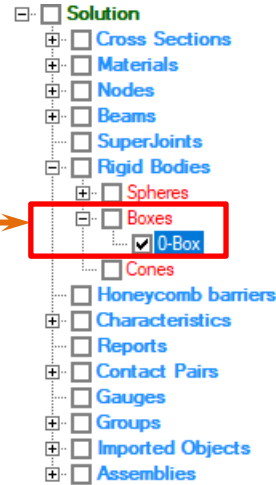


# COLLAPSE / EXPAND SOLUTION TREE



The **“Collapse Solution Tree”** tool automatically collapses all folders of the explorer tree apart of those in which an object has been selected.

The **„Expand Solution Tree”** tool automatically expands all folders of the Solution Explorer

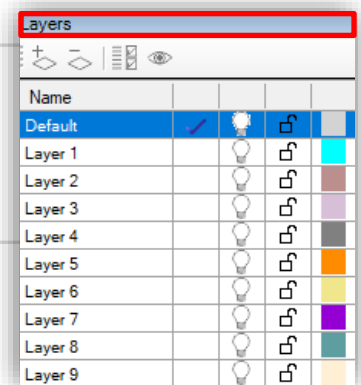


# SOLUTION LAYERS

In VCS you can create objects of a Solution on separate layers. Apart from the Solution Explorer tree, VCS provides the **Layers window**, where the user can create and organize all the Solution’s Objects on separate layers. This facilitates the process of modeling, especially in case of complex and multipart constructions.

Each layer can be selected by clicking on it on the layers list. Afterwards each new Object created in the Solution will be automatically assigned to the selected Layer.

Main toolbar of the Layer window enables the user to:



Add and remove layers by clicking on the “remove” and “add layers” icons.



Select all objects assigned to the chosen layer





Set visibility of all layers to true.

Additionally, in the Solution Layers window the user can:

- Rename the Layers 9double click on selected layer.
- Toggle the visibility of Layers. You can set the visibility of each layer by clicking on the "light bulb" icon. If a "light bulb" is "turned off" all objects assigned to that layer will not be visible in the Solution's 3D view.
- Block the Layer. You can block and unblock the layer by clicking on the "padlock" icon. If a layer is blocked you will not be able to select objects assigned to this layer in the Solution's 3D view.
- Set color of the Layer. For each layer you can select a default color by clicking on the "color field" in the Layers window. Note that all new objects created on the selected layer will share the layers color in the Solution 3D view.

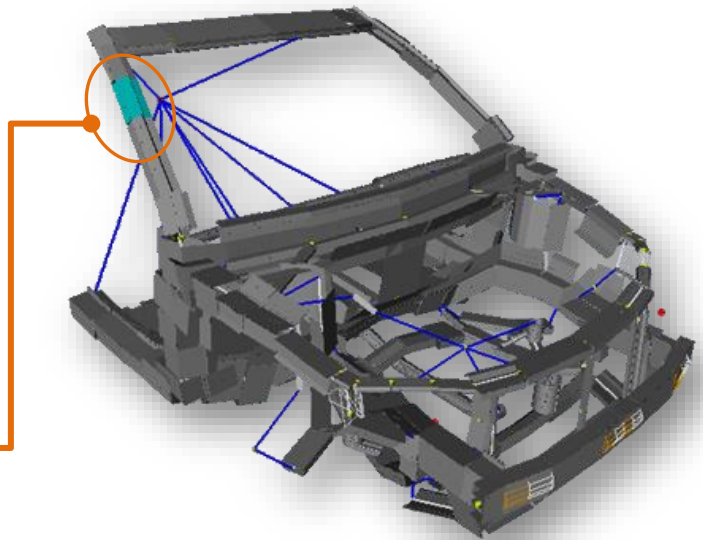
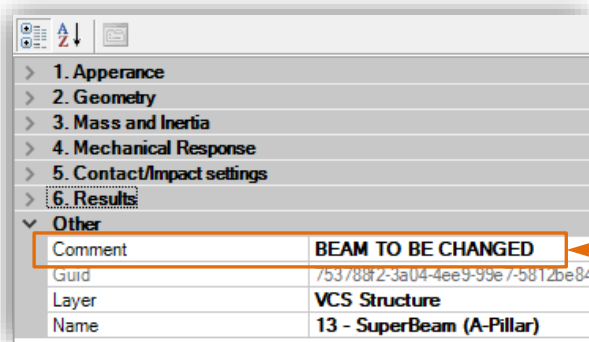


For each object of the Solution you can set the Layer to which the object is assigned. In the **Properties window** of an object, in the Other section, you can select from a drop down list the requested Layer.

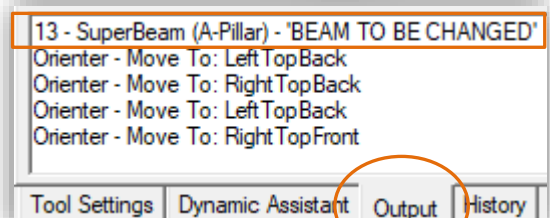
## COMMENTS

In Visual Crash Studio a Comment can be assigned to any Object of the Solution.

You can enter additional information about a Beam, Node, Rigid Body or other in the Comment section of the element's properties window



If the Object with the assigned comment will be selected during further work, additional information will be displayed in the properties window, and in the Output window on the bottom of the screen.

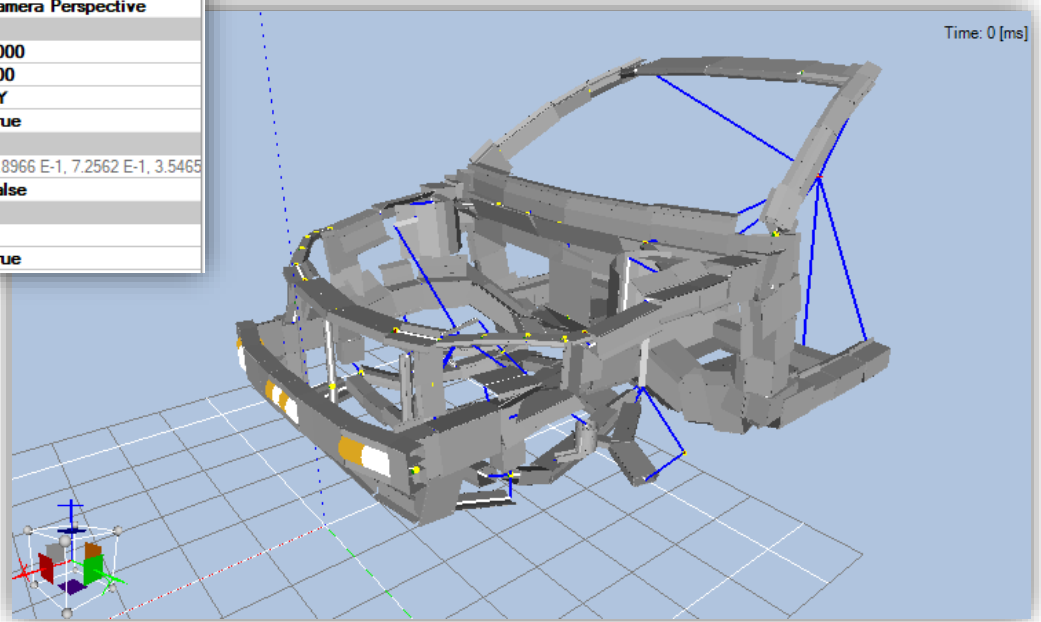


# MAIN 3D VIEW

▼ <b>Appearance</b>	
BackgroundColor	<input type="checkbox"/> LightSteelBlue
▼ <b>Axes</b>	
> ModelAxesLength	(3 E3, 4.218 E3, 3 E3)
ModelAxesVisible	True
ReferenceVorsors	Up: J, Side: I
▼ <b>Camera</b>	
> CurrentCamera	Camera Perspective
▼ <b>Grid</b>	
GridSize	1000
GridStep	200
GridSurface	XY
GridVisible	True
▼ <b>Miscellaneous</b>	
> LightDirection	(5.8966 E-1, 7.2562 E-1, 3.5465)
ReferenceSphere	False
▼ <b>Mouse options</b>	
RotationSpeed	1
TrackBall	True

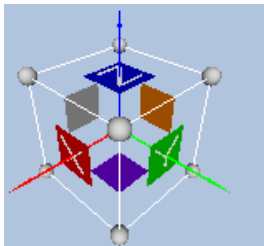
The 3D view window is located in the center of the VCS screen.

By default, axes of the global coordinate system are displayed as well as the grid in the XY plane



The user can edit the properties of 3D view after in the Properties window (after clicking on the background)

View tools for the 3D view are located on the left side of the window.



In the down left corner of the 3D view you will find the Orientation tool. It is designed to help the user to set the solutions view in the required position in the 3D space. The Orientation tool resembles of a cube, with colorful sides, white lined edges and yellow sphere corners

Note that three side's colors correspond to the default colors of the positive axis of the global coordinate system (red – X axis, green – Y axis, blue – Z axis). Also note that the colors of the faces of the orientation tool match the ones present in the view icons in the 3D view toolbar.

You can click on any side, edge or corner of the Orientation tool cube. The 3D view will rotate automatically to match the position of the Orientation tool.

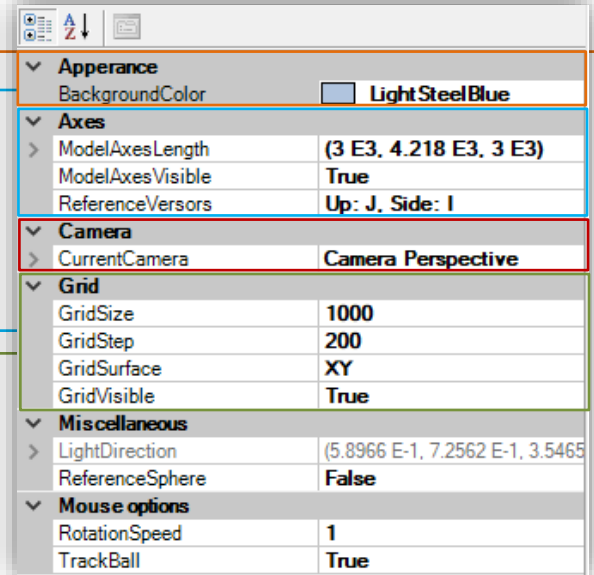
Whenever you will rotate the 3D view using the mouse, the Orientation tool will automatically rotate adjusting its position accordingly to the solutions orientation in 3D space.



# 3D VIEW PROPERTIES

After clicking on the background in the 3D view, in the Properties window you will find sections which will enable you to define the VCS main workspace.

In the **Appearance** section of the Properties window you can change the color of the background of the 3D view.

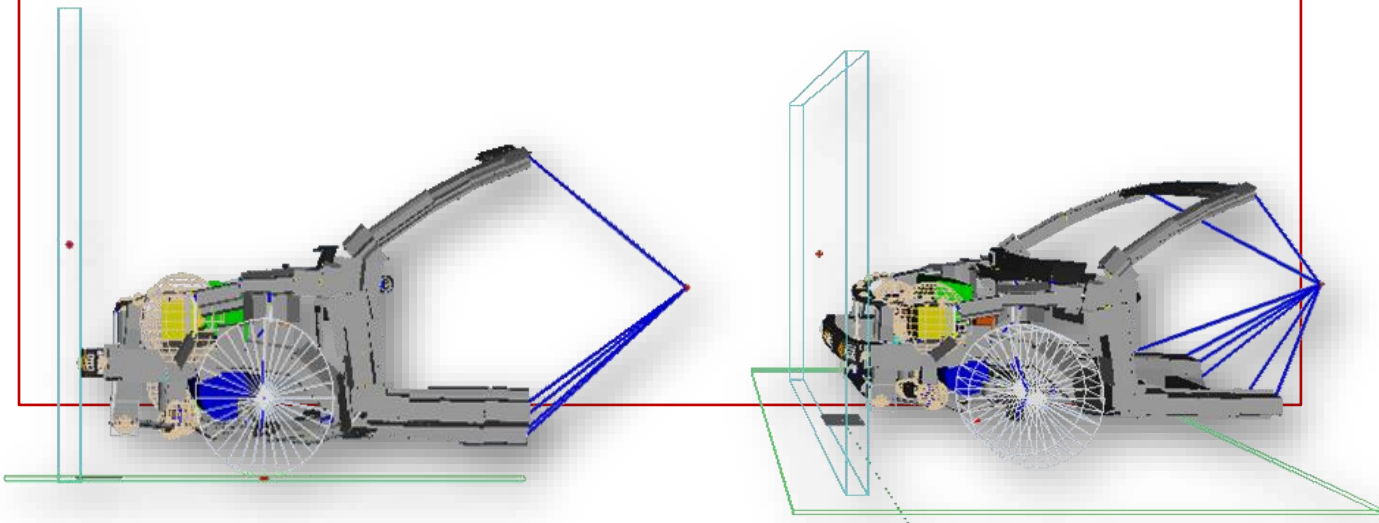


<b>Appearance</b>	
BackgroundColor	LightSteelBlue
<b>Axes</b>	
ModelAxesLength	(3 E3, 4.218 E3, 3 E3)
ModelAxesVisible	True
ReferenceVersors	Up: J, Side: I
<b>Camera</b>	
CurrentCamera	Camera Perspective
<b>Grid</b>	
GridSize	1000
GridStep	200
GridSurface	XY
GridVisible	True
<b>Miscellaneous</b>	
LightDirection	(5.8966 E-1, 7.2562 E-1, 3.5465 E-1)
ReferenceSphere	False
<b>Mouse options</b>	
RotationSpeed	1
TrackBall	True

In the **Axes** section of the Properties window you can define the length of each of the main axes of the VCS global coordinate system. You can also decide whether the main axes will be visible in the 3D view

In the **Grid** section of the Properties window you can set the size of the grid (white lines) visible in the 3D view. You can also define the step of the grid as well as the plane on which it is located. By default the grid is placed on the XY surface. You can also decide whether the grid will be visible in the 3D view

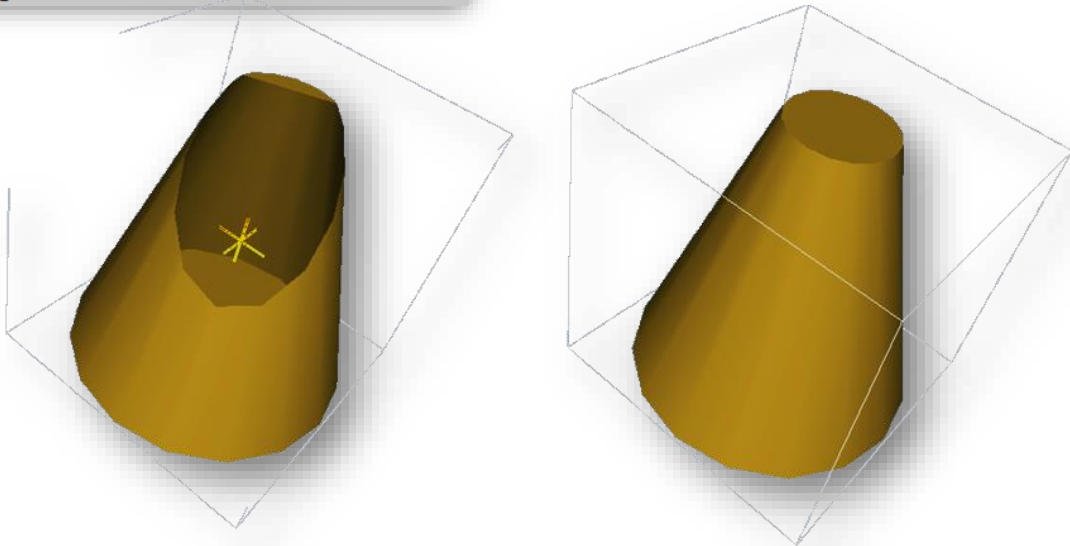
In the **Camera** section of the Properties window you will find definition of the 3D camera settings. Two types of camera are available in VCS: camera perspective and camera orthographic. The user can also toggle the camera type by clicking on the "Perspective view on/off" icon on the left hand side of the screen



# CAMERA SETTINGS

Camera	
CurrentCamera	Camera Perspective
Far	5000000
FieldOfView	45
MaxZoom	5
Near	772.5762939453125
Position	(9.5837 E2, 1.5879 E3, 2.7139 E3)
X	958.36998046271469
Y	1587.9408023247684
Z	2713.9195540571818
Target	(-4.1058 E2, 9.2251 E2, 1.3579 E3)
UpVector	(-3.7323 E-1, -5.0667 E-1, 7.7716 E-1)
Grid	
Miscellaneous	
Mouse options	

Settings of the current camera are summarized in the properties window. The parameters shown in black can be changed by the user the gray parameters are displayed for information only. The picture below illustrates the usage of Near and Far settings of the clipping planes. Position of both planes can be changed in the Properties window.

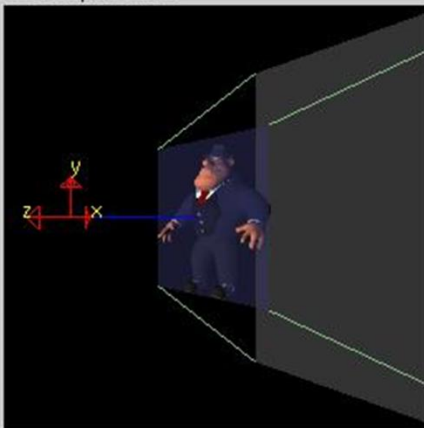


In the visualization of camera properties you can find the red coordinate system which corresponds to camera Position (view port).

Two planes are Near and Far clipping plane respectively. Position of the Near clipping plane is changed by the mouse wheel + ctrl key combination. The F3 key brings the clipping plane back to the default position.

Green lines correspond to edges of view prism.

World-space view



Screen-space view





## 3D VIEW TOOLS

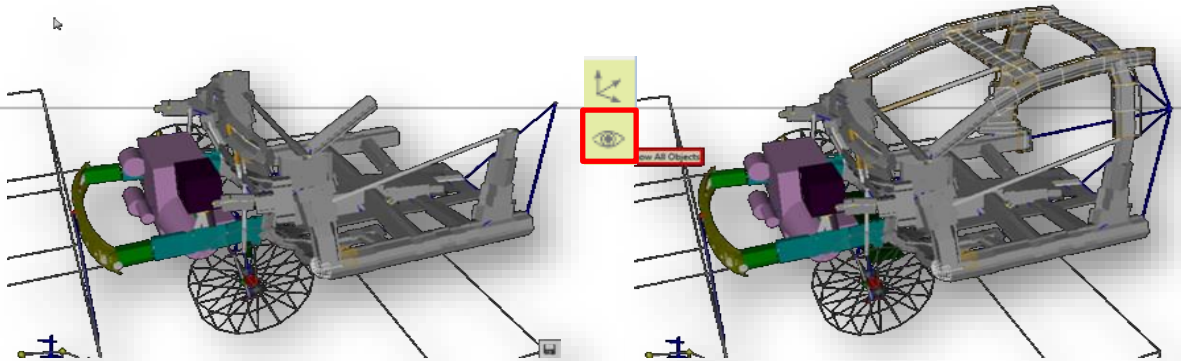


On the left side of the main 3D view you will find several "visibility" tools which will enable you to edit the main VCS workspace.

The icons visible on the left will enable you to easily toggle the visibility of different groups of VCS objects. Those functions are especially useful in case of a complex model.

By clicking on one of the icons you can turn on and off the visibility of Nodes, Beams, Rigid Bodies, Rulers & Protractors, FE Parts, Barriers and finally Spine Lines. When the visibility of a group of objects is turned on, the appropriate icon is highlighted in light green (as shown in the picture on the left)

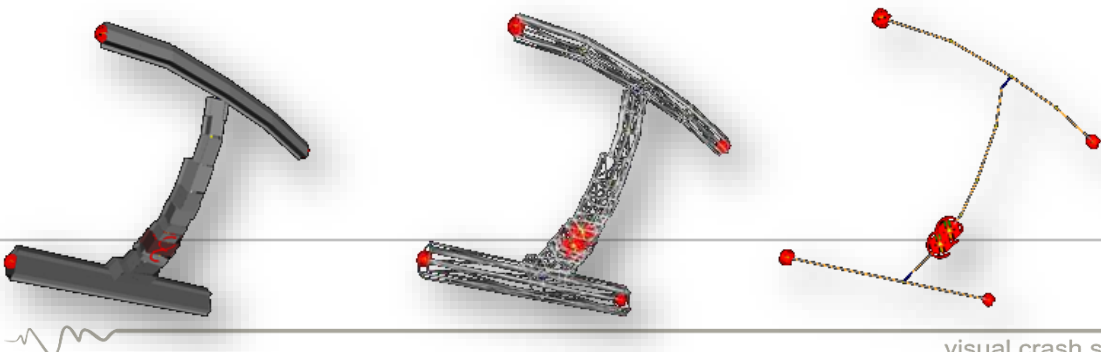
The "Show All Elements" icon, visible here on the right, enables the user to view all objects modelled in the Solution, regardless of their previous visibility settings, as it is illustrated in the pictures below.



The new "Toggle Global Draw Type" icons are situated on the left edge of the screen.

By clicking on those icons you can change the view of VCS objects displayed in the 3D view. The default draw type of the Solution's objects is 'As defined in Object' view, which allows different settings of draw type for each object (the definition of draw type can be defined in the Properties window for each object separately).

- After selecting the top-most icon, the Render view will be presented.
- After selecting the second icon, a Wireframe view will be presented.
- After selecting the third icon, a Centroid view will be presented.
- After selecting the bottom-most icon, the default, 'As defined in Object' view will be presented.



## 3D VIEW TOOLS

*Below the Toggle Global Draw View icon you will find three Zoom tool icons.*

*After clicking on the "**Zoom to all**" icon the 3D view will automatically set to fit in the entire structure modelled in the Solution.*

*The starting point of the global coordinate system will be then set as the Target of the Camera view.*

*The "**Area Zoom**" tool provides the possibility to view objects contained within the selected area.*

*The middle of the selected area will be also automatically set as the Target of the Camera view. In consequence the 3D view rotation center will be set to the middle of the selected area.*

*"**Zoom to Selected Object**" enables the user to zoom the view to one chosen object simply by clicking on it. The selected object will be automatically set as the Target of the Camera view and in consequence will define the center of 3D view rotation.*

*The view icons are purposed to help the user to set the 3D view in the required position.*

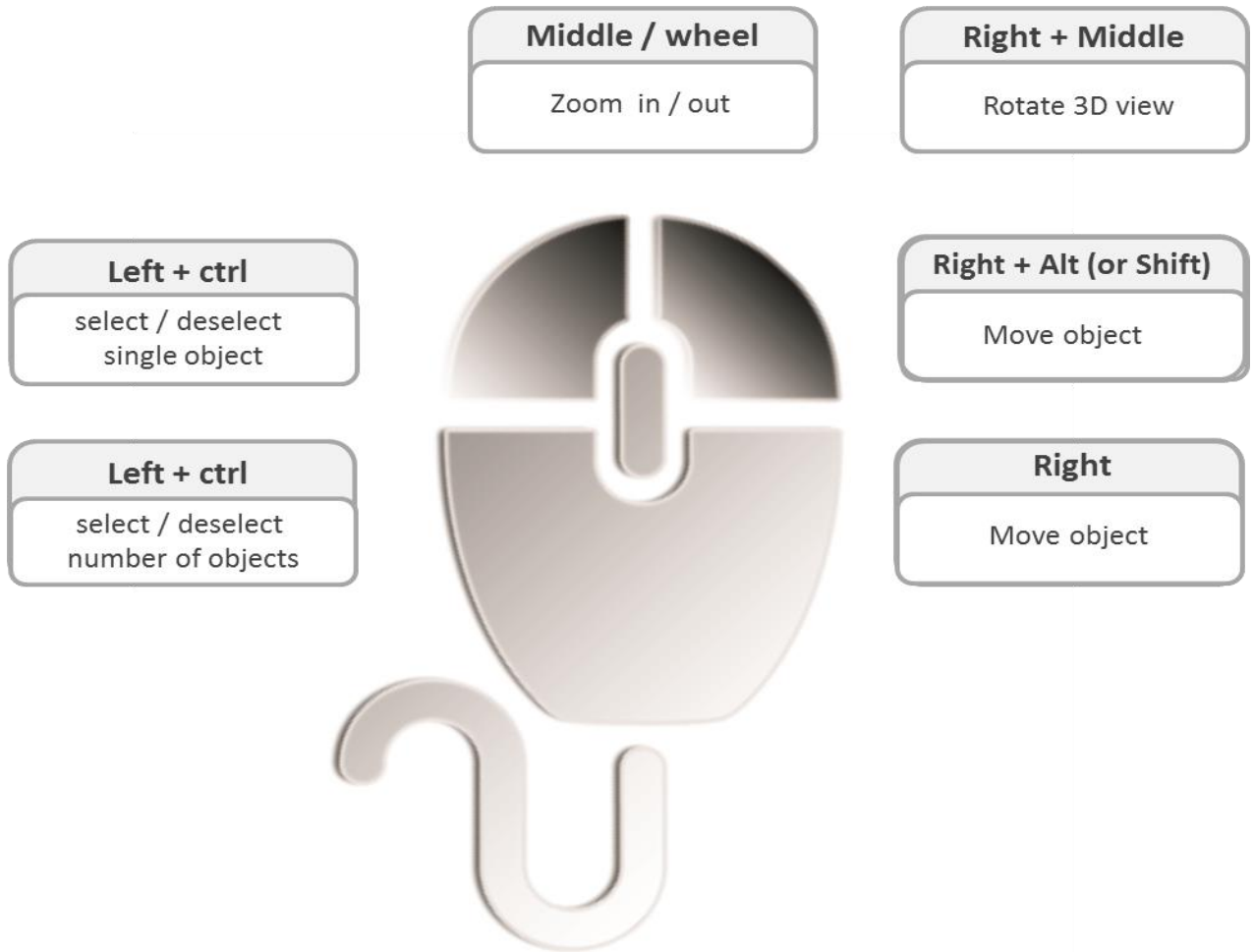
*On each view icon you can find a cube with one colorful side corresponding to one 3D view setting.*

*Note that three side's colors correspond to the default colors of the axis of the global coordinate system in positive direction (red – X axis, green – Y axis, blue – Z axis).*

*Also note that the colors of the view icons match the ones visible on the orientation tool.*



## BASIC MOUSE OPERATIONS



## KEYBOARD SHORTCUTS

**Useful keyboard shortcuts listed below were available in VCS.**

**P -- toggle FE Parts -->** by pressing the 'P' button, you may toggle the selection of FE Parts (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**S -- toggle Surfaces -->** by pressing the 'S' button, you may toggle the selection of Surfaces (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**G -- toggle Groups -->** by pressing the 'G' button, you may toggle the selection of Groups (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**L -- toggle Rulers and Protractors -->** by pressing the 'L' button, you may toggle the selection of Rulers and Protractors (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).



**B -- toggle Beams -->** by pressing the 'B' button, you may toggle the selection of Beams (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**N -- toggle Nodes -->** by pressing the 'N' button, you may toggle the selection of Nodes (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**R -- toggle Rigid Bodies -->** by pressing the 'R' button, you may toggle the selection of Rigid Bodies (they will be or will be not selected while using the Area Selection tool as well as when using the "traditional" objects selection).

**J -- toggle Joints -->** by pressing the 'J' button, you may toggle the selection of Joints (they will be or will be not selected while using the Area Selection tool (as well as when using the "traditional" objects selection).

**D -- toggle Deformable Barriers -->** by pressing the 'D' button, you may toggle the selection of Deformable Barriers (they will be or will be not selected while using the Area Selection tool (as well as when using the "traditional" objects selection).

**Q -- All OFF**

**A -- All ON**

**F2/F3 -- Set/Clear rotation center at selected object(s) -->** by pressing the F2 button ,after selecting an object, you will set the center of rotation of the 3D solution view on that chosen object. By pressing the F3 button you will set the rotation back to the center of the solution view.

**F4/F5 -- Exclusive visibility of selection/All objects visible -->** after pressing the F4 button, previously selecting an object or a number of objects, only the chosen objects will be visible in the solution 3D view. After pressing the F5 button, all objects of the solution will be visible again.

**F6 -- Hide current selection -->** after pressing the F6 button, all the selected objects will not be visible in the solution 3D view.

**F7 -- Hide/Show current selection -->** by pressing the F7 button you may toggle the visibility of the selected objects.



# KEYBOARD SHORTCUTS

*In order to enter the Keyboard Shortcuts Definition tool, click on View and then select the Preferences*

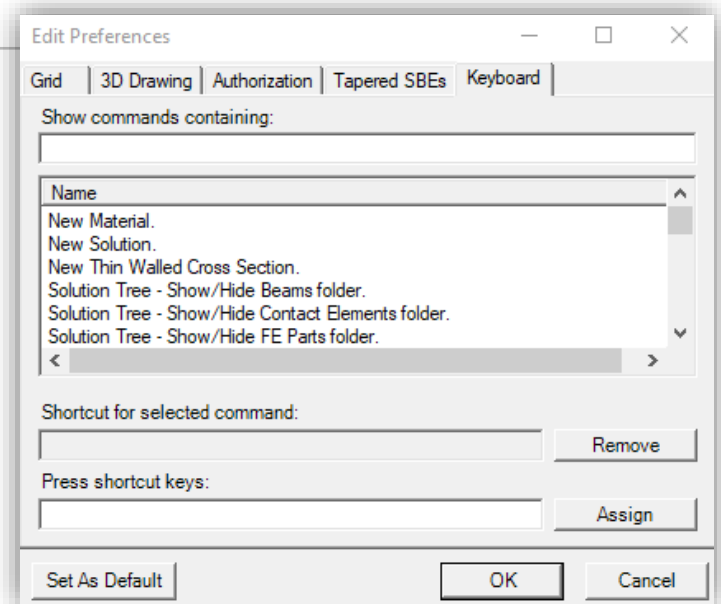
*A window named Edit Preferences will appear. In this window click on the Keyboard bookmark.*

*You will see a list of all commands for which shortcuts are available. After selecting one of the listed commands, in the 'Shortcut for selected command' you will find its default keyboard shortcut (for example: for the 'New Material' command the keyboard shortcut is: Ctrl + N, Ctrl + M).*

*In the 'Press shortcut keys' window you may write a user-defined shortcut for the selected command. After clicking the 'Assign' button, the new shortcut will be set. After pressing the 'Set As Default' button the user defined shortcuts will be saved and they will be set automatically for every VCS solution on this machine.*

**Notice:**

*The 'Show commands containing:' window is not case sensitive, which means you may write the searched name in small or capital letters.*



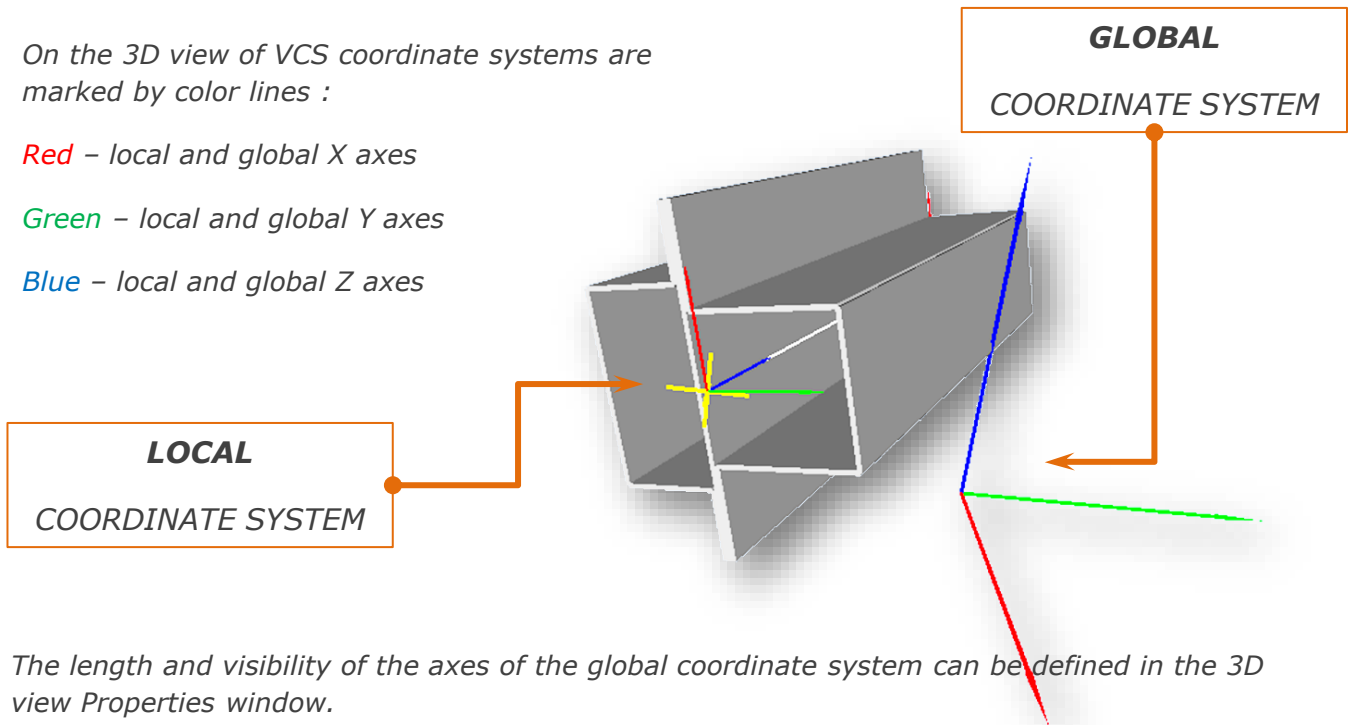
# VCS GLOBAL & LOCAL COORDINATE SYSTEM

On the 3D view of VCS coordinate systems are marked by color lines :

**Red** – local and global X axes

**Green** – local and global Y axes

**Blue** – local and global Z axes



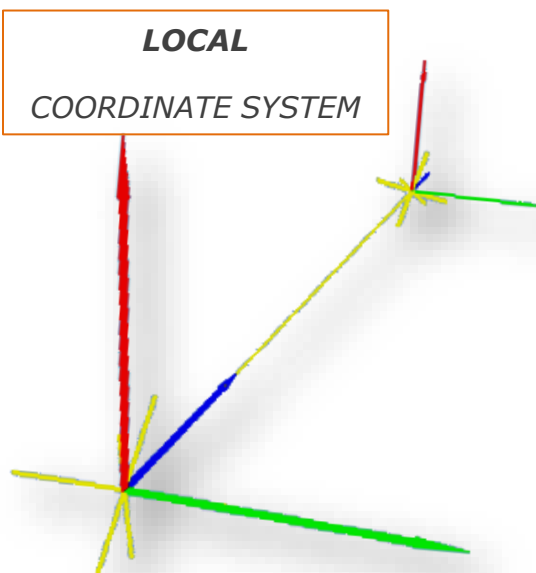
The length and visibility of the axes of the global coordinate system can be defined in the 3D view Properties window.

The axes of the local coordinate system will be defined in an objects Properties window.

In the picture above difference between the global and local coordinate system is visualized.

Global (reference) coordinate system of VCS is denoted by capital letters  $\{X, Y, Z\}$ . The local (corotational) coordinate systems are denoted by small letters  $\{x, y, z\}$ .

All forces and moments defined in VCS follow the right-handed coordinate system convention. The calculated forces acting on Node Objects are given in global coordinate system while internal forces in deformable elements (Super Beams, Solid Beams, etc.) are given in local corotational frames.



All local frames of reference in VCS are defined as co-rotational Euclidean frames. The co-rotational frame is a frame rigidly attached to an object.

The co-rotational frame moves and rotates together with an object.

The most common example of a co-rotational frame is the central principal coordinate system of a rigid body: frame is rigidly attached to the center of mass; co-rotational axes coincide with principal axes.



In the case of deformable objects co-rotational frame is typically coupled with principal stress or strain directions (3D elements) or principal axes (beam elements).

The concept of local co-rotational frame greatly simplifies formulation and numerical solution to nonlinear systems since all the nonlinear terms related to rigid body rotation are effectively handled by the kinematics of co-rotational frame.

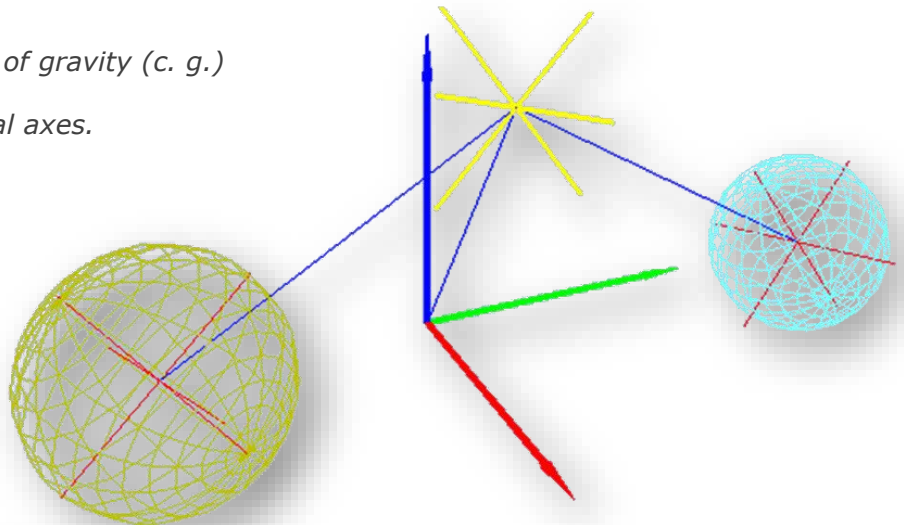
The co-rotational frame is sometimes confused with a curvilinear coordinate system where base vectors are functions of the deformation. Since the co-rotational system is simply a rotated global system this interpretation is incorrect.

The co-rotational frame is attached to each node of VCS element. The frame can be displayed on any 3D view by setting the Show Principal Axes switch to true in the Beams Properties window.

## LOCAL COORDINATE SYSTEM – NODE OBJECT

Proper interpretation of three major parameters of the Node Objects: is crucial for effective usage of the VCS. The important parameters of the Node Object are:

- user defined position,
- spatial position of the center of gravity (c. g.)
- orientation of central principal axes.



0. Basic Properties	
ConcentratedInertia	SecondOrderTensor
ConcentratedMass	0
Mass	1000
Origin	(-7.97 E2, 0 E0, -5.87 E0)
X	-797
Y	0
Z	-5.87
PrincipalMoments	(7.5003 E2, 5.2087 E2, 1.2708 E3)
TransformedMoments	SecondOrderTensor
1. Appearance	
2. Geometry	
CentreOfGravity	(-7.97 E2, 0 E0, -5.87 E0)
X	-797
Y	0
Z	-5.87
4. Kinematic Constraints and Concentrated Loadings	
5. Contact/Impact settings	
Other	

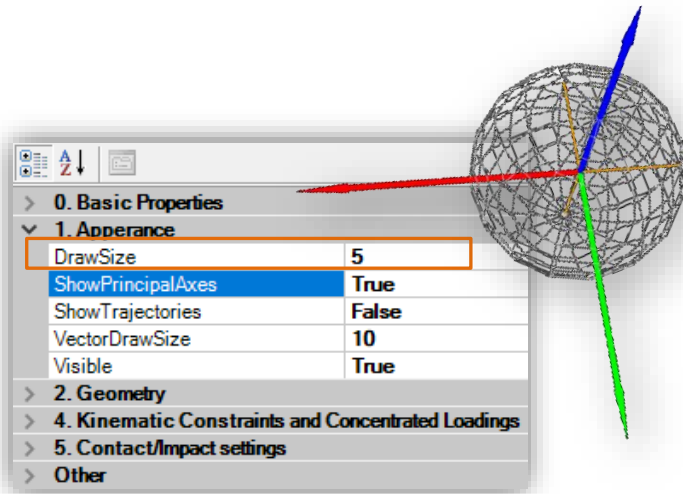
**User defined position** of the Node object is marked on 3D views by a yellow cross. The user defined position of the Node Object is defined by specification of its spatial coordinates in the global coordinate system.

In the Nodes Properties window the user defined position can be found in the **Geometry** section, in the **Origin** fields.



When the Node Object is defined it is massless and does not have any inertial properties, therefore the orientation of the Node Object, identical to the orientation of central axes of the global coordinate system, cannot be defined at this point of the modeling procedure.

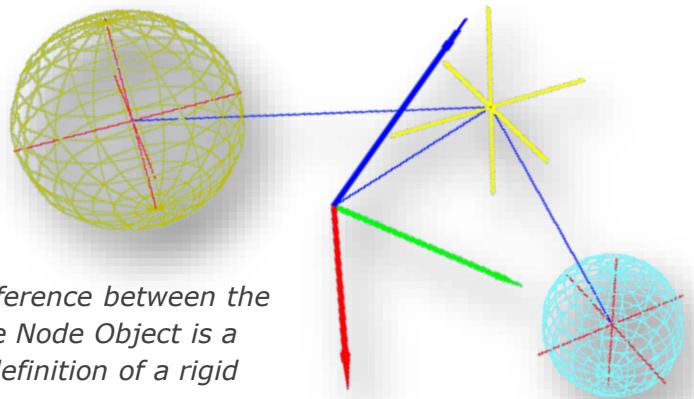
When various objects, like beams, rigid bodies, user defined mass and inertia etc. are attached to the node the resulting inertia properties are calculated in the Node model. In particular center of gravity (c. g.) and orientation of principal axes (local coordinate system) is determined following each change of the Node properties or a modification of any object attached to the Node.



Position and orientation of the Centre of Gravity of a Node as well as orientation of principal axes (local coordinate system) can be displayed on 3D view as illustrated in the pictures below.

In order to view the local principal axes of a Node set the Show Principal Axes property to **True**

It should be noted that the position of the center of gravity of a Node differs, in general, from the position defined by the user. Therefore, this position is referred to as a user defined reference point of the Node Object. All the dynamic calculation routines take into account position of the center of gravity and orientation of the principal axes rather than position of the reference point.



The picture on the right illustrates the difference between the term Node Object and the term node. The Node Object is a complex class, build around the general definition of a rigid body.

Each Node Object must recognize inertia properties of all elements attached to it, must be capable of updating these properties during simulation process and transfer to attached objects information on the current dynamic state.

A node, on the other hand has a conventional meaning of a center of gravity of rigid body, spot of a centroid at an end face of a beam element etc. In the picture above it is visible as a red cross in the middle of each rigid sphere. It is obvious that several nodes can be included in single Node Object.



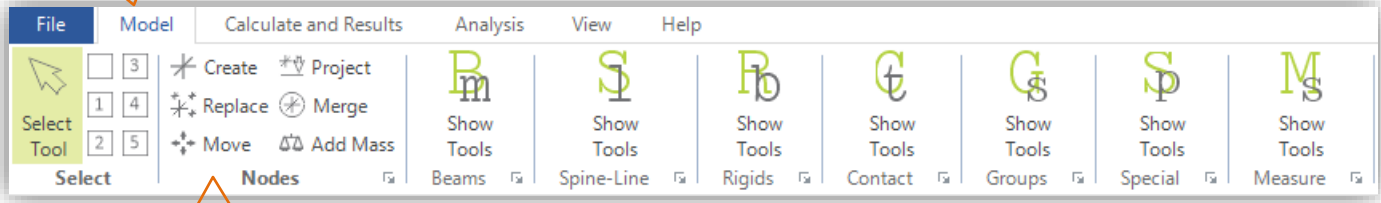


# VCS – MAIN TOOLBAR

In VCS main toolbar is divided into several tool groups.

First Group, called "Model", contains all tools required during the model creation process.

## **"MODEL" TOOLS**




## **Node object's tools**

### **Model tools**

This set of tools allows modeling of a complete VCS model.

Modeling tools are grouped in several blocks – each corresponding to a separate VCS object type. You will find expandable containers containing tools dedicated for Nodes, Beams, Rigid Bodies and Gauges

Additionally, in this section you will find the Selection tool, Groups tools, Contact tools and Special features

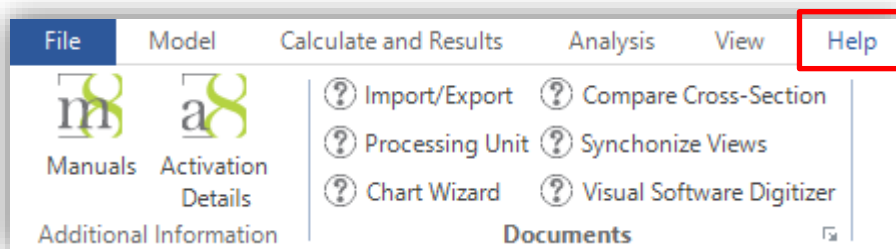
Each block of tools can be expanded and collapsed at any time. If you wish to leave a block expanded, click on the  icon in the bottom-right corner.

In the "Calculate and Results" group you will find the processing unit, Chart Wizard, animation toolbar and other features helpful during calculations and results comparison.

The Analysis section is dedicated to automatic analysis functionalities (Cross Section Analyzer)

Tools located in the View section provide additional 3D view tools

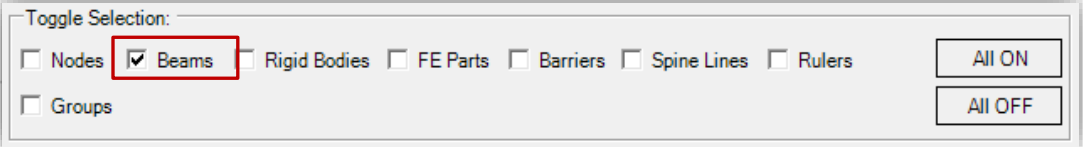
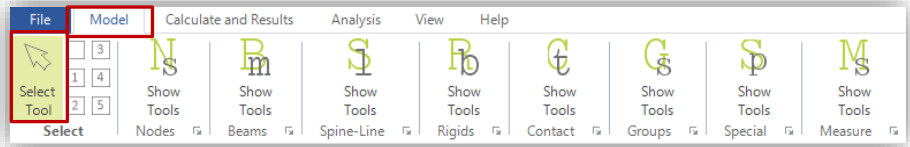
In the Help Section you will find all up-to-date manuals and help information covering all features present in the VCS software.





# "Select" tool

"Select" tool allows you to select any object visible in the 3D view. You can click on a chosen object or you can use the area selection option.



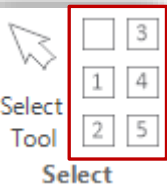
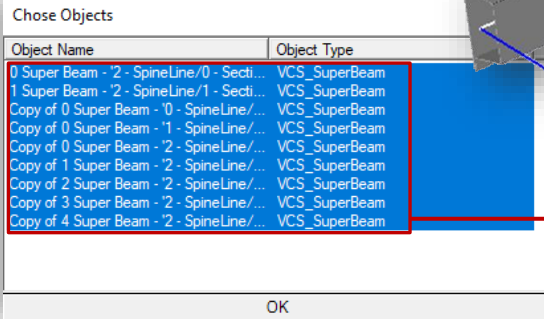
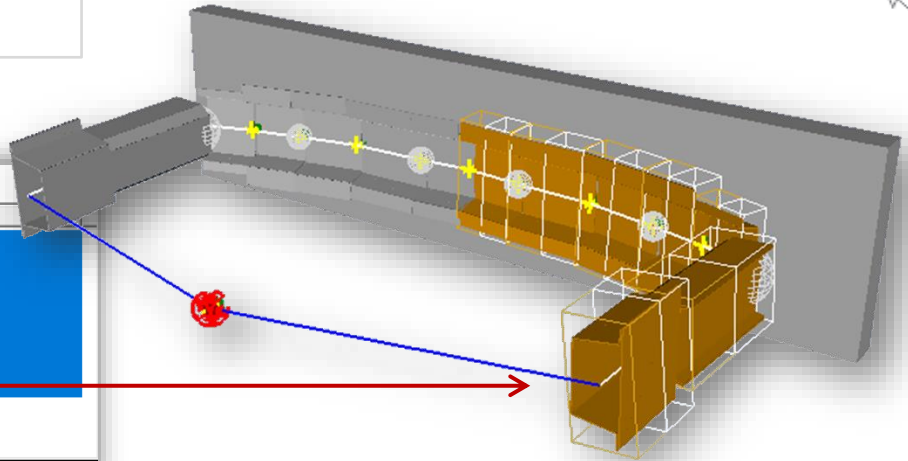
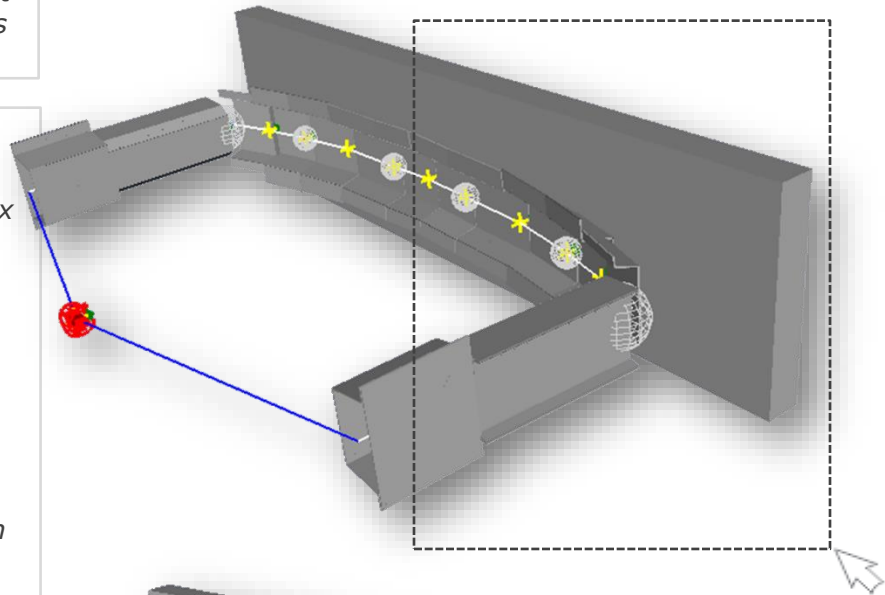
## Toggle Selection:

Each check box allows you to select exclusively one type of VCS objects

## EXAMPLE: Select only Beams

- 1) Click on the "Beams" check box in the Tool Settings window
- 2) Use area selection option to select number of elements in the 3D view
- 3) Result: Only Beams will be selected

Please note the objects selected in VCS 3D view are displayed in orange color



## Save Selection:

The "Save Selection" functionality icons are located in the main toolbar, next to the "Selection" tool.

The procedure of saving a selection is as follows:

- 1) With activated "Select" tool click on the "remember selection" icon
- 2) In the VCS 3D view select requested objects
- 3) Click on a free "remember selection" number

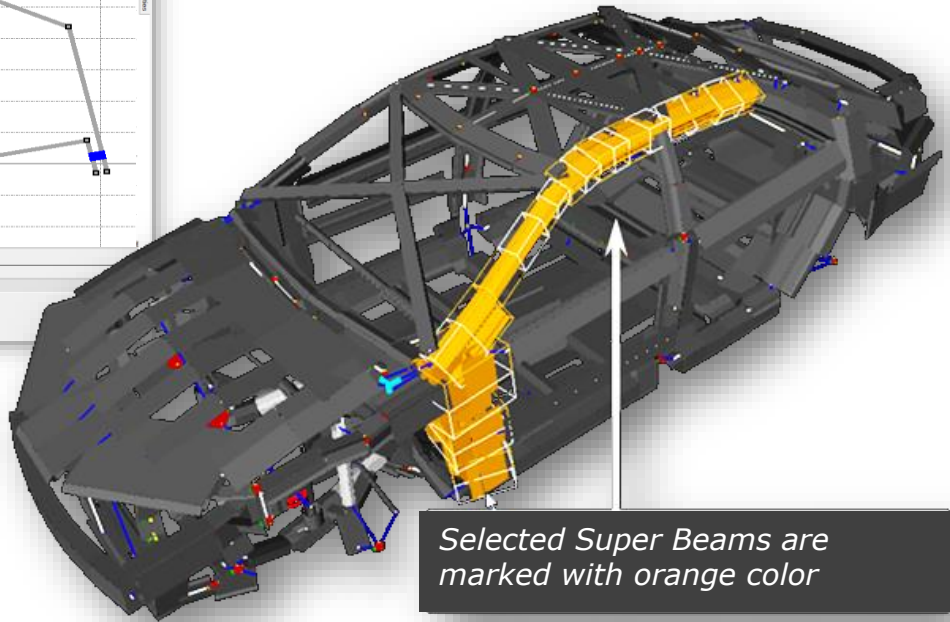
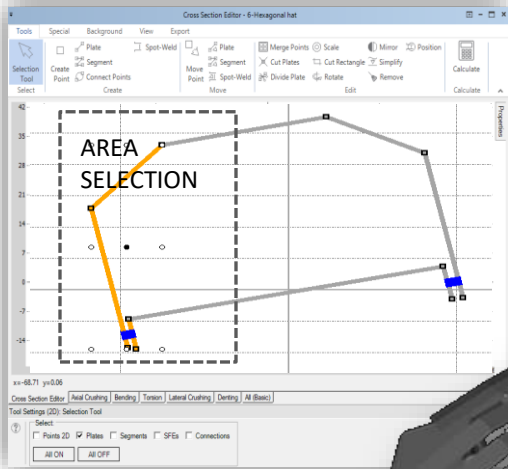




# "Select" tool

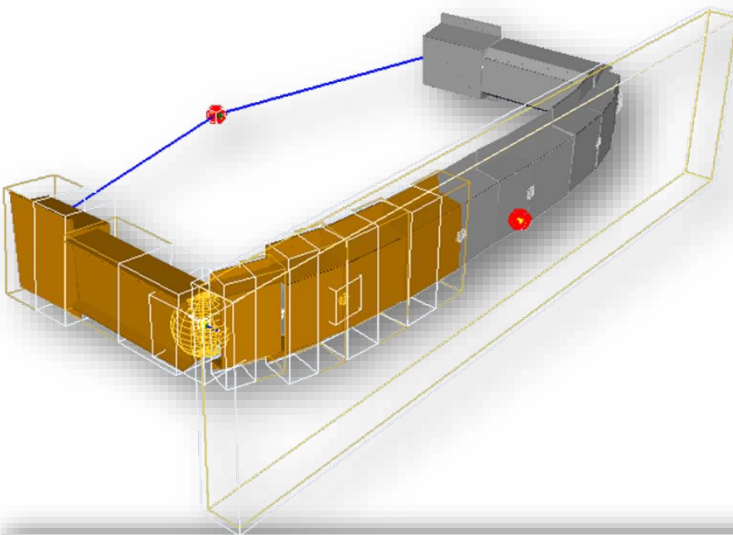
All objects selected in VCS 3D view or in the Solution Explorer window will be marked with orange color.

Similarly, elements of a cross section selected in the Cross Section Editor's 2D view or in the Solution Explorer window will be displayed in orange color



*Selected Super Beams are marked with orange color*

## Selected Elements Count



*Information about the number and type of selected elements can be found at the bottom of the 3D view window.*

*In the presented example several objects of a bumper model have been selected by means of the area selection tool.*

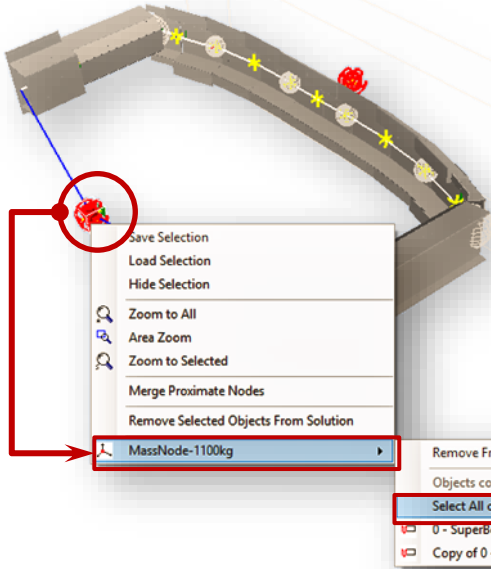
*At the bottom of the 3D view window number of selected nodes, beams and rigid bodies is given as well as the overall number and mass of selected objects.*

**Selected: 14   Mass: 145.497 [kg]   Node(s): 5 Beam(s): 6 Rigid Bodie(s): 3**



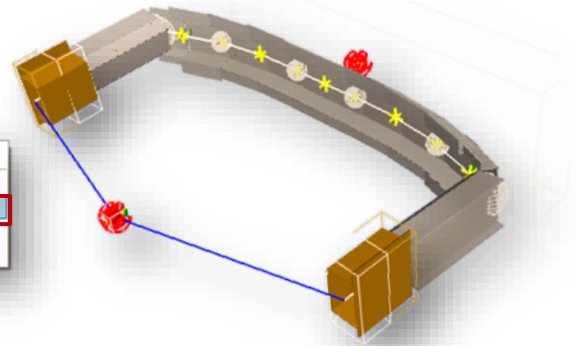
## Select All Connected Objects

You can easily select all objects connected to a selected element of the model. This functionality is especially useful to highlight all VCS object sharing a common node

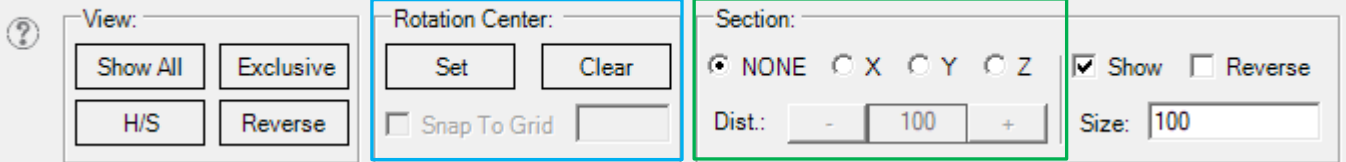


In the 3D view right click on a selected object. From the displayed menu select the name of the chosen element. Afterwards click on the "Select ALL connected objects" option.

All elements connected to the selected objects will be automatically highlighted in orange in the CVS 3D view and selected in the Explorer tree.



### Tool Settings (3D): Select Elements Tool



### **Rotation Center.**

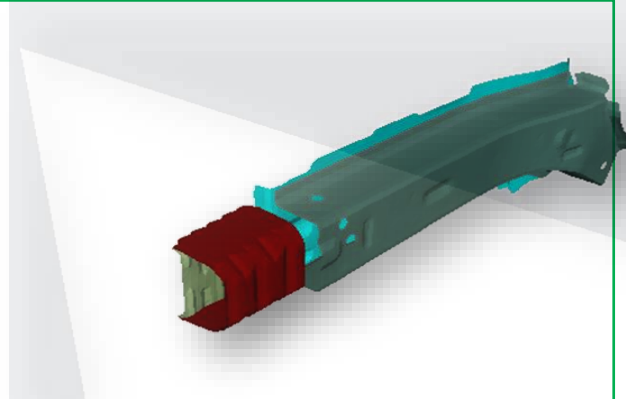
This tool enables the user to set the 3D view rotation center into a preferable location. Click on the "Set" button and afterwards in a requested place in the VCS 3D view.

### **The "Section" functionality**

enables the user to create and move a cutting plane in order to view the models section view.

In the "Section" field an axis along which the cutting plane will be oriented needs to be selected.

In the "Distance" section the user can define the size and position of the plane. Additionally an option to see the reversed view is available.



In the lower picture a bumper model's section view cut along the X axis has been presented.

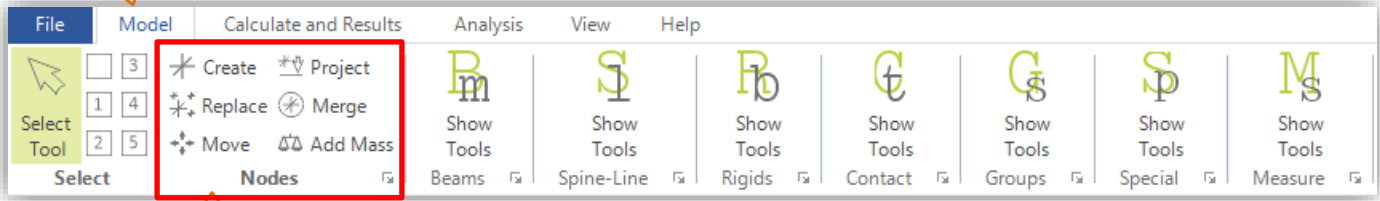
In the upper picture a similar operation has been made along the Y axis of the VCS global coordinate system.

# "MODEL" TOOLS

In VCS main toolbar is divided into several tool groups.

First group of VCS tools, called "Model", contains all tools required during the model creation process.

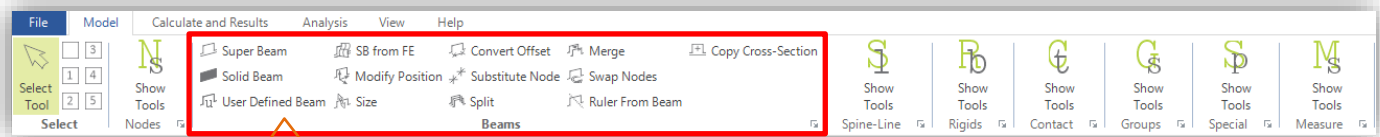
## "MODEL" TOOLS



## Node object's tools

This set of tools is used to create and edit VCS Nodes.

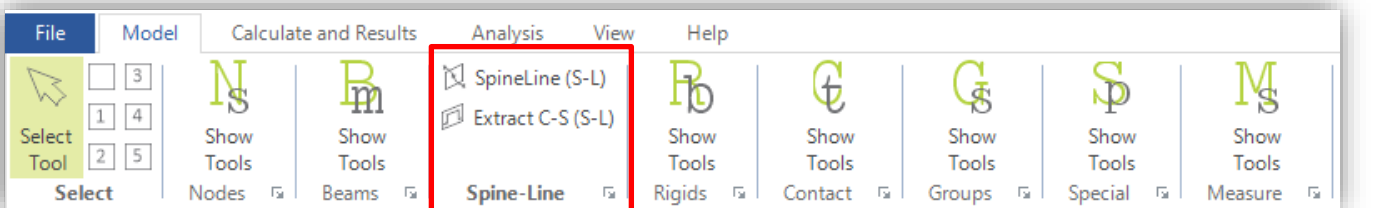
(\*) Detailed description of each tool and Nodes properties can be found in "VCS 3D modeling" manual



## Beam object's tools

This set of tools is used to create and edit Super Beams, Solid Beams and User Defined Beams.

(\*) Detailed description of each tool and VCS Beams properties and application can be found in "VCS 3D modeling" manual



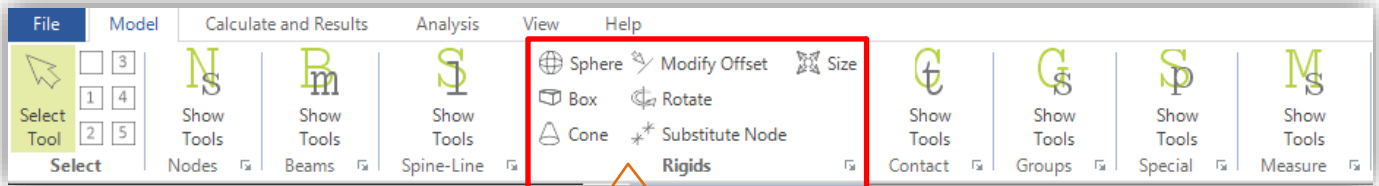
## Spine Line tools

This set of tools is used to create a simplified beam model basing on an imported FE geometry by means of the Spine Line functionality.

(\*) Detailed description of each tool and modeling procedures can be found in "VCS 3D Modeling" manual



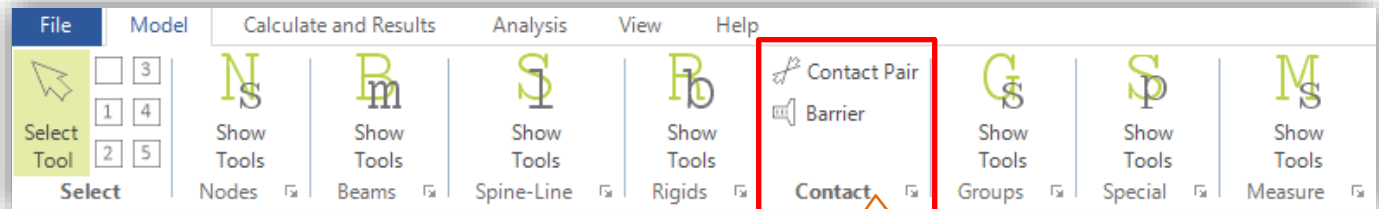
# "MODEL" TOOLS



## **Rigid Bodies tools**

This set of tools is used to create and edit VCS Rigid Bodies.

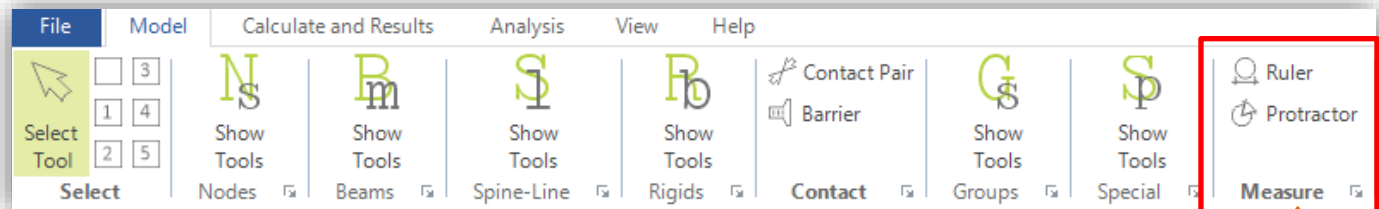
(\*) Detailed description of each tool and Rigid Bodies properties and application can be found in "VCS 3D modeling" manual



## **Contact tools**

Those tools enable the creation of VCS Deformable Barriers and Contact Pairs which are crucial during simulation settings.

(\*) For more information about VCS deformable barriers and contact settings please see "VCS 3D Simulations" manual



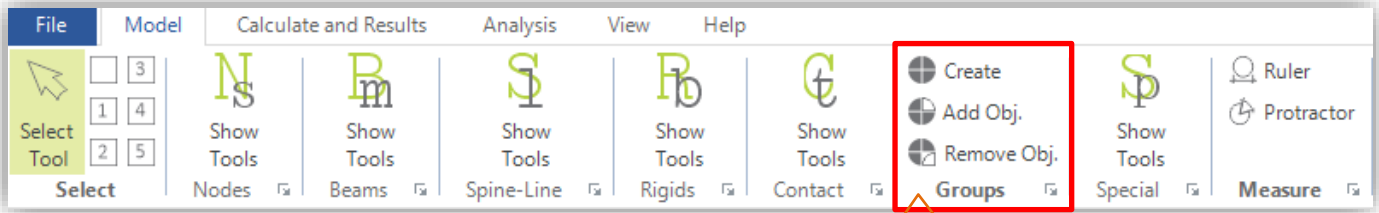
## **Measure tools**

Those tools enable the creation of rulers and protractors.

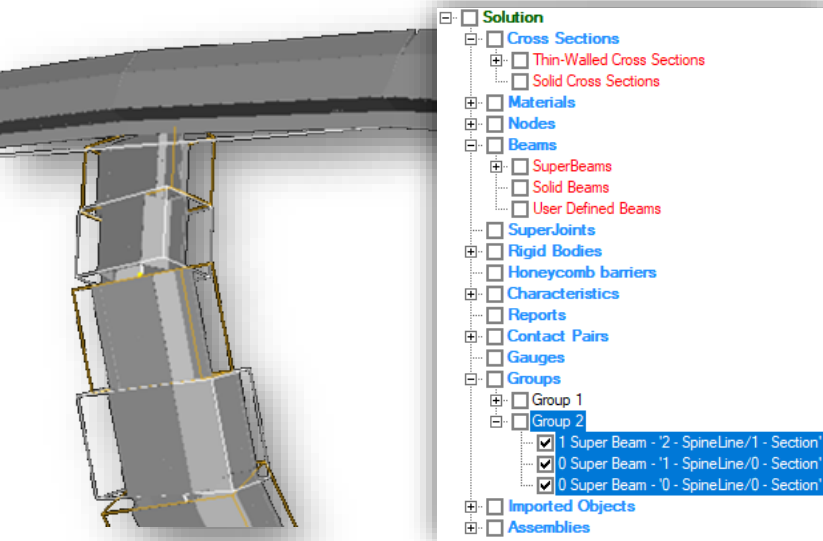
(\*) For more information please see "VCS 3D Modeling" manual



# "MODEL" TOOLS



## **Groups tools**



*Several elements of a VCS model can be collected in a Group.*

*After selecting required VCS Objects in the 3D view click on the Group icon located in the main toolbar (Group icons are visible in the picture above). All selected elements will be now gathered in a Group.*

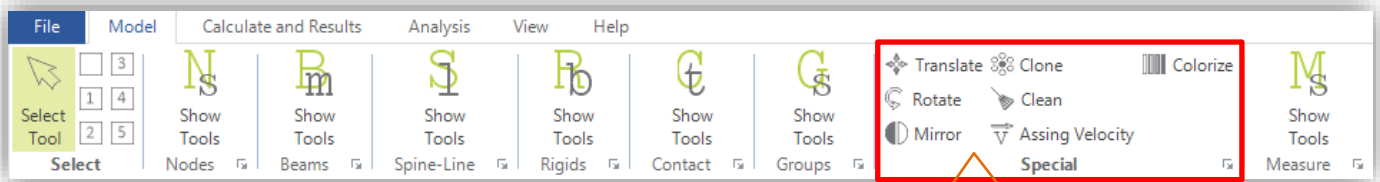
*Automatically a new Group branch will be added to the Solution Explorer three containing all object included in the group.*

*You can add or remove an Object from a Group at any time.*

*After selecting an object which you wish to add or remove click on the Add to Group or Remove from Group icon.*



# "MODEL" TOOLS



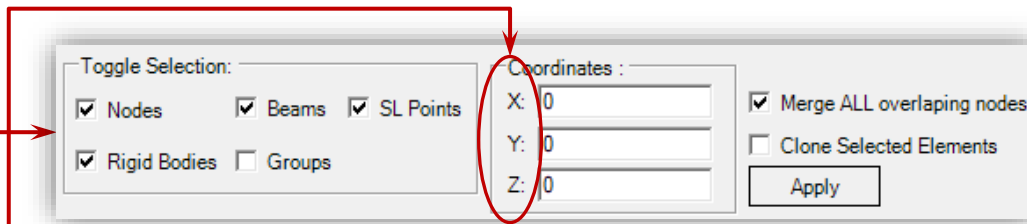
**Special tools**



## "Translate" tool

With the usage of the "Translate" tool you can move an object or number of objects along one of the chosen axis of the VCS global coordinate system.

After clicking on the "Translate" icon select required objects in the 3D view. In the tool settings window define new coordinates for each axis of the global coordinate system. Confirm by clicking "Apply"

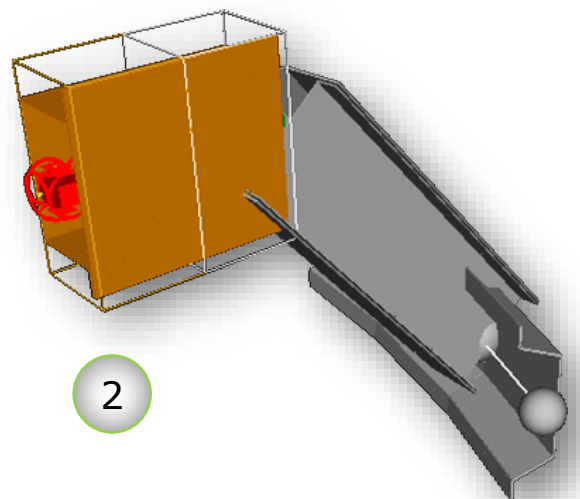
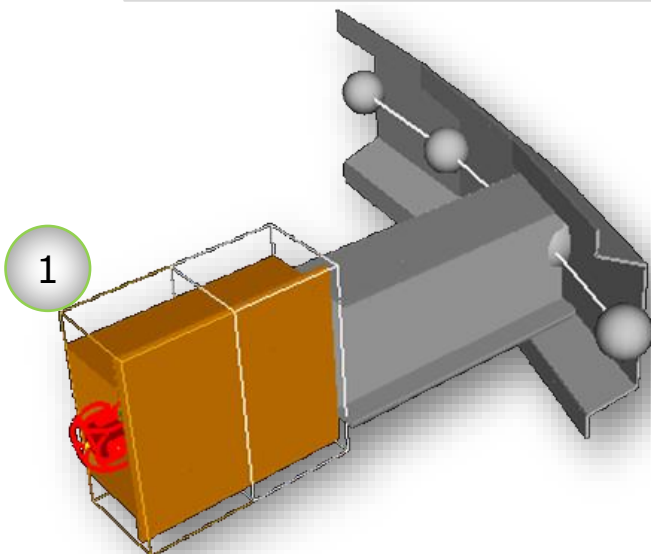


In the Tool Settings window select the axis of the global coordinate system along which you wish to move objects of the model.

The tool enables selection of specified object type – in the Toggle Selection section specify object type to be selected in the 3D view

The tool includes the option to merge all overlapping nodes.

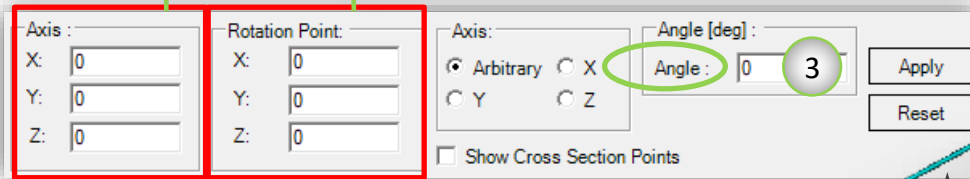
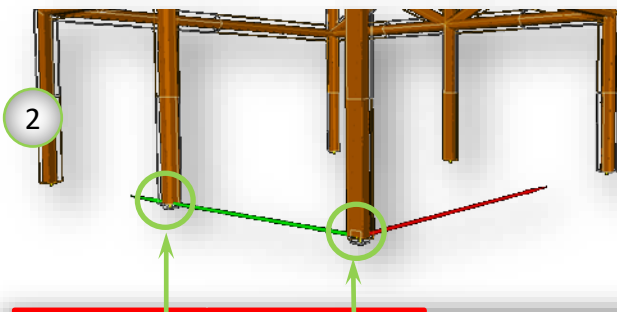
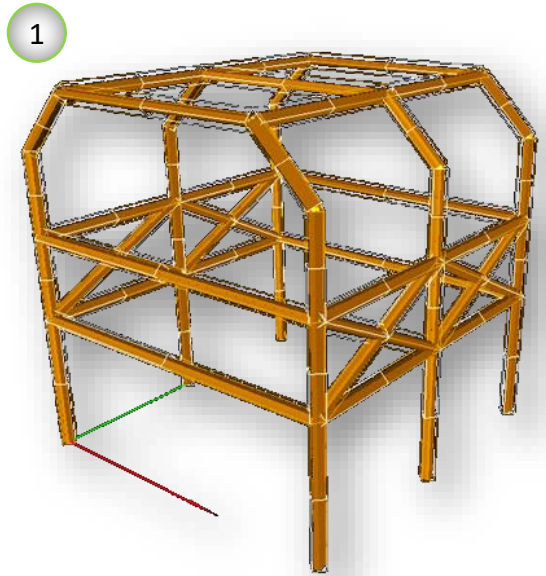
Moreover, you can use the "Clone Selected Elements" option to automatically create a copy of the translated objects.





The "Rotation" tool enables the user to rotate a beam structure with respect to a user defined rotation axis

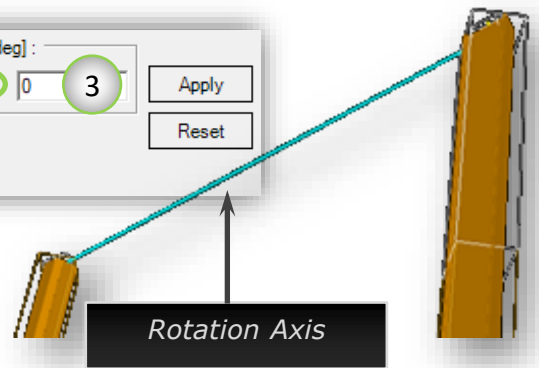
- 1) After choosing the "Rotation" tool from the main toolbar select the beams you wish to rotate. Note that you can use the area selection option.
- 2) Select two Nodes in the 3D view in order to define the rotation axis. You can also enter the coordinates manually. You can also use the cross-section points to define the rotation axis ("Show Cross Section Points" checkbox)



Note that the rotation axis will be displayed in the 3D view.

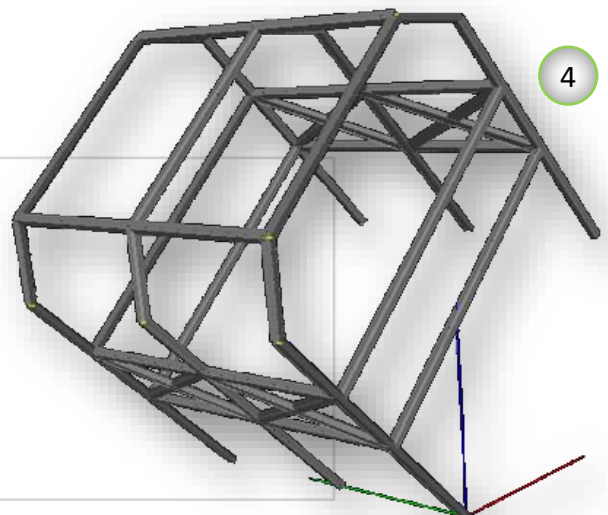
Alternatively, you can rotate the model with respect to one axis of the global coordinate system

- 3) Define the rotation angle



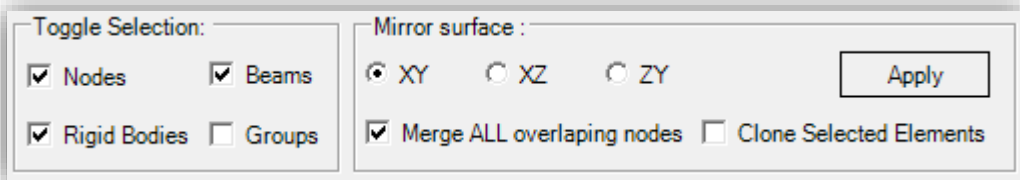
After pressing the "Apply" button all previously selected beams will be rotated with respect to the defined rotation axis.

Please note that all previously defined offsets will be preserved.

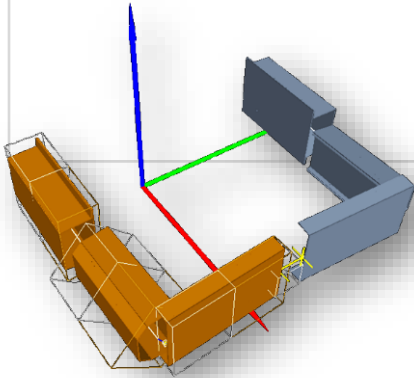


## "Mirror" tool

With the usage of the "Mirror" tool you can mirror an object or a group of objects with respect to the chosen mirror surface defined by axis of the VCS global coordinate system. After clicking on the "Mirror" icon select the required objects in the 3D view



The tool enables selection of specified object type – in the Toggle Selection section specify object type to be selected in the 3D view



In the Tool Settings window select the mirror surface defined by axis of the global coordinate system.

The tool includes the option to merge all overlapping nodes. Moreover, you can use the "Clone Selected Elements" option to automatically create a symmetrical copy of the mirrored structure

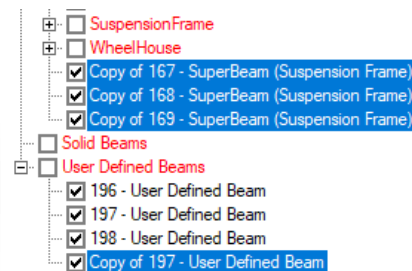
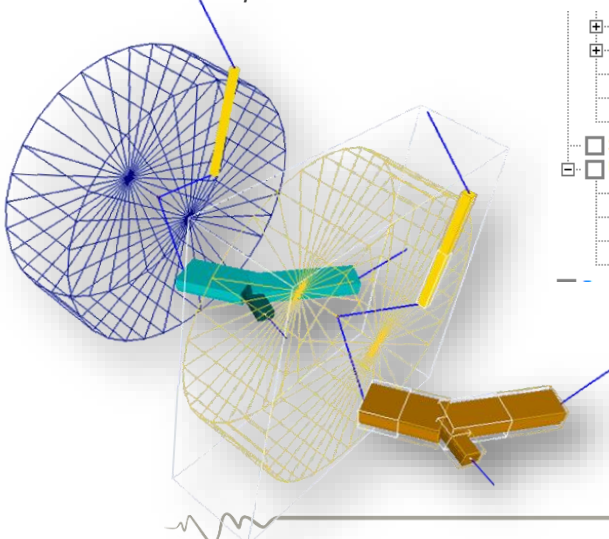
## "Clone" tool

The Clone tool enables the user to duplicate a chosen object. It is possible to create a copy of a selected Cross Section, Beam, Node, Rigid Body, Protractor or Characteristic simply by clicking on the Clone icon in the VCS main toolbar.

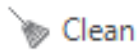
It is possible to clone the entire Spine Line after selecting it in the Solution Explorer tree. Single Lines cannot be cloned.

Moreover, it is possible to clone elements of a model collected in a Group.

In result of the clone operation, copied objects will appear in the 3D view, and will be added to the Solution Explorer tree



After creating a copy, the cloned object is automatically selected. Thanks to this it is easy to change any parameters (for example the coordinates) of the new created object.



## "Clean Model" tool

With the usage of the "Clean Model" functionality any unused characteristics, materials, cross sections, cross sectional points, nodes, Spine Line points or contact pairs can be removed from the Solution with a single mouse click. Select type of object you wish to remove and click OK.

Additionally, the tool is equipped with the possibility to define the number of decimal places for several parameters:

- Nodes position
- Beams offset
- Beams orientation vector
- Material constants

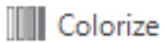
Clean Model Options

Clean Options:

Remove Unused Characteristics:	<input checked="" type="checkbox"/>	<input type="button" value="All ON"/>
Remove Unused Materials:	<input checked="" type="checkbox"/>	<input type="button" value="All OFF"/>
Remove Unused Cross Sections:	<input checked="" type="checkbox"/>	
Remove Unused Points on CS:	<input checked="" type="checkbox"/>	
Remove Standing Alone Nodes:	<input checked="" type="checkbox"/>	
Select not used Contact Pairs:	<input type="checkbox"/>	
Remove Material Duplicates:	<input type="checkbox"/>	
Remove Standing Alone SL Points:	<input checked="" type="checkbox"/>	

Round Options:

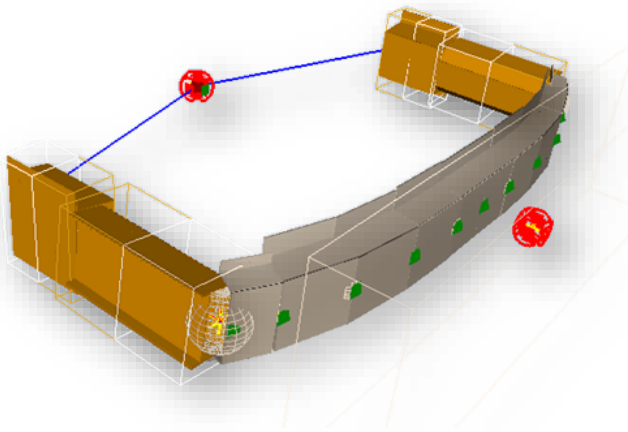
Round Nodes Position:	<input type="checkbox"/>	Decimal No.:	<input type="text" value="3"/>
Round Beams Offset:	<input type="checkbox"/>	Decimal No.:	<input type="text" value="3"/>
Round Beams Orientation Vector:	<input type="checkbox"/>	Decimal No.:	<input type="text" value="4"/>
Round CS Points:	<input type="checkbox"/>	Decimal No.:	<input type="text" value="3"/>
Round Material Constants:	<input type="checkbox"/>		



## "Colorize" tool

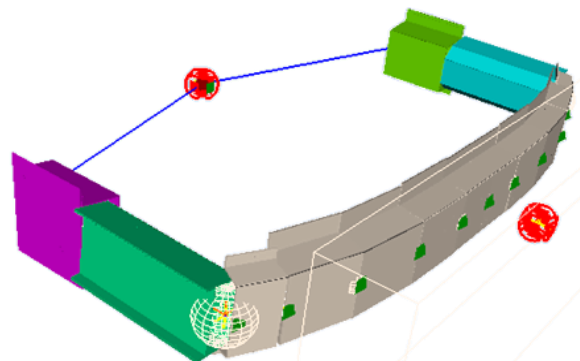
The "colorize Selection" tool automatically sets various colors to a group of selected VCS objects.

The tool is especially useful in case of an imported STL model, which parts by default share gray color.

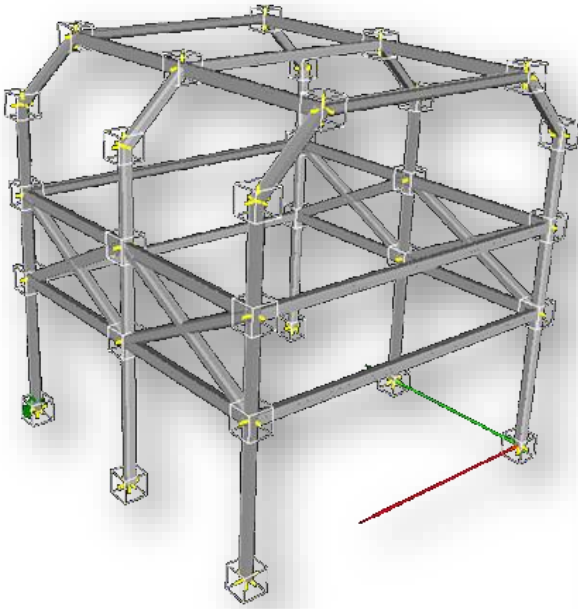


Question

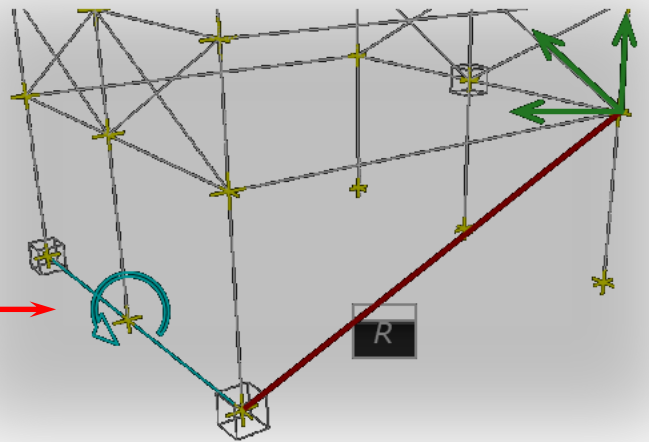
Do you want to change color of 4 objects?



## "Assign Initial Velocity" tool



- 1) After choosing the **"Assign Initial Velocity"** tool from the main toolbar select all nodes to which you wish to assign initial velocity.
- 2) Select two Nodes in the 3D view in order to define the rotation axis. You can also enter the coordinates manually



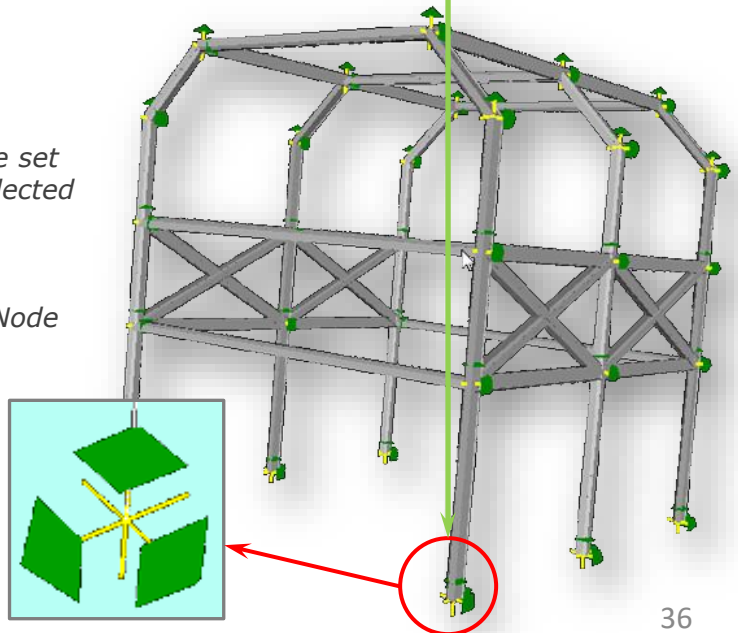
Axis Vector:		Base Point:		Omega [rad/s]:	3
X:	0	X:	0	Omega:	0
Y:	0	Y:	0	<input type="checkbox"/> Show Cross Section Points	
Z:	0	Z:	0	Apply	Reset

### 3) Define the angular velocity

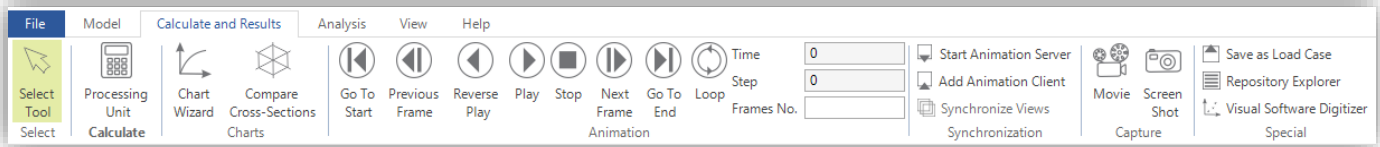
In the VCS 3D view you will be able to see set of linear velocities assigned to all prior selected Nodes.

Linear velocity is represented by 3 green arrows.

You can view assigned velocities of each Node in its Properties window.

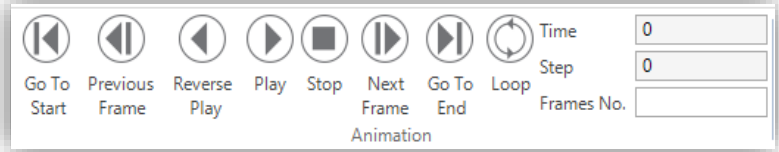


# "CALCULATE AND RESULTS" TOOLS



## **Animation tools.**

This set of tools are responsible for the VCS animation display.

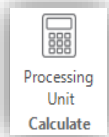
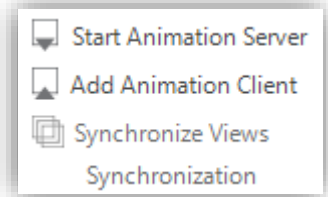


Apart from standard play options the user has the possibility to set the requested time or step of the simulation.

(\*) for more information, please see "VCS Simulations" manual

## **Synchronization Functionality**

This set of tools allows synchronization of animations of several VCS files. Additionally, thanks to the Synchronization functionality it is possible to easily compare results of number of VCS solutions.



## **Calculate Solution**

This icon is used to calculate a completely defined VCS solution



## **Chart Wizard**

Chart Wizard window enables the user to view detailed results for any object of a 3D VCS model.

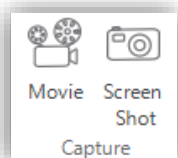
(\*) for more information, please see the "Chart Wizard" manual



## **Compare Cross Sections tool**

The "Compare Cross Sections" tool enables the user to easily compare results of number of selected thin-walled cross sections.

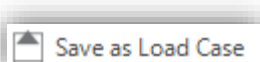
(\*) for more information, please see the "Cross Section Editor" manual



## **Capture tools**

„Movie" tool enables export of VCS animation.

„Screen Shot" tool enables



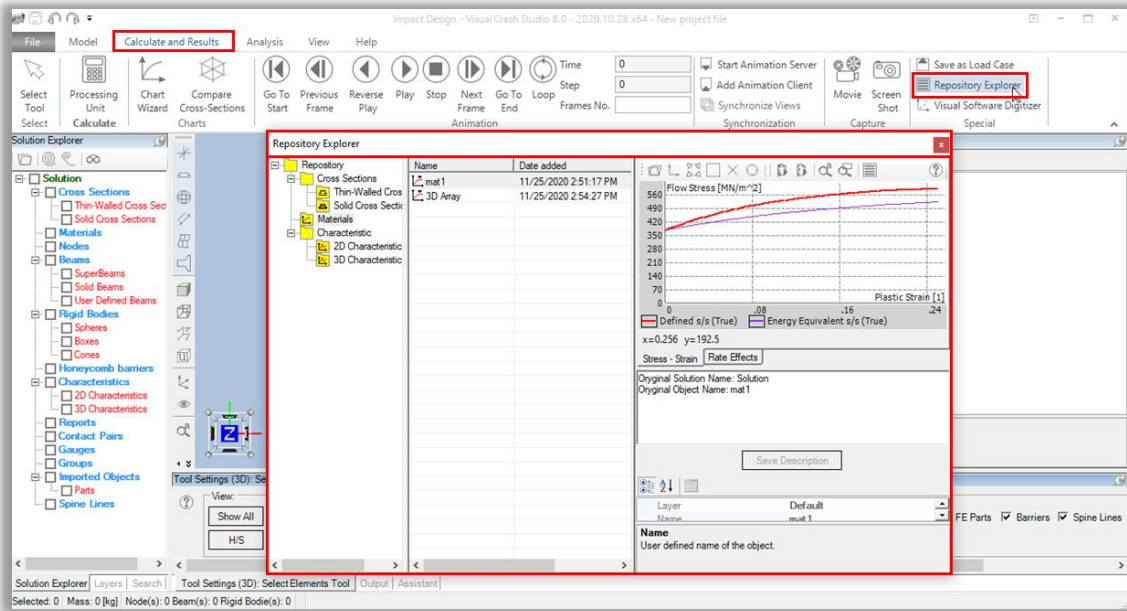
## **Save as Load Case**

Enables future comparison of VCS results

(\*) for more information, please see the "Chart Wizard" manual

# VCS REPOSITORY

The commands sequence: Calculation and Results → Special section → Repository Explorer  
After clicking on 'Repository Explorer' button, the Repository window will appear.



The Repository Explorer enables the user to create a personal Material, Cross Sections and Characteristic library, which can be opened and used whenever working on a new solution. You may now save any Material, Cross Section or Characteristic and easily use it in a new Solution. You may also export any Material, Cross Section or Characteristic from a Solution into the Repository.

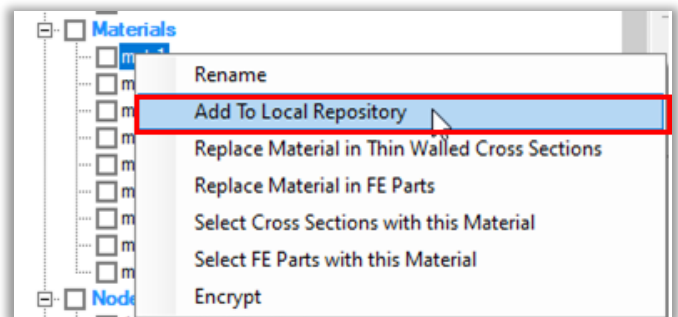
You may organize saved Materials, Cross Sections and Characteristics by ascribing them to a selected folder (listed on the left side of the "Repository Explorer" window). You may also create new folders, transfer or copy objects from one folder to another and so on. This will enable you to create a personal, easy to use library. In order to create or delete a folder right-click on one of the folders on the left column of Repository Explorer. You may then select the "Add folder" tool to create a new folder or "Delete folder" tool.

To move folders or object to new location simply drag and drop it. Remember that similarly to solution explorer in VCS you can't move material into characteristics folder etc.

In the middle of the "Repository Explorer" window you will find a list of Materials, Cross Sections or Characteristics together with the date of its addition to the repository and the date of the latest modification. You may sort the Materials and Characteristics by name (alphabetically) by clicking on the "name" button, by the date of addition (click on "Date added") or by the date of last modification (click on "Date modified").

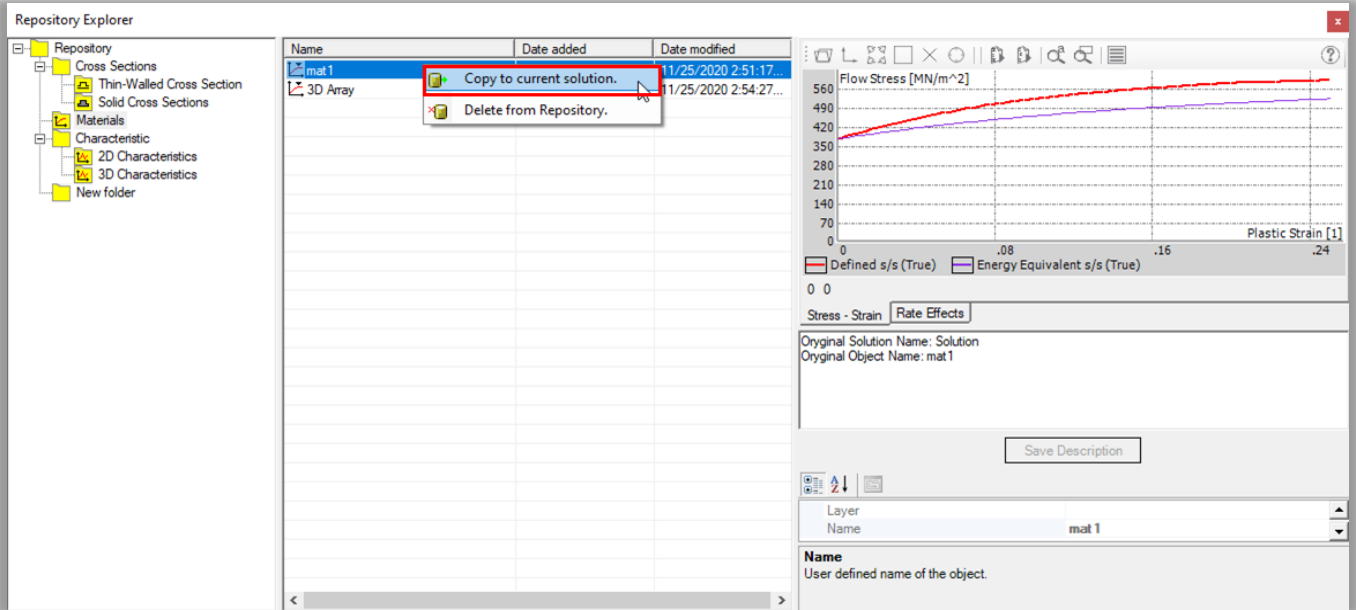
On the right side of the 'repository Explorer' window you will find the detailed 'read - only' properties of the selected Material or Characteristic.

In order to copy a object from the Solution into the Repository, left-click on the chosen object in the Solution Explorer window, and then right-click. After choosing the "Add to Local Repository" a window will appear, in which you may describe the selected object. The described object will be automatically added to the main material folder in the Repository.



# VCS REPOSITORY

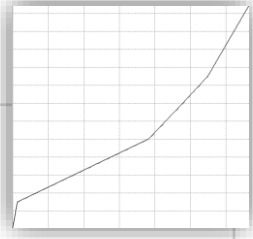
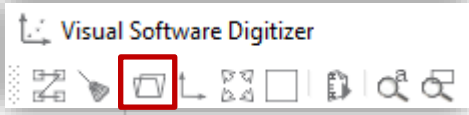
In order to import a Material, Cross Section or Characteristic from the Repository into the Solution you need to right-click on the required object and choose the "Copy to current solution" option. The object will be automatically added to the Solution Explorer window.



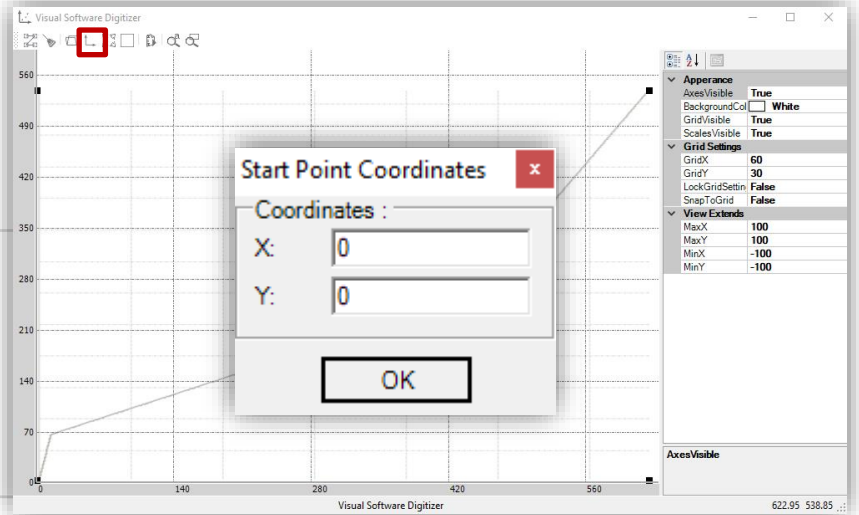
All the data gathered in the Repository Explorer will be automatically saved on your computer's drive in a separate folder. In order to find the Repository data, open the "Documents" folder, then find and open the "Visual Crash Studio" folder in which you will find the "Repository" folder with "repository.rvcs" file in it. You may easily copy the "repository.rvcs" file creating a backup of all of the Materials and Characteristics gathered in the Repository Explorer.



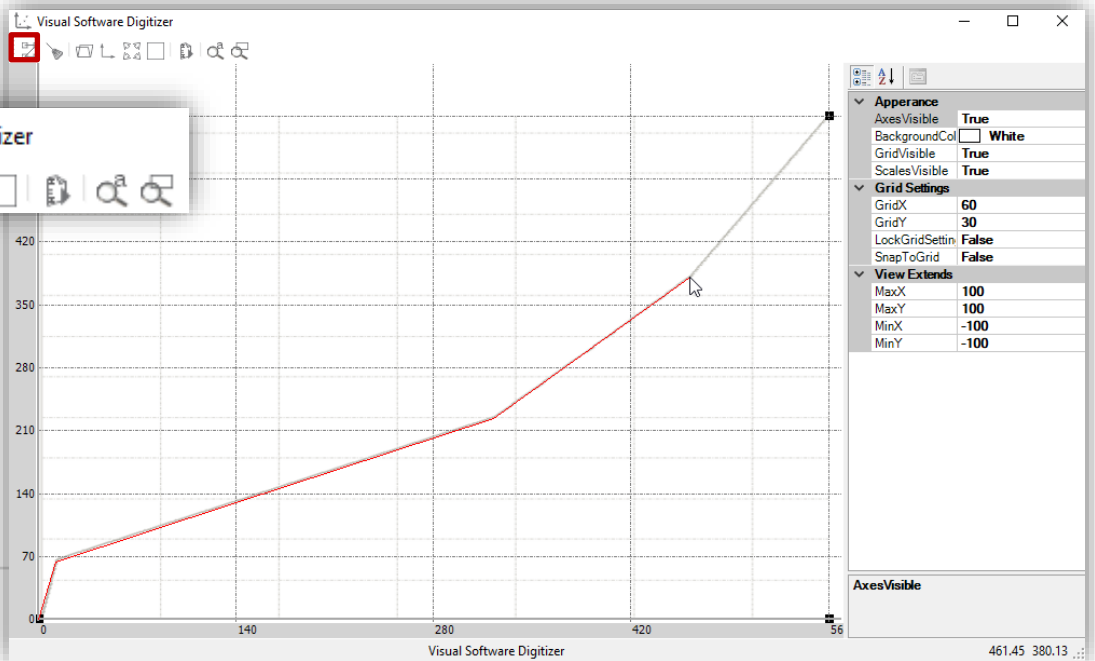
The Visual Software Digitizer (VSD) enables the user to import a picture representing any chart or graph of a function and easily translate it into numerical data, which can be later used to define the properties of a new VCS Material or VCS Characteristic.



In the Visual Software Digitizer window click on the "Open" button. Now you may import any picture (for example a bitmap or a scan of a document) into the Visual Software Digitizer.



The imported picture will be visible in the main window of the VSD. Use the "Define Axis", "Size Background" and / or "Pan Background" tools to manage the imported picture



After clicking on the "Add Point" tool you can enter points on the imported graph of a function. A red line will be automatically drawn between every two points. The coordinates of each point will be saved, in the correct order based on horizontal axis coordinates.



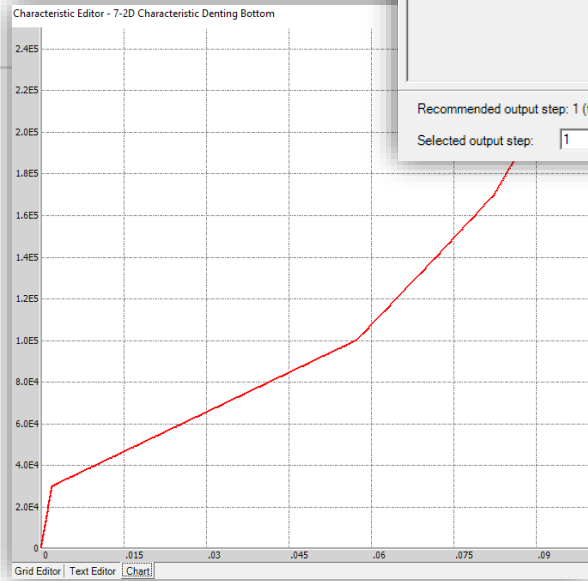
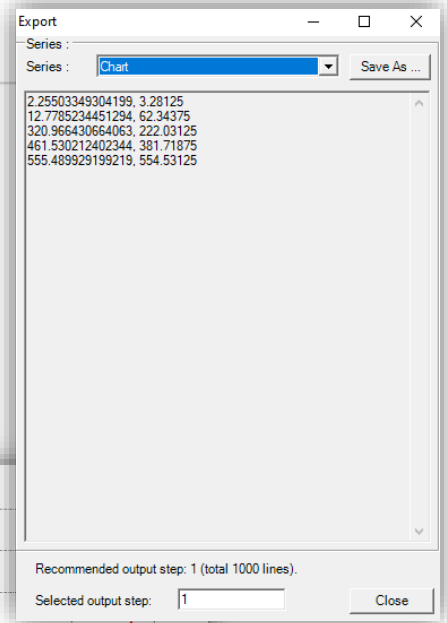


Visual Software Digitizer



Click on the "Export" icon to export the text list of points entered in the picture view. This data can be later used to define parameters of a new VCS Characteristic or Material.

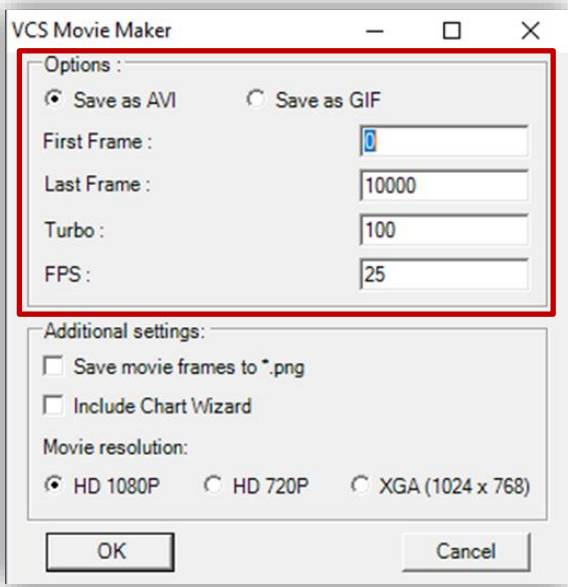
In case of a new VCS material, you can use the exported text file or clipboard data to create the Stress Strain Characteristic of the Material or any other characteristics.



(\* ) please note that points' coordinates are automatically exported with a coma separating the two numbers. Make sure to remove the coma before entering point's coordinates to the VCS Characteristic Editor or for the purpose of material definition.



# "Save Movie" tool



VCS gives the possibility to save the movie based on the animation in 3D window. To save the movie select Movie tool from Main Toolbar.

The movie can be saved in AVI (\*.mp4) or GIF(\*.gif) format.

By default, as the first and last frame of the movie are set respectively first and the last frame of the animation. However, they can be changed by the user at any time.

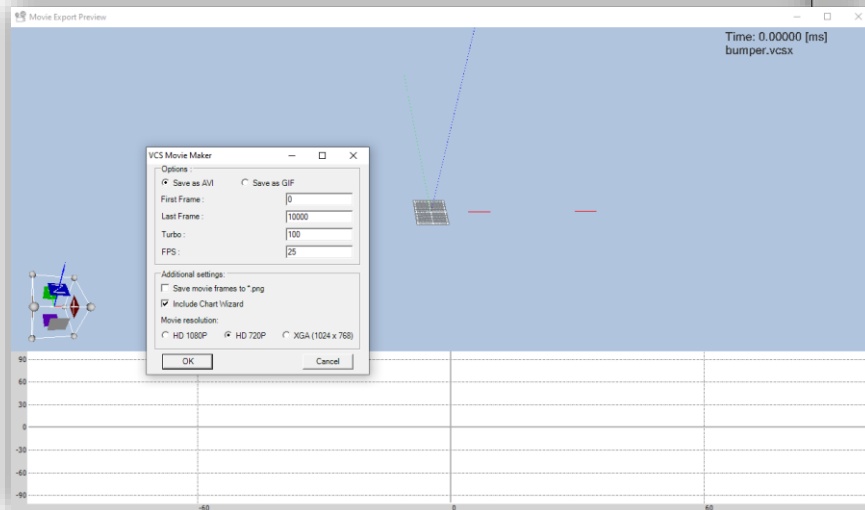
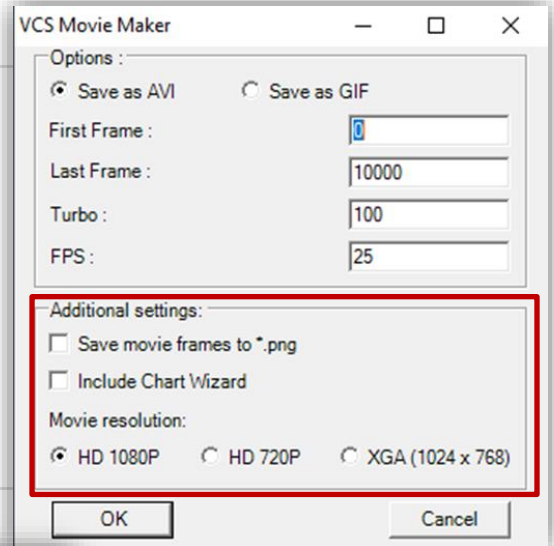
## **IMPORTANT NOTICE:**

To be able to save the movie, calculations must be performed.

Additionally, VCS enables to save all movie frames in \*.png format.

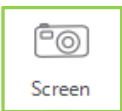
If the Chart Wizard is open while saving the movie and any curve is displayed, the user can include this chart in the movie.

Three different recording resolution are available in VCS: HD 1080P, HD 720P, XGA (1024x768).

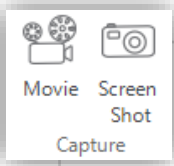


Once the settings are selected, user can view them in the Movie Preview Window

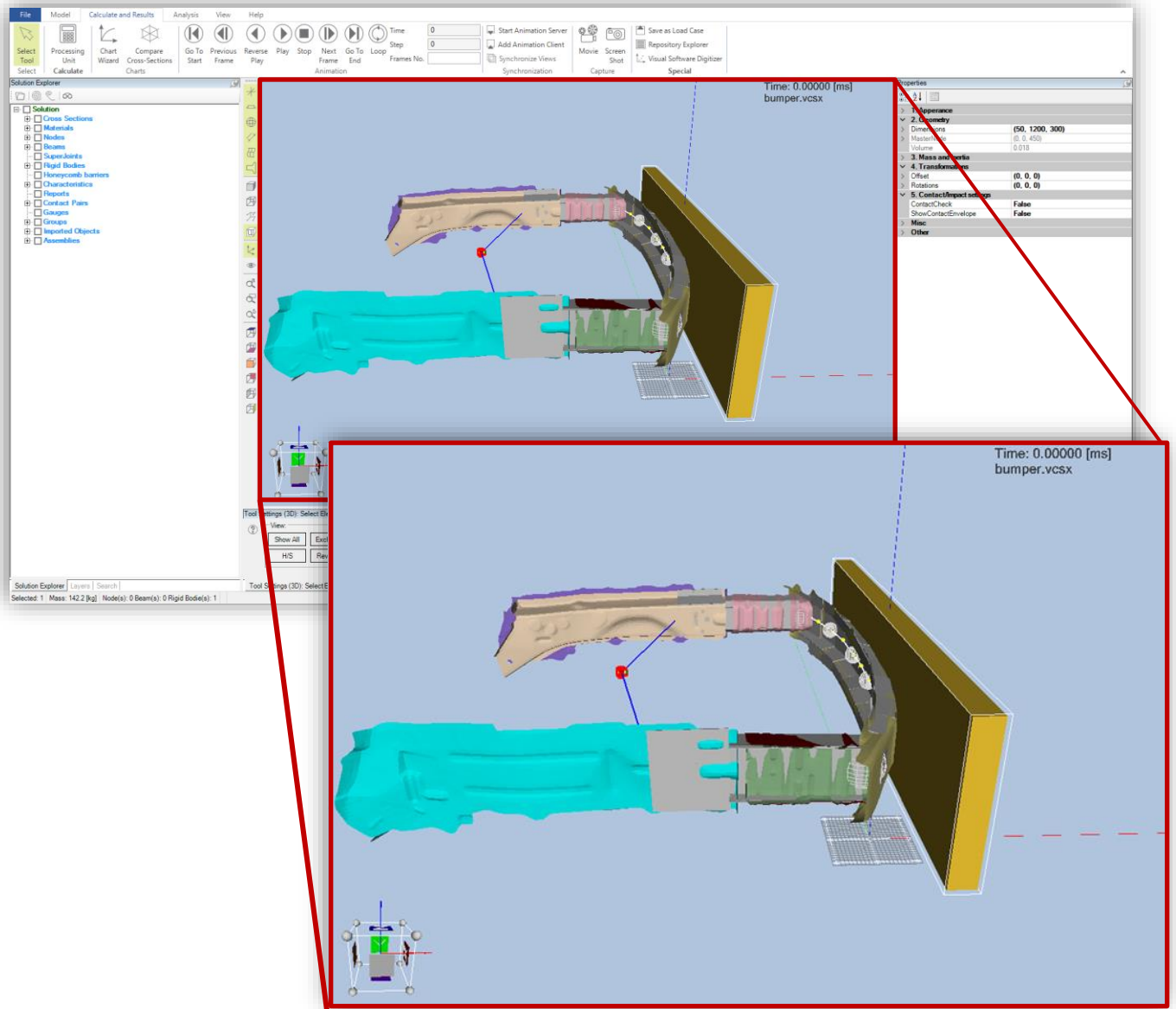




# "Screen Shot" tool



*Screen Shot tool gives the possibility to copy 3D window directly to the clipboard. After selecting the Screen Shot tool current view of 3D window is copied to clipboard and can be pasted directly to another program.*

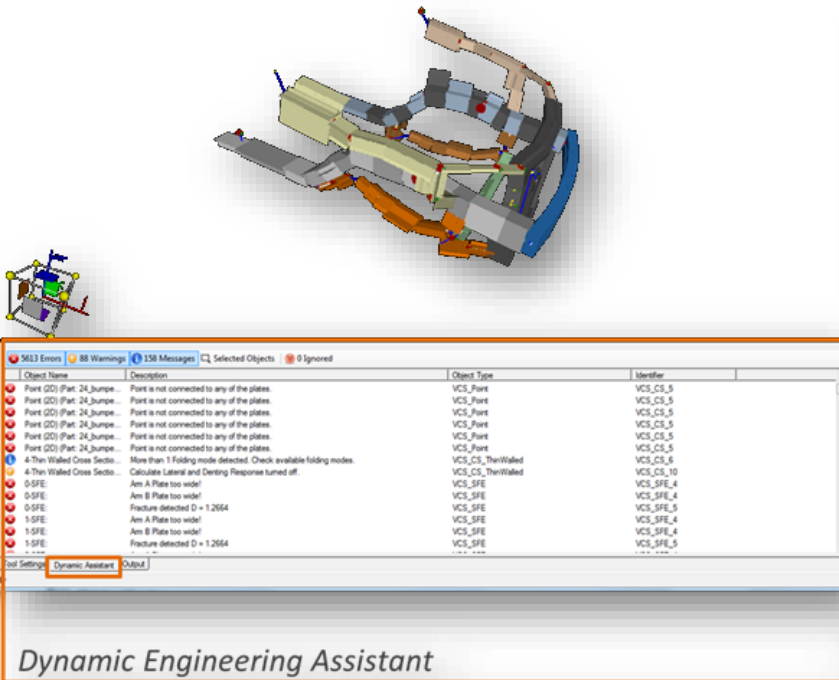


# DYNAMIC ENGINEERING ASSISTANT

Dynamic Engineering Assistant provides information about all errors and inaccuracies detected in the currently opened Solution.

Dynamic Engineering Assistant can be found on the bottom of the screen, in the location of the Output window.

In order to view the error messages, you need to click on the "Dynamic Assistant" bookmark, as illustrated in the picture below.



The Dynamic Engineering Assistant window is divided into several columns.

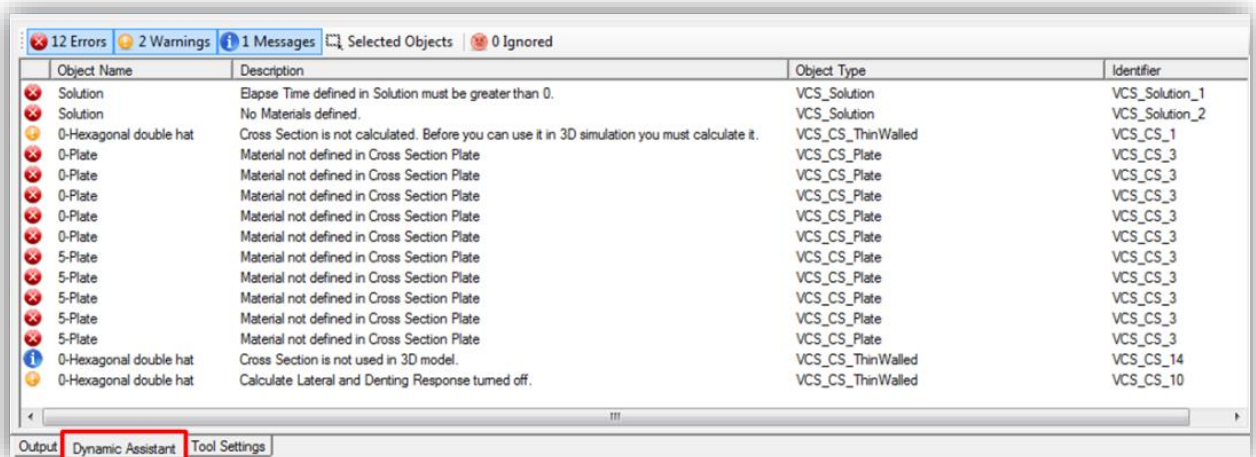
The first column contains symbols which indicate whether the provided information is an error, warning or a message. Error information is crucial for proper calculations of the VCS model, warnings and messages provide tips useful during the modeling procedures.

Second column contains the name of an object in which a problem has been detected

The "**Description**" column provides basic data about the nature of the detected mistake.

"**Object Type**" column indicates that type of an object is listed in the Dynamic Engineering Advisor. This information helps to find the problematic object in the Solution Explorer window.

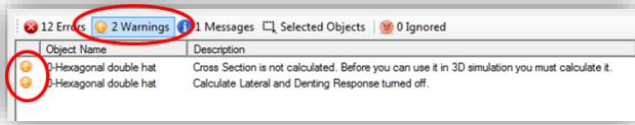
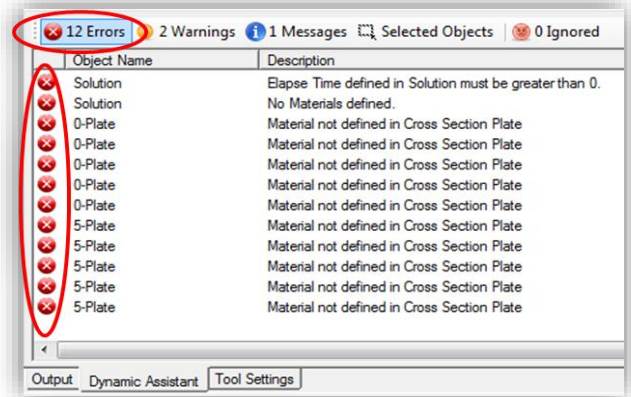
The last column contains error identifiers.



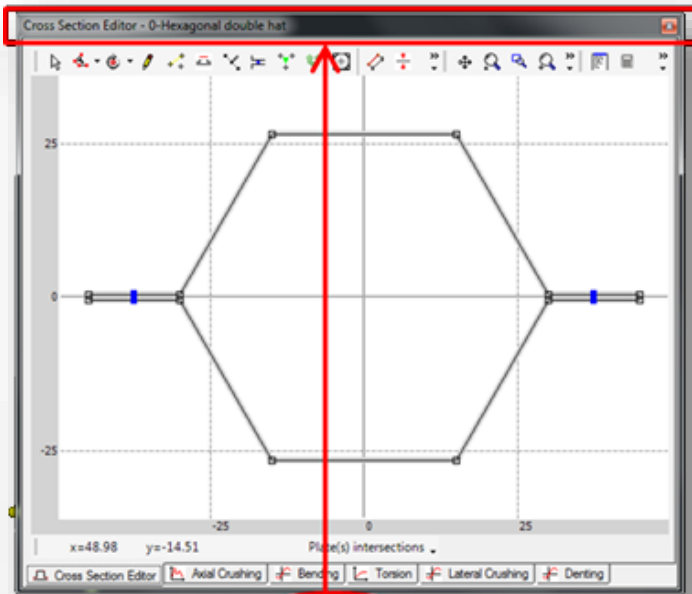
# DYNAMIC ENGINEERING ASSISTANT

The Dynamic Engineering Assistant is a user-editable tool. The User can decide that types of data are to be displayed on the screen.

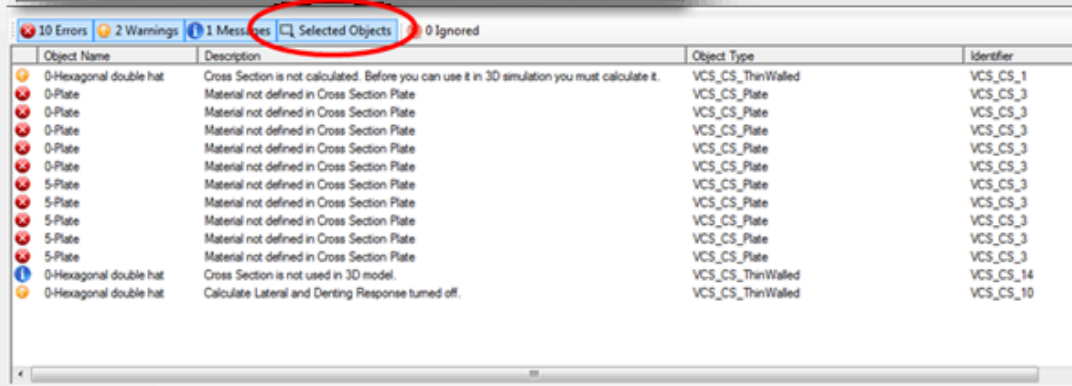
As illustrated in the pictures below, the user can select errors, warnings or messages by clicking on the appropriate bookmarks.



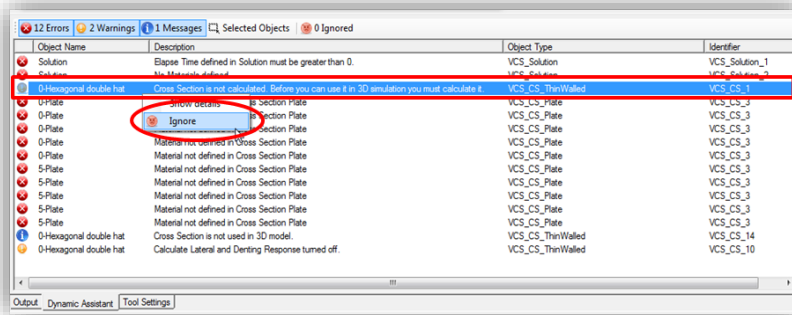
By default, the Dynamic Engineering Assistant provides information about all inaccuracies detected in all objects of the VCS Solution. The functionality provides however also the possibility to check correctness of one individual VCS object.



After selecting an object (for example an individual cross section) click on the "Selected Object" bookmark in the Dynamic Engineering Assistant window (as Illustrated in the picture below). Afterwards the tool will display errors, messages and warnings adequate only for this selected element of the solution. If you find information irrelevant, or in case when too many errors are displayed at the same time, you can use the "Ignore" option

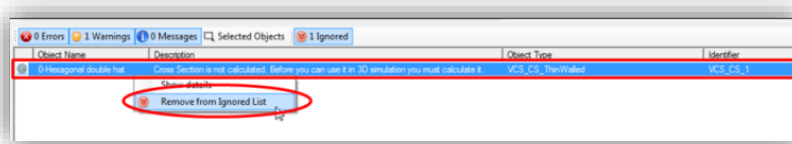


# DYNAMIC ENGINEERING ASSISTANT



After selecting a required error, warning or message right click on it and choose the "Ignore" option. The selected information will be automatically moved to the "Ignored" folder.

If you wish to move information back to the main folder, select the "Return from Ignored List" option, as illustrated in the picture on the right.



Dynamic Engineering Assistant provides additionally detailed help information appropriate for each error type.

After selecting a required information right-click on it and select the "Show details" option (as illustrated in the picture on the left)

A new window named "Error details" will be displayed on the screen.

