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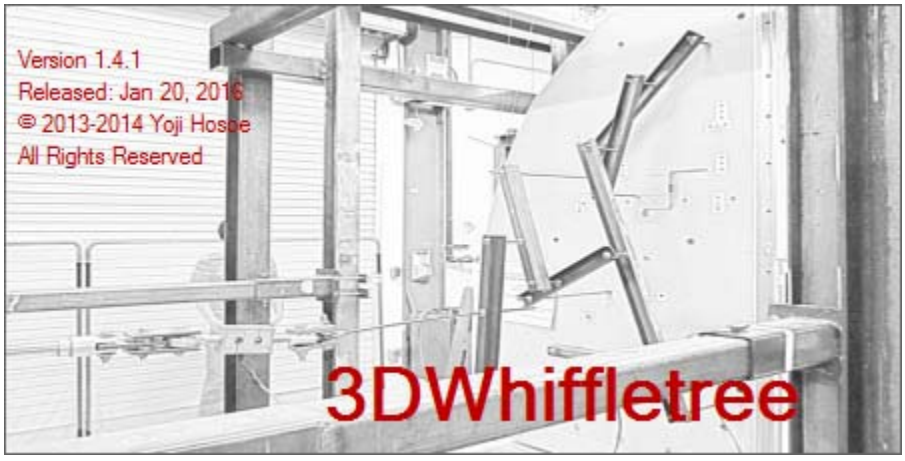
3DWhiffletree

Version 1.4.1

User's Manual



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CAUTION

Any example data presented in this manual or available from website (these include but are not limited to FEM element property data, FEM element material data, weight and CG data, whiffletree diagrams, and whiffletree material data) are fictitious values intended to illustrative purpose use only or deliberately changed to unrealistic values due to proprietary reasons, and should not be used to perform any analysis and/or calculations in your job.

Although every reasonable effort has been made to verify 3DWhiffletree application software, end-users are fully responsible for any results produced by the software including computed results and software errors.

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1.0 GENERAL

1.1 Copyright and Liability

3DWhiffletree Version 1.4.1 (released Rev 2016-01-20)
©2013-2014 Yoji Hosoe. All rights reserved.

This is a freeware. Sharing, copies and redistributions of this product are accepted; however, selling or modifying this product is prohibited.

Although every reasonable effort has been made to verify *3DWhiffletree* application software, end-users are fully responsible for any results produced by the software including computed results and software errors.

1.2 Support

The following website can be used to access all resources for *3DWhiffletree* software.

http://www.3dwhiffletree.com/

From the website, you can:

- Download the latest version of *3DWhiffletree.exe*
- Download the latest *3DWhiffletree* User's Manual
- Request Product Key (It's free!)
- Download sample files
- View Demo/Tutorial Videos
- Comment on the software (suggestion for improvement is welcome!)

1.3 System Requirement

This program will only work on Windows platform. This program does not require an installation package or change in registry. However, it is assumed that .Net Framework 4.0 or higher is installed on the user's PC.

1.3.1 .Net Framework

If an appropriate version of Net Framework is not installed on your computer, you will see an error message saying something like ".Net Frame 4.0 is not installed" when you attempt to launch the program. If so, you will need to download and install the correct version of .Net Framework. There are different versions of .Net Framework depending on the Windows OS version. You can download it from the Microsoft website:

http://www.microsoft.com/net

For Windows XP or Windows 7 user, install .Net Framework 4.0.
http://www.microsoft.com/net/download/version-4

For Windows 8 user, install .Net Framework 4.5.
http://www.microsoft.com/visualstudio/eng/downloads#d-net-45

It may be possible to run this program with old version of .Net Framework in Windows XP machine. However, it is known that certain display problems will occur.

1.3.2 CATIA V5, Word 2010, Excel 2010

To have this program fully function, you will need the following applications installed on your computer. Without these applications, some functions are limited as listed in Table 1-1. All other functions can be still performed.

Table 1-1

Application	Function
CATIA V5 or later version	Export whiffletree into *CATIA* model
Word 2010	Export whiffletree diagram into Word Format
Excel 2010	Export whiffletree diagram into Excel Format

1.4 System File

This program requires a system file placed in the same folder where *3Dwhiffletree.exe* is placed. The system file will come with the application package, or you can download or request it at http://www.3dwhiffletree.com/. The system file should be named exactly as the following (case not sensitive):

3DWTSystem.ini

If the system file is missing, you will get the following error message (Figure 1-1). If you see this message, check the system file if it is in the correct folder or has named correctly.

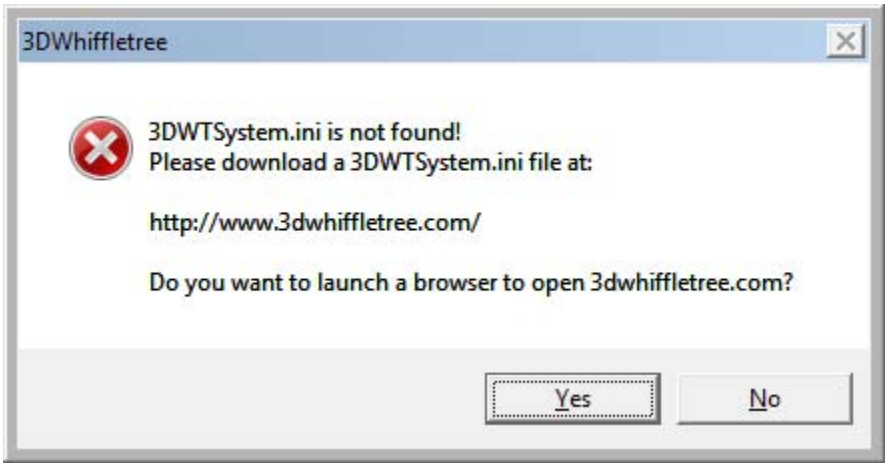

Figure 1-1

1.4.1 Product Key and Expiration Date

System file includes 40-digit alpha-numeric product key. Each product key is associated with an expiration date (called "License Expiration Date").

Once you start *3DWhiffletree* program, you can check the product key and expiration date by the following *File Menu*.

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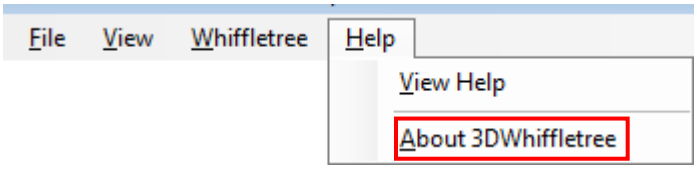

Figure 1-2

You will see a window like one below and there you can find the product key and expiration date.

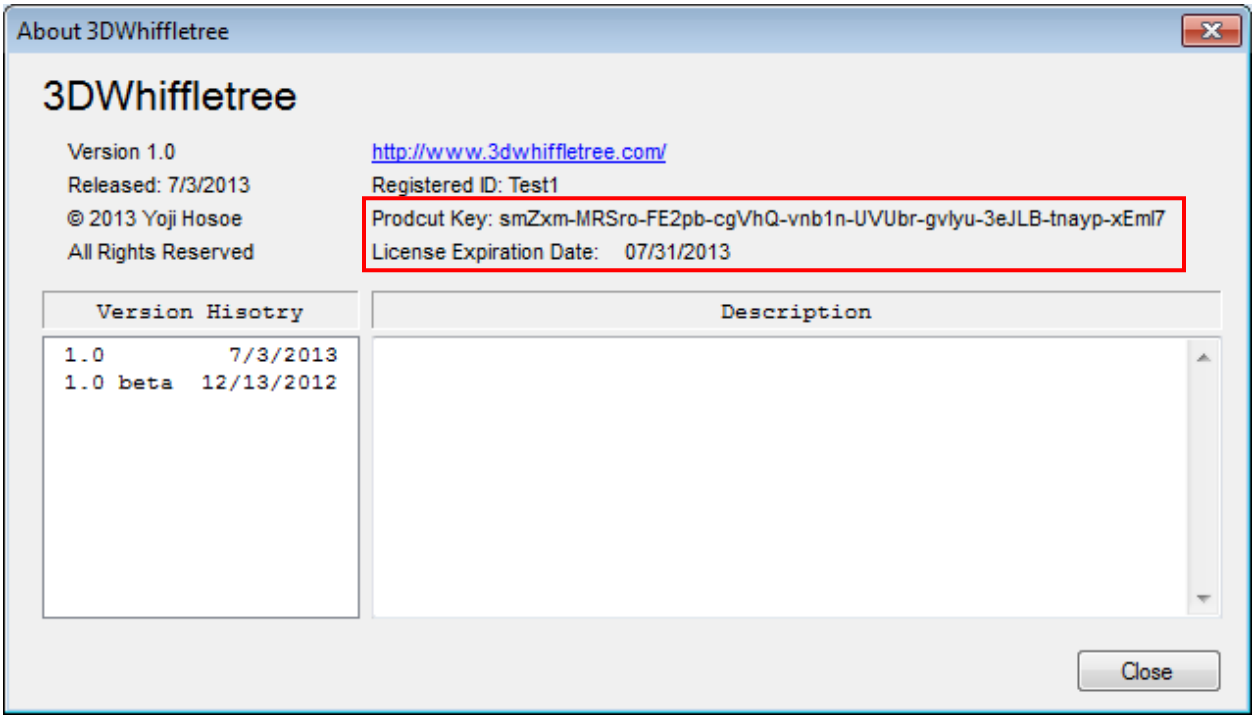

Figure 1-3

Once the product key (or "License") has expired, you are no longer able to start the software. Then, you need to request a new product key (or new system file) at http://www.3dwhiffletree.com/.. If you get a new product key only, then open the file by text editor and replace the old product key in the system file and save the system file.

In an event that the product key is expired, you will see a message (Figure 1-4) and program will not start.

In an event that the product key is invalid, you will see a message (Figure 1-5) and program will not start.

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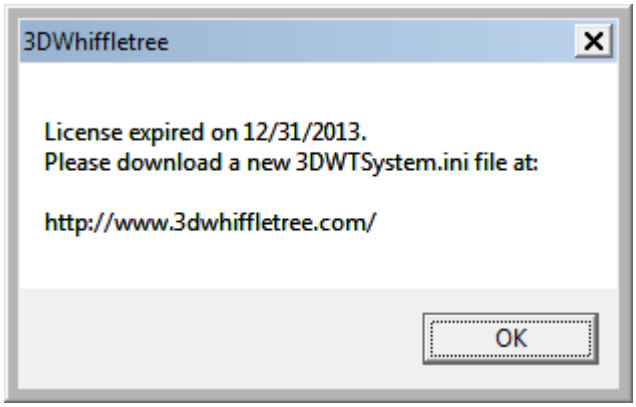

Figure 1-4

Figure 1-5

When you request a new product key only and replace the old one in the system file, you may get an error message (Figure 1-6). This means there is the later version of *3DWhiffletree.exe*. In such a case, you cannot run the program anymore unless you obtain the latest version of *3DWhiffletree.exe* associated with the product key. This ensures that you use the most reliable version.

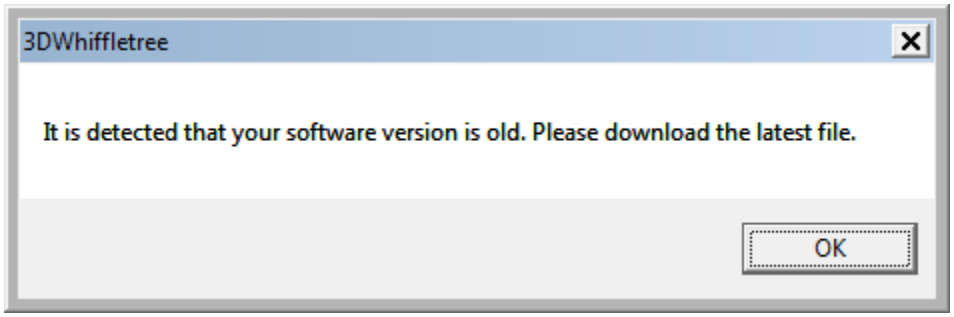

Figure 1-6

1.4.2 Default Values in System File

The system file controls default values used in the program. Any lines start with a dollar mark ("$") are considered as comments and will be ignored.

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Table 1-2

System File	Description
Launch Mode	Only used for debugging purpose and user should not change this value.
AirplaneCoordinate	Defines default airplane coordinate system to be used when you display axis in FEM/Whiffletree view window. (See Section 4.3.3.)
4NodeQuadElement	Specifies 4-node Nastran plane element type to be read.
3NodeTriangleElement	Specifies 2-node Nastran plane element type to be read.
2NodeLineElement	Specifies 2-node Nastran line element type to be read.
SolidElemnt	Specifies Nastran solid element type to be read. For version 1.0 only CTETRA can be read.
WarningLength	Specifies a default minimum moment arm length that the program provides a warning message. The warning can be turned off from Whiffletree menu. (See Section 6.7.)
WTRUnits	Defines default units used in the new whiffletree.
WTRDisplayDecimals	Defines default decimal places used in the new whiffletree. See Section 6.8 for formatting rules.
MTLDisplayDecimals	Defines default decimal places used in the new whiffletree material properties. See Section 7.4 for formatting rules.

If any of values in the system file is missing, you will see an error message and program will not start. Below shows an error message when 3NodeTriangleElement is missing in the system file.

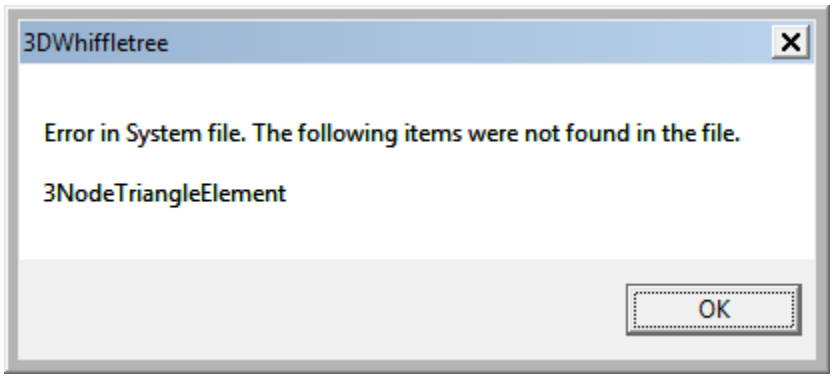

Figure 1-7

1.5 Files – How files work each other

There are 7 types of files associated with *3DWhiffletree* program, including main program (executable file), as shown in Table 1-3.

Table 1-3

File Name	Description
3DWhiffletree.exe	Main program runs *3DWhiffletree*
3DWTSystem.ini	System file that requires to run *3DWhiffletree.exe* (See Section1.4.)
****.d (*.dat)***	FEM files in Nastran format, used to display FEM model. (See Section 1.5.1)
****.wtr***	Files that save information to construct whiffletree (See Section 1.5.2)
****.mtl***	Files that save information of material used in building whiffletree. (See Section 1.5.3)
****.csv***	Files that is used to read loading points = weight and CG data. (See Section 1.5.4)
****.col***	Files that save color associated with element property ID (See Section 3.7)

Further explanations on certain types of files are shown below.

1.5.1 *.d (*.dat)

This file is used to show FEM model in *Model Window*. The file can be directly created by preprocessors (such as Femap or HyperMesh) or manually created. The format is same as Nastran and can be any of Small-Field Format (8 columns for one entry field), Large-Field Format (16 columns for one entry field), or Free-Format (comma delimited format). For Free-Field format, unlike Nastran's Free-Field format only allows 8 characters per each entry field; this software can read any length.

When using "Include" statement, the following limitations apply.

Limitations using "Include" statement:

1. Use of "Include" statement is supported but referenced files must be relatively referenced from the folder where *3DWhiffletree.exe* is located. "Include" statement can be nested, that is, use of "Include" inside "Include"-referenced file is accepted as deep folders as you want, and there is no character length limit.

   Example 1:

   3DWhiffletree.exe is in *C:\3DWhiffletree* and you want to read a file of *C:\3DWhiffletree\input.d*

   Correct: `INCLUDE 'input.d'`
   Wrong: `INCLUDE 'C:\3DWhiffletree\input.d'`

   Example 2:

   3DWhiffletree.exe is in *C:\3DWhiffletree* and you want to read a file of *C:\3DWhiffletree\files\input.d*

   Correct: `INCLUDE 'files\input.d'`
   Wrong: `INCLUDE 'C:\3DWhiffletree\files\input.d'`

The FEM model in *Model Window* is only to display models and does not do anything with actual whiffletree constructions or does not interact with other files (*.wtr, *.mtl, or *.csv). You still can read *.csv file for weight and CG data, *.wtr for whiffletree, or *.mtl for materials without reading *.d file.

Grid Real Number Format:

Real number format for grid points (X, Y, Z) are generally same as Nastran format with one exception that it may not need to contain a decimal point. Therefore, the following values are all acceptable formats for real number seven (7).

```
7.0
7          (Nastran does not allow this as a real number)
.7E1
.7E+1
0.7+1
0.70+1
7.E+0
70.-1
700E-2     (Nastran does not allow this as a real number)
```

1.5.2 *.wtr

When you are creating whiffletree, you can save your work. Your work will be saved as *.wtr file. This file contains all information associated with the whiffletree (with some exceptions, see Table 5-2). See Section 5.2 for more details about file operation of *.wtr file.

1.5.3 *.mtl

You can save material properties for rod and beams used in whiffletree constructions. This will be saved as *.mtl file. See Section 7.0 for more details about material and its use.

1.5.4 *.csv

Unlike *.wtr or *.mtl files, this file is what YOU will need to create so that Whiffletree.exe can read weight and CG data. The weight and CG are essentially become loading points of the whiffletree.

The *.csv file is, as the name specifies, comma-separated values. You can create a *.csv file by using spreadsheet application or by using text editors.

The first line in the file is reserved for a header and always required. Since the first line is ignored by Whiffletree.exe, values do not matter. It is recommended to use the same header name as shown in the Table 1-4.

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Table 1-4

Column No.	Header	Description	Rule
1	Description	Item Name	Any Characters
2	Weight	Item Weight	Numeric values only (8-byte, double)
3	X	Item Xcg location	Numeric values only (8-byte, double)
4	Y	Item Ycg location	Numeric values only (8-byte, double)
5	Z	Item Zcg location	Numeric values only (8-byte, double)

Using Microsoft Excel:

This is the easiest way to create *.csv file.

1. Start MS Excel application and type values that look like Figure 1-8. In most cases users already have weight and CG data in hand. In such cases, simply copy and paste the weight and CG data. Don't forget to add a header in the first row.

	A	B	C	D	E	F
1	Description	Weight	X	Y	Z	
2	Structure	395.9995	606.9093	-79.7873	243.4218	
3	Cart (Fwd-Inbd)	150	600.8	-71	221.92	
4	Cart (Fwd-Otbd)	150	600.8	-87.45	221.92	
5	Cart (Aft-Inbd)	150	613.2	-71	221.92	
6	Cart (Aft-Otbd)	150	613.2	-87.45	221.92	
7	Refrigerator	110	618.47	-78.9	256.2	
8	Glass Rack Lower (Content)	15	600.277	-74.6555	261.884	
9	Glass Rack Upper (Content)	15	600.277	-74.6555	269.87	
10	Attendant Module	36	629.68	-68.6	267.87	
11						
12						

Figure 1-8

2. Use "Save As" and choose "CSV (Comma delimited)" in "Save as Type"

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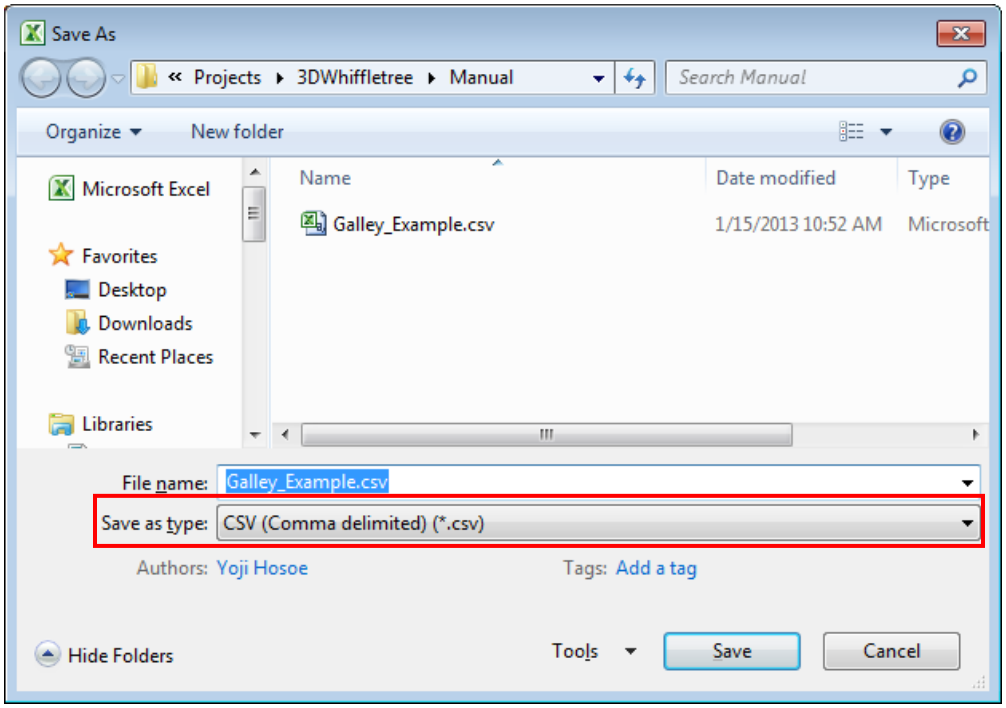

Figure 1-9

Using Text Editors:

You can use any text editors to create *.csv files. The following basic rules apply (quoted from http://en.wikipedia.org/wiki/Comma-separated_values#Toward_standardization).

- *Each record "should" contain the same number of comma-separated fields.*
- *Any field may be quoted (with double quotes).*
- *Fields containing a line-break, double-quote, and/or commas should be quoted. (If they are not, the file will likely be impossible to process correctly).*
- *A (double) quote character in a field must be represented by two (double) quote characters.*

Notes:
Use of comma and double-quote in the column 1 is supported; however, the current version is not fully tested for irregular use (such as multi repeated use of comma and double-quote combined together).

Figure 1-10 shows text-edited *.csv file that is the same file created in Excel file in the above example.

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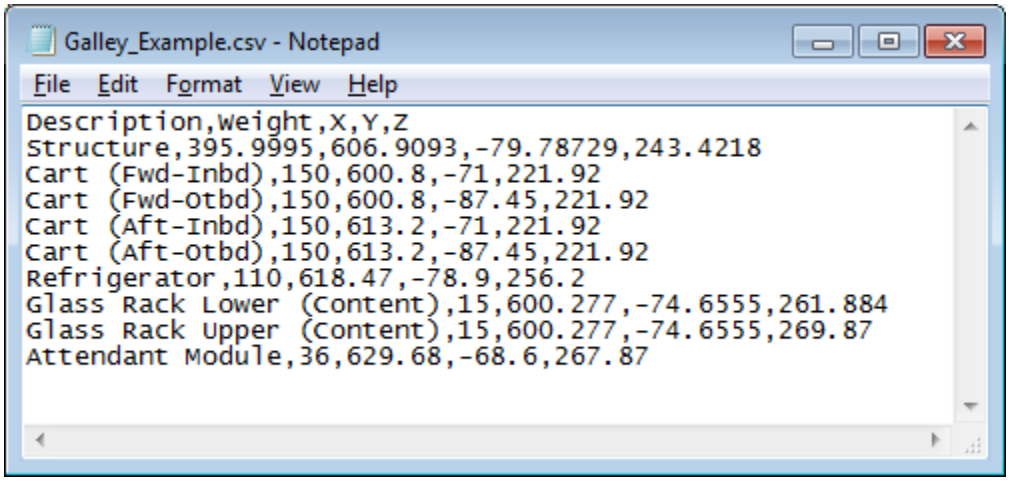

Figure 1-10

1.5.5 *.col

Colors assigned to property IDs can be saved into *.col file. The file only contains property IDs and associated Color IDs. One Color file can be shared with many FEM files, or many Color files can be used with one FEM file whichever meets user's working environment.

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2.0 OVERVIEW OF USER INTERFACE

The below screenshot shows *3DWhiffletree* main widow.

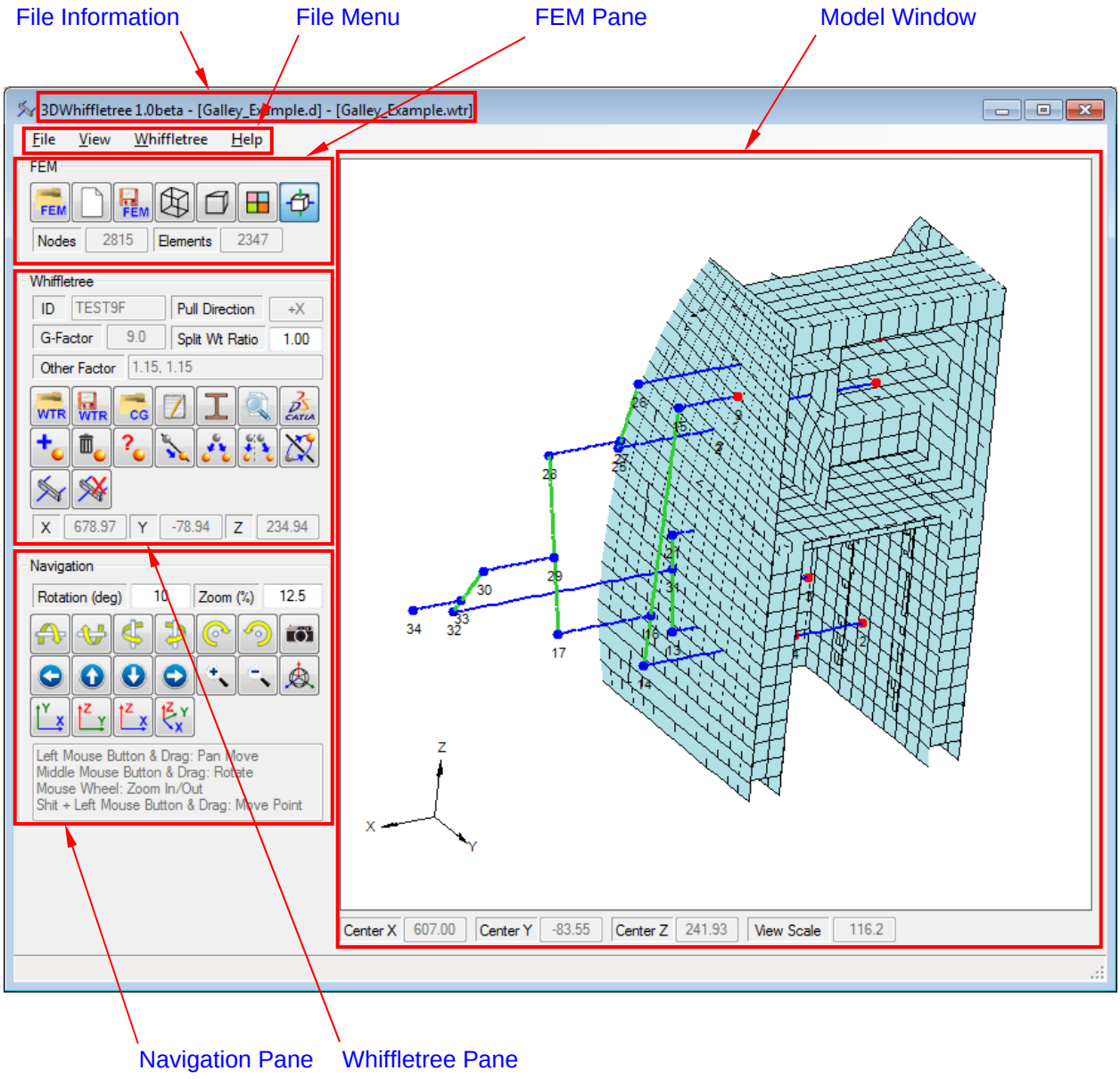

Figure 2-1

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2.1 General

2.1.1 Window Size

The default window size, which is also the minimum window size, is 885 (W) x 720 (H) pixels with *Model Window* size 598 (W) x 598 (H) pixels. You can maximize the window size, or adjust the window size by dragging the right-bottom corner of the window. You can enlarge the window size to any size and the *Model Window* size also changes at the same ratio. However, *Model Window* remains in square shape based on the height of the window.

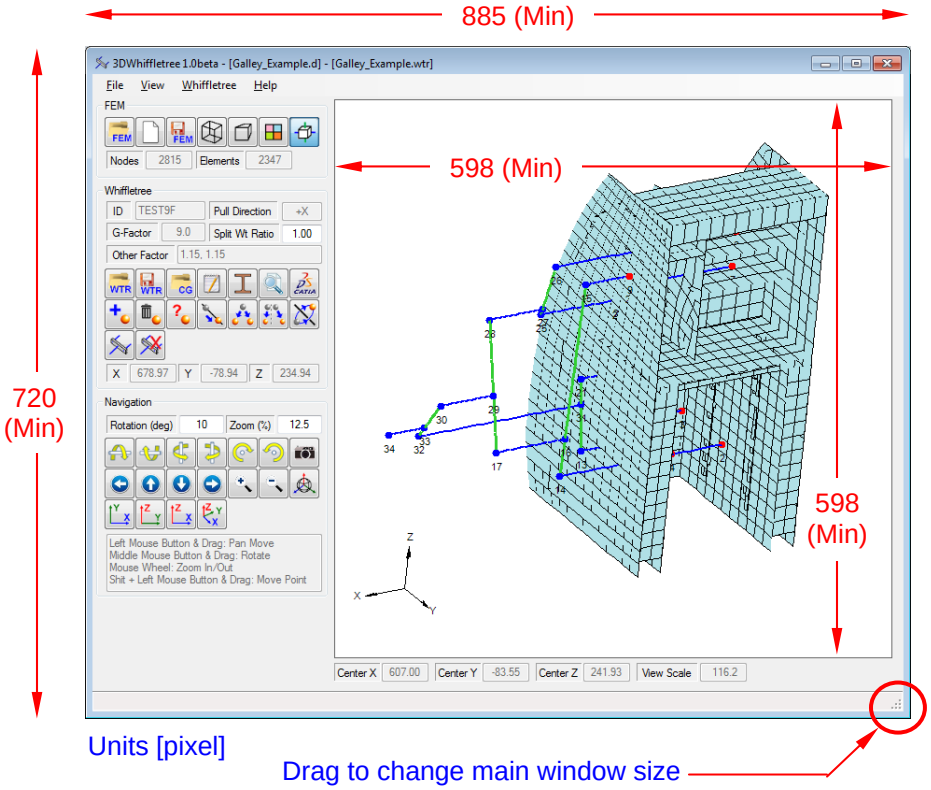

Figure 2-2

2.1.2 Tooltips

Tooltips are available for the most of icons by placing a mouse pointer over the icon and hold it for a second.

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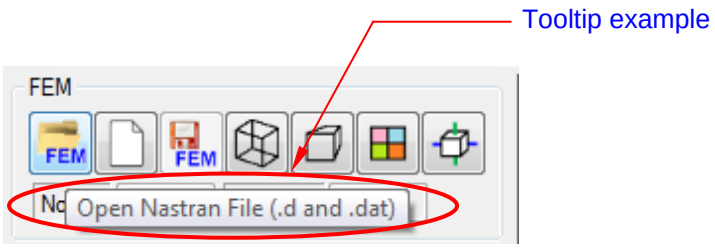

Figure 2-3

2.1.3 Click or Toggle Button

Icon buttons have two types: regular click button and toggle button. The way to see if the toggle button is toggled or not is a color of the button as shown in the figure below. **

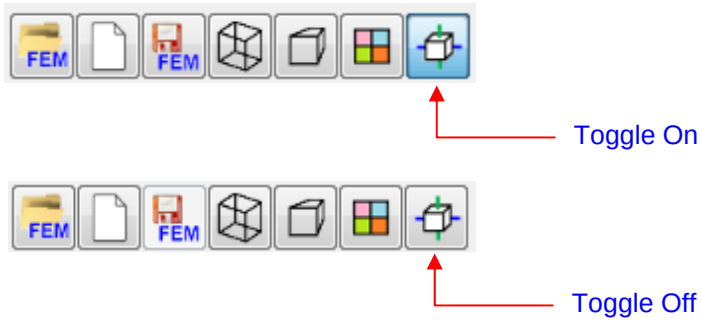

Figure 2-4

**If your PC is set to "Classic Windows View" the toggle button actually "toggles".

2.1.4 Locked or Unlocked Button

Some buttons are locked (grayed out) when their functions are unavailable. They become enabled automatically when functions are available. Below figures show an example of enabled and locked button.

Figure 2-5

2.1.5 Status Bar

Occasionally you will see messages in *Status Bar* at the left-bottom of the window. They are supportive message for you to perform certain tasks. Figure below shows an example.

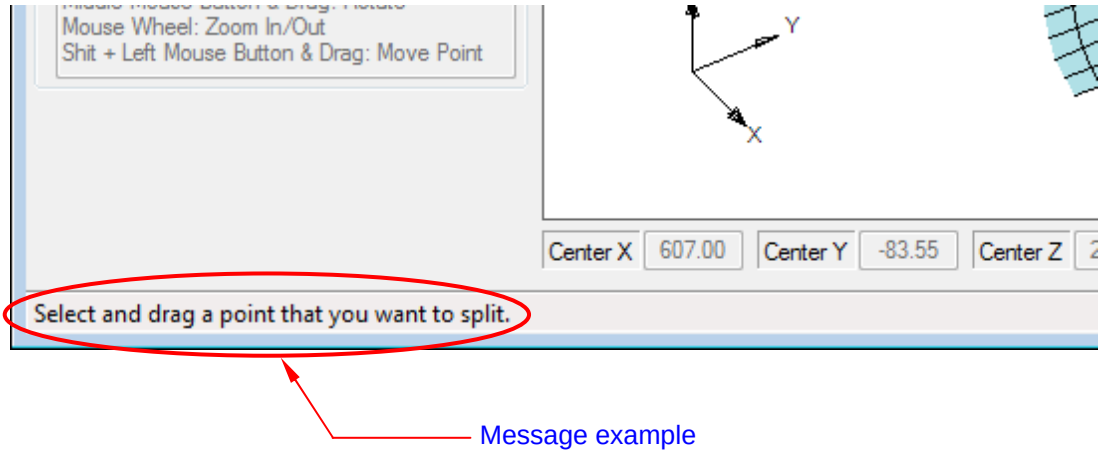

Figure 2-6

2.2 File Information

At the very top of the window, you can see the followings:

- Software Version
- FEM File Name shown in the first square-bracket
- Whiffletree File Name shown in the second square-bracket

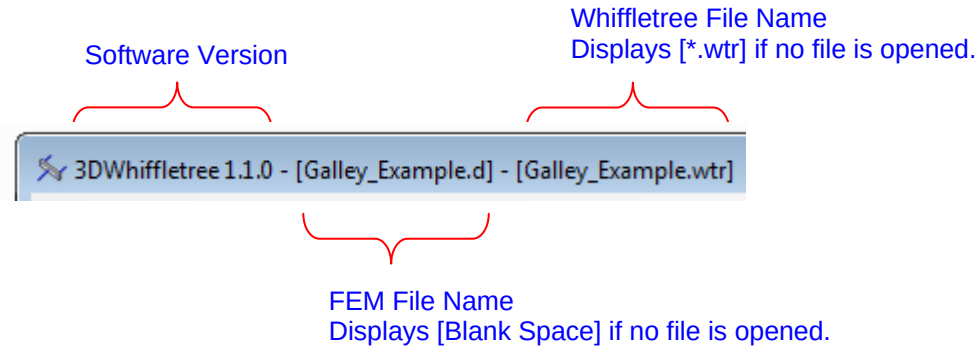

Figure 2-7

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2.3 File Menu

File Menu is available to perform tasks. Most tasks can be completed from Icons, but there are some functions only available from *File Menu*. See corresponding sections for detail explanations of each menu.

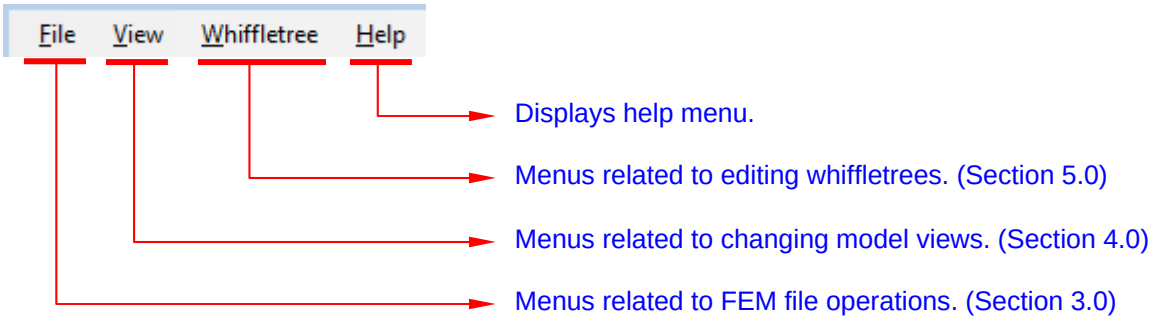

Figure 2-8

2.4 FEM Pane

FEM Pane is to perform tasks related to FEM file operation and also to change FEM model views. See Section 3.0 for more details.

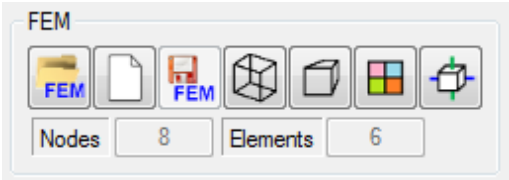

Figure 2-9

2.5 Whiffletree Pane

Whiffletree Pane is to perform tasks related to Whiffletree constructions. See Section 5.0 for more details.

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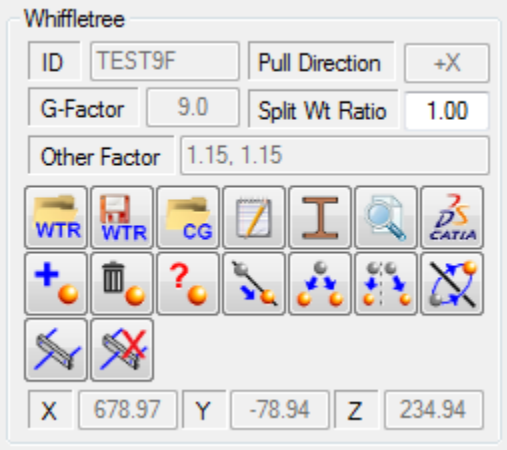

Figure 2-10

2.6 Navigation Pane

Navigation Pane is to move, rotate, zoom, and change center location of models in *Model Window*. See Section 4.0 for more details.

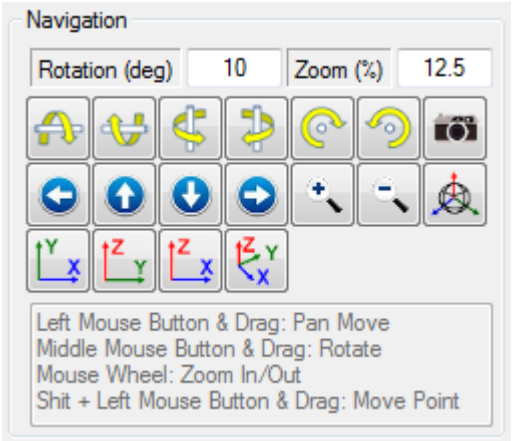

Figure 2-11

2.7 Model Window

Model Window shows the following information.

- FEM Model
- Whiffletree Model
- Coordinate Axis

FEM model and Whiffletree model in *Model Window* they are simply overlapped view and do not act each other.

In addition, there are information boxes to show the following information.

- Center X
- Center Y
- Center Z
- View Scale

Center X, Y, and Z are model center. When you rotate the models, the models are rotated about the point. The default model center is set to the geometric center of FEM model. The model center can be changed. See Section 4.4 to adjust the model center.

View Scale is a factor related to zoomed size of the model. The larger *View Scale* is, the smaller the models appear in the *Model Window*. The values depend on the model geometric size and view orientation and users have no control on it.

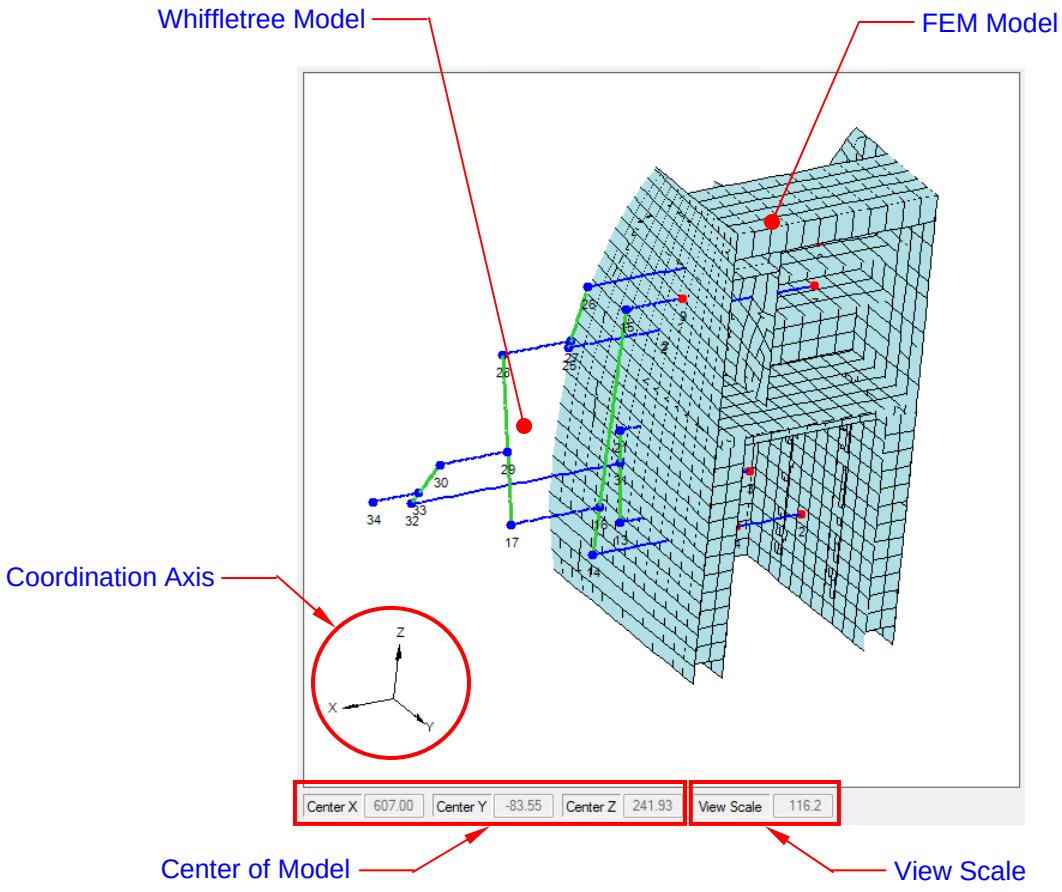

Figure 2-12

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3.0 FEM FILE AND MODEL VIEW

This section explains functions related to FEM file operations and FEM model views in *3DWhiffletree*.

3.1 General

Functions are available through icon buttons and *File Menu*. You have more options to certain functions only through *File Menu*.

3.1.1 FEM Pane

FEM Pane has icon buttons to access most of basic functions related to FEM file operations and model views.

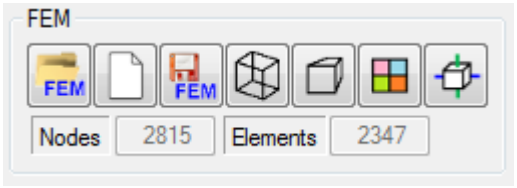


Figure 3-1

Open FEM model file (Section 3.2)

Start in blank space (Section 3.4)

Save FEM model as a new file (Section 3.3)

Switch model view between Solid Color and Wire Mesh (Section 3.5)

Switch model view between Perpendicular View and Perspective View (Section 3.6)

Change element colors by element properties (Section 3.7)

Switch whiffletree views shown as Most-Front or With-FEM (Section 0)

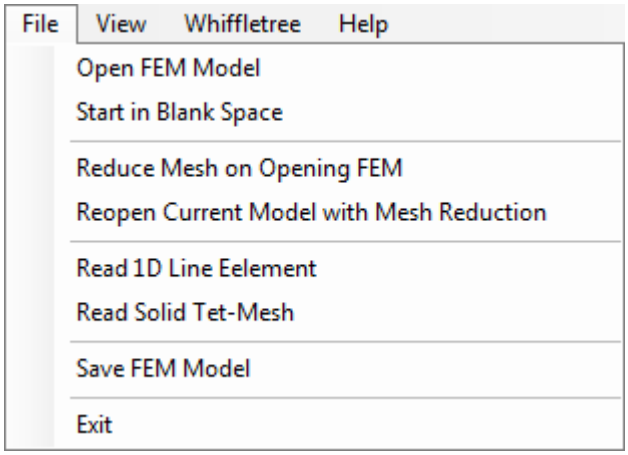
Number of Nodes is displayed in *FEM Pane*. These numbers are actual nodes used to show the FEM models and are NOT the number of nodes contained in the original FEM file.

Similar to Nodes, actual number of elements used in *3DWhiffletree* is displayed.

3.1.2 File Menu

File Menu associated with FEM file operations can be access from *"File"*. Menus associated with FEM model views can be access from *"View"*. Some functions are not available through icon buttons in *FEM Pane*.

Menus for FEM File Operations



Menus for Model View Operations

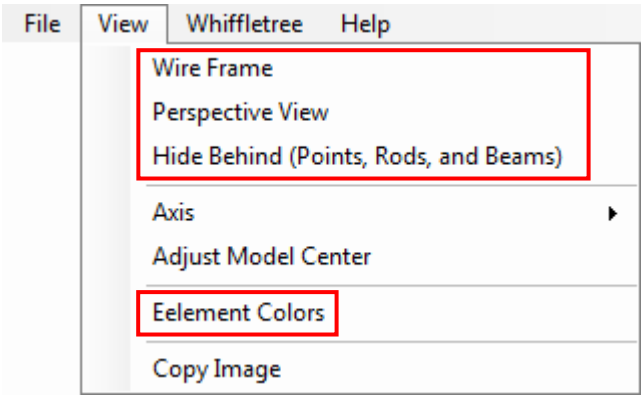


Figure 3-2

3.2 Open FEM Model File

The command to open FEM model file can be accessed from either icon in *FEM Pane* or *File Menu* as shown in the figure below. Default folder that you see in *File Open Dialog* is the same folder where *3DWhiffletree.exe* is stored.

or

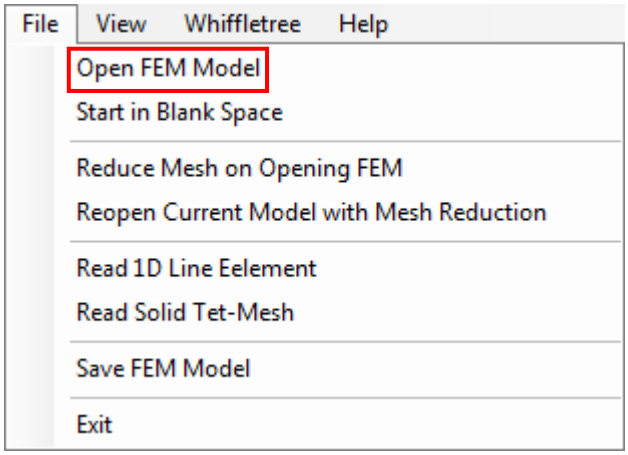


Figure 3-3

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3.2.1 Supported File Format and Limitation

3DWhiffletree can read FEM data files in any Nastran formats. The default file extensions to open are: *.d, *.dat, *.blk, *bdf, *.nid, and *.nas. However, any file extensions can be used as long as the files are written in plain text format (ASCII) and texts follow Nastran format.

Even though the file is written in Nastran format, certain restrictions will apply. See Section 1.5.1 for format limitation.

Because 3DWhifletree does not rely on 3D engine or physical graphic board to display 3D model data, number of nodes/elements directly affects the CPU usage of your machine, and thus, it affects the performance of the software. You may feel slow responses if the FEM model has more than 5,000 elements (of course it should depend on your machine). If your FEM model has large number of elements, for example, nodes more than 10,000, it is recommended to coarse-mesh the model before open it in *3DWhiffletree*, or use *"Reduce Mesh"* function explained in the following section.

3.2.2 Reduce Mesh

3DWhiffletree comes with a built-in function to reduce meshes (i.e., to reduce number of elements and nodes). This can be done in 2 different ways: Before you open the FEM file, or After you open the FEM file.

Method A:
1. Before opening FEM file, select "*Reduce Mesh on Opening"* FEM in "*File"* Menu. You will see that the option is checked. (Figure 3-4)
2. Open FEM file as normal.

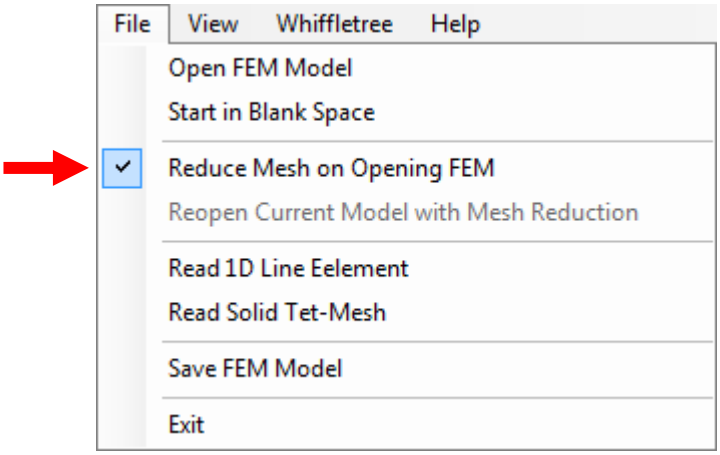

Figure 3-4

Method B:
1. Open FEM file first as normal.
2. Select *"Reopen Current Model with Mesh Reduction"*. (Figure 3-5)

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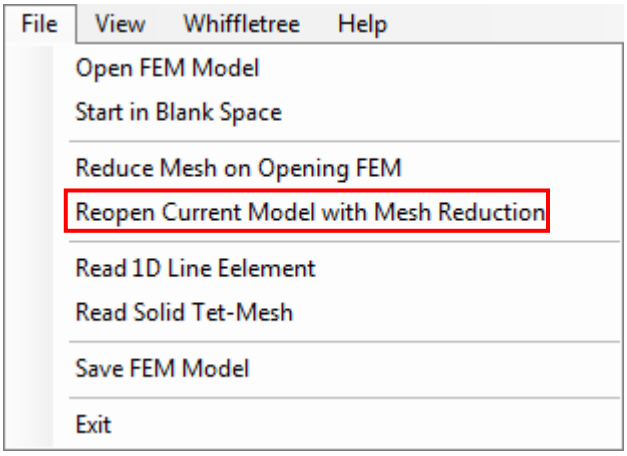

Figure 3-5

Once the mesh reduction is successfully completed, you will see a message showing how much the elements are reduced (Figure 3-6).

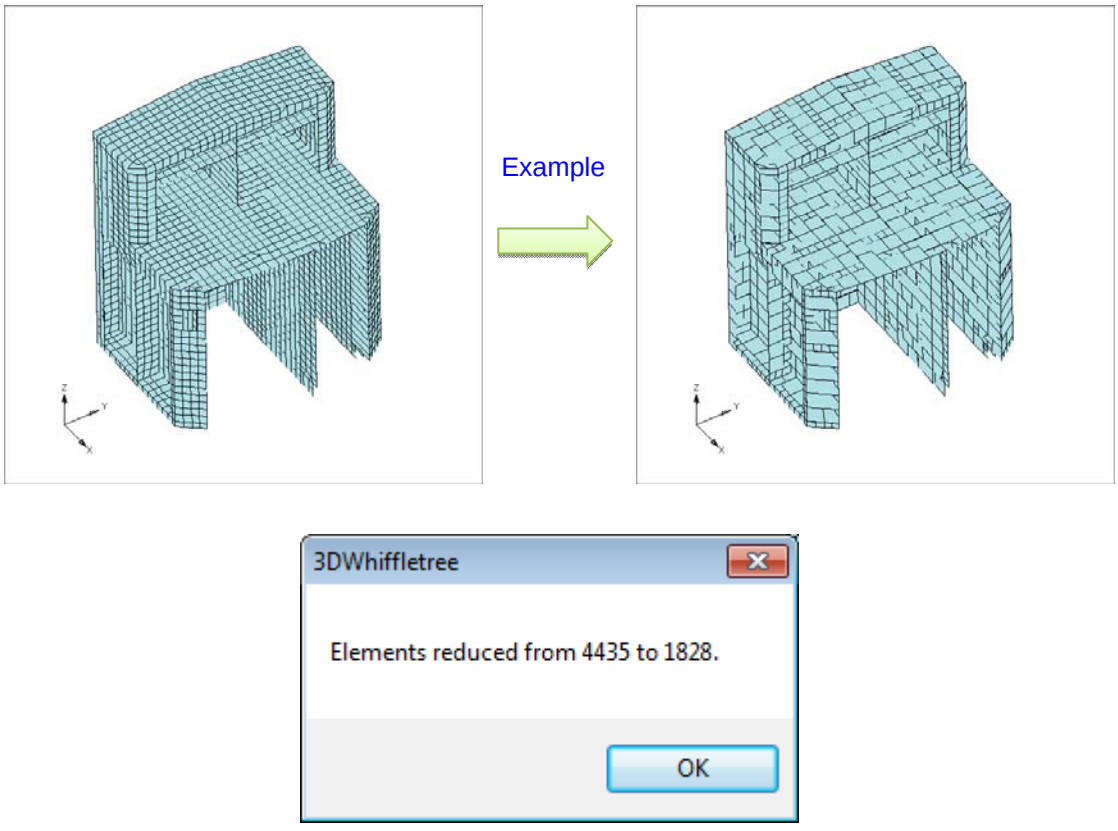

Figure 3-6

Logics Behind:

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Mesh reductions are performed by merging 4 of CQUAD4 elements into one CQUAD4 element. All mid-notes will be removed. The mesh reduction takes place only if the mid-center node (a node shared among 4 elements) is connected with 4 of CQUAD4 elements. If there are more than 4 elements or there is CTETRA3 elements, then these elements will not be merged.

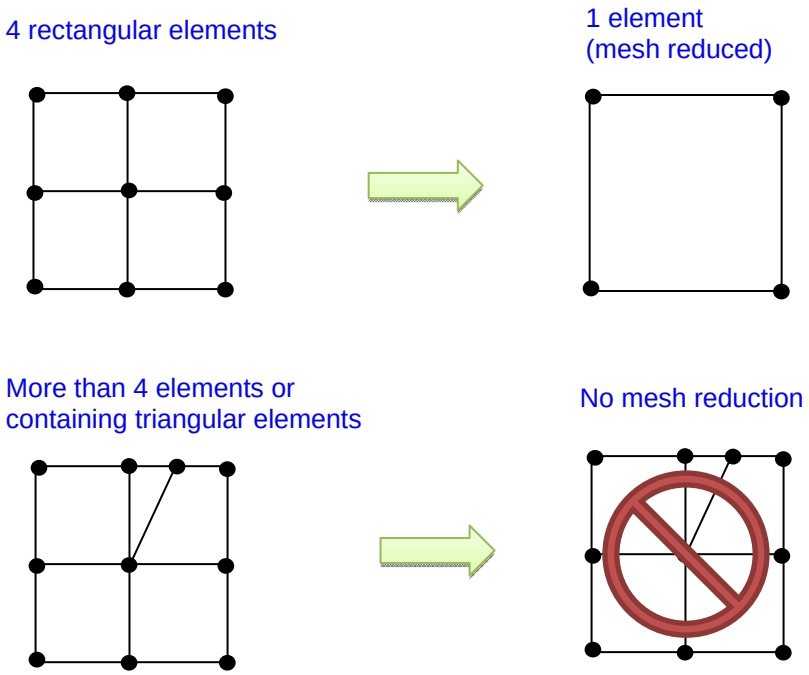

Figure 3-7

Warnings and Precautions:

1. Merged Joints

   When you are proceeding with mesh reductions by either Method A or Method B above, you will see the following warning message.

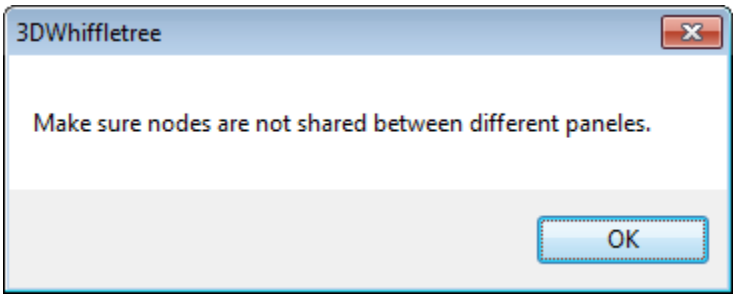

Figure 3-8

   This is because *3DWhiffletree* cannot distinguish out-of-plane nodes.

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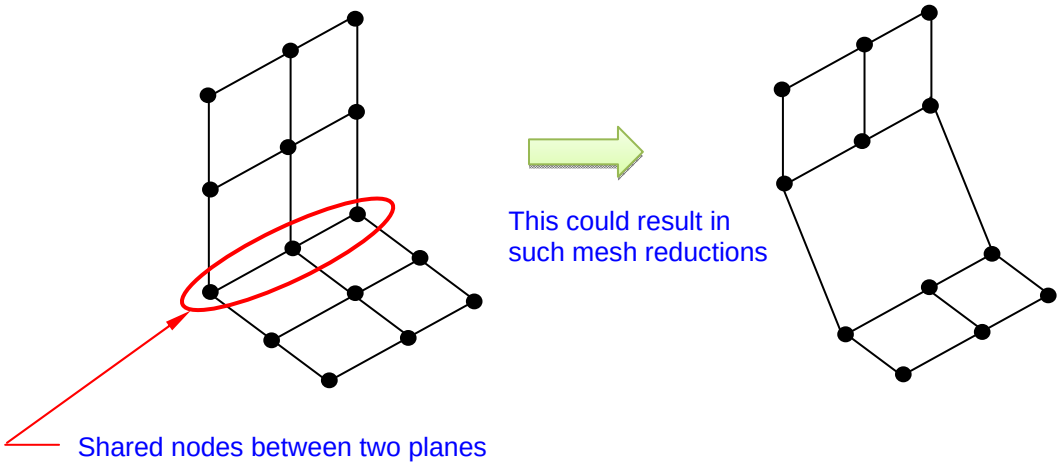

Figure 3-9

2. Re-Opening the Re-Opened File

   It is known that error will occur when you try to use *"Reopen Current Model with Mesh Reduction"* when the model is already open with mesh reduction. Therefore, the command becomes unavailable once you reopen the model. However, it is possible to further reduce elements. To do so, save the reopened model first, open the saved model, and then, use *"Reopen Current Model with Mesh Reduction"* again. Refer to Section 3.3 for how to save model.

   When you reach a point that no more reduction is possible, you will see the following message.

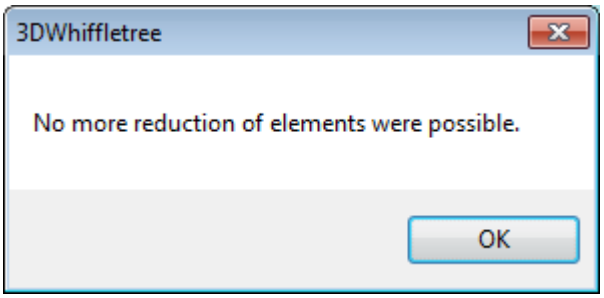

Figure 3-10

3. Distorted Element

   It is also known that some of elements are distorted after mesh reduction. This is due to mesh-reduction algorithm. Example is shown in the figure below. As FEM model is just for a supportive view to construct whiffletrees, the mesh quality will not affect the actual whiffletree constructions.

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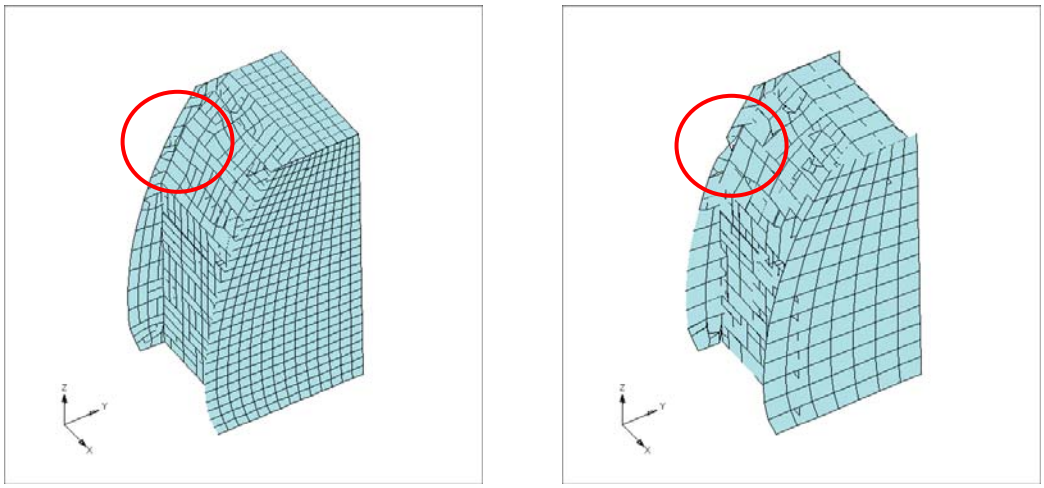

Original Mesh Reduced Mesh

Figure 3-11

Merged Element and Property:

When 4 of CQUAD4 elements are merged into 1 of CQUAD4 element, original elements are deleted and a new element is created with an element property ID set to zero. If you open *Element Property Color* window (Section 3.7), you can see Property ID = 0, which ID means merged element.

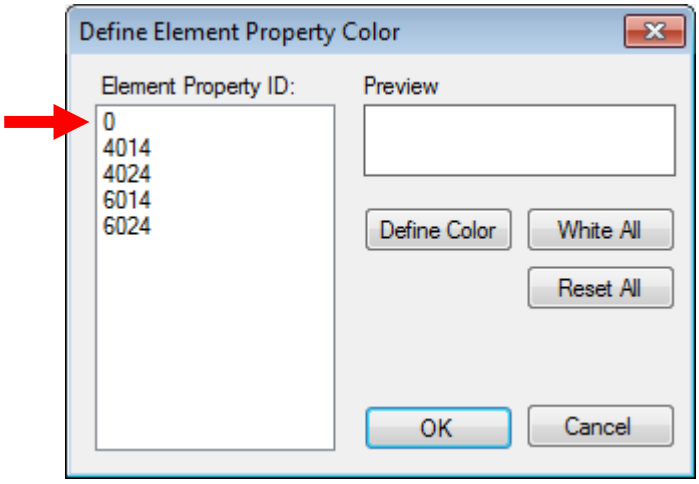

Figure 3-12

Using *Element Property Color* window, you can set a color for merged element (Element Property ID = 0). Figure below shows FEM model with merged element color set to gray.

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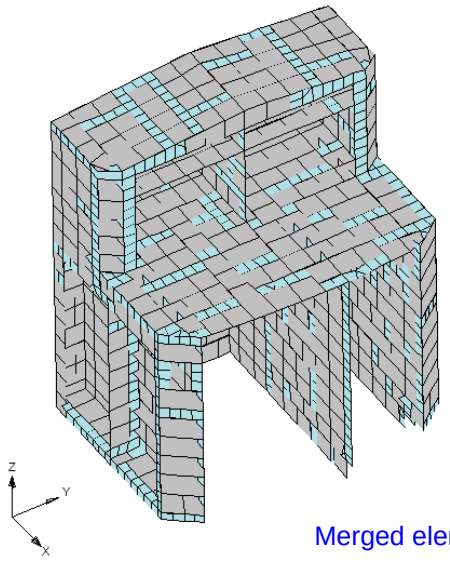

Merged element color set to "Gray"

Figure 3-13

3.2.3 Read 1D Line Element

1D line elements can be displayed if the following option is checked when opening the FEM model. By default, this option is turned off.

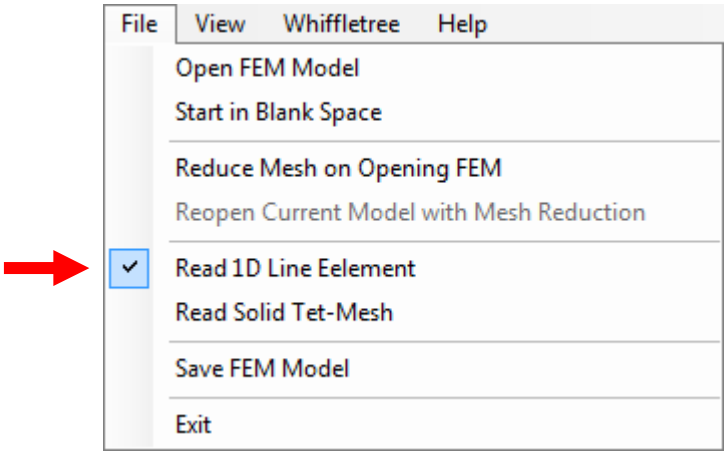

Figure 3-14

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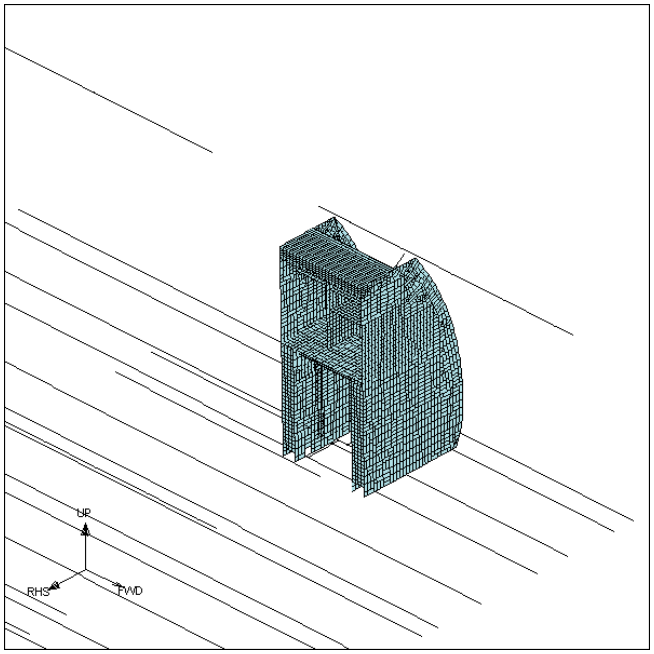

Model with Line Elements

Figure 3-15

Types of 1D elements allowed to be used are defined in *3DWTSystem.ini* file. Only the most common line elements (CBAR, CBEAM, CROD) are defined by default; however, it is possible for users to add more elements in the *3DWTSystem.ini* file. Additional allowed element types are CBEND, CONROD, CTUBE, and CVISC.

```
$-----------------------------------------------
$Element Types (Add more elements separated by
$Solid Element is CTETRA only.
4NodeQuadElement: CQUAD4
3NodeTriangleElement: CTRIA3
2NodeLineElement: CBAR, CBEAM, CROD
SolidElemnt: CTETRA
$-----------------------------------------------
```

Add more line elements as necessary, separated by comma.

Figure 3-16

Remarks for Displaying 1D line elements:

1. 1D line elements are always shown in black color when displayed. There is not option to change the line element colors.

2. Even though some elements look like line elements such as CELAS2 (scalar elements) or RBE2 (R-type elements), they will NOT be displayed even though you add the element types in *3DWTSystem.ini* file. This is because the Nastran Bulk data formats are different for these elements.

3. It is a known issue that FEM model may be crashed when reading 1D element at the same time the option of reducing meshes is turned on. If you attempt to read 1D element with reducing meshes, the

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following warning message will be displayed. Click *Cancel* to just open the FEM model without reducing meshes (still reads 1D element).

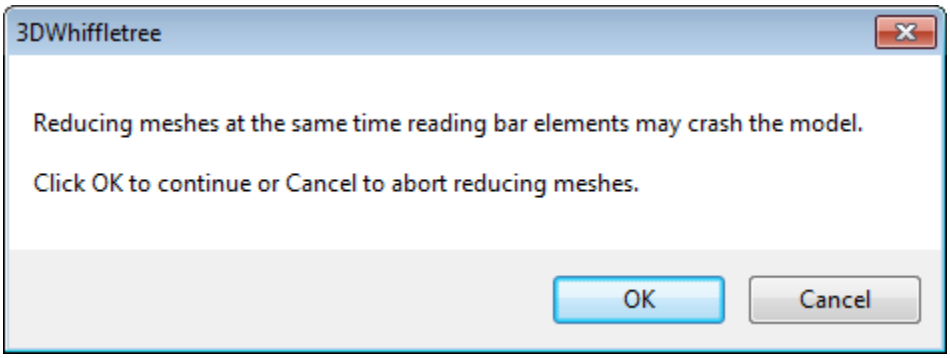

Figure 3-17

3.2.4 Read Solid Tet-Mesh

Solid tetra mesh can be displayed if the following option is checked when opening the FEM model. By default, this option is turned on.

When opening the model, tetra meshes are converted into CTETRA3 elements only for outer surfaces. Because of this conversion process, it will take longer time to open the file.

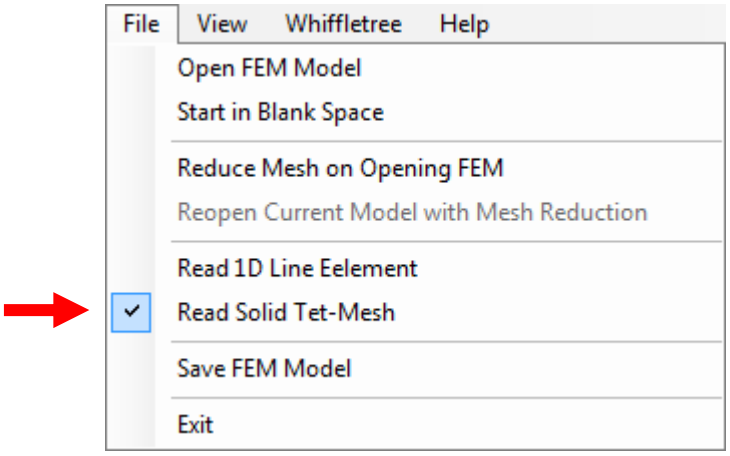

Figure 3-18

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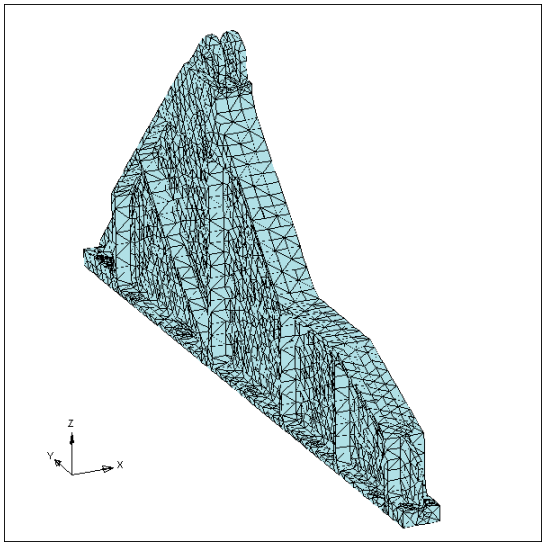

Figure 3-19

3.3 Save File

The command to save FEM model file can be accessed from either icon in *FEM Pane* or *File Menu* as shown in the figure below.

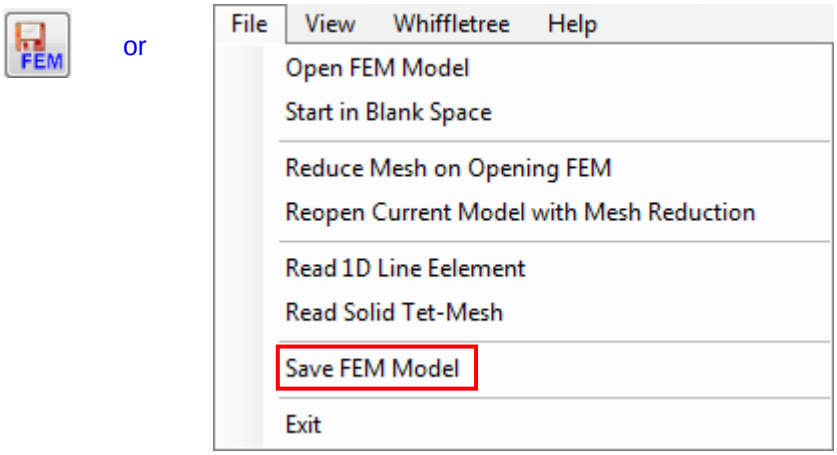

Figure 3-20

When saving the file, the following messages will pop up. It is to confirm whether you want to include "E" in the scientific format. If you click *Yes*, "E" will be included in the scientific format, otherwise, "E" will be omitted.

Example:		
Original values:	`-1.234E-6`	`1.2345E+6`
Click Yes to use "E":	`-1.23E-6`	`1.235E+6`
Click No not to use "E":	`-1.234-6`	`1.2345+6`

As explained in Section 1.5.1, 3DWhiffletre can read both format with or without a symbol "E" as regular Nastran does. Since the saved file can only be used in *3DWhiffletree.exe*, it does not matter which format you take. However, if you want to use the values imported to other software, such as Microsoft Excel, then scientific format without a symbol "E" may not work.

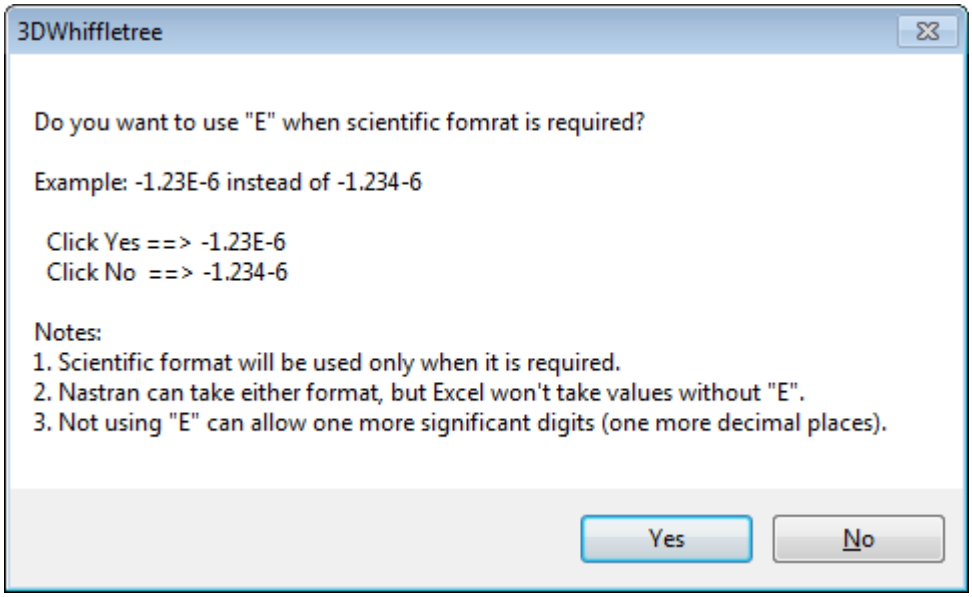

Figure 3-21

Followings are some remarks that you may want to know.

a) Default folder that you see in *File Save Dialog* is the same folder where *3DWhiffletree.exe* is stored.

b) File extension of the saved file is ".d".

c) Default file name is "XXX-Copy.d" where XXX is the original file name, but you can change it when you saving. (So, technically you can consider it as "Save As" function.)

d) The saved data created by *3DWhiffletree* only contains model data that is displayed. All other data such as Nastran executive control data or any element data that are not displayed will not be saved. For example, if your model does not show 1D line element (See Section 3.2.3), the 1D element data will be removed from the saved file. Further, element and grid numberings may be different from the original Nastran data file.

e) Even though *3DWhiffletree.exe* can read Large-Field format and Free-Field format (See Sec 1.5.1), saving FEM data is currently available only in Small-Field format.

Cautions:

Saved file shall be used by *3DWhiffletree.exe* only. It does not guarantee any use for commercial FEM pre/post processors or solvers.

Example Use of the "Save" Function

1. You used mesh reduction (Section 3.2.2). If you want to further reduce the model, you need to save the reduced mesh model first, then open the file to reduce mesh again.

2. You used mesh reduction (Section 3.2.2). You don't want to reduce the mesh every time you open the same model so you want save the reduced mesh model.

3. You have a large model file but most of contents are non-relevant data for just FEM view purpose such as DMIG entries. You want to compact the file only to contain the necessary data to be used in *3DWhiffletree*.

3.4 Start in Blank Space

When launched, *3DWhiffletree* starts with an initial blank screen with 3 main axes (X, Y, and Z) as shown in the Figure below.

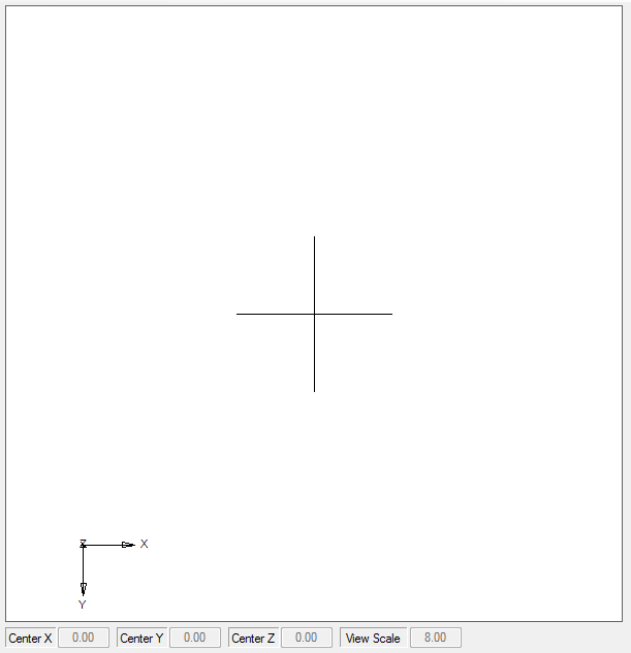

Figure 3-22

This initial screen can be brought at any time by either clicking an icon or from *File Menu*. If there are any unsaved whiffletree data, you'll be asked if you want to save. Use of this function (*Start in Blank Space*) actually does the almost same thing that you close the application and start it again.

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or

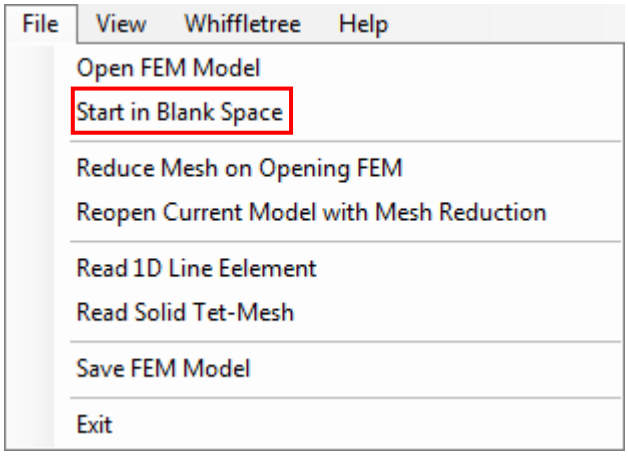

Figure 3-23

3.5 Wire Frame View

Wire Frame View can be turned on and off from the following icon or *File Menu*.

or

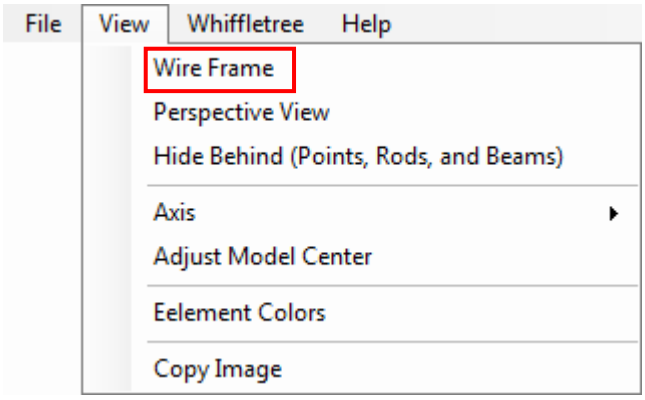

Figure 3-24

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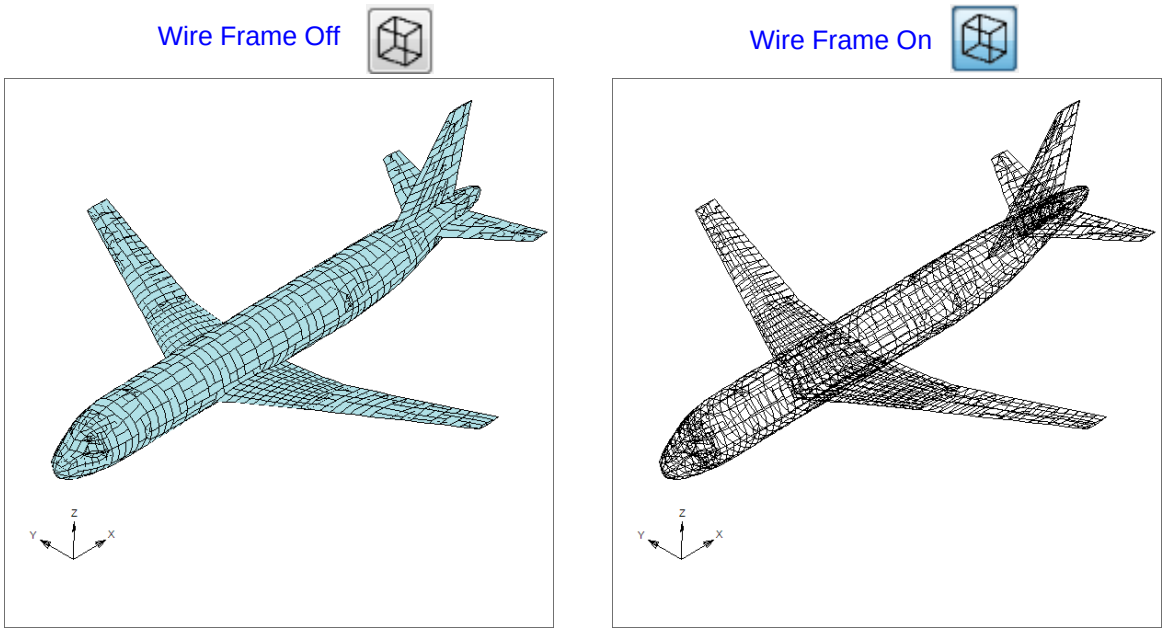

Figure 3-25

3.6 Perspective View

Perspective View can be turned on and off from the following icon or *File Menu*.

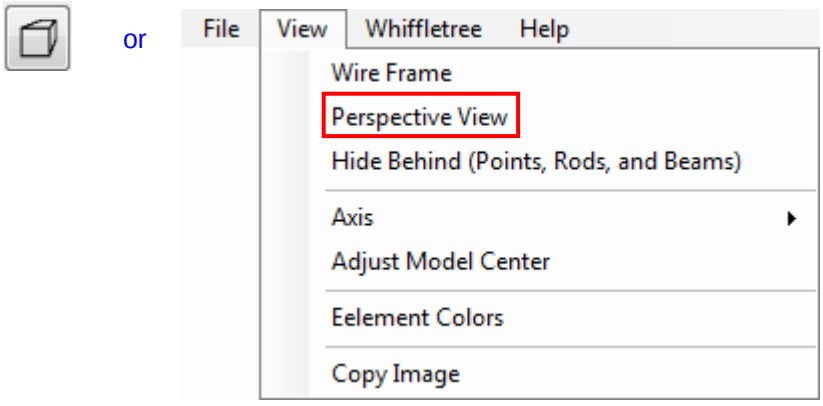

Figure 3-26

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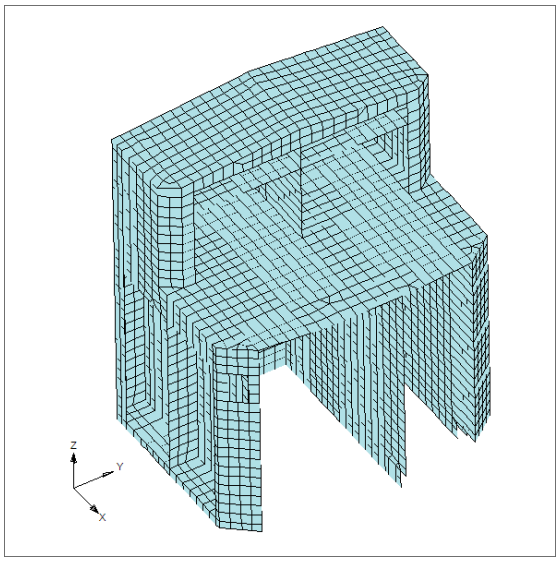
Perspective View Off Perspective View On



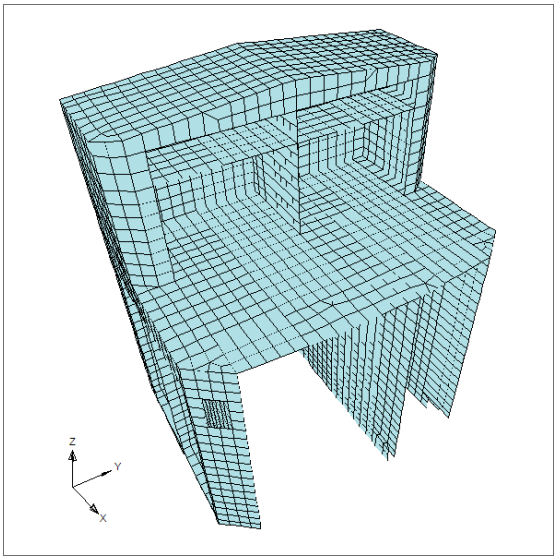


Figure 3-27

3.7 Change Element Color

Element colors can be changed from the following icon or *File Menu*.

or

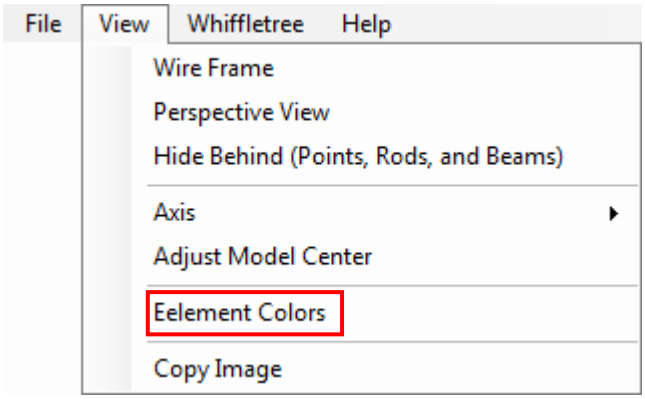


Figure 3-28

Remarks:

1. Separate element property IDs are required for separate colors.
2. No colors can be assigned for 1D line element.
3. Assigned colors cannot be saved even though you use *Save FEM* function (Section 3.3). The initial default color is always *Powder Blue* when you load FEM model.
4. Customized color is available as shown in the figure below.

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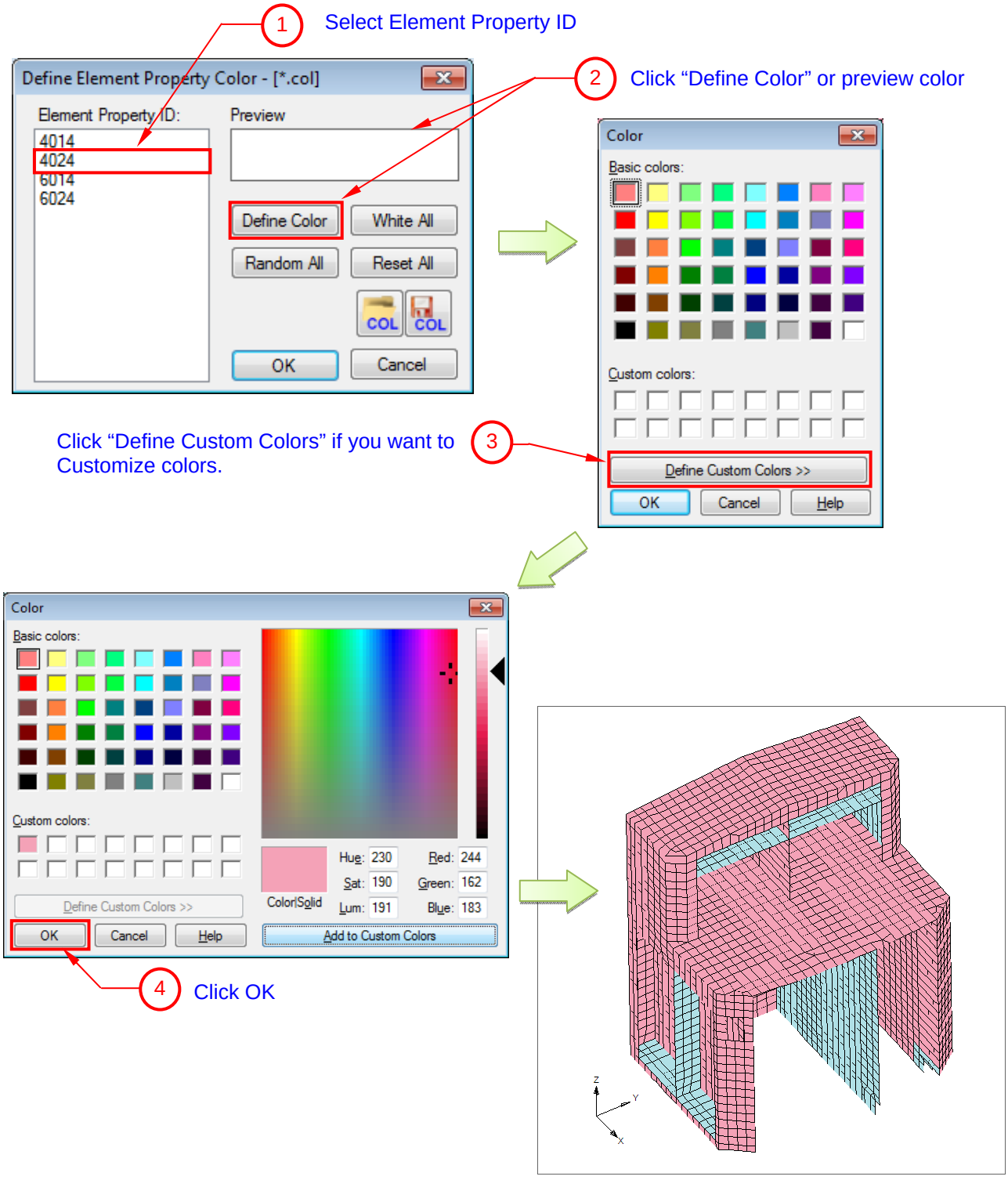

Figure 3-29

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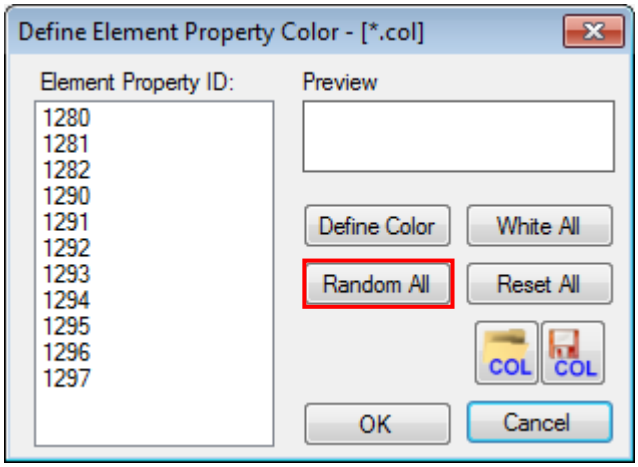
Assign Random Colors

If you want to assign colors all at once, use "Random All" button. Random colors will be assigned to each property.



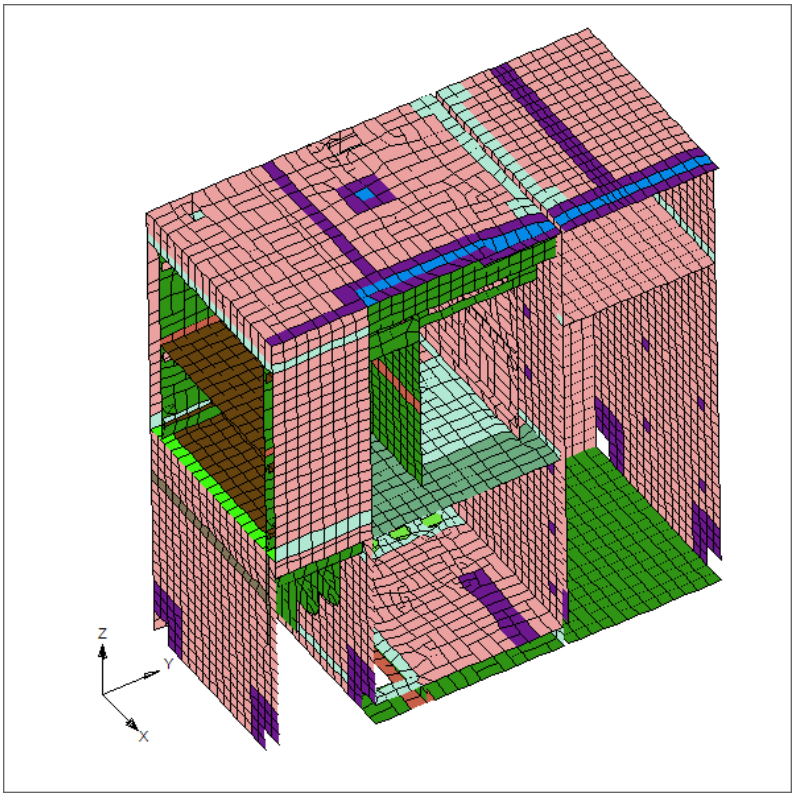


Figure 3-30

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Save/Open Color Setting

1. User can save color settings associated with element property IDs.
2. By opening saved color file (*.col), element colors are automatically assigned per previously set colors per element property ID.
3. If element property ID are not found in the previously saved color file, the color will not change in that property ID (but all other property ID found in the file will change).
4. User can save as many color files as user want to meet user's work environment.

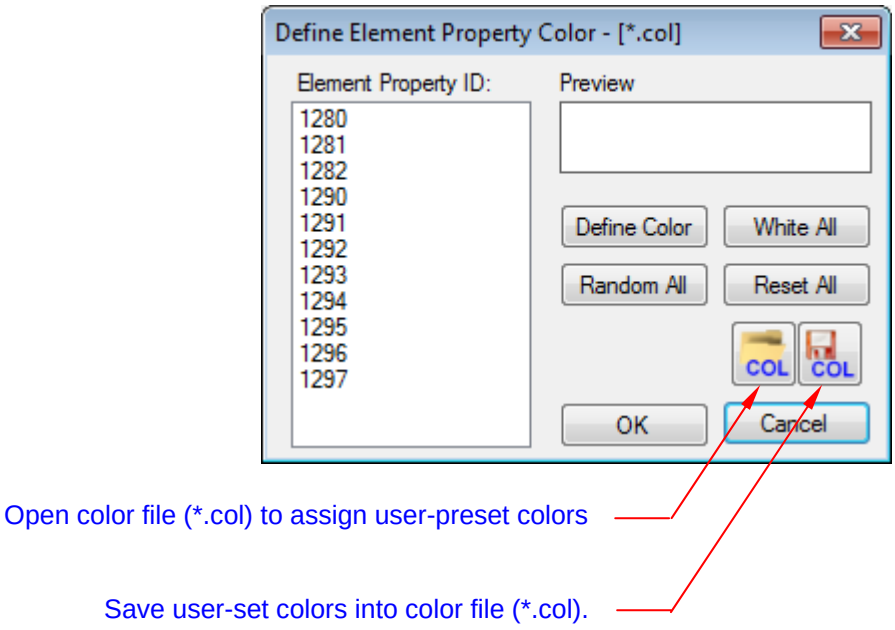

Figure 3-31

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3.8 Hide-Behind View

Hide-Behind View is to hide points, rods, and beams behind the FEM model if they are actually behind of it. The view can be turned on and off by the following icon or *File Menu*.

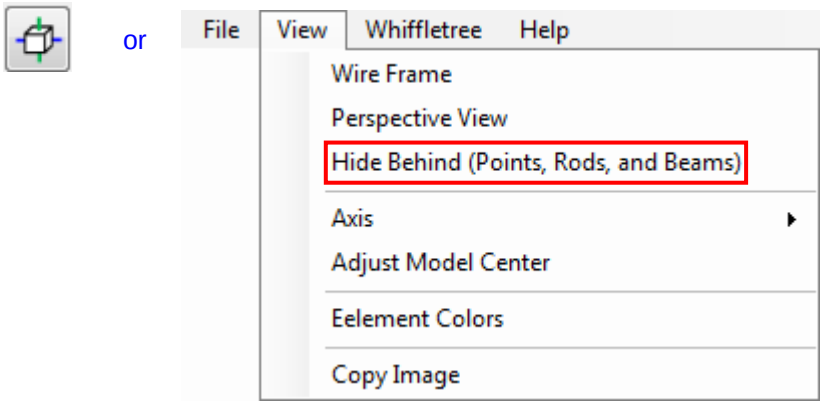

Figure 3-32

Remarks:

1. Turning on the *Hide-Behind View* makes it easier to visualize whiffletrees.
2. The view can only be turned on when there is at least one loading point.
3. By turning on the view, each rod and beam in the whiffletrees are divided into 20 elements. Therefore, turning on this view makes the model heavy and you may feel slower responses if there are many rods and beams in your whiffletrees.

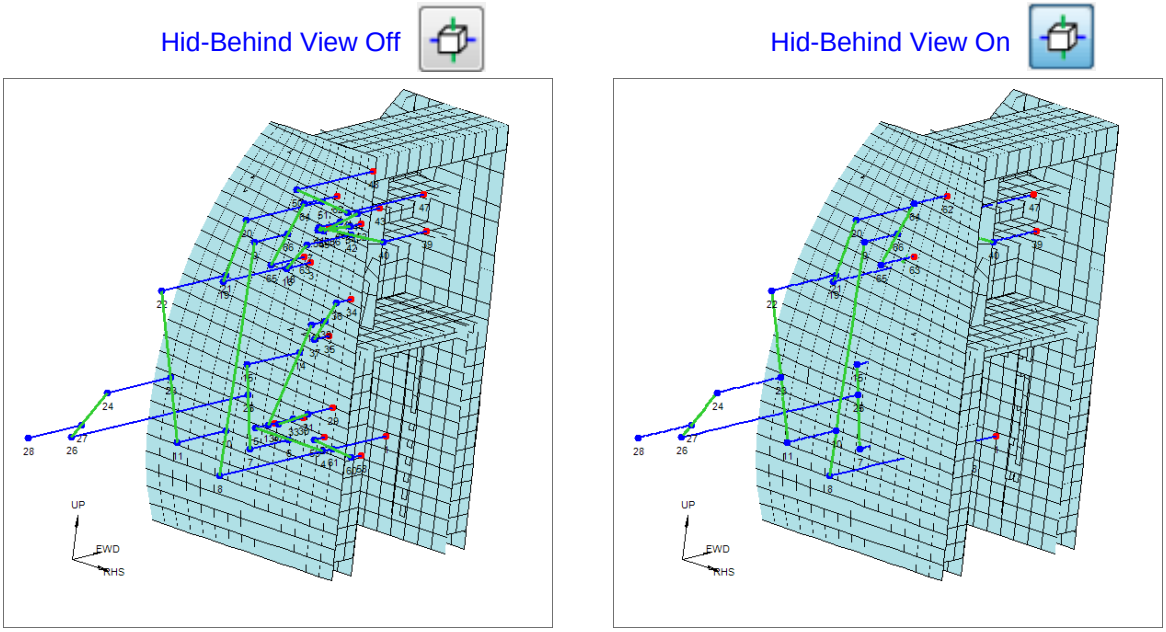

Figure 3-33

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4.0 NAVIATION OF MODEL

This section explains functions related to FEM and whiffletree model navigation.

4.1 General

Functions are available through icon buttons and *File Menu*. Most of view operations (move, zoom, or rotate model) have mouse shortcut.

4.1.1 Navigation Pane

Navigation Pane has icon buttons to access most of basic functions related to FEM and whiffletree model navigations.

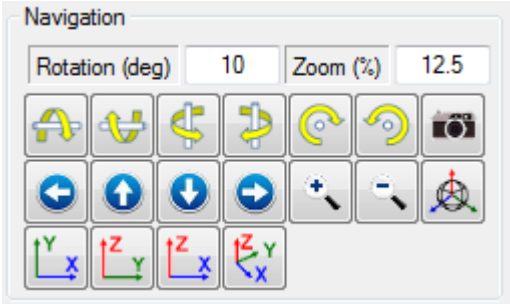
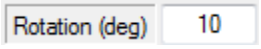
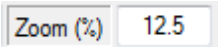


Figure 4-1



Angle of rotation achieved by one click on related icons or mouse move. The initial value is set between 2 to 16 degrees depending on number of elements and CPU speed, but it can be changed by typing the desired values in the box.



Percentage of zooming in/out of the model with respect to the current view size, achieved by one click on related icons or mouse scroll move. The default value is set to 12.5 percent but it can be changed by typing the desired values in the box.

Rotate model down (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag Down [Inside Circle]

Rotate model up (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag Up [Inside Circle]

Rotate model right (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag Right [Inside Circle]

Rotate model left (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag Left [Inside Circle]

Rotate model clockwise (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag [Outside Circle]

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Rotate model counterclockwise (Section 4.2.1)
Shortcut: Middle Mouse Button + Drag [Outside Circle]

Pan move left model (Section 4.2.2)
Shortcut: Left Mouse Button + Drag

Pan move up model (Section 4.2.2)
Shortcut: Left Mouse Button + Drag

Pan move down model (Section 4.2.2)
Shortcut: Left Mouse Button + Drag

Pan move right model (Section 4.2.2)
Shortcut: Left Mouse Button + Drag

Zoom in model (Section 4.2.3)
Shortcut: Mouse Scroll Back

Zoom in model (Section 4.2.3)
Shortcut: Mouse Scroll Forward

Change model view into XY plane (Section 4.2.4)

Change model view into YZ plane (Section 4.2.4)

Change model view into XZ plane (Section 4.2.4)

Change model view into Isometric (Section 4.2.4)

Copy model image into clipboard (Section 4.5)

Adjust model center (Section 4.4)

4.1.2 File Menu

There is basically no *File Menu* associated with model view operations such as move, zoom, or rotate models. There are some functions available from *File Menu*. The *Axis* option is only available from *File Menu*.

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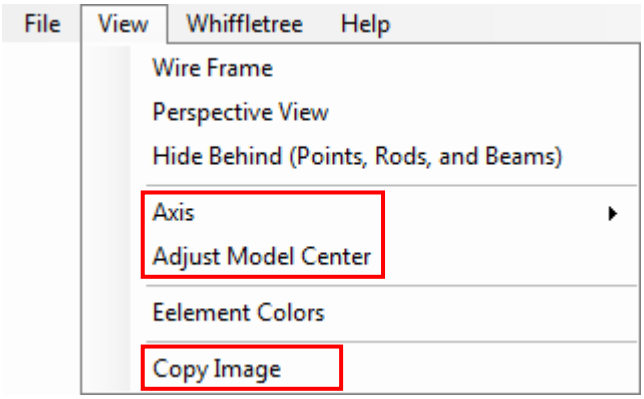

Figure 4-2

4.2 Model View Operation

There are four types of model view operations. Following subsections describe detail of each operation.

- Rotate
- Pan Move
- Zoom
- Preset View

4.2.1 Rotate

By Icon

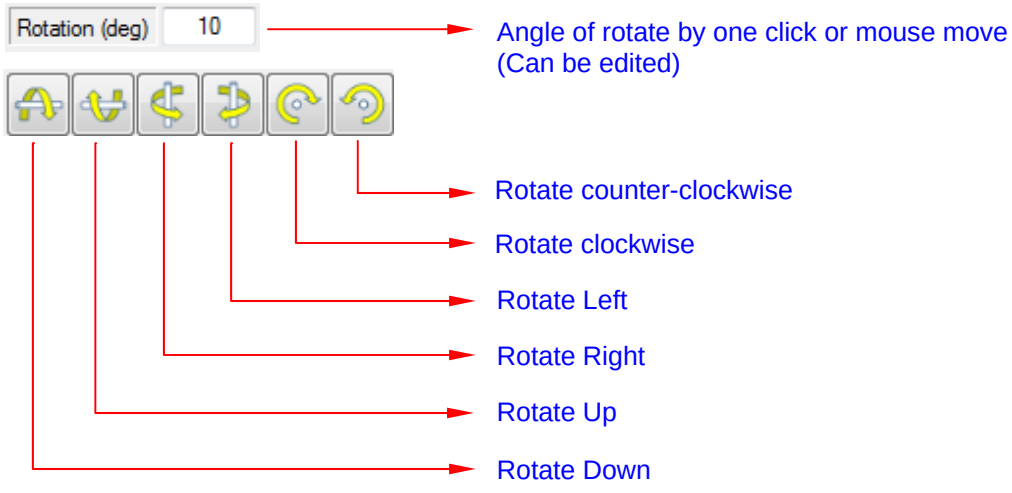

Figure 4-3

By Mouse

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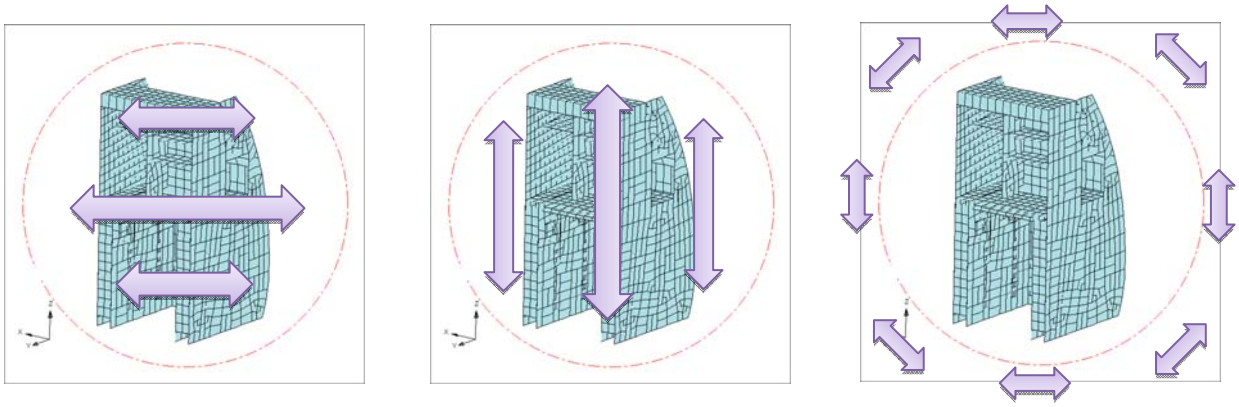
Dragging cursor by middle mouse button in the *Model Window* can rotate the model. When you try to rotate, a red-dotted circle will appear in the *Model Window*. Dragging inside the circle will rotate the model around vertical or horizontal axis. Dragging outside the circle will rotate the model around the axis perpendicular to the screen.



Rotate Left – Right | Rotate Up – Down | Rotate Clock – Counterclockwise

Figure 4-4

Remarks:

1. By default, the center of rotation is set to the geometric center of FEM. It is *NOT* the center of view window. The center of rotation can be changed by using *Adjust Model Center* function (Section 4.4).

2. If your model rotate too fast by mouse (usually happens when model size is small in terms of number of nodes/elements), lower the "*Rotation (deg)*" in the box.

Figure 4-5

4.2.2 Pan Move

By Icon

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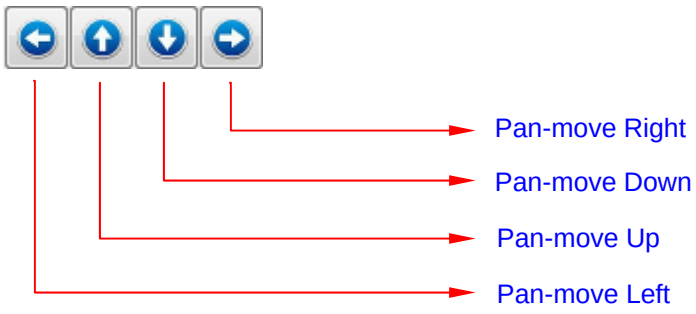

Figure 4-6

By Mouse

Dragging left mouse button in the *Model Window* can pan-move the model.

Remarks:

Moving model does *NOT* shift the model center for zoom in/out. The model center can be changed by using *Adjust Model Center* function (Section 4.4).

4.2.3 Zoom In and Out

By Icon

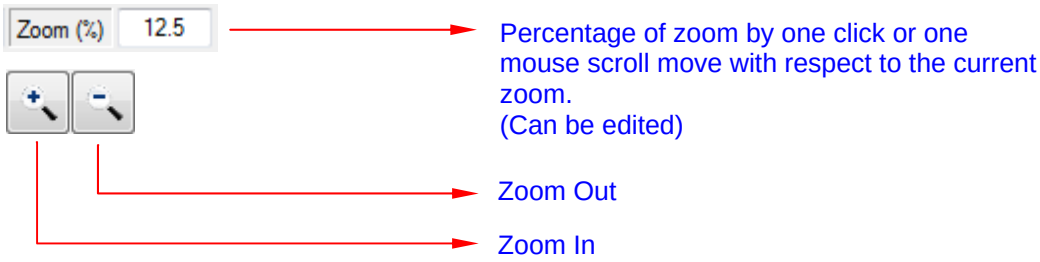

Figure 4-7

By Mouse (Scroll)

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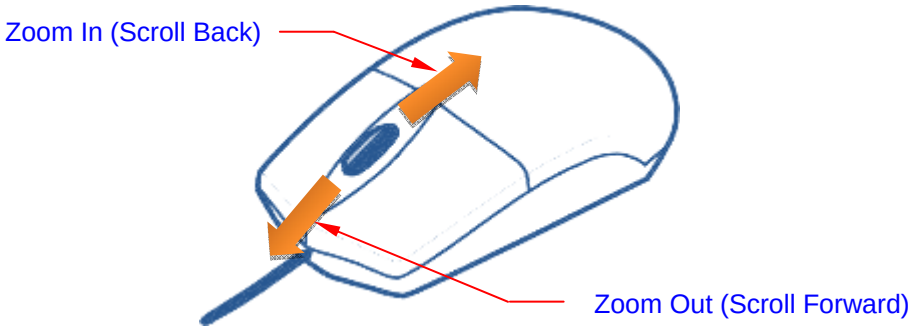

Figure 4-8

Remarks:

By default, the center of zoom in/out is set to the geometric center of FEM. It is *NOT* the center of view window. The center of zoom in/out can be changed by using *Adjust Model Center* function (Section 4.4).

4.2.4 Preset View Angle

There are four types of preset view: XY Plane, YZ Plane, XZ Plane, and Isometric View. All of them can be accessed only from icons. Whenever preset view is selected, the zoom level is automatically adjusted to fit in *Model Window*. The default is Isometric view when opening a new FEM model (not whiffletree model).

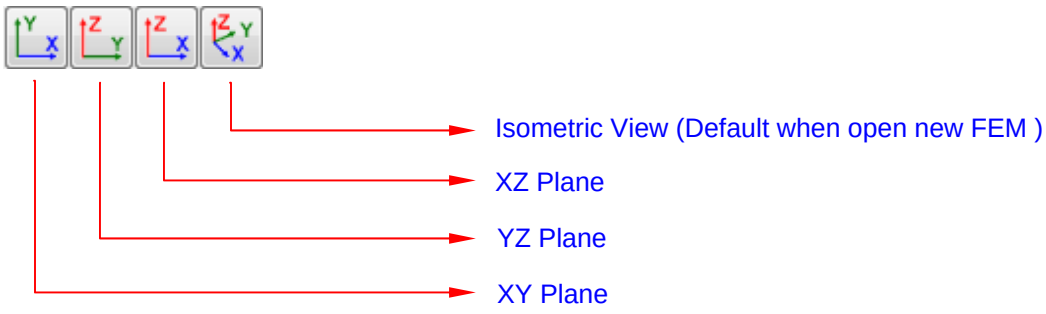

Figure 4-9

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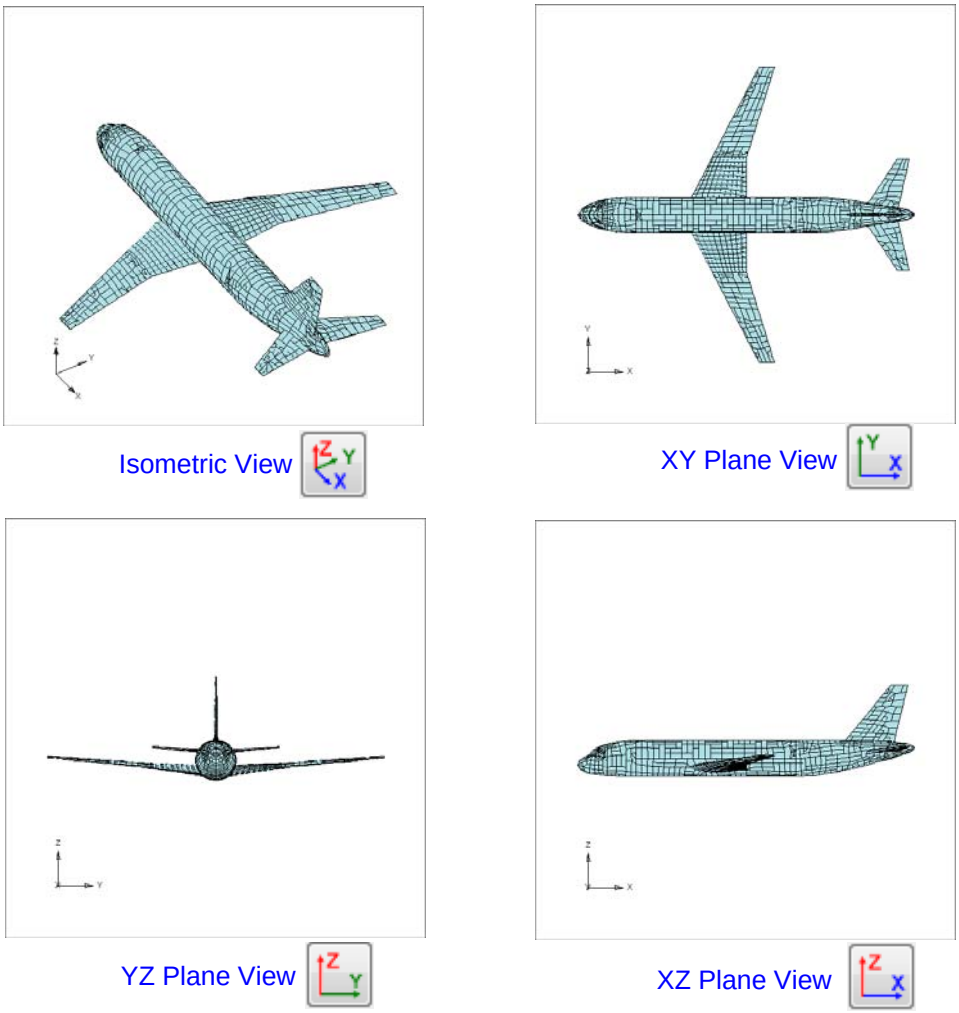

Figure 4-10

4.3 Coordination Axis

By default, global coordinate axis is shown at the lower left corner in the model view window. Axis properties can be changed only from *File Menu, View >> Axis*.

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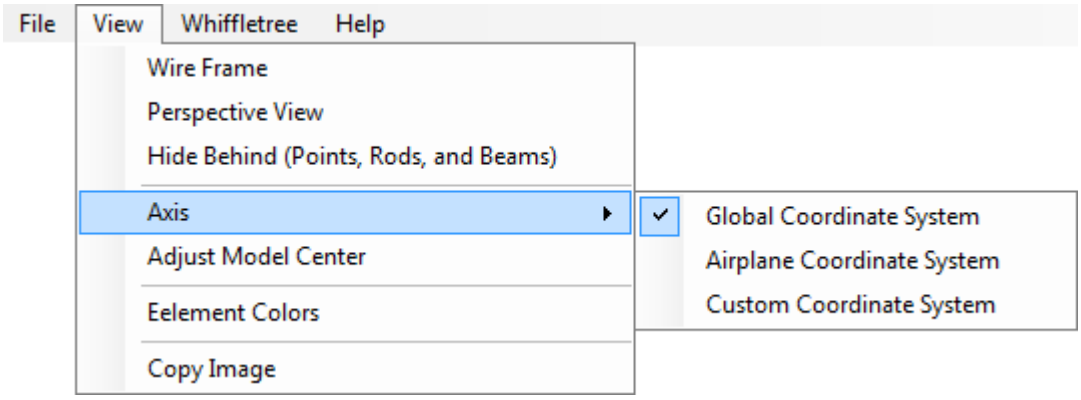

Figure 4-11

4.3.1 Turn On and Off the Axis

Axis can be turned on by selecting unchecked coordinate system from *File Menu*. Re-selecting checked coordinate system again will uncheck and turn off the axis view.

Checked (Turned On) Unchecked (Turned Off)

Figure 4-12

4.3.2 Global Coordinate System

Global coordinate system is a default coordinate system. It shows X-Y-Z axis corresponding to FEM model axis.

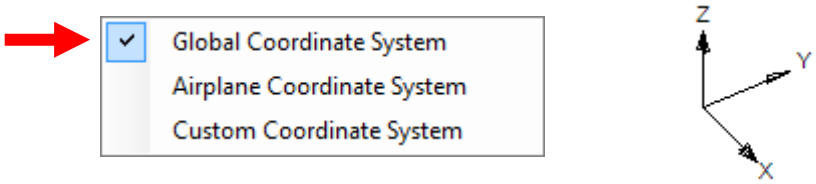

Figure 4-13

4.3.3 Airplane Coordinate System

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Airplane coordinate system can be shown as FWD, RHS, and UP.

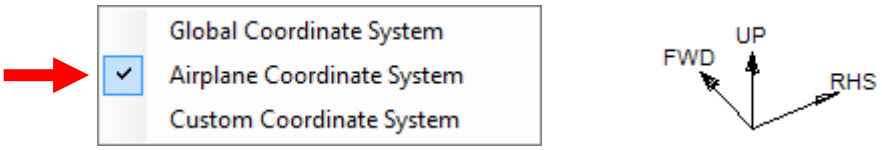

Figure 4-14

Remarks:

The default airplane coordinate system is set as follows.

```
FWD  =  -X
RHS  =  +Y
UP   =  +Z
```

This default can be changed in *3DWhiffletree.ini* file by changing the following line. Currently, FWD can be only changed to either "+X" or "-X", RHS to "+Y" or "-Y", and UP to "+Z" or "-Z". Assigning other values will cause errors.

Also note that only FWD, RHS, and UP can be used for airplane coordination. For example, AFT, LHS or DOWN cannot be used.

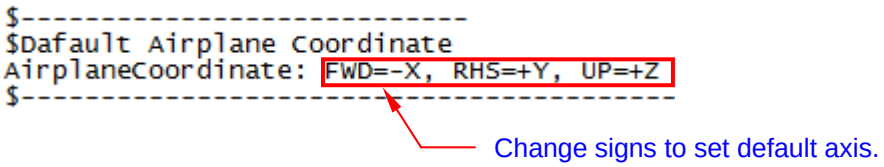

Figure 4-15

4.3.4 Custom Coordinate System

Custom Coordinate System can allow you to specify your own axis for airplane coordinate system. Currently following axis can be set to FWD, RHS, and UP.

```
FWD  =  +X or -X
RHS  =  +Y or -Y
UP   =  +Z or -Z
```

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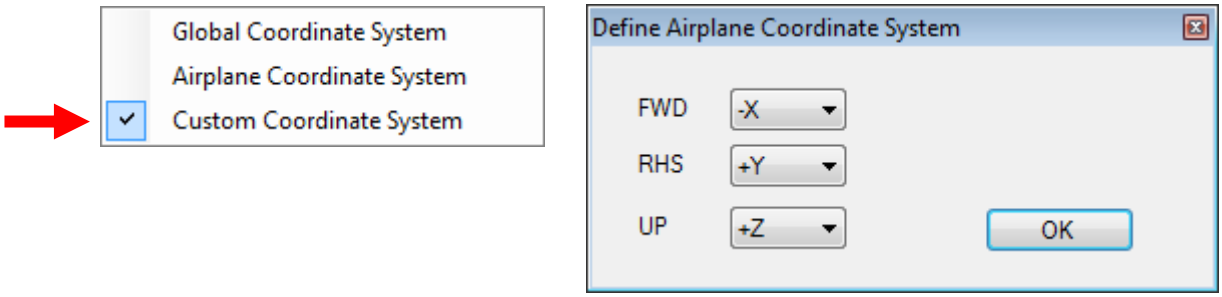

Figure 4-16

Remarks:

This customized coordinate system is effective only for the current window and will not be saved.

4.4 Adjust Model Center

Center of model is displayed just below the *Model Window*. The model center is a base point for zooming in/out the model as well as rotating the model. When FEM file is opened, the model center is calculated based on the FEM model geometry. Then, the geometric center is set to the model center.

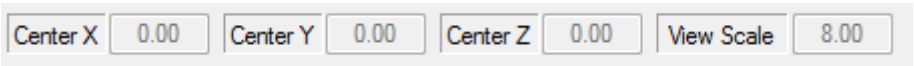

Figure 4-17

The model center can be adjusted from the following icon or *File Menu*.

or

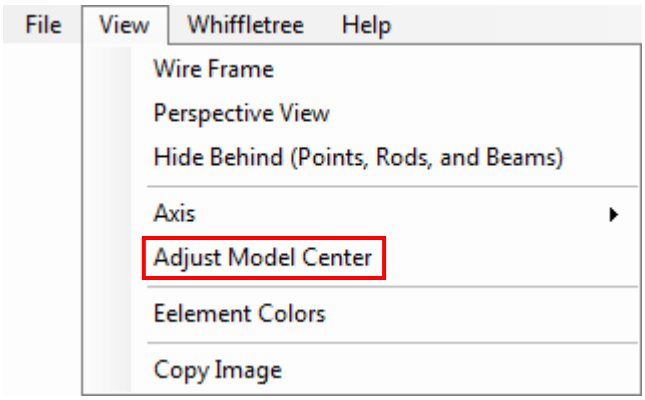

Figure 4-18

There are four types of center you can select. Each property is explained in the table below.

- FEM Geometric Center
- Loading Points Overall CG
- Current Window Center
- Custom

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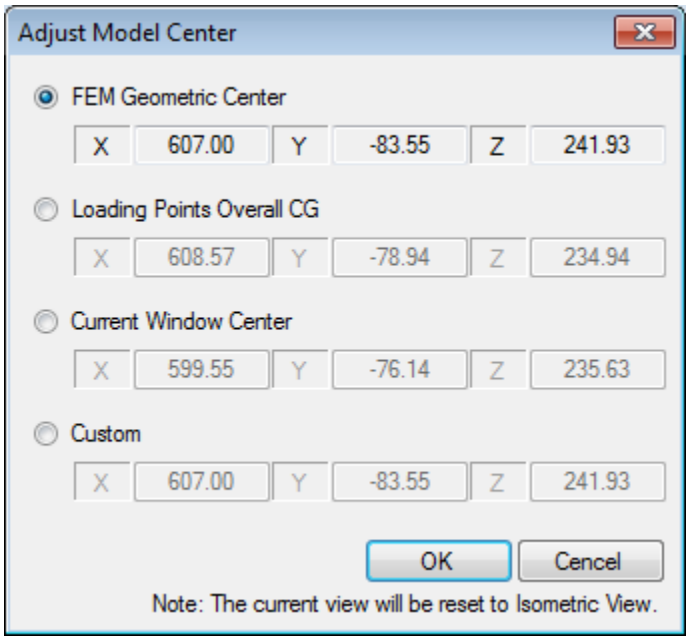

Figure 4-19

Table 4-1

Option Button	Model Center
FEM Geometric Center	$(x, y, z) = \left(\frac{X_{Max} - X_{Min}}{2}, \frac{Y_{Max} - Y_{Min}}{2}, \frac{Z_{Max} - Z_{Min}}{2}\right)$
Loading Points Overall CG	$(x, y, z) = \left(\frac{\sum m_i \cdot x_i}{\sum m}, \frac{\sum m_i \cdot y_i}{\sum m}, \frac{\sum m_i \cdot z_i}{\sum m}\right)$ To select this option, there must be at least one loading point in the current model.
Current Window Center	Current window center will be automatically extracted.
Custom	Any numbers can be typed in.

Once new model center is selected, the model will be regenerated to be fit in *Model Window with Isometric View*.

4.5 Copy Image

Copy Image function can be accessed from the following icon or *File Menu*. This will capture a bitmap image of *Model Window*. The copied image will be stored into clipboard so that it can be pasted to other application.

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or

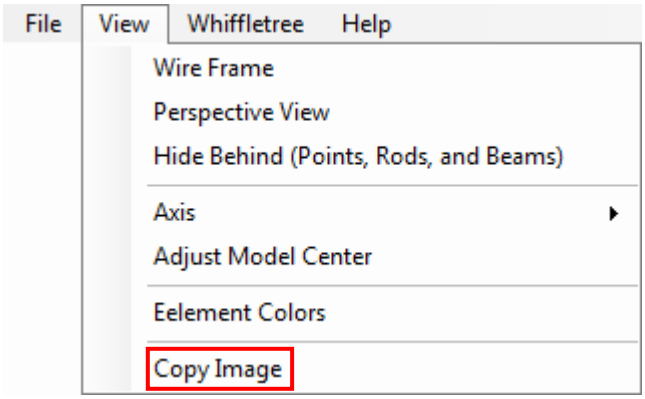

Figure 4-20

Warnings:

1. As of Version 1.0, this *Copy Image* function from *File Menu* is disabled.
2. This function is almost same as PC's Print Screen function. Therefore, the *Model Window* must be cleared and entire window should be seen in your screen to capture correct images. Otherwise, loss of image will happen.

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5.0 WHIFFLETREE CONSTRUCTION

This section explains functions related to construction of whiffletree which is a core part of this software.

5.1 General

Functions are available through icon buttons and *File Menu*. You have more options to certain functions only through *File Menu*.

5.1.1 General Model View and Nomenclature

Below figures show an example view of building whiffletrees. Whiffletrees generally consist of CG points, Rods, Beams, and Connecting Points. Nomenclatures of these components are explained in the table below.

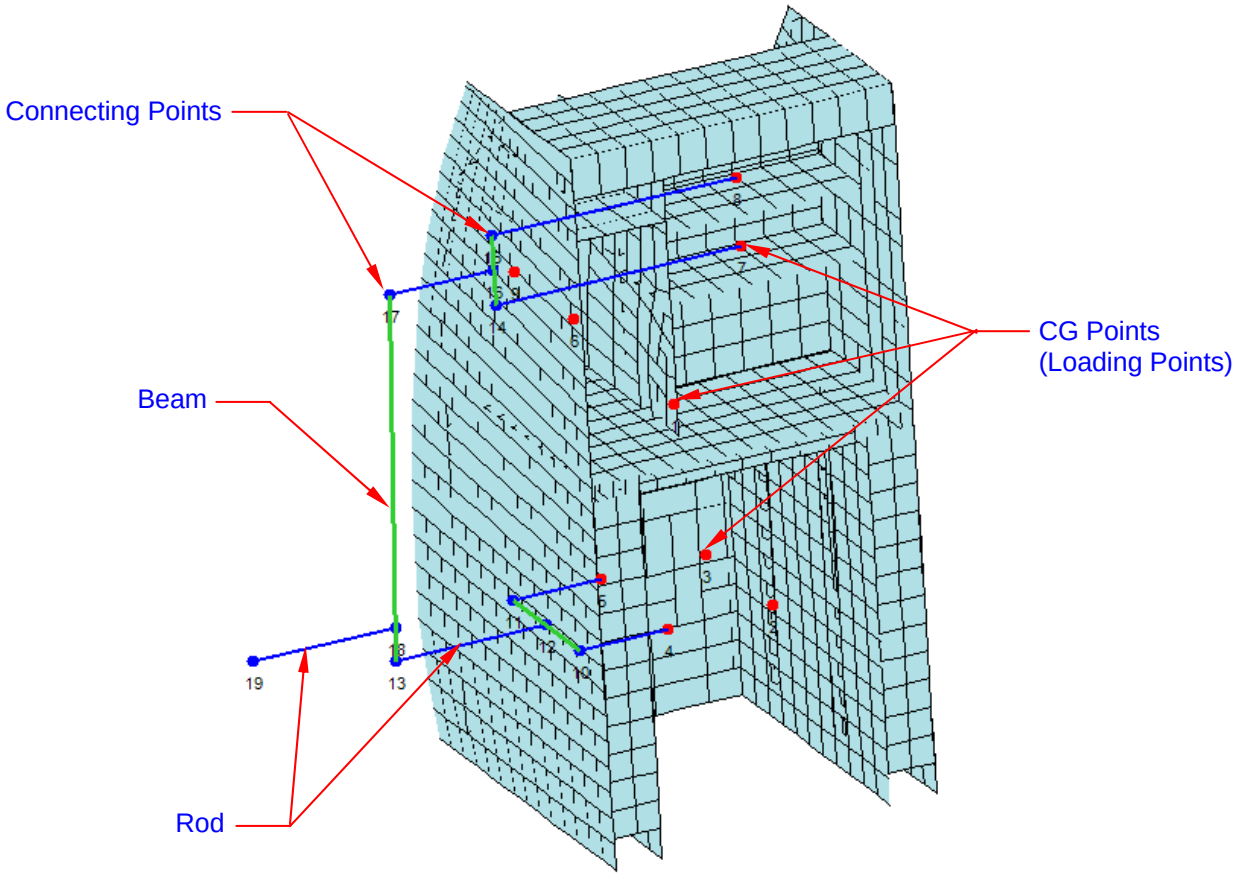

Figure 5-1

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Table 5-1

Nomenclature	Appearance in Model	Meanings
CG	Red Dot	It is also called "*Loading Point*". The point represents weight components where loads are applied. CG points have the following properties: • Can be only connected by rod. • CG properties (weight, location, and name) can be edited at any time. • Can be split. • Can be moved together with another CG in the plane perpendicular to the loading direction while keeping the overall CG same. • Can be moved in the plane perpendicular to the loading direction (overall CG will change.) • Can be added at any time. • Can be deleted only when not connected to the other point.
***Beam* (*1)**	Green Line	This is moment arm. It connects with two rods at both ends and with one rod at somewhere in between. Beam has the following properties: • Must contain 3 connecting points. • Must be perpendicular to the loading direction.
***Rod* (*2)**	Blue Line	This is axially loaded device. It connects between two connecting points (one end can be CG). Rod has the following properties: • Must contain 2 points at ends. • Must be parallel to the loading direction.
Connecting Point	Blue dot	This is a connecting point between rod and beam. It has the following properties: • Must be connected with beam except for the top of whiffletree. • Can be moved in rod's axial direction. • Can be deleted if it is at the top of whiffletrees. • All 3 points within the same beam will move together.
(Numbers)	Numbers	Numbers are automatically assigned at CG (Loading Points) and Connecting Points. Numbers are not fixed and can be changed automatically at any time if construction changes but cannot be edited by users.

Notes:
*1) Even though it is called "Beam", the physical constructions do not need to be actually a beam.
*2) Even though it is called "Rod", the physical constructions do not need to be actually a rod.

5.1.2 Whiffletree Pane

Whiffletree Pane has icon buttons to access most of basic functions related to whiffletree constructions.

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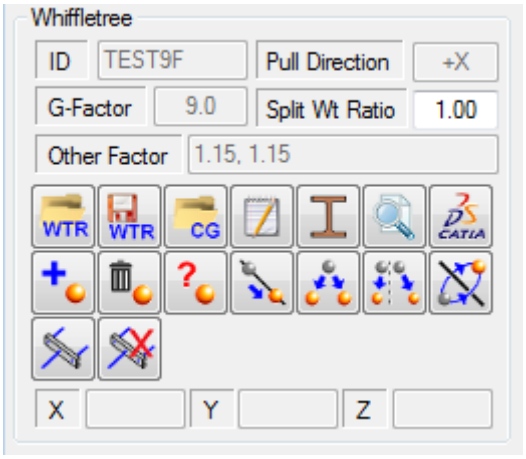
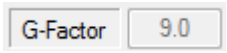


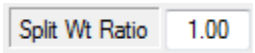
Figure 5-2

ID can be assigned to an individual whiffletree model. It can be assigned or changed in *Whiffletree Edit Window*. See Section 6.2 for more detail.

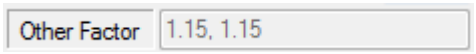
Pull Direction shows a loading direction. It can be set or modified in *Whiffletree Edit Window*. See Section 6.4for more detail.



G-Factor is a loading factor multiplied to the original weight at each *CG Point*. It can be set or modified in *Whiffletree Edit Window*. See Section 6.5 for more detail.



This is a weight ratio to be used when splitting a CG into to. It can be directly modified. See Section 5.14.3 for more detail about splitting a *CG point*.



Other Factor is any additional factors multiplied together with *G-Factor*. You can enter as many factors as you want. It can be edited in *Whiffletree Edit Window*. See Section 6.6 for more detail.

This shows supplemental information about the location of point. It can be displayed when you are modifying a point.

Open whiffletree (*.wtr) file (Section 5.2)

Save whiffletree (*.wtr) file (Section 5.3)

Open and read CG (*.csv) file (Section 5.4)

View and edit whiffletree data (Section 5.5)

View and edit whiffletree material data (Section 5.6)

View whiffletree diagram (Section 5.7)

Export whiffletree to *CATIA* (Section 5.8)

Create a whiffletree between two points (Section 5.9)

Delete all whiffletrees (Section 5.10)

Add a CG point (Section 5.11)

Delete a point (Section 5.12)

Obtain information of a point (Section 5.13)

Move a point along loading direction (Section 5.14)
Shortcut: SHIFT KEY + Mouse Left Button Drag

Split a CG point (Section 5.14.3)

Move two CG points together (Section 5.14.4)

Move a CG point in a plane perpendicular to loading direction (Section 5.14.5)

5.1.3 File Menu

Most of *File Menu* is available in icons, but there are some functions only available from *File Menu* such as changing graphic size of rod/beam/point and turning on/off the warning for whiffletree beam length.

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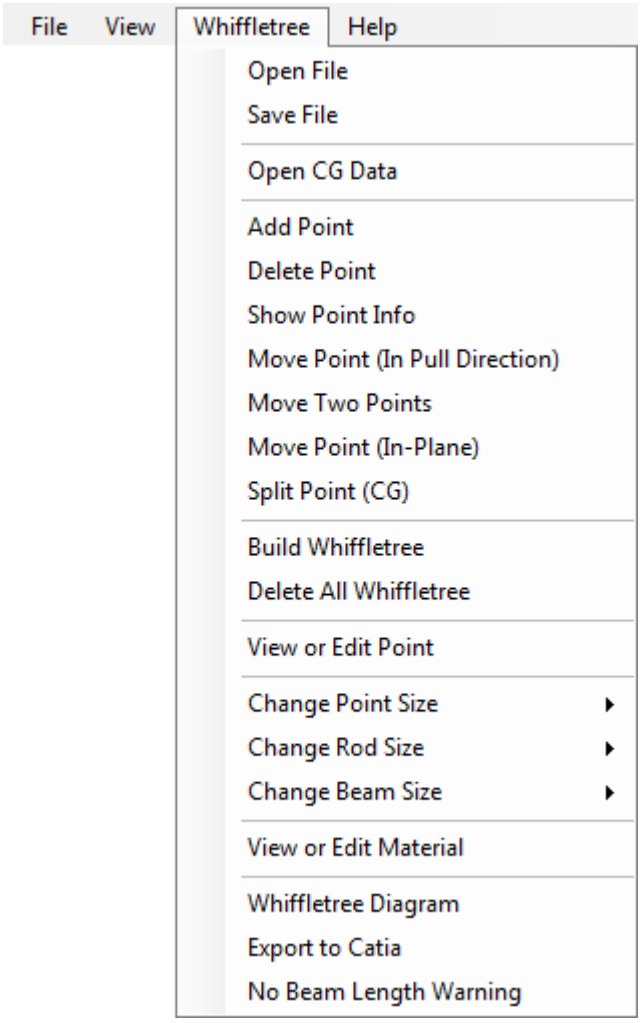

Figure 5-3

5.2 Open Whiffletree File (*.wtr)

Previously saved whiffletree data (*.wtr file) can be opened from the following icon or *File Menu*.

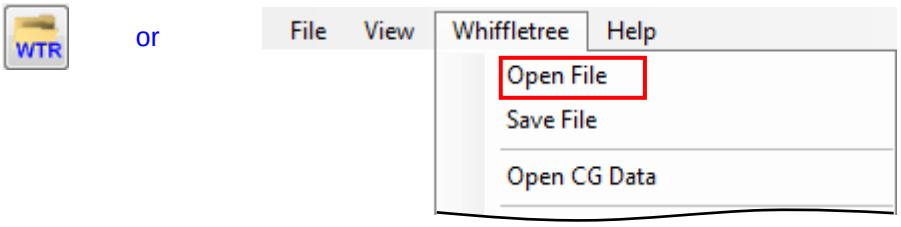

Figure 5-4

What is Whiffletree Data (*.wtr) File?

Whiffletree data file is a text-formatted file containing whiffletree geometry data as well as other associated information to the whiffletree model. It is used to save your whiffletree created in *3DWhiffletree* program to be used for later time. Even though the file is written in ASCII-format, it is not intended to be edited by text editors. The contents have to be written in specific format and order. The default file extension is (*.wtr); however, any file extensions can be opened as long as it is written in text format.

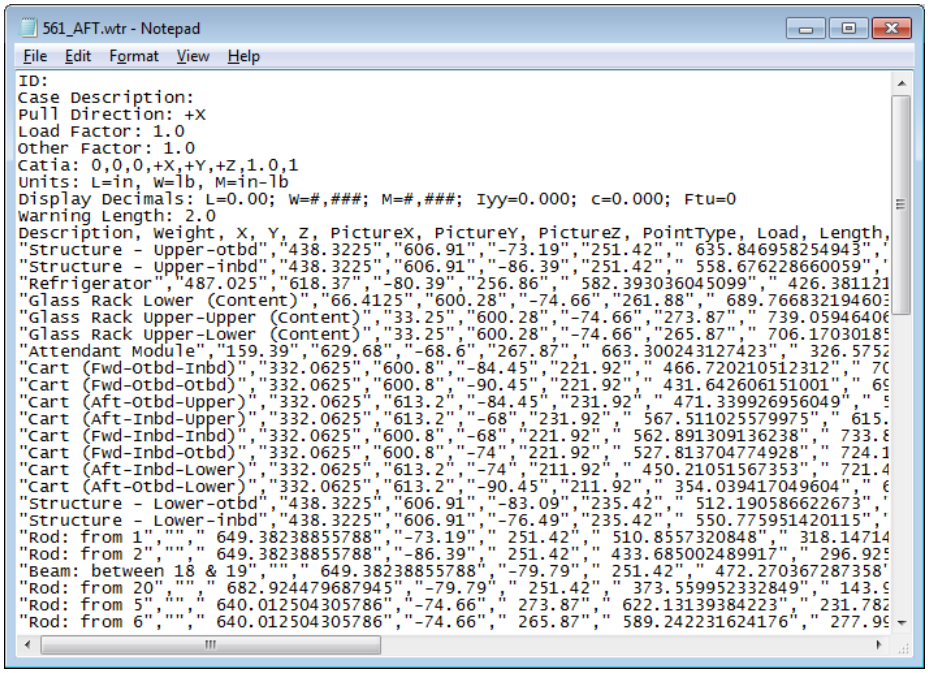

Figure 5-5

Remarks:

1. Default file extension in *File Open Dialog* is (*.wtr).

2. Opening whiffletree models does not automatically readjust the center of model based on the whiffletree geometry or its overall CG. This is because FEM model is usually opened first and whiffletree model will be constructed based on the FEM model space. If you open whiffletree model only, you may need to adjust model center to view your whiffletree models (See Section 4.4).

5.3 Save Whiffletree File (*.wtr)

You can save your whiffletree data for later use. Saving whiffletree data can be done from the following icon or *File Menu*. Table 5-2 summarizes what you can save and what you can NOT save in the *.wtr file.

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Figure 5-6

Table 5-2

What you can save	What you can NOT save
• ***Whiffletree ID*** • ***Case Description*** • ***Pull Direction*** • ***Load Factor*** • ***Other Factor(s)*** • ***Whiffletree Constructions including CG, Loads, Rod, and Beam*** • ***Origin for CATIA export*** • ***Coordinate for CATIA export*** • ***Scale Factor for CATIA export*** • ***Scale Conversion for CATIA export*** • ***Whiffletree Display Units (L, W, M)*** • ***Display Format (L, W, M, Iyy, c, and Ftu for Whiffletree, but not for Material. You can save them in a separate *.mtl file – See Section 7.0)*** • ***Warning Length***	• ***Relationship between FEM model. Remember FEM model is just an image to help whiffletree constructions and there is no interaction with whiffletree models.*** • ***Whiffletree Model View Properties including Rotation Angle, View Angle, Location, and Zoom Level*** • ***Point Size*** • ***Rod Size*** • ***Beam Size*** • ***Whiffletree Material (You can save them in a separate *.mtl file – See Section 7.0)***

Remarks:

1. Default file extension in *Save File Dialog* is (*.wtr).
2. Icon and *File Menu* can become active only when changes are made in whiffletree data.
3. You can change/edit file name before you confirm to save. Therefore, this function is technically considered as "*Save As*" function.

5.4 Read CG Data

CG data file (*.csv) can be read through the following icon or *File Menu*.

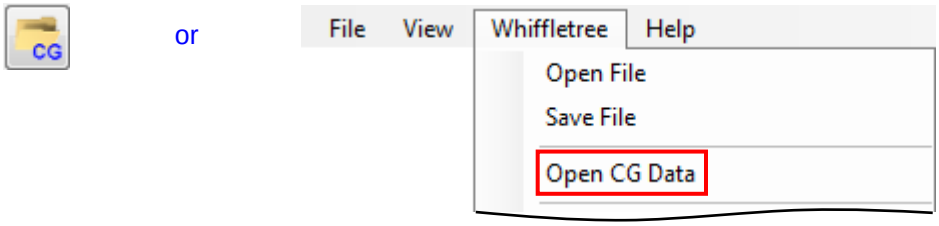

Figure 5-7

What is CG data?

CG data is a set of point data where loads will be applied by whiffletree. The *CG Points* are located very bottom of the whiffletree, and therefore, it shows distribution of loads. The *CG Points* can be created in *3DWhiffletree* by *Add Point* command (Section 5.11). However, it is more common and efficient to create *CG points* separately from *3DWhiffletree* and let the program read the points. This is because users usually have a set of CG data already if the users already have FEM model.

How the CG data file (.csv) can be created?

There is no function to save points as CG data file in *3DWhiffletree* program. You need to create CG data file by yourself. Since the file is in CSV format (comma-separated values), you can use any commercial software such as Microsoft Excel to edit and save the file in CSV format. Refer to Section 1.5.4 for how to create CSV file.

Difference between CG data file (*.csv) and whiffletree data file (*.wtr)

CG data (csv) file can only contain data for CG points while whiffletree data (wtr) file can contain both CG points and whiffletree models. (This is of course because CG point is a part of whiffletree model.)

5.5 View and Edit Whiffletree Data

All whiffletree data can be viewed and managed in a separate window called *Whiffletree Edit Window*. The window can be launched from the following icon or *File Menu*. The detail to manage whiffletree data is explained in Section 6.0.

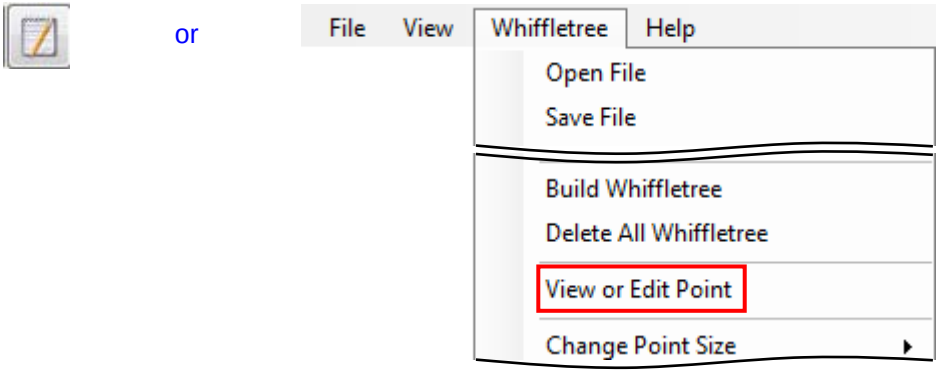

Figure 5-8

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5.6 View and Edit Whiffletree Material Data

Whiffletree material data can be opened, viewed, edited, and saved in a separate window called *Material Edit Window*. The window can be launched from the following icon or *File Menu*. The detail to manage whiffletree material data is explained in Section 7.0.

or

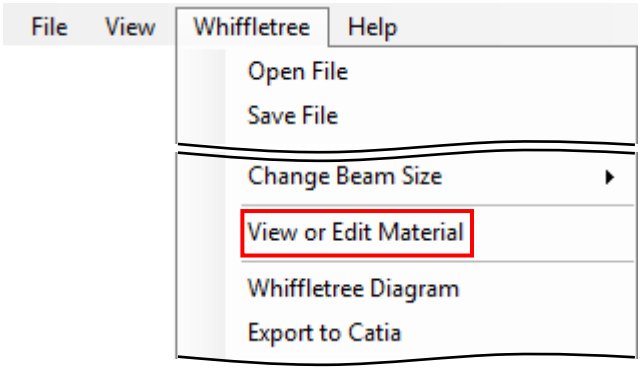

Figure 5-9

5.7 View Whiffletree Diagram

Whiffletree diagram can be reviewed in a separate window. The window can be launched from the following icon or *File Menu*. The detail about whiffletree diagram is explained in Section 8.0.

or

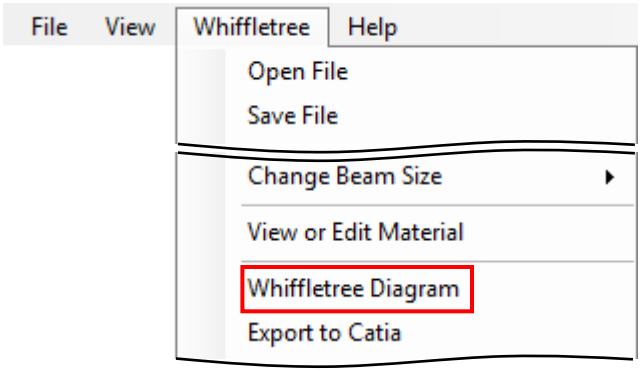

Figure 5-10

5.8 Export to CATIA

Exporting whiffletree model into *CATIA* can be done in a separate window. The window can be launched from the following icon or *File Menu*. The detail about exporting model in to *CATIA* is explained in Section 9.0.

Figure 5-11

5.9 Build Whiffletree

Building whiffletree can be done by the following icon or *File Menu*. Take the following procedures described in the following subsections.

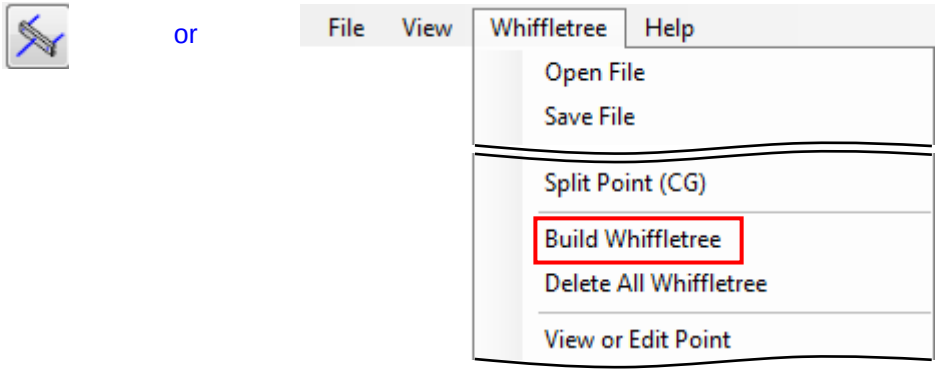

Figure 5-12

5.9.1 Procedures

1. Click icon or start from *File Menu*. You will see a message "*Select the first point*" in *Status Bar*.

2. Pick the first point by clicking a point in *Model Window* by mouse. Zoom in/out or rotate the model as necessary. Once you click a point, the point turns to yellow and the message in *Status Bar* changes to "*Select the second point.*"

3. Pick the second point by clicking a point in *Model Window* by mouse. As soon as you select the second point, a message will appear to confirm the connection between the points you selected.

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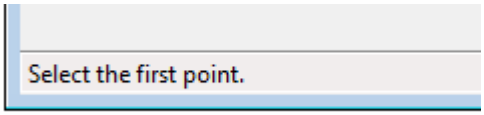
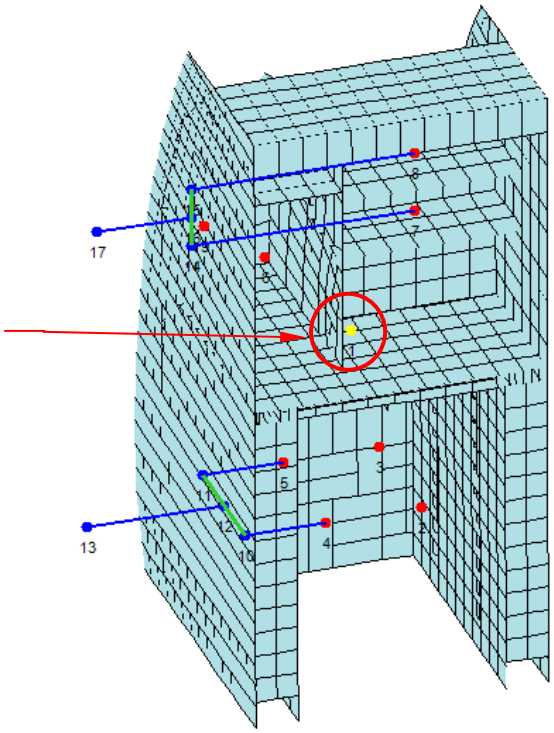
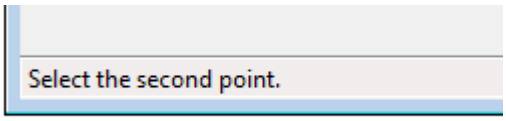
1) Message in *Status Bar* for the first point.



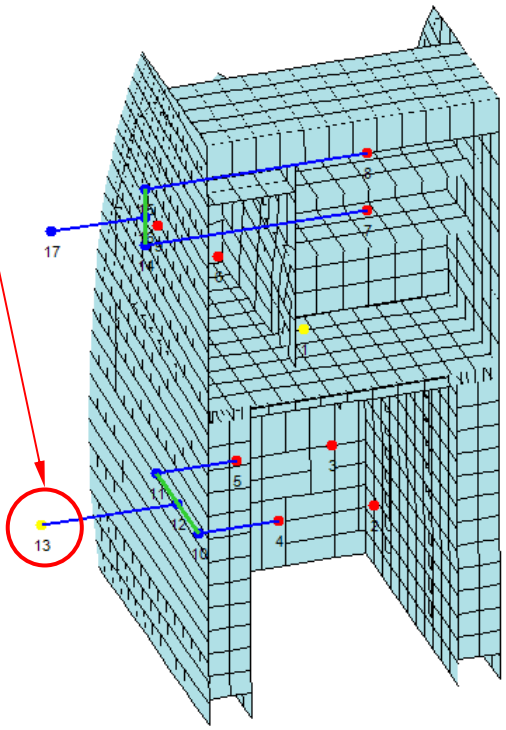
2) Point 1 is selected (color turns to yellow).



3) Message in *Status Bar* for the second point.



4) Point 13 is selected as the second point.



5) Message will appear to confirm the connection.

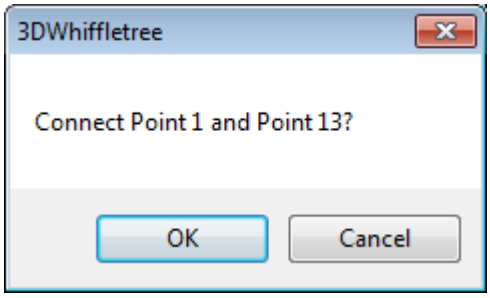


Figure 5-13

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4. Whiffletree is built with rods and beam (new point 18, 19, and 20 are created in this example).

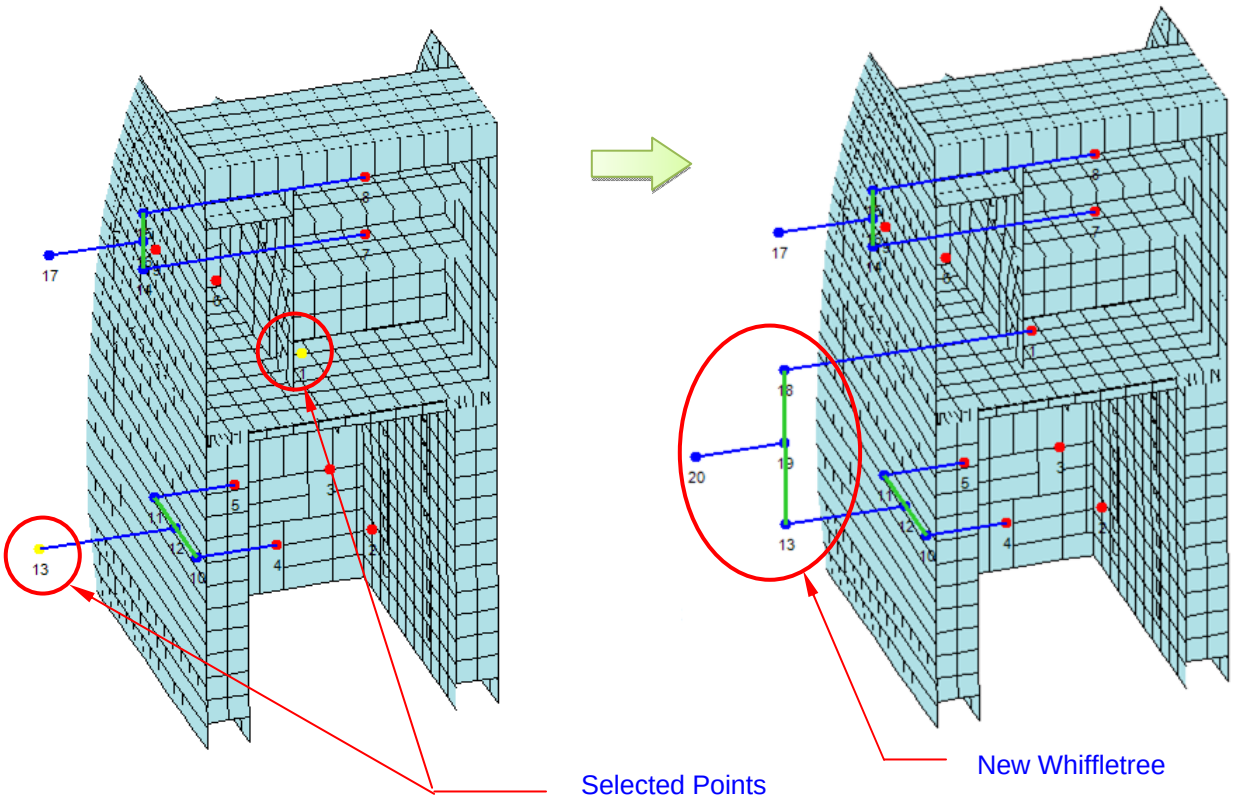

Figure 5-14

Non-selectable points for whieeltree construction

You can select points for whiffletree only if they are CG points that are not connected with rods or the point at the top of the tree. In summary belows are points that cannot be selected for whiffletree construction.

1. *CG points* that are alrady connected with a rod
2. Points that are already part of whiffletree (i.e., Beam)
3. Point for 2nd point that is already selected as the 1st point.

When selecting any of these points, you will see an error message shown in the figure below.

Examples of Non-Selectable Points

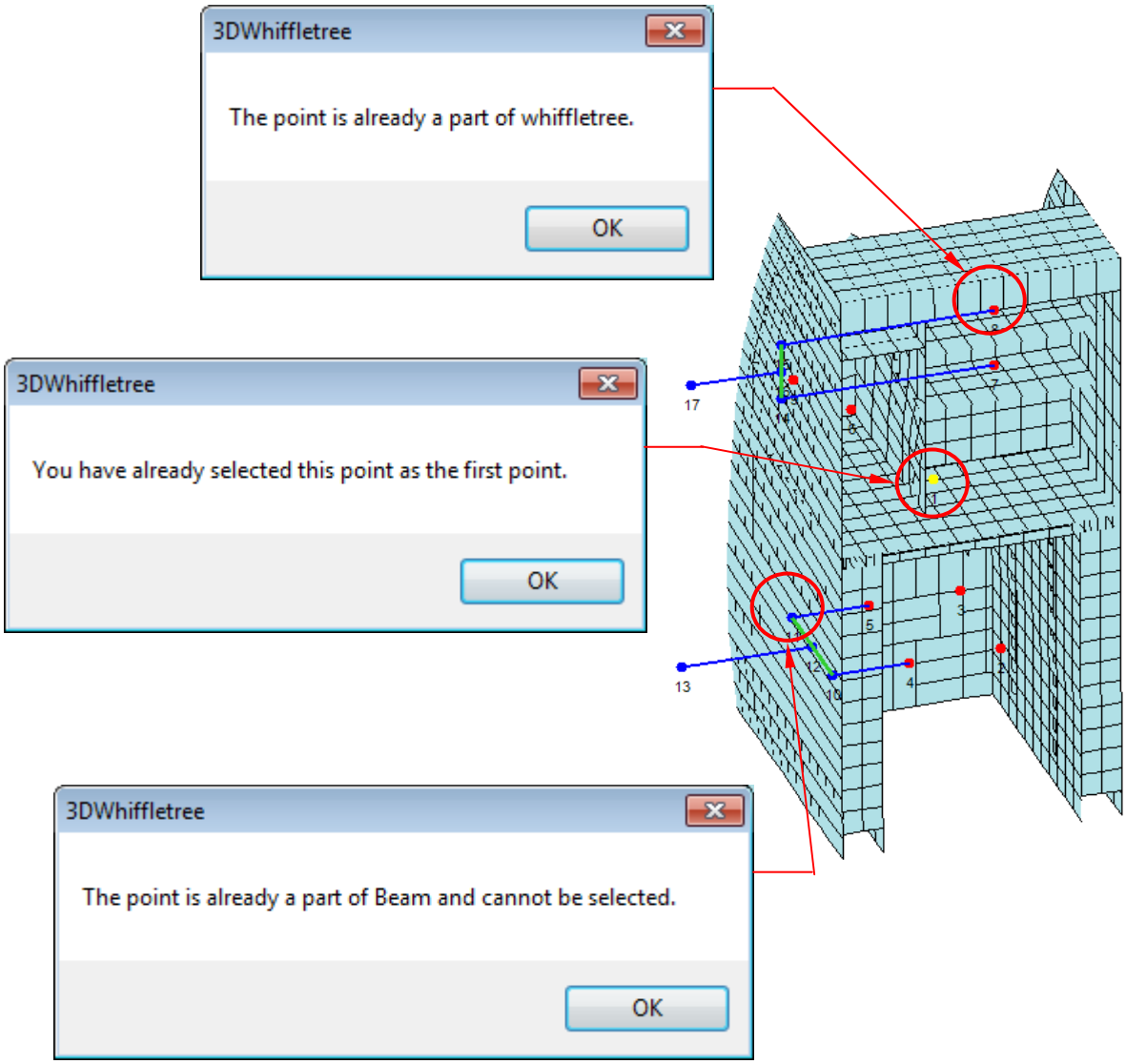

Figure 5-15

5.9.2 Technical Background

Calculation method for whiffletree construction is shown below. In the below example the pulling direction is assumed to be Z direction. Method is similar for the case of pulling direction in X or Y. *3DWhiffletree* program only can take the pulling direction parallel to major global axes (X, Y, or Z).

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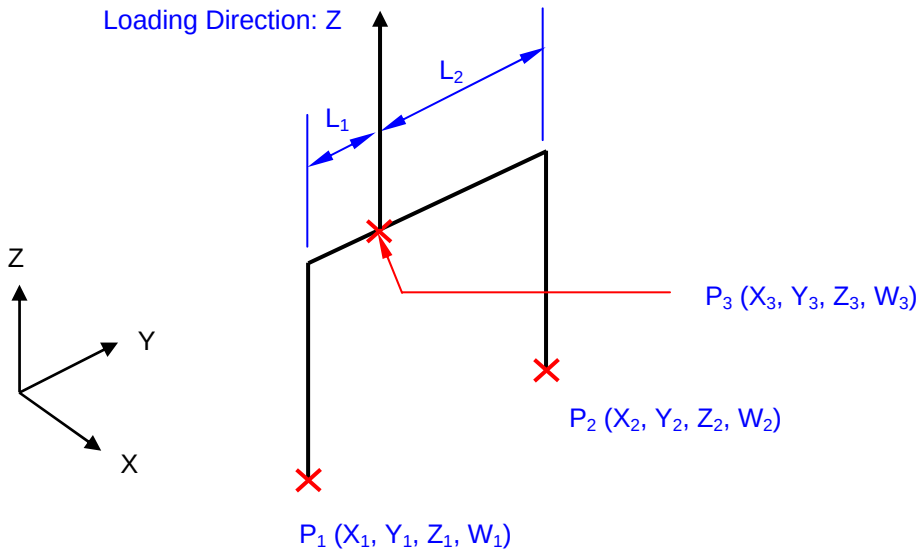

Figure 5-16

In the figure above, we want to find P_3 based on P_1 and P_2 properties. Therefore,

Find: P_3 coordinate (X_3, Y_3, Z_3) and Load (W_3)

Known: P_1 coordinate (X_1, Y_1, Z_1) and Load (W_1)
P_2 coordinate (X_2, Y_2, Z_2) and Load (W_2)
Direction to pull (+Z in this example)

By taking a moment about P_3,

$$L_1 \cdot W_1 = L_2 \cdot W_2$$

If $L = L_1 + L_2$, then

$$\frac{L_1}{L} \cdot = \frac{W_2}{W_1 + W_2}$$

Therefore,

$$X_3 = (X_2 - X_1)\frac{W_2}{W_1 + W_2} + X_1$$

$$Y_3 = (Y_2 - Y_1)\frac{W_2}{W_1 + W_2} + Y_1$$

$$W_3 = W_1 + W_2$$

Note that default Z_3 value is automatically calculated by program based on the distance between P_1 and P_3.

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5.10 Delete All Whiffletree

This command will delete ALL whiffletrees. To delete a part of whiffletree, use *Delete a Point* (See Section 5.12).

Delete All Whiffletree function is available through the following icon or *File Menu*.

or

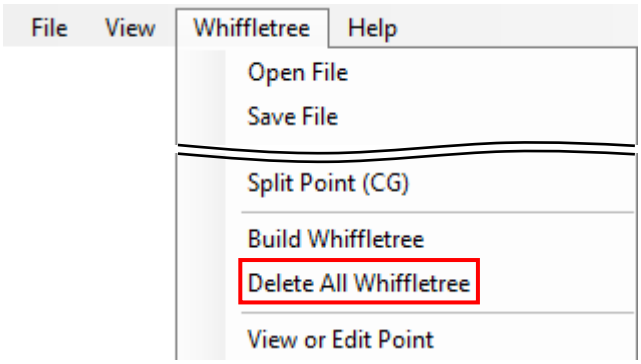

Figure 5-17

Delete All Whiffletree will delete all rods, beams, and points except for CG points. You will see a confirmation message. Click *Yes* will delete all rods and beams.

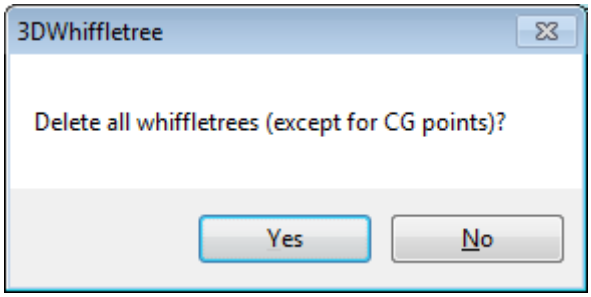

Figure 5-18

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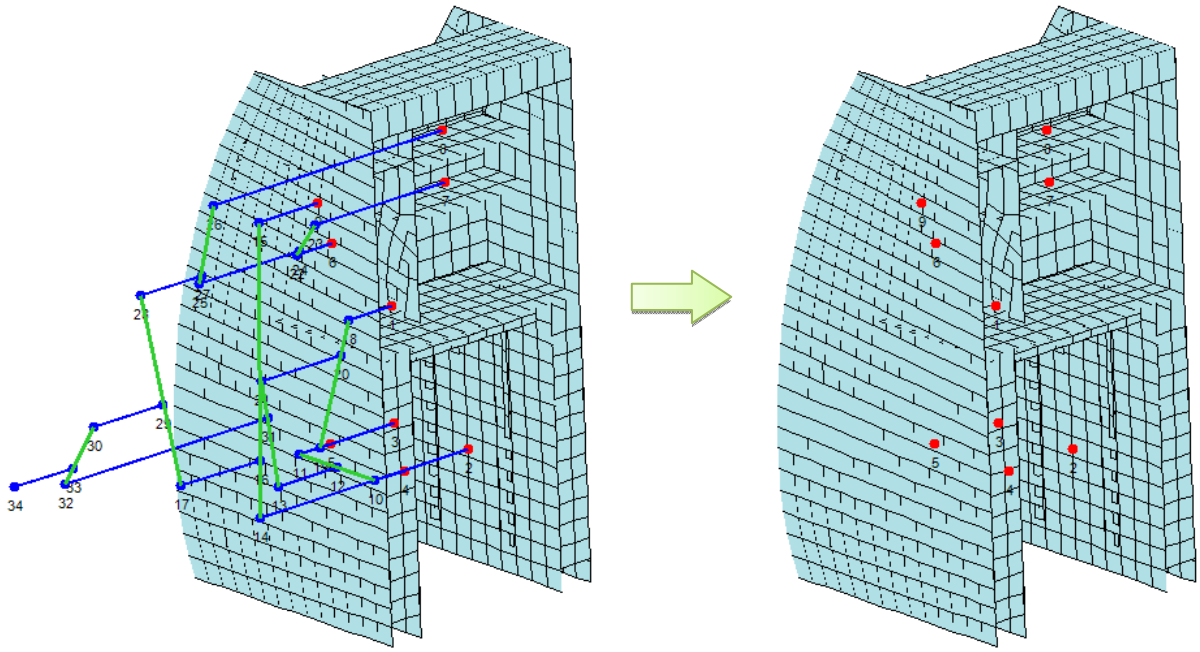

Figure 5-19

5.11 Add a Point

The *Add a Point* function is available through the following icon or *File Menu*.

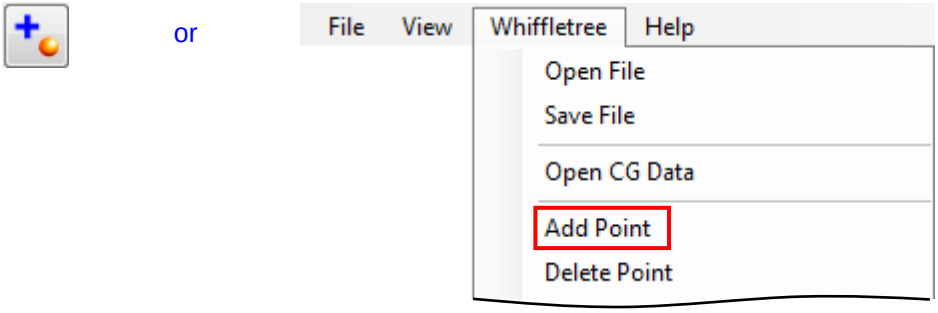

Figure 5-20

Procedures:

1. A separate window will open.
2. Fill out X, Y, and Z coordinate, Description, and Weight.

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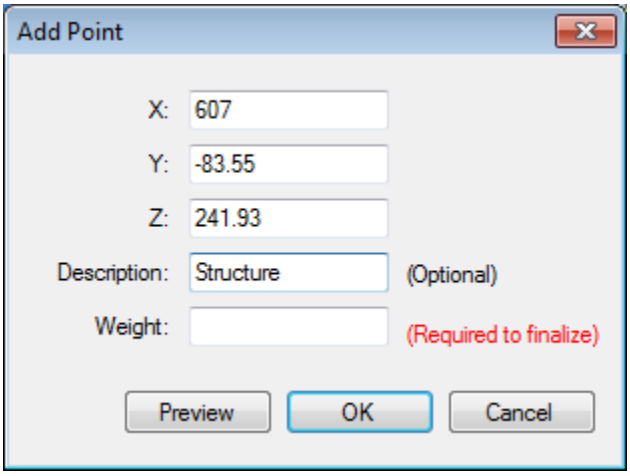

Figure 5-21

3. Click *Preview* to check the point. The new point will show in yellow.

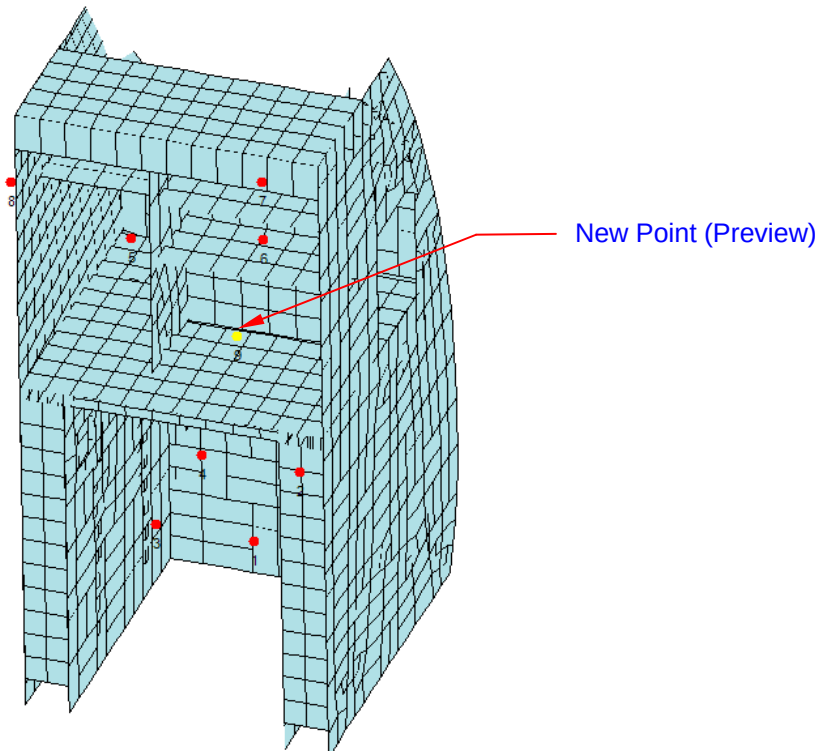

Figure 5-22

4. Click *OK* to finalize the point. The yellow point will turn to red. Weight must be greater than 0. Description is optional.

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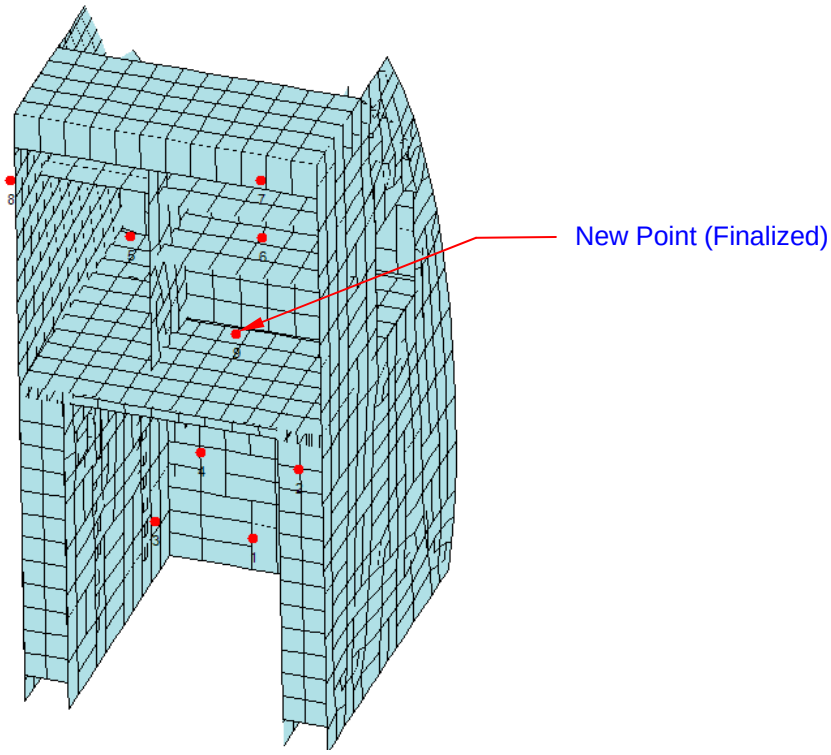

Figure 5-23

5. You can check the new point from *Whiffletree Edit Window*. See 6.0 for detail about *Whiffletree Edit Window*.

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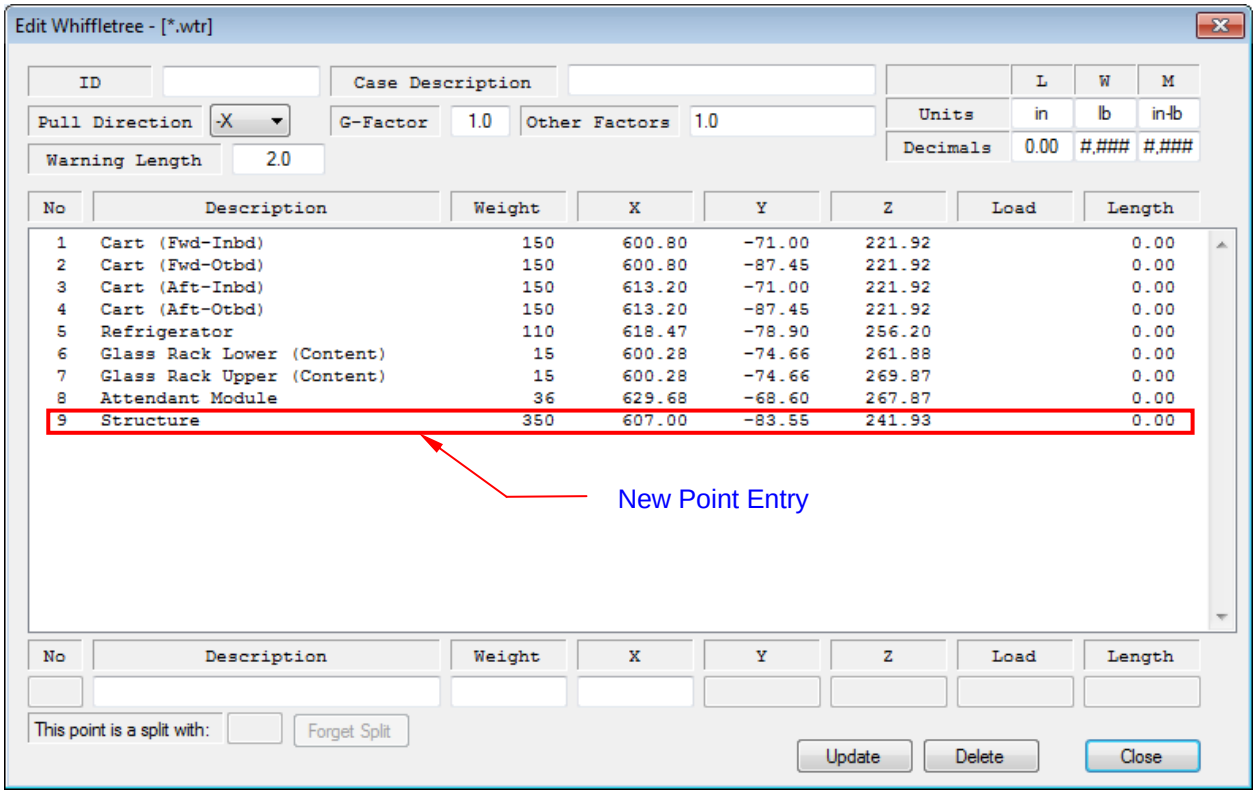

Figure 5-24

5.12 Delete a Point (Delete Whiffletree)

The *Delete a Point* function is available through the following icon or *File Menu*.

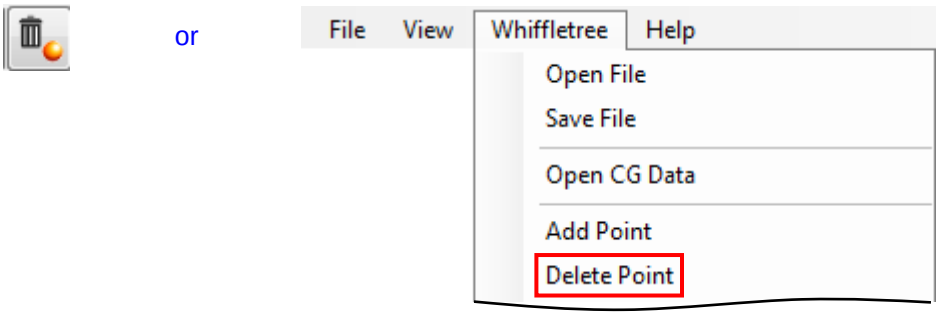

Figure 5-25

There are two functions for this command: to delete a point, and to delete a whiffletree.

5.12.1 Delete a Point

Only CG points that are not connected can be deleted.

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1. Click icon or use *File Menu* to activate *Delete a Point* function. You'll see a message in *Status Bar*.

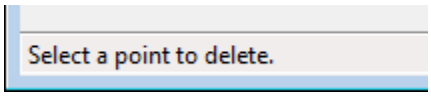

Figure 5-26

2. Select a *CG point* that you want to delete. Below figure shows an example of deleteable *CG points*.

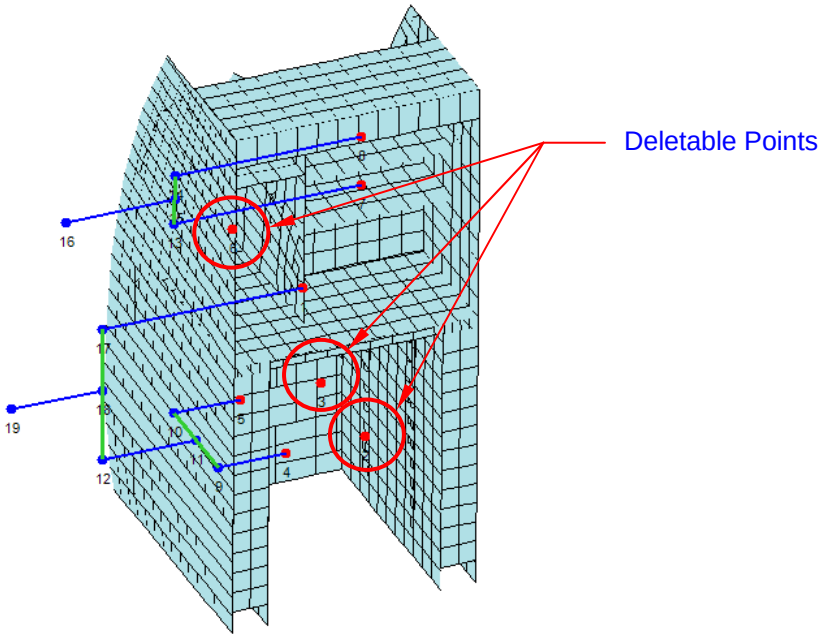

Figure 5-27

3. A confirmation dialog will pop up. Click *OK* to confirm the point deletion.

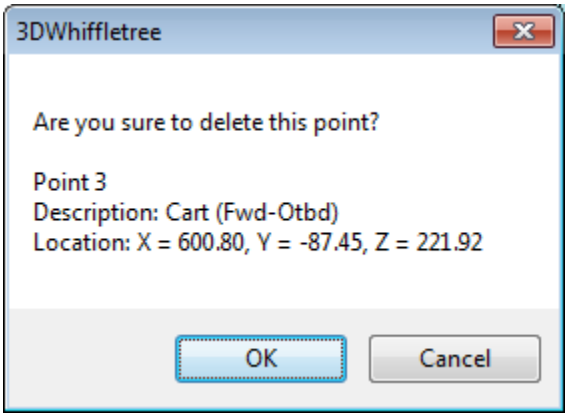

Figure 5-28

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4. Point has been deleted. Note that point numbers have been updated automatically.

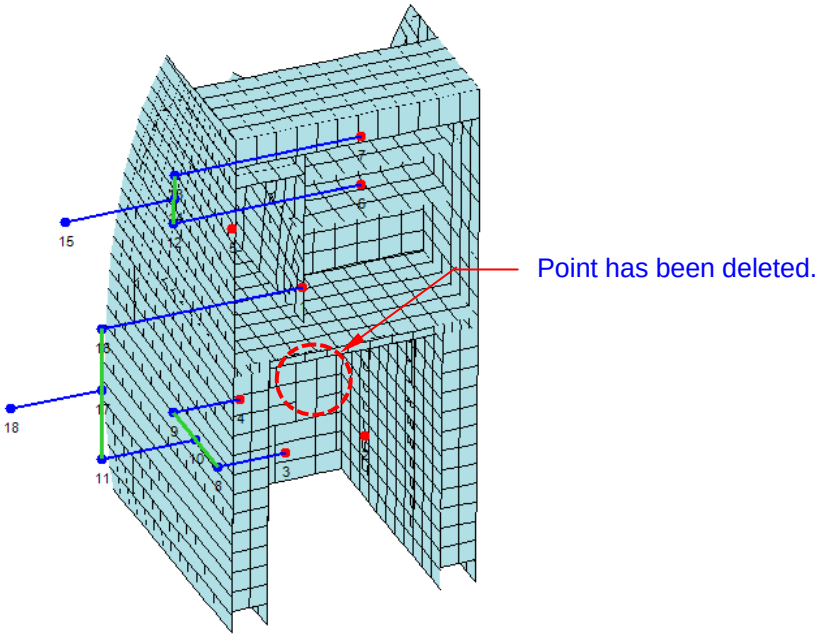

Figure 5-29

Notes:
If you select any non-deletable points, you'll see the following warning message.

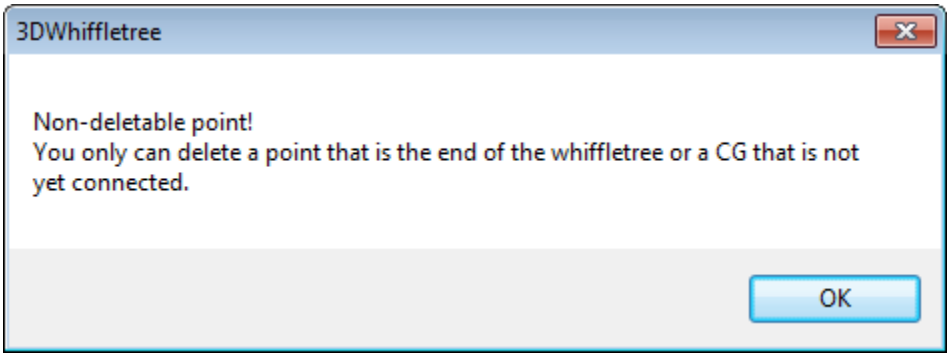

Figure 5-30

5.12.2 Delete Whiffletree

Points and whiffletree (Beam and Rod) can be deleted if they are located at the top of whiffletrees. You need to select the point located top of the whiffletree. Then, rod and beams only one level below of the points will be deleted together.

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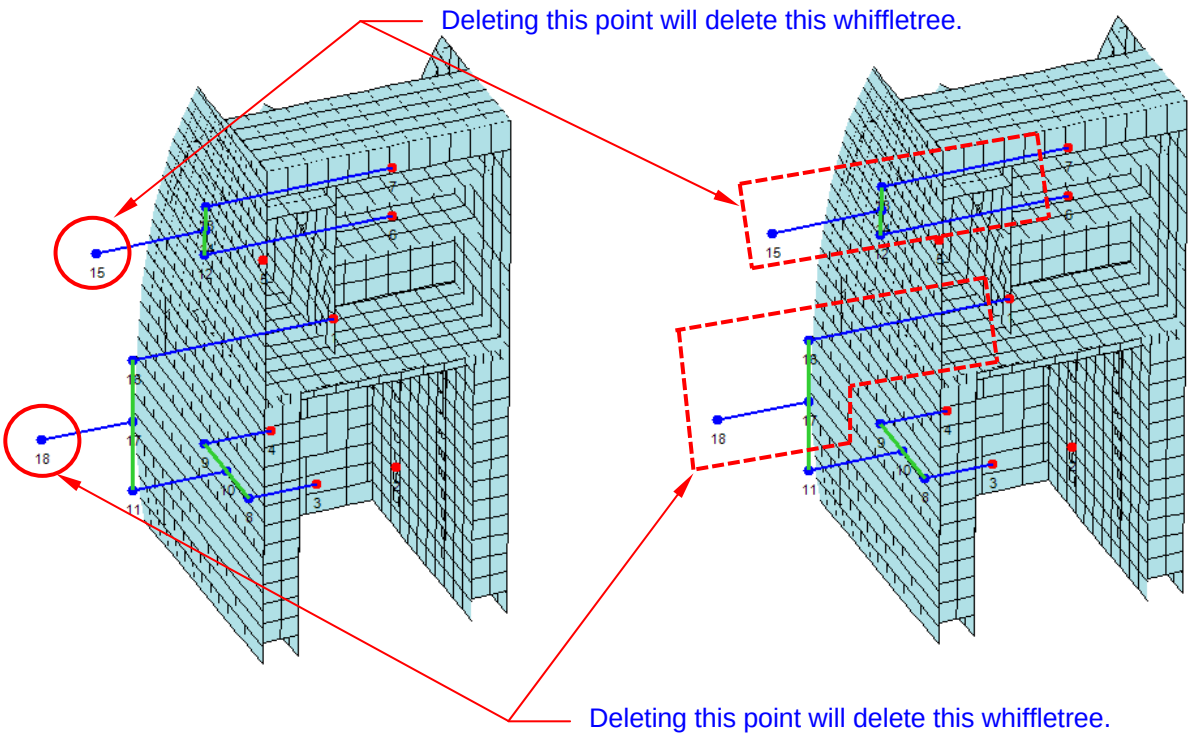

Figure 5-31

Procedures are essentially the same as deleting *CG points*.

1. Click icon or use *File Menu* to activate *Delete a Point* function.
2. Select a point at top of whiffletrees.

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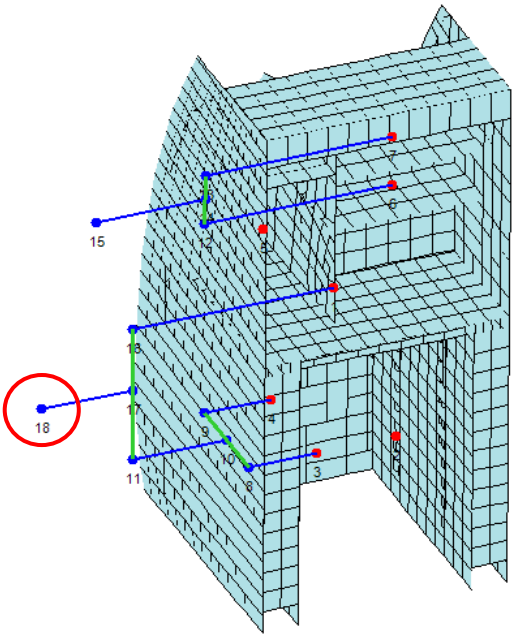

Figure 5-32

3. Confirm in a pop up dialog message.

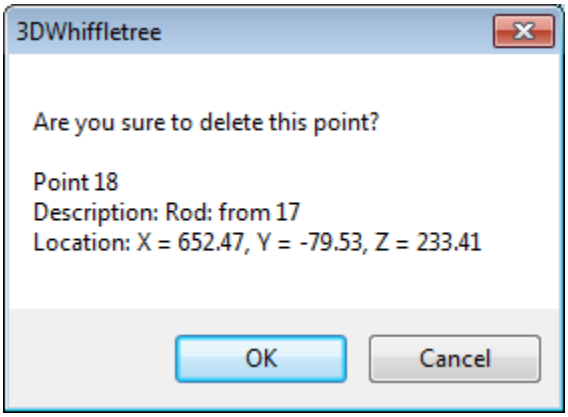

Figure 5-33

4. Point along with rods and beam are deleted. Note that point numbers will be automatically updated as necessary.

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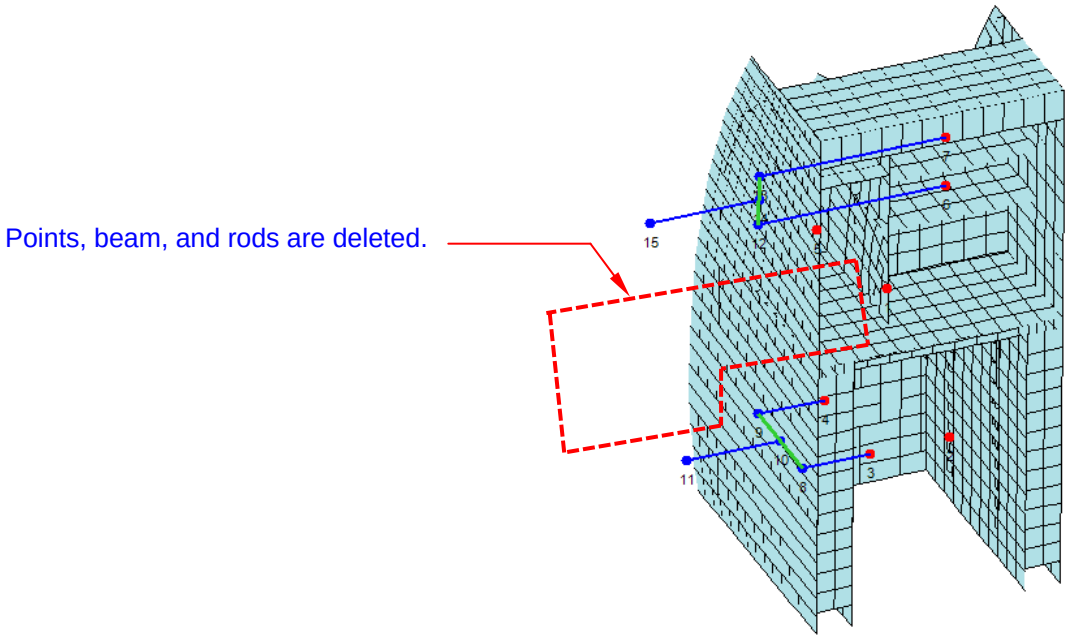

Figure 5-34

5.13 Show Point Info

The *Show Point Info* function is available through the following icon or *File Menu*.

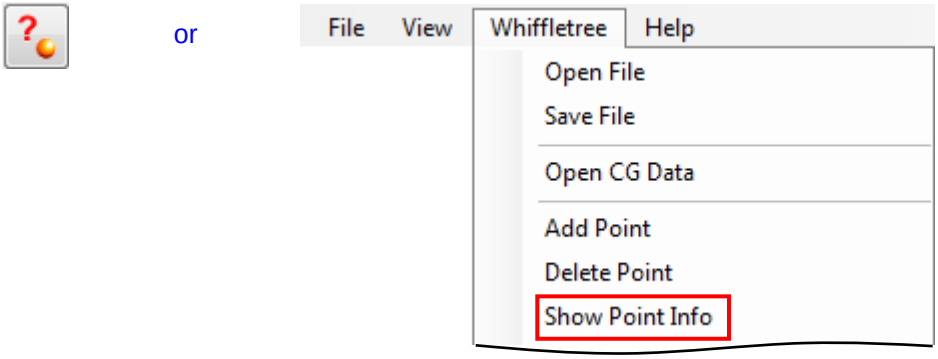

Figure 5-35

1. Activate *Show Point* function by clicking icon or from *File Menu*. You'll see a message in *Status Bar*.

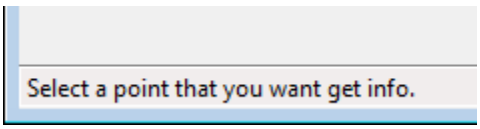

Figure 5-36

2. Click a point that you are interested. You can click any point including points that are part of rods or beams. A message window will pop up.

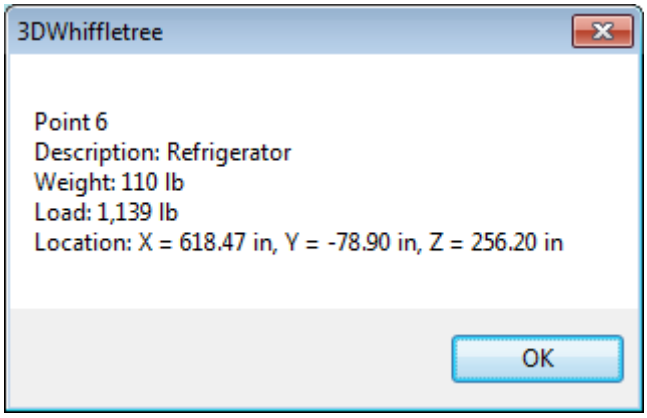

Figure 5-37

Remarks:
1. Weight is given only for CG points.
2. Load will be shown with units and decimal places set by users (See Section 6.8.)
3. X, Y, and Z values will be shown with units and decimal places set by users (See Section 6.8.)

5.14 Move and Edit Points

There are four types of moving or editing points in addition to directly editing point in *Whiffletree Edit Window*. (See Section 6.0 for editing whiffletrees in *Whiffletree Edit Window*.) They are:

- Move a Point (Along Loading Direction)
- Split a Point
- Move Two Points Together
- Move a Point (In Plane)

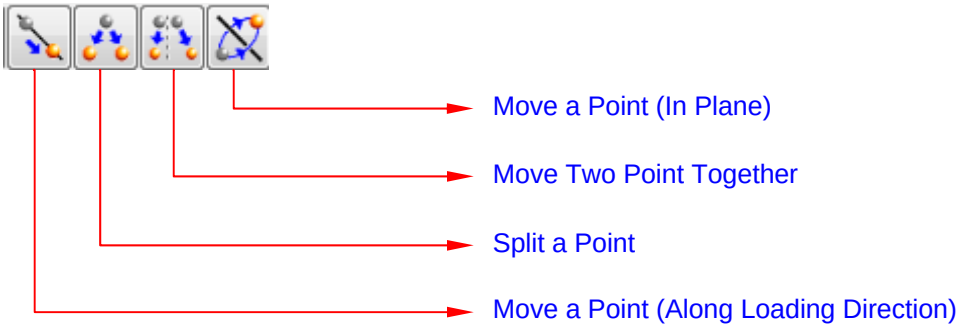

Figure 5-38

5.14.1 Summary of Moving Points

Table 5-3 summarizes different function of moving points.

Table 5-3

Function	Direction	Points	Final Loading Points
Move a Point (Along Loading Direction)	Along loading direction	Any	No Change
Split a Point	In plane perpendicular to loading direction	CG Only	No Change
Move Two Point Together	In plane perpendicular to loading direction	CG Only	No Change
Move a Point (In Plane)	In plane perpendicular to loading direction	CG Only	Will Change (*1)

Notes:
(*1) If the point you are moving is a split point (and have not been forgotten), then, the point will only move with other split point. This behavior is exactly same as *Move Two Point Together*, unless you forget the split between two points. See Section 6.11 for how to forget split.

5.14.2 Move a Point (Along Loading Direction)

This command will move any points along loading direction. Any points (CG, rod, or beam) can be moved. The final loading point will not change. This command is useful when you want to:

- move a *CG Point* to accurate location where actually loaded in the static test,
- clean overlapped beams and rods, or
- adjust rod lengths to be more accurately represent actual static test.

The *Move a Point* is available through the following icon or *File Menu*.

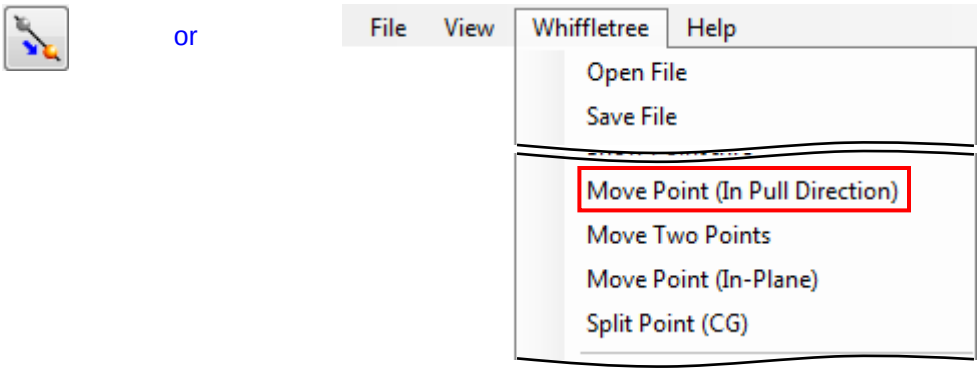

Figure 5-39

1. Activate *Move a Point* function by clicking icon or from *File Menu*. You'll see a message in *Status Bar*.

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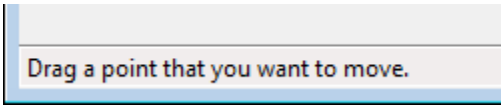

Figure 5-40

Since this function is frequently used, a shortcut key is also available.

Shortcut Key: Hold SHIFT Key and drag a point by mouse left button

2. Click and drag the point you want to move by mouse left button.

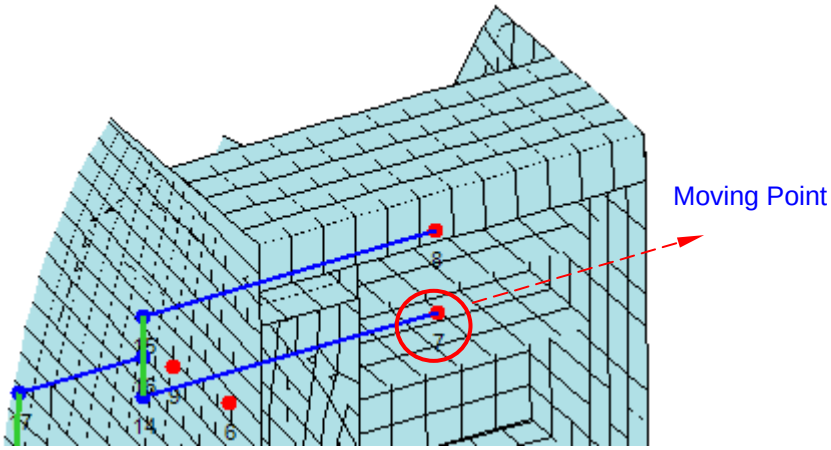

Figure 5-41

3. While dragging a point, the point turns to yellow.

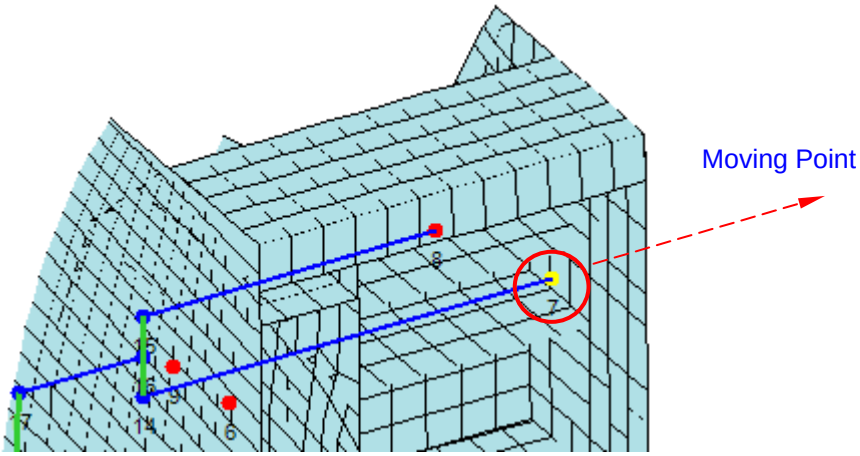

Figure 5-42

4. If you pick a point that is part of beam, three points consist of the beam will move together.

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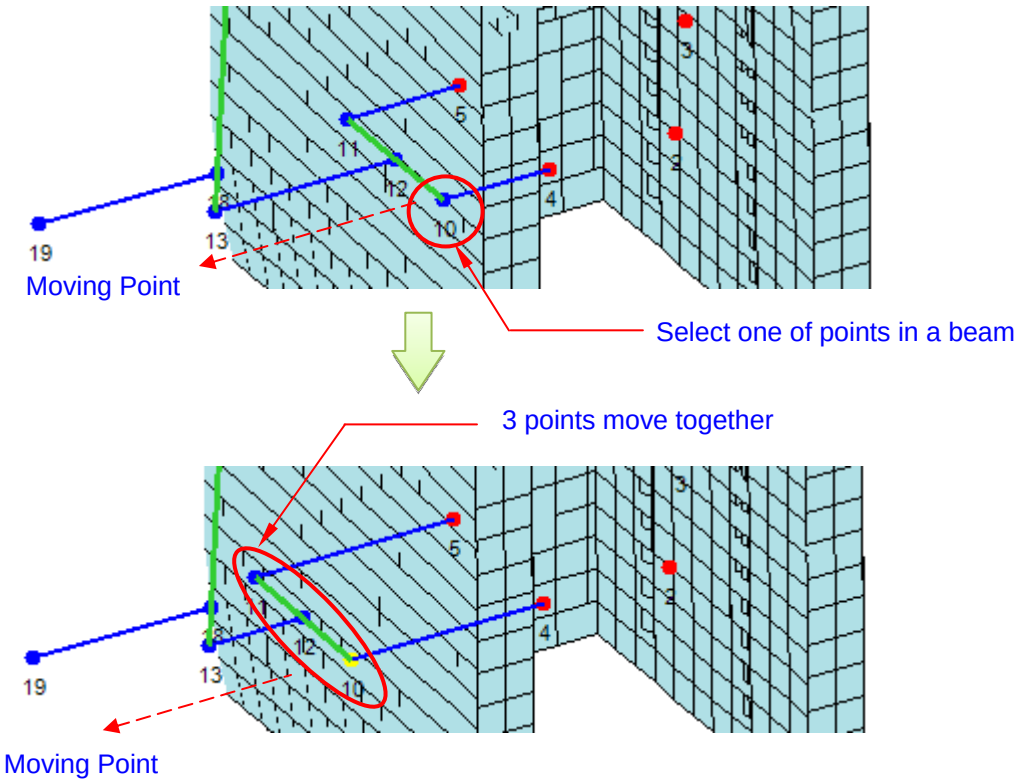

Figure 5-43

5.14.3 Split a Point

This command can split a *CG Point* into 2 new points. Final load point and overall CG will not change. This command is useful when you want to:

- Distribute a loading points, or
- Split a loading point to avoid interferences with test fixture.

The *Split a Point* is available through the following icon or *File Menu*.

or

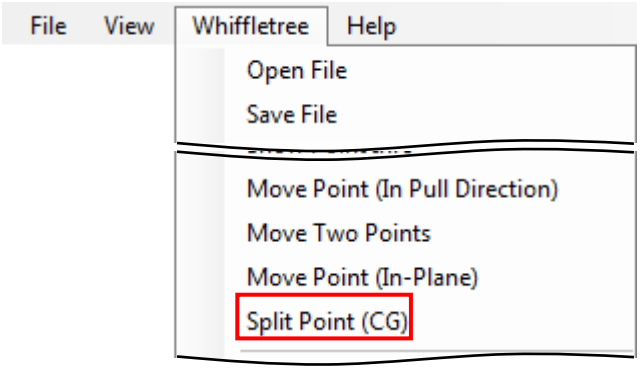

Figure 5-44

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1. Activate *Split a Point* function by clicking icon or from *File Menu*. You'll see a message in *Status Bar*.

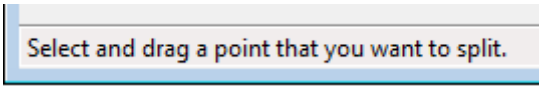

Figure 5-45

2. Select a point by mouse left button and drag it. While dragging, two new yellow points will dynamically appear showing new split points.

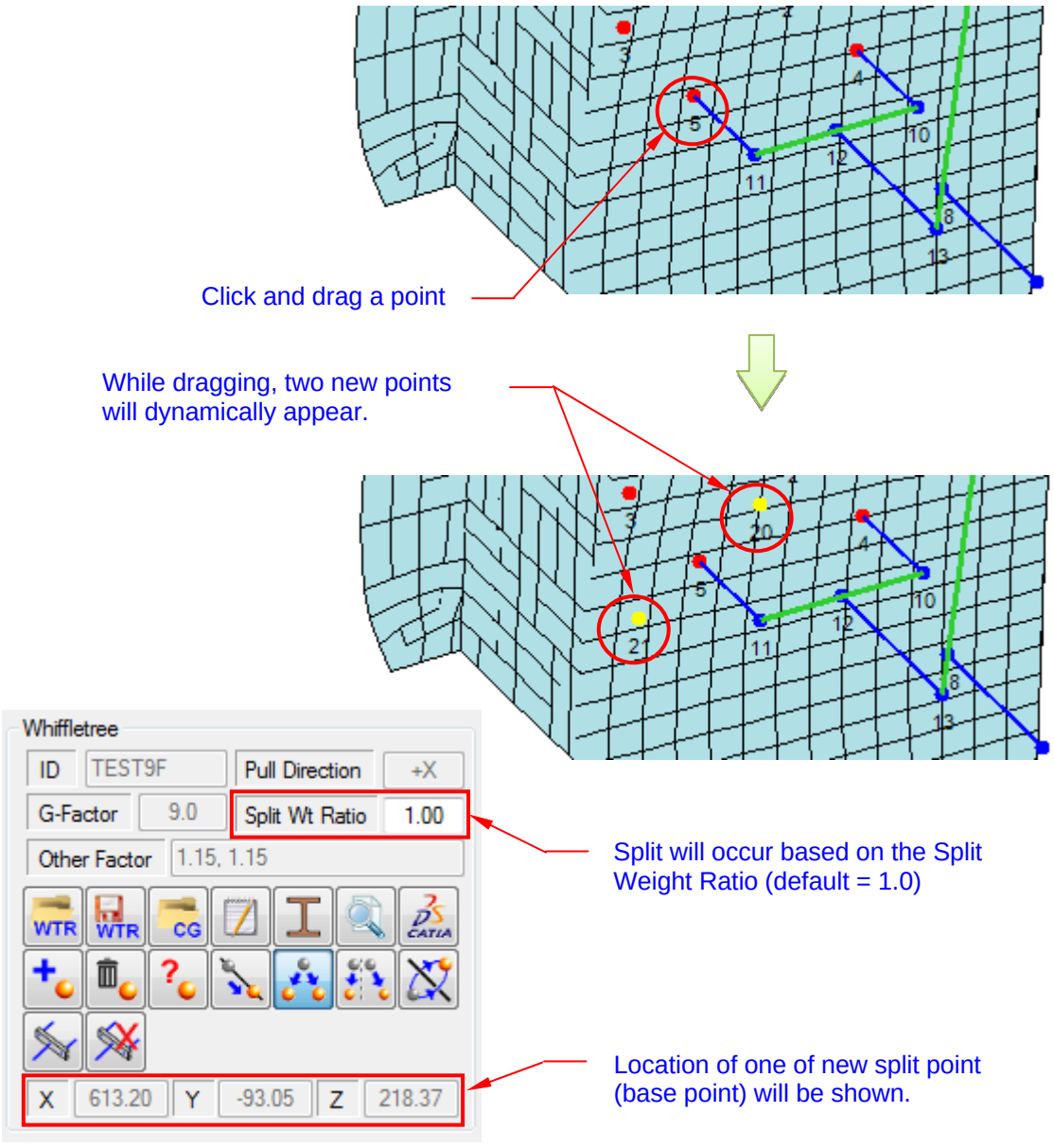

Figure 5-46

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3. Once you drag the point at approximate desired locations, release the mouse left button. Then, below window will pop up. In the window you can fine-tune the location or split ratio.

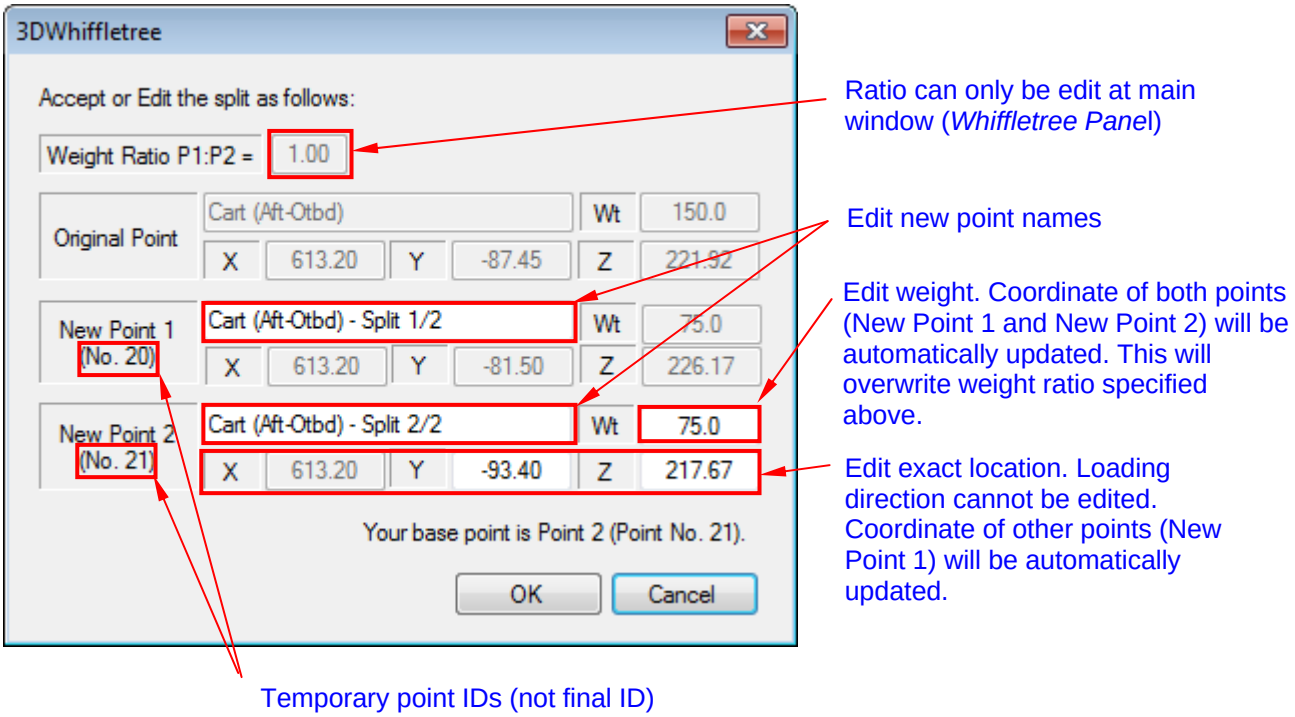

Figure 5-47

Remarks:

a) Weight Ratio:
"P1:P2 = 1.00" means weight are distributed equally. For example, "P1:P2 = 2.0" means P1 weight will be distributed twice of P2 weight.

b) Default Name

Following suffix will be added to the new points

New Point 1: "Original Name" – Split 1/2
New Point 2: "Original Name" – Split 2/2

c) Weight:
Weight distribution can be edited. The new weight distribution will overwrite the Weight Ratio. (i.e., no matter what the weight ratio is, the new weight can be distributed as entered in the weight box.)

4. Click *OK* to confirm. Then, whiffletrees will be updated with split points.

Remarks:

Once a point is split, the new split points cannot be recovered. There is no command to combine two points into one.

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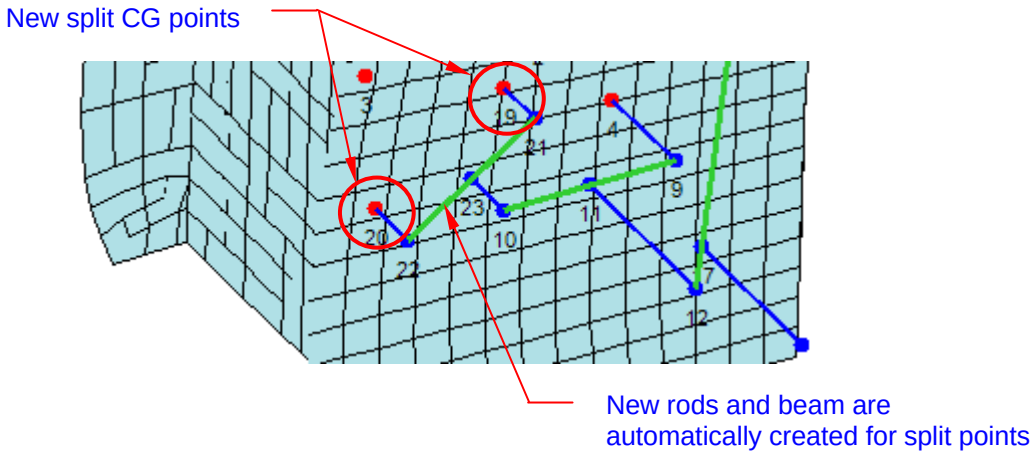

Figure 5-48

5. You can check split points in *Whiffletree Edit Window*.

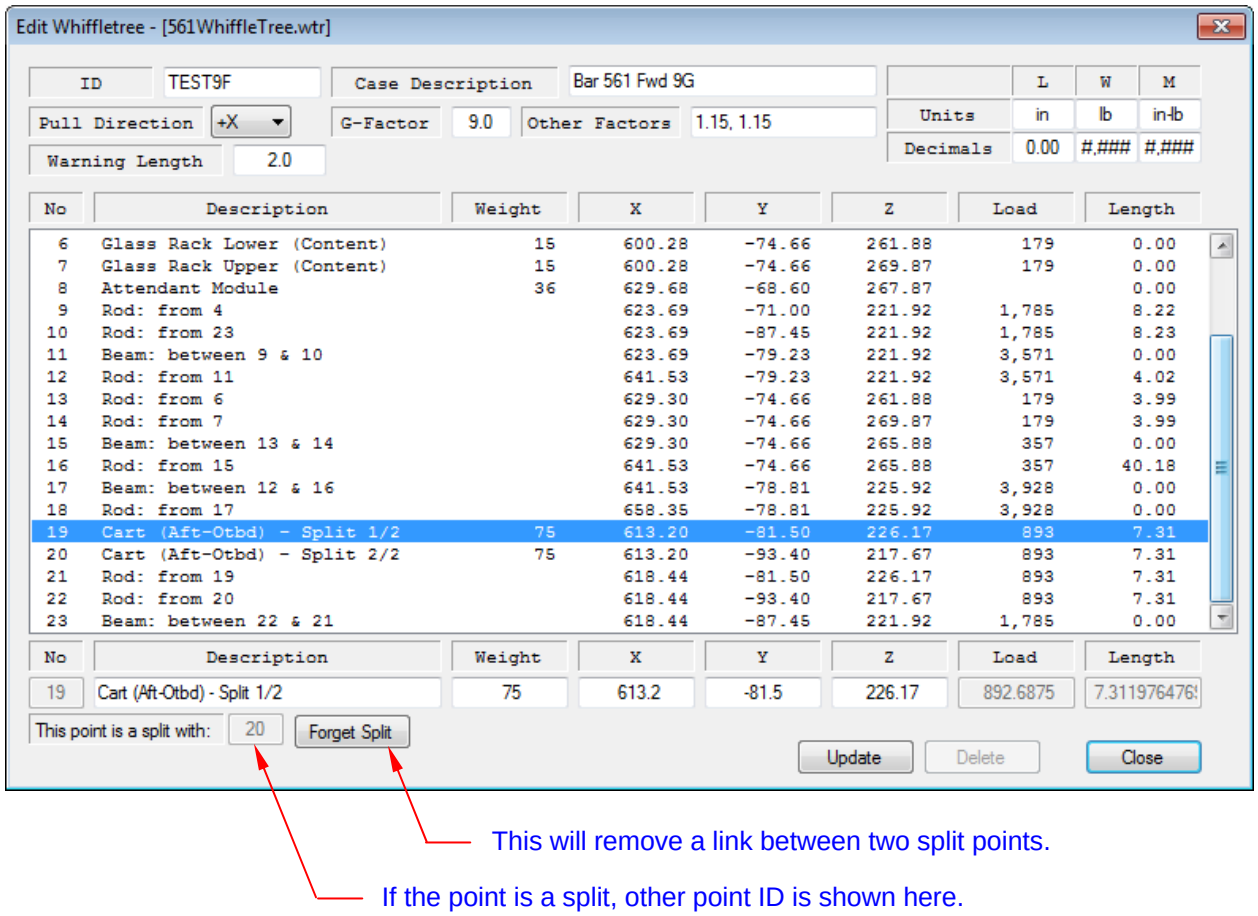

Figure 5-49

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Remarks:

What is [Forget Split] for?

When a *CG Point* is split, the new points will be linked as split points. This is to ensure that the overall CG will not change when moving a point in plane (see Sec 5.14.5). *Forget Split* will delete this link and make these split points to an individual *CG Point*.

By clicking *Forget Split* button,

- Split information is permanently removed.
- Other split point will be automatically updated.
- Point name will not be changed automatically. (i.e., if the name contains "- Split 1/2", then it remains unchanged.)

5.14.4 Move Two Points Together

This command can move two *CG Points* together in a plane perpendicular to the loading direction while keeping overall CG being unchanged. This command is useful when you want to:

- Adjust whiffletree loading points but keep the same overall CG

The *Move Two Points* is available through the following icon or *File Menu*.

or

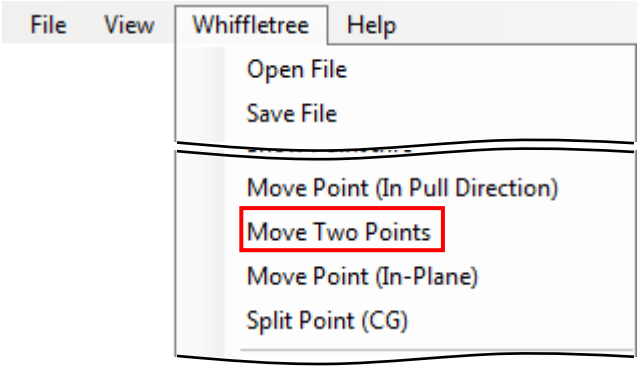

Figure 5-50

1. Activate *Move Two Points* function by clicking icon or from *File Menu*. You'll see a message in *Status Bar*.

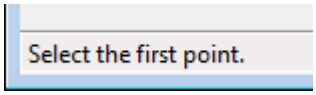

Figure 5-51

2. Once selecting the first point, the selected point turns to yellow. Then, you'll see the next message in *Status Bar*.

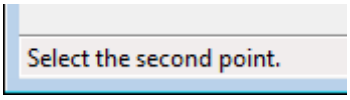

Figure 5-52

3. Once selecting the second point, both selected points now turn to yellow. Then, you'll see the next message in *Status Bar*.

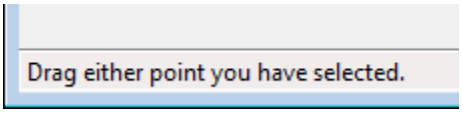

Figure 5-53

4. Dragging either point in yellow will dynamically update the whiffletrees. Overall CG will not change. The distance that the other point moves depends on the weight ratio of the two selected points.

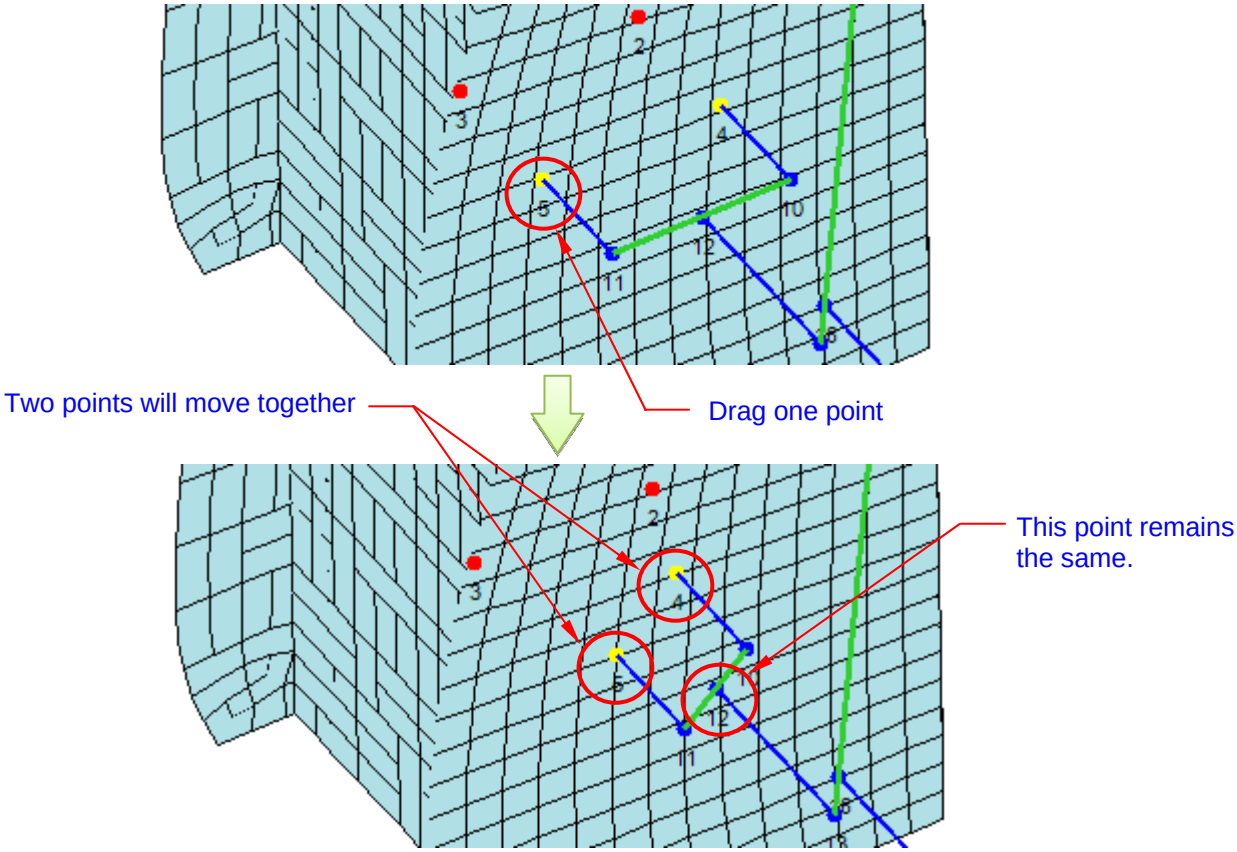

Figure 5-54

5.14.5 Move a Point (In Plane)

This command will move a *CG Point* in a plane perpendicular to loading direction. Depending on the moving point, there are two different results.

- Moving a *Split Point* will result in the same move as *Move Two Points Together* previously described in Section 5.14.
- Moving all other points will result in change in overall CG.

The *Move a Point (In Plane)* is available through the following icon or *File Menu*.

or

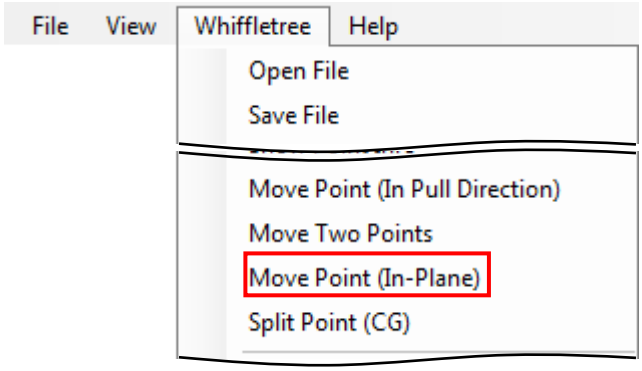

Figure 5-55

1. Activate *Move a Point (In Plane)* function by clicking icon or from *File Menu*. Because this function will change the original overall CG, the following message will appear to ensure that the use is aware of this function.

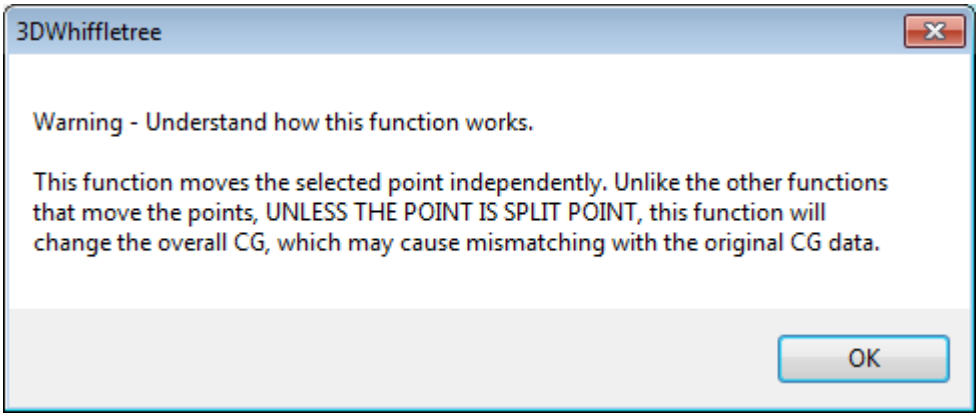

Figure 5-56

2. Then, you'll see a message in *Status Bar*.

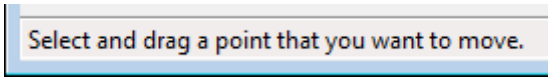

Figure 5-57

3. Select a point and drag it to the desired location. There are two different results depending on the type of point you choose.

1) Split Points
   If the selected point is a *Split Point*, the selected point will move together with the other linked split point. The behavior is exactly same as *Move Two Point Together* as described in Section 5.14, except you select one point instead two points. Therefore, the overall CG will not change.

2) Other CG points
   The point will freely move independently on the other points. Therefore, overall CG will change.

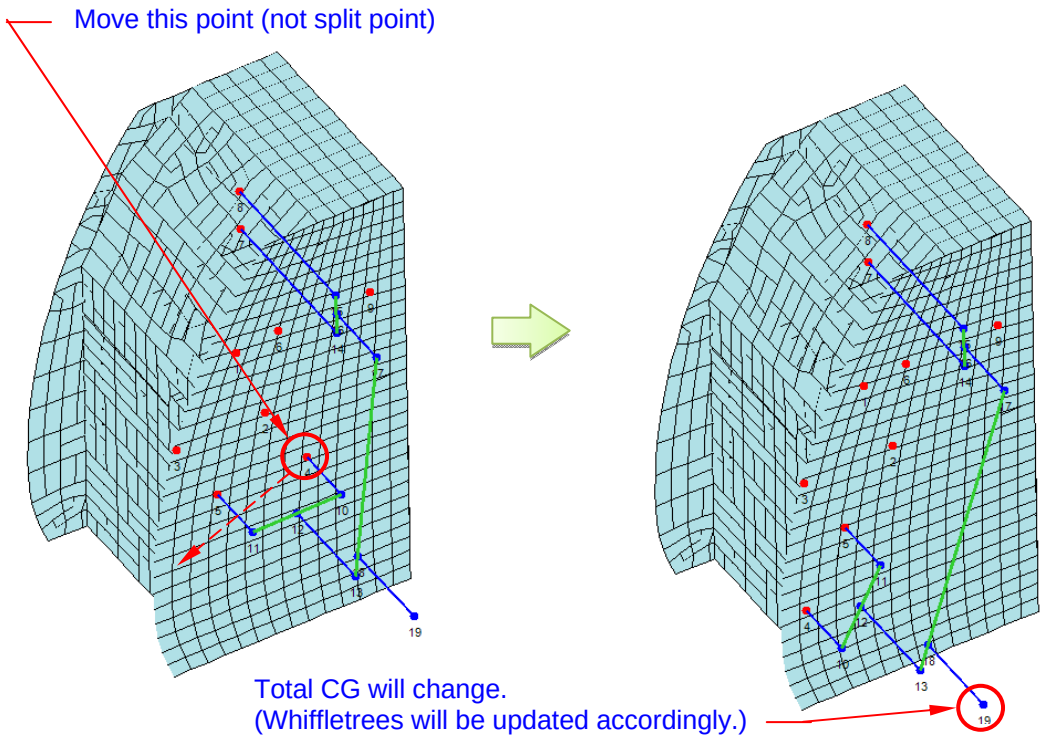

Figure 5-58

5.15 Change Point/Rod/Beam Sizes

Point, Rod, and Beam size can be changed from the following menus. (There is no icon for these commands.) Note that the change of size is temporary and will not be saved.

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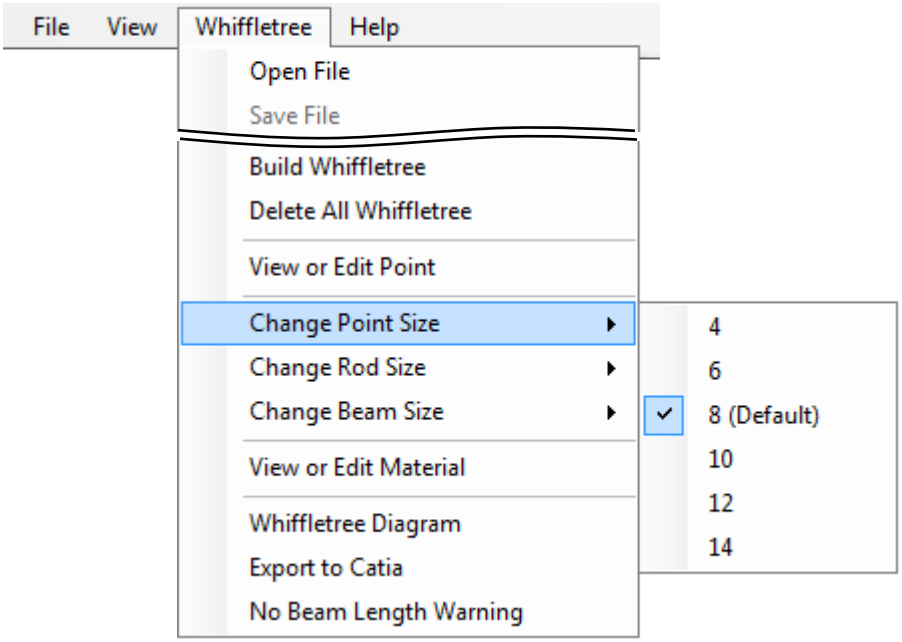

Figure 5-59

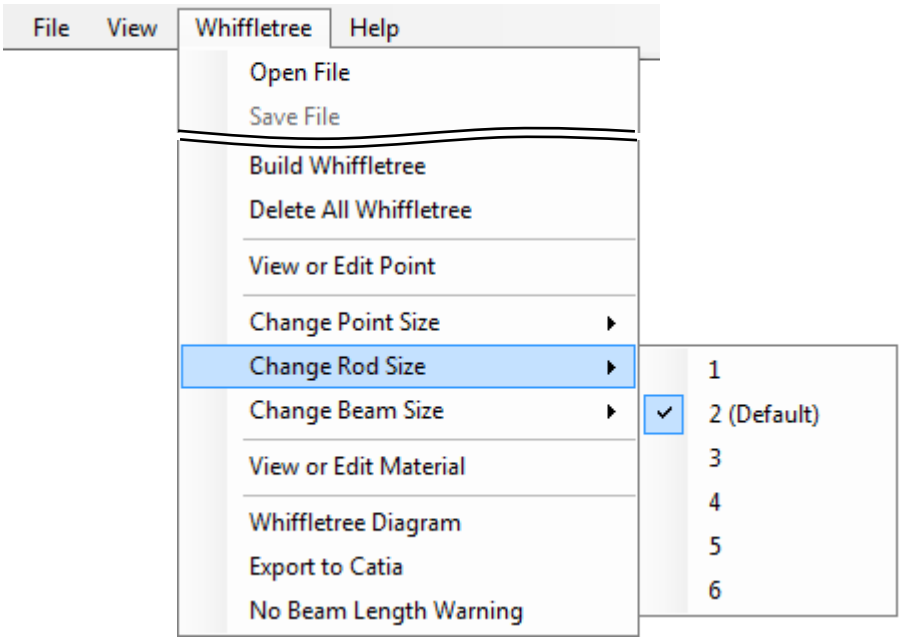

Figure 5-60

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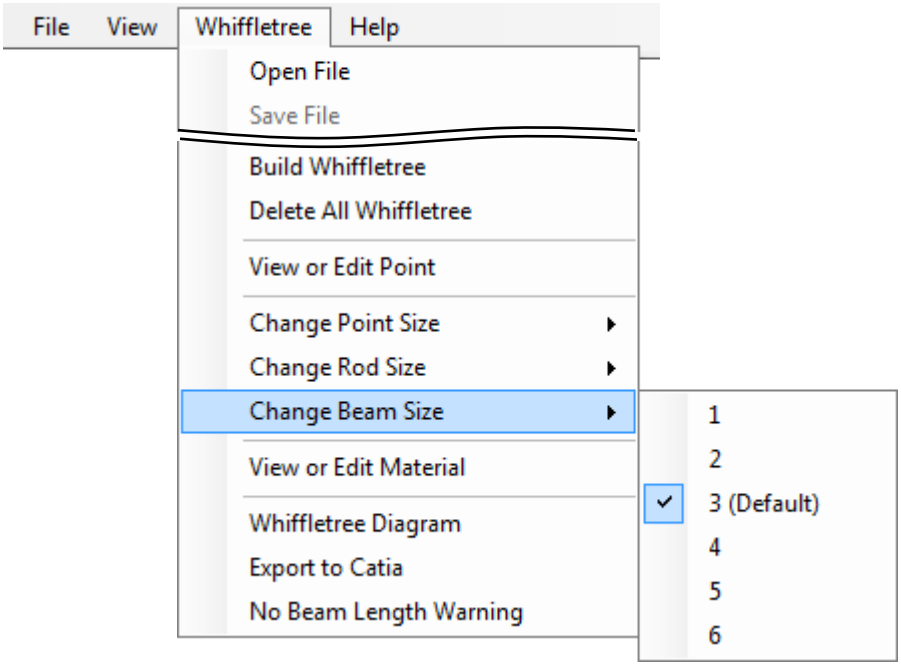
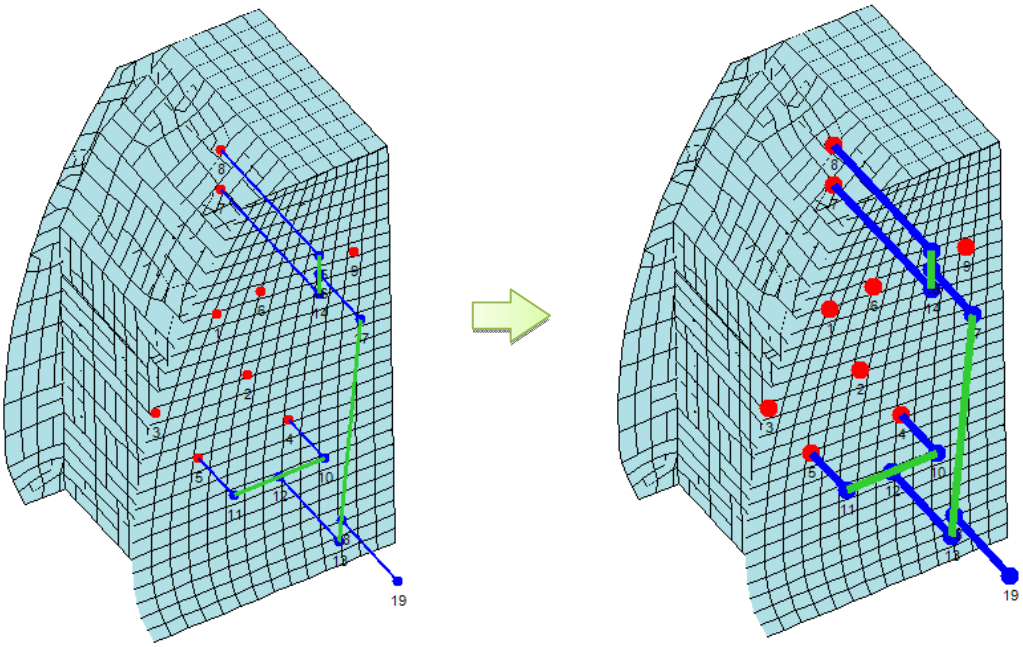


Figure 5-61



Default Sizes

Largest Sizes

Figure 5-62

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5.16 No Beam Length Warning

By default, *3DWhiffletree* provides warning message when beam length (one of the moment arms) become less than specified length (default is 2 inches).

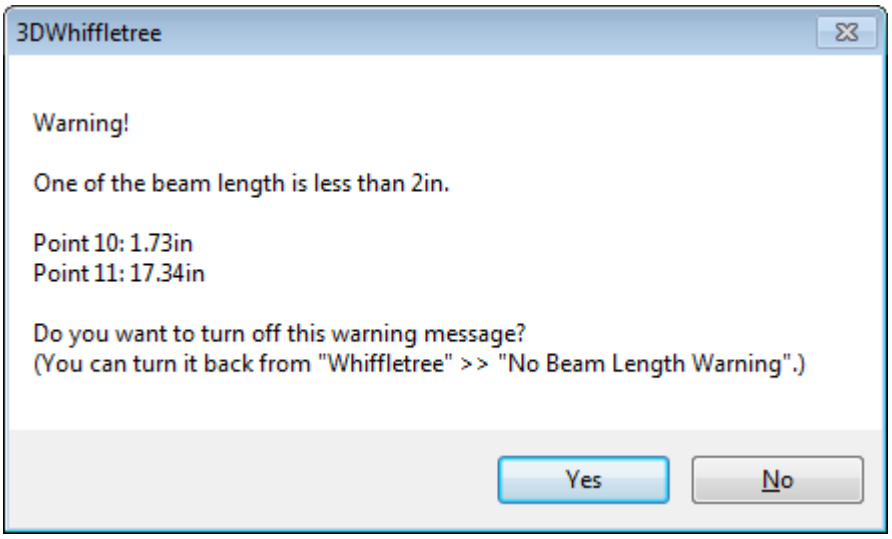

Figure 5-63

You can change the setting so that such warning message will not appear by checking "*No Beam Length Warning*" in the *File Menu*.

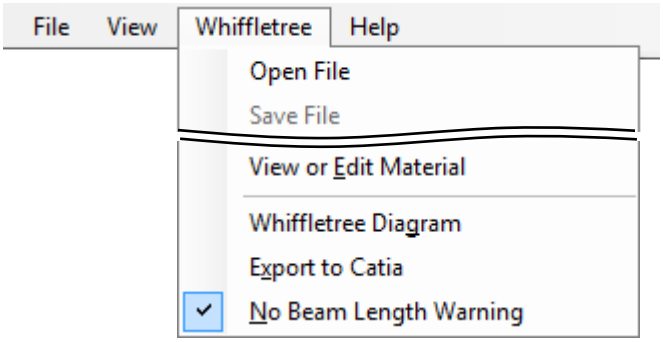

Figure 5-64

This function is useful when you are moving the CG point and get this message. In such a case, unless you turn on this function, you will be stack and cannot move or change the whiffletree anymore as the warning message keep showing if you try to move the point.

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6.0 VIEW AND EDIT WHIFFLETREE DATA

This section explains how to view and edit whiffletree data through *Whiffletree Edit Window*.

Whiffletree Edit Window can be accessed by the following icon or *File Menu*. (The name "*View or Edit Point*" in *File Menu* is not intuitive for this command. In fact, it can do more than just view or edit points.)

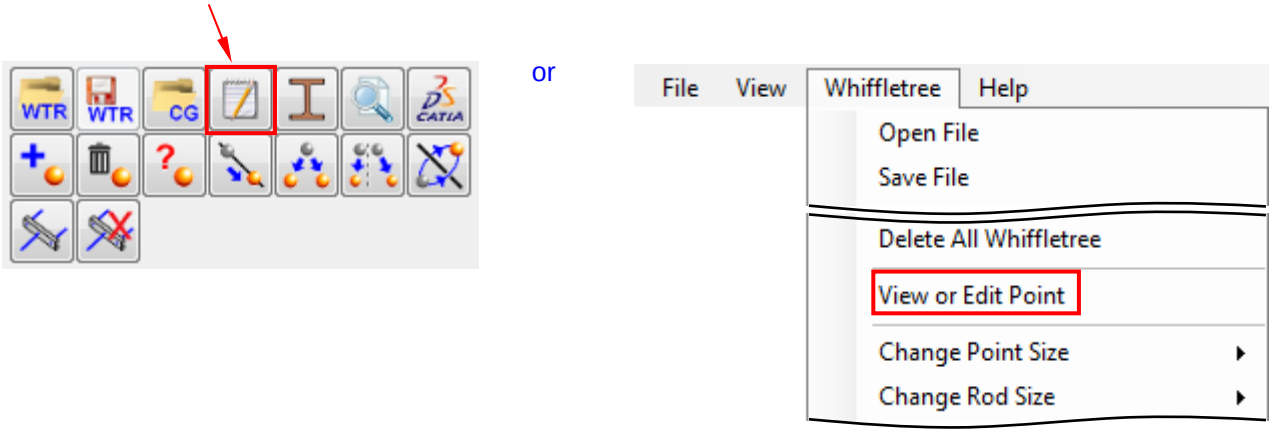

Figure 6-1

6.1 Display General

Figure 6-3 on the next page shows a typical view of *Whiffletree Edit Window*.

All data and information in the window will be saved in *.wtr file when saved. The *.wtr file name will appear on the top of window.

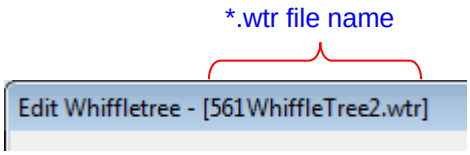

Figure 6-2

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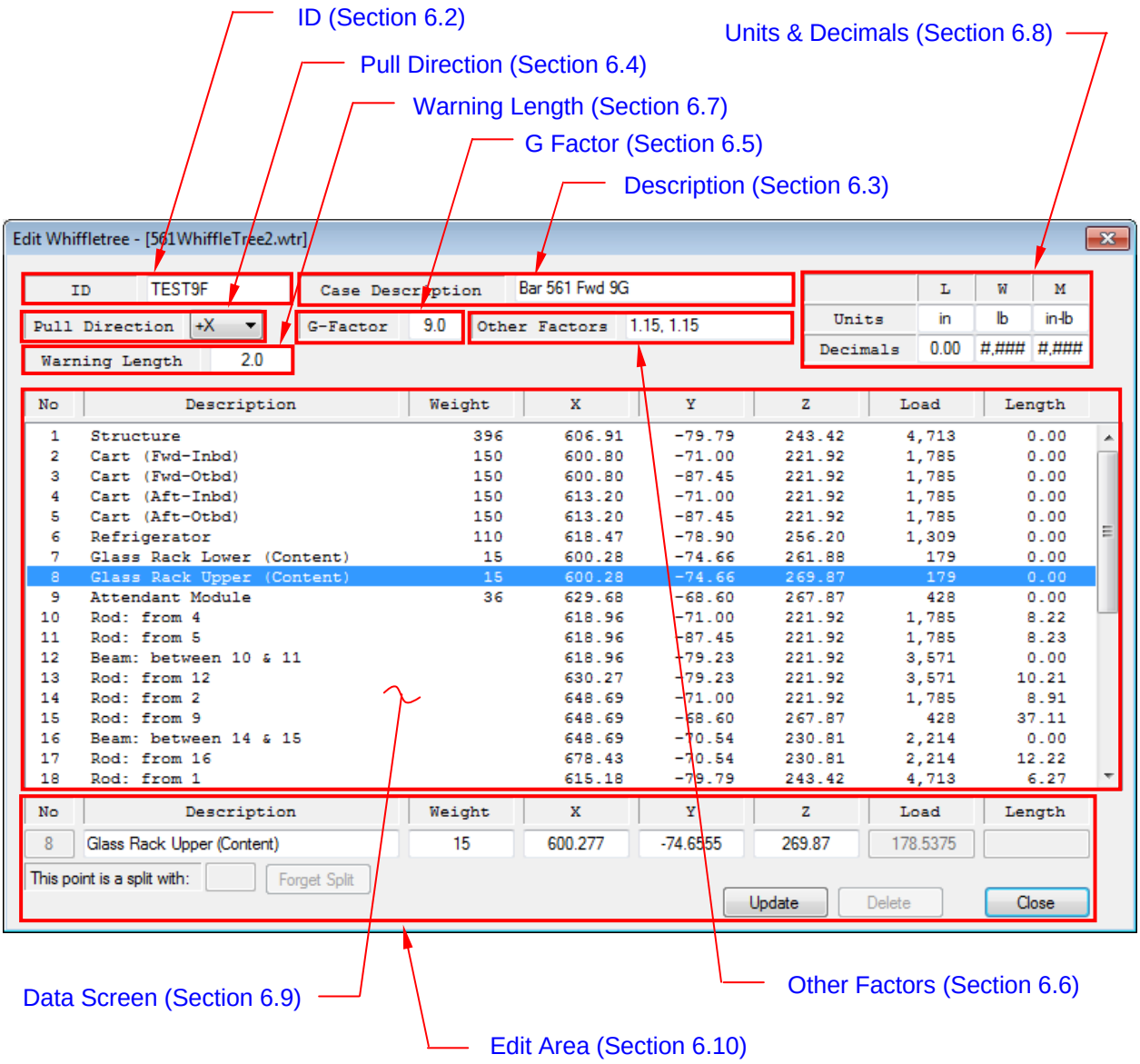
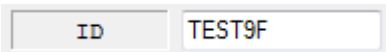


Figure 6-3

6.2 ID



ID can be any strings in any length, and it's optional (can be left blank). *ID* can be used as a root number of whiffletree beam IDs when showing ID on whiffletree diagram (Section 8.4.2). You need to click Update to confirm the change.

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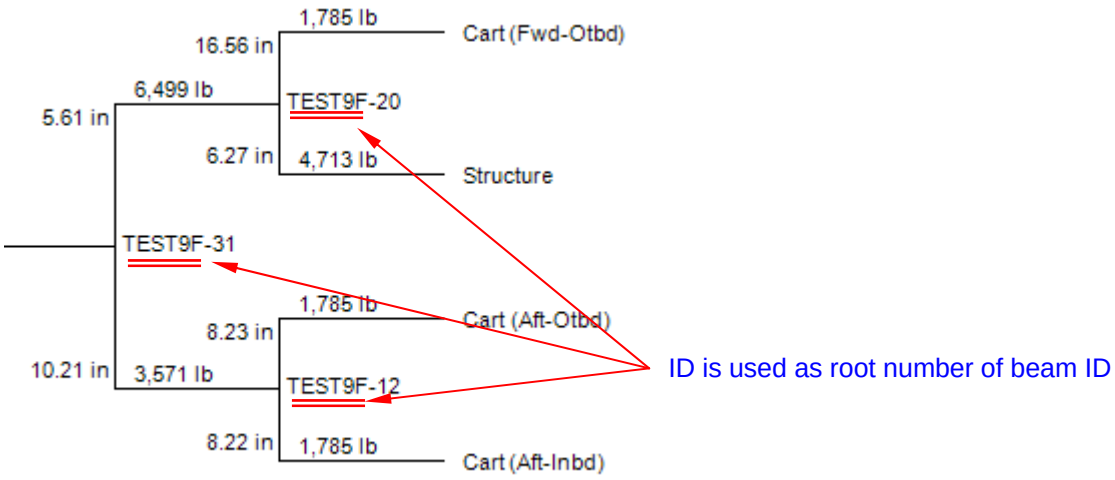
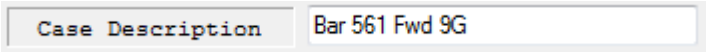


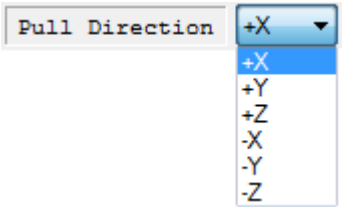
Figure 6-4

6.3 Case Description



Case Description can be any strings in any length, and it's optional (can be left blank). It is only for your purpose to identify your whiffletree. You need to click Update to confirm the change.

6.4 Pull Direction



Pull Direction determines the loading direction of the whiffletree. It's a dropdown menu and the default value is "-X". It can be changed only if there is no whiffletree constructed. In other words, if there are any whiffletrees (beam and rods) created in the whiffletree model, you cannot change the *Pull Direction* value. Therefore, always make sure to set the correct *Pull Direction* value before you create any new whiffletree connections. If you try to change *Pull Direction* value after creating any whiffletrees, you will see the following message. You need to click Update to confirm the change if you edit the value.

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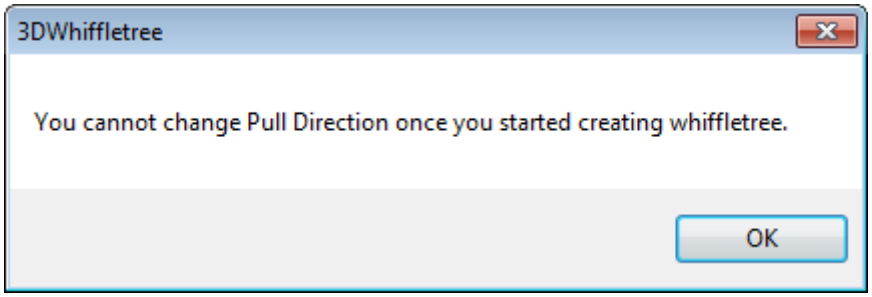
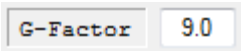


Figure 6-5

Remarks:
The *Pull Direction* value can be chosen only in parallel to global axis (X, Y, Z). If you need to load in arbitrary direction, adjust FEM model so that the desired loading direction can be in line with one of global axis.

6.5 G-Factor



G-Factor is a multiplication factor applied to the weight to get a load. Together with *Other Factors* (Section 6.6), the final loading values are determined. You need to click Update to confirm the change if you edit the value.

6.6 Other Factor

Other Factors are additional factors applied to the weight. You can enter as many factors as you want by separating each factor by comma. (Spaces after comma is optional and not required). You need to click Update to confirm the change if you edit the value.

For example, by entering

```
1.15, 1.15
```

will result in the factor

1.15 x 1.15 (=1.3225)

and will be multiplied to the weight together with *G Factor*.

Below figure shows an example of how the load is calculated from *Weight*, *G Factor*, and *Other Factors*.

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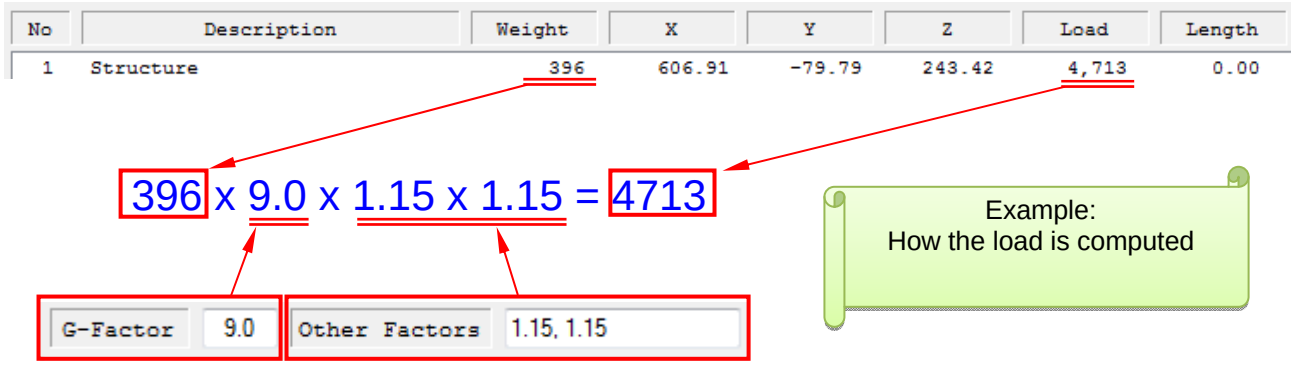
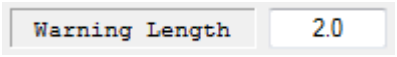


Figure 6-6

6.7 Warning Length



Warning Length will set the value and provide warning message when moment arm of any whiffletree beams become less than the value (an example figure below). Default value is 2.0. You need to click Update to confirm the change if you edit the value.

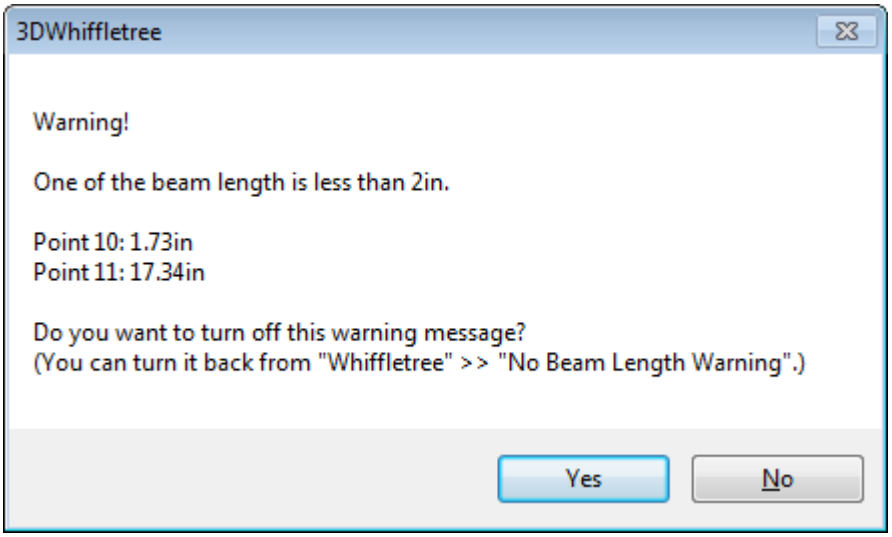


Figure 6-7

As explained in Section 5.16, there won't be any warning message when "*No Beam Length Warning*" is turned on.

6.8 Units and Decimals

	L	W	M
Units	in	lb	in-lb
Decimals	0.00	#,###	#,###

Units and Decimals controls displaying units and decimals. The default values are as shown above. The units are mainly for the use in *Whiffletree Diagram*. The below figure shows an example of whiffletree diagram with default units and decimals. (Moment in beam is also set to shown in this example.) You need to click Update to confirm the change if you edit the value.

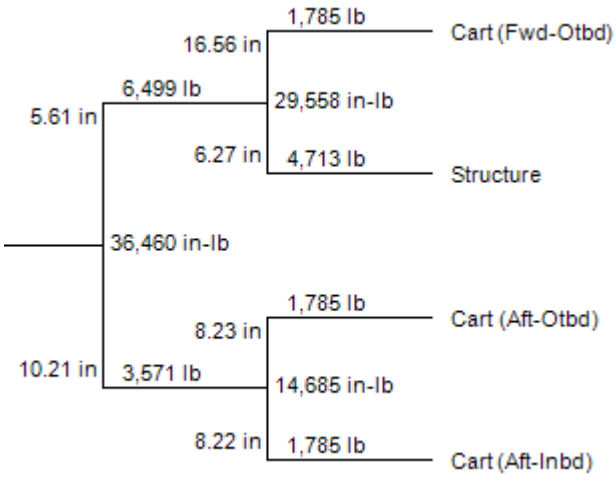
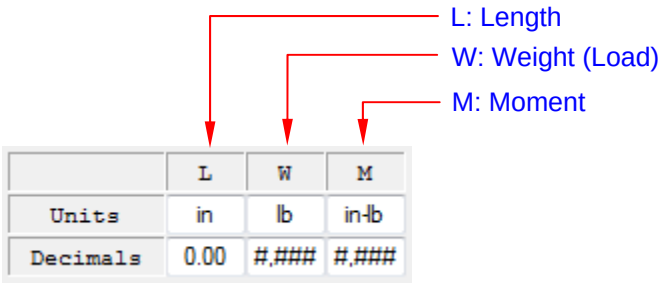


Figure 6-8

Rules Decimal Format



	L	W	M
Units	in	lb	in-lb
Decimals	0.00	#,###	#,###

Figure 6-9

Decimal format is per visual basic format. For examples, this can be used to limit number of decimal places or add a thousand-separator in the figure. The default value will work for the most common cases when using US units (inches and pounds). This function is useful when using Metric units and need to control decimal places.

Refer to the following table for the rules of formatting.

Remarks:
Changing decimal places only affects the format of displaying values, not actual values stored in database. No figures in decimal places will be lost by changing the format.

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Table 6-1

Character	Description
None	Displays the number with no formatting.
(0)	Digit placeholder. Displays a digit or a zero. If the expression has a digit in the position where the zero appears in the format string, display it; otherwise, displays a zero in that position. If the number has fewer digits than there are zeros (on either side of the decimal) in the format expression, displays leading or trailing zeros. If the number has more digits to the right of the decimal separator than there are zeros to the right of the decimal separator in the format expression, rounds the number to as many decimal places as there are zeros. If the number has more digits to the left of the decimal separator than there are zeros to the left of the decimal separator in the format expression, displays the extra digits without modification.
(#)	Digit placeholder. Displays a digit or nothing. If the expression has a digit in the position where the # character appears in the format string, displays it; otherwise, displays nothing in that position. This symbol works like the 0 digit placeholder, except that leading and trailing zeros aren't displayed if the number has fewer digits than there are # characters on either side of the decimal separator in the format expression.
(.)	Decimal placeholder. The decimal placeholder determines how many digits are displayed to the left and right of the decimal separator. If the format expression contains only # characters to the left of this symbol; numbers smaller than 1 begin with a decimal separator. To display a leading zero displayed with fractional numbers, use zero as the first digit placeholder to the left of the decimal separator. In some locales, a comma is used as the decimal separator. The actual character used as a decimal placeholder in the formatted output depends on the number format recognized by your system. Thus, you should use the period as the decimal placeholder in your formats even if you are in a locale that uses a comma as a decimal placeholder. The formatted string will appear in the format correct for the locale.
(,)	Thousand separator. The thousand separator separates thousands from hundreds within a number that has four or more places to the left of the decimal separator. Standard use of the thousand separator is specified if the format contains a thousand separator surrounded by digit placeholders (0 or #). A thousand separator immediately to the left of the decimal separator (whether or not a decimal is specified) or as the rightmost character in the string means "scale the number by dividing it by 1,000, rounding as needed." Numbers smaller than 1,000 but greater or equal to 500 are displayed as 1, and numbers smaller than 500 are displayed as 0. Two adjacent thousand separators in this position scale by a factor of 1 million, and an additional factor of 1,000 for each additional separator. Multiple separators in any position other than immediately to the left of the decimal separator or the rightmost position in the string are treated simply as specifying the use of a thousand separator. In some locales, a period is used as a thousand separator. The actual character used as the thousand separator in the formatted output depends on the Number Format recognized by your system. Thus, you should use the comma as the thousand separator in your formats even if you are in a locale that uses a period as a thousand separator. The formatted string will appear in the format correct for the locale.

Reference:http://msdn.microsoft.com/en-us/library/microsoft.visualbasic.strings.format.aspx

The decimal formatting will also affect the displaying values in *Data Screen*. See the following figure as an example.

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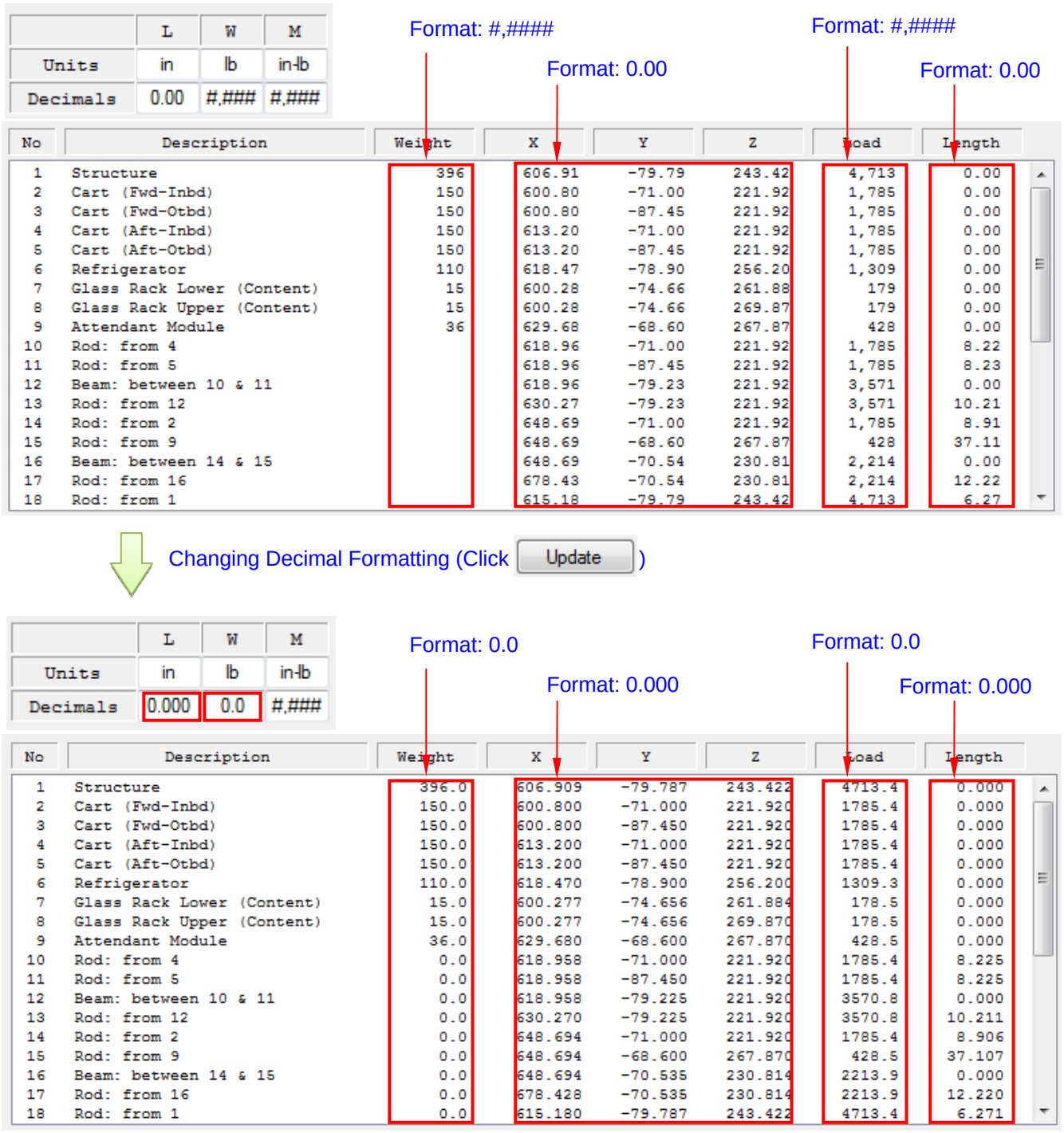

	L	W	M
Units	in	lb	in-lb
Decimals	0.00	#,###	#,###

No	Description	Weight	X	Y	Z	Load	Length
1	Structure	396	606.91	-79.79	243.42	4,713	0.00
2	Cart (Fwd-Inbd)	150	600.80	-71.00	221.92	1,785	0.00
3	Cart (Fwd-Otbd)	150	600.80	-87.45	221.92	1,785	0.00
4	Cart (Aft-Inbd)	150	613.20	-71.00	221.92	1,785	0.00
5	Cart (Aft-Otbd)	150	613.20	-87.45	221.92	1,785	0.00
6	Refrigerator	110	618.47	-78.90	256.20	1,309	0.00
7	Glass Rack Lower (Content)	15	600.28	-74.66	261.88	179	0.00
8	Glass Rack Upper (Content)	15	600.28	-74.66	269.87	179	0.00
9	Attendant Module	36	629.68	-68.60	267.87	428	0.00
10	Rod: from 4		618.96	-71.00	221.92	1,785	8.22
11	Rod: from 5		618.96	-87.45	221.92	1,785	8.23
12	Beam: between 10 & 11		618.96	-79.23	221.92	3,571	0.00
13	Rod: from 12		630.27	-79.23	221.92	3,571	10.21
14	Rod: from 2		648.69	-71.00	221.92	1,785	8.91
15	Rod: from 9		648.69	-68.60	267.87	428	37.11
16	Beam: between 14 & 15		648.69	-70.54	230.81	2,214	0.00
17	Rod: from 16		678.43	-70.54	230.81	2,214	12.22
18	Rod: from 1		615.18	-79.79	243.42	4,713	6.27

	L	W	M
Units	in	lb	in-lb
Decimals	0.000	0.0	#,###

No	Description	Weight	X	Y	Z	Load	Length
1	Structure	396.0	606.909	-79.787	243.422	4713.4	0.000
2	Cart (Fwd-Inbd)	150.0	600.800	-71.000	221.920	1785.4	0.000
3	Cart (Fwd-Otbd)	150.0	600.800	-87.450	221.920	1785.4	0.000
4	Cart (Aft-Inbd)	150.0	613.200	-71.000	221.920	1785.4	0.000
5	Cart (Aft-Otbd)	150.0	613.200	-87.450	221.920	1785.4	0.000
6	Refrigerator	110.0	618.470	-78.900	256.200	1309.3	0.000
7	Glass Rack Lower (Content)	15.0	600.277	-74.656	261.884	178.5	0.000
8	Glass Rack Upper (Content)	15.0	600.277	-74.656	269.870	178.5	0.000
9	Attendant Module	36.0	629.680	-68.600	267.870	428.5	0.000
10	Rod: from 4	0.0	618.958	-71.000	221.920	1785.4	8.225
11	Rod: from 5	0.0	618.958	-87.450	221.920	1785.4	8.225
12	Beam: between 10 & 11	0.0	618.958	-79.225	221.920	3570.8	0.000
13	Rod: from 12	0.0	630.270	-79.225	221.920	3570.8	10.211
14	Rod: from 2	0.0	648.694	-71.000	221.920	1785.4	8.906
15	Rod: from 9	0.0	648.694	-68.600	267.870	428.5	37.107
16	Beam: between 14 & 15	0.0	648.694	-70.535	230.814	2213.9	0.000
17	Rod: from 16	0.0	678.428	-70.535	230.814	2213.9	12.220
18	Rod: from 1	0.0	615.180	-79.787	243.422	4713.4	6.271

Figure 6-10

6.9 Data Screen

Data Screen shows detail information of each point that constructs full whiffletree. Table 6-2 explains some important facts in *Data Screen*.

No	Description	Weight	X	Y	Z	Load	Length
1	Structure	396	606.91	-79.79	243.42	4,713	0.00
2	Cart (Fwd-Inbd)	150	600.80	-71.00	221.92	1,785	0.00
3	Cart (Fwd-Otbd)	150	600.80	-87.45	221.92	1,785	0.00
4	Cart (Aft-Inbd)	150	613.20	-71.00	221.92	1,785	0.00
5	Cart (Aft-Otbd)	150	613.20	-87.45	221.92	1,785	0.00
6	Refrigerator	110	618.47	-78.90	256.20	1,309	0.00
7	Glass Rack Lower (Content)	15	600.28	-74.66	261.88	179	0.00
8	Glass Rack Upper (Content)	15	600.28	-74.66	269.87	179	0.00
9	Attendant Module	36	629.68	-68.60	267.87	428	0.00
10	Rod: from 4		618.96	-71.00	221.92	1,785	8.22
11	Rod: from 5		618.96	-87.45	221.92	1,785	8.23
12	Beam: between 10 & 11		618.96	-79.23	221.92	3,571	0.00
13	Rod: from 12		630.27	-79.23	221.92	3,571	10.21
14	Rod: from 2		648.69	-71.00	221.92	1,785	8.91
15	Rod: from 9		648.69	-68.60	267.87	428	37.11
16	Beam: between 14 & 15		648.69	-70.54	230.81	2,214	0.00
17	Rod: from 16		678.43	-70.54	230.81	2,214	12.22
18	Rod: from 1		615.18	-79.79	243.42	4,713	6.27

Figure 6-11

Table 6-2

Items	Explanations
No	The number corresponds to the point ID of the model in *Model Window*. The number is not a fixed number and can be changed as you edit whiffletree, but always shown in order of small to large number.
Description	There is a limit in number of characters to be displayed in *Data Screen*. However, any length can be stored in database.
Weight	Non-zero weight value is displayed for CG points. Other points that do not have weight will be displayed either blank or zero depending on your decimal format setting. By default setting, weight is only displayed for *CG Points*.
X, Y, Z	Values will be displayed for all points.
Load	Values will be displayed for all points. This is the load acting on the point.
Length	This is moment arm length in beam and only shown for Rod (each end of beam). CG points and Beam (middle point of the beam) do not have length; therefore, it is displayed as zero.

6.10 Edit and Update Data

Whiffletree data can be edited and updated through *Data Screen*.

1. Select time that you want to edit.
2. The selected item is displayed in the bottom pane.
3. Edit values. Note that only editable items can be accessed. Other items are locked (grayed out).

   See table below for edit permit of each item.

4. Once you have done editing, click Update to confirm change. Whiffletree models in *Model Window* will be automatically updated too.

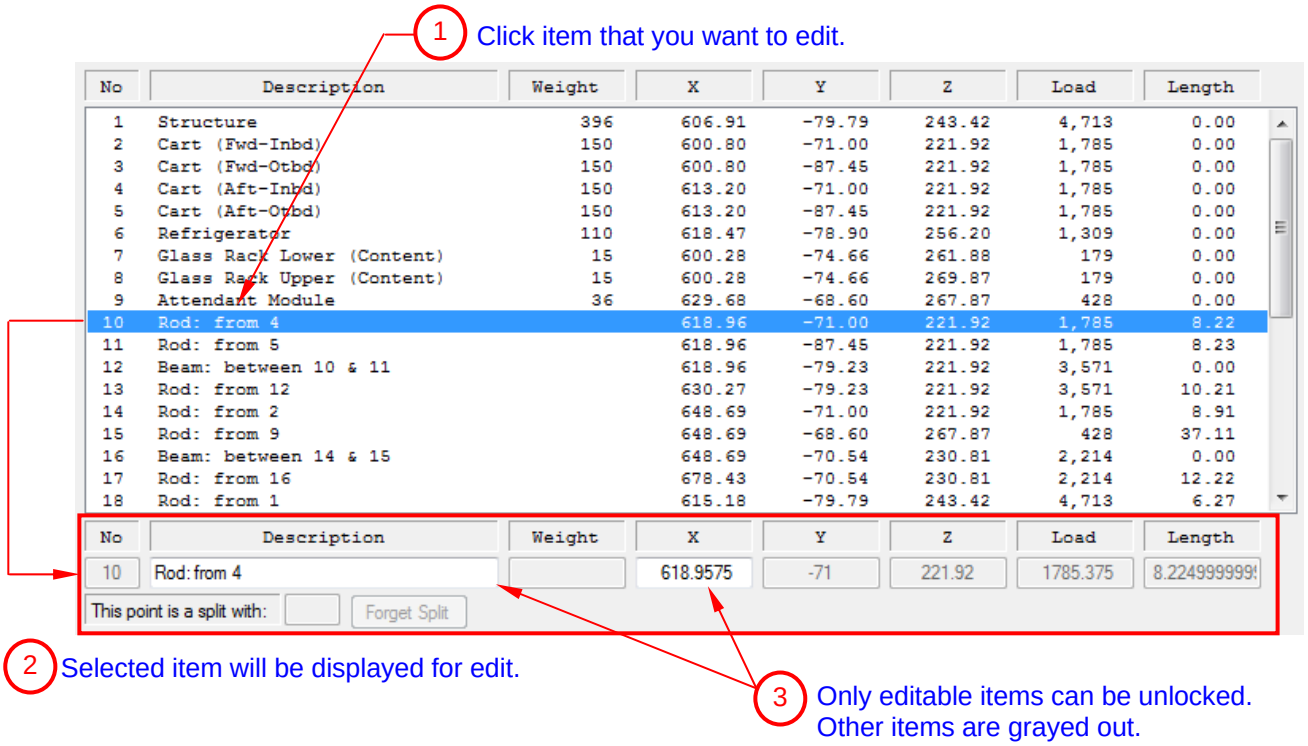

Figure 6-12

Table 6-3

Items	Edit Permit	Remarks
No	None	Automatically assigned by the program
Description	*CG Points* only	-
Weight	*CG Points* only	-
X, Y, Z	*CG Points*: Fully editable Other points: Only loading component	-
Load	None	Automatically computed by the program
Length	None	Automatically computed by the program
Forget Split	Yes	For *Split Points* only

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6.11 Split and Forget Split

You can remove the link between two *Split Points*. Refer to Section 5.14.3 for details of this function.

6.12 Delete

As explained in Section 5.12.1, whiffletree data point can only be deletable if the point is located at the top of the whiffletrees. Delete button is locked if you select items which is not deletable.

Click Delete to delete the point. Rest of whiffletrees (including IDs) will be automatically updated.

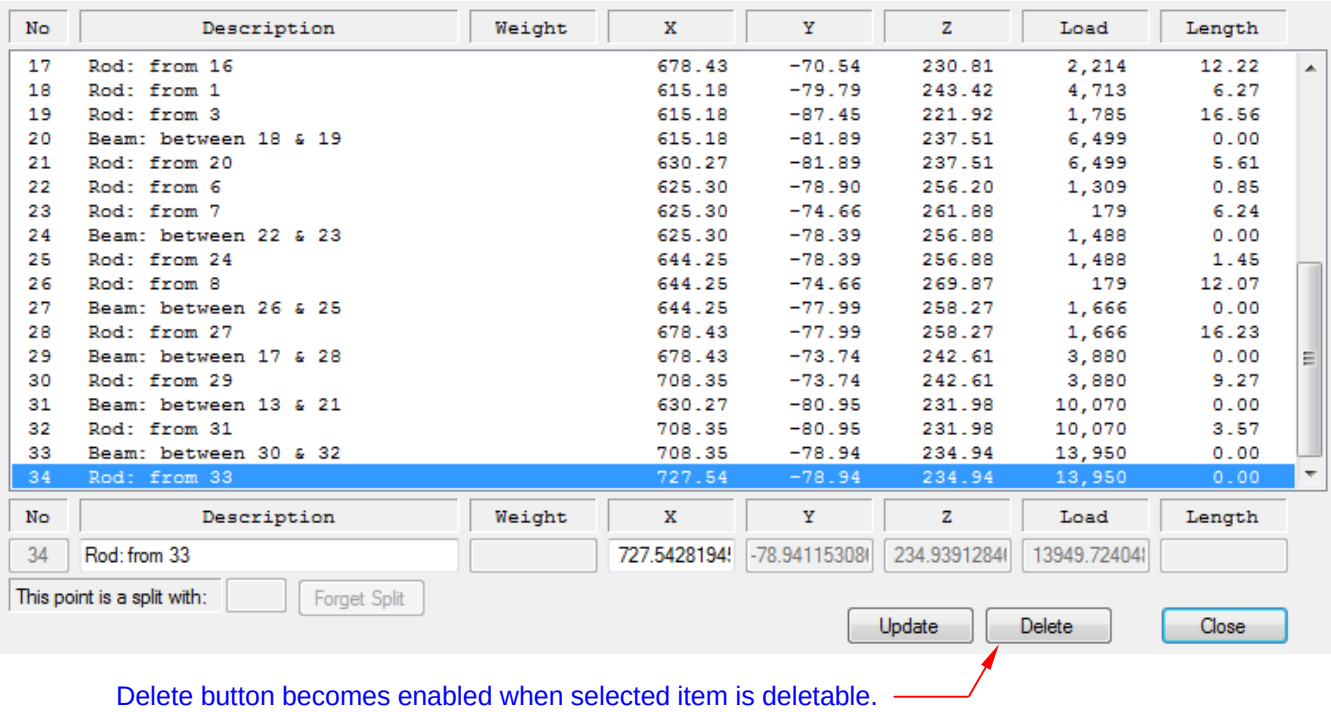

Figure 6-13

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7.0 VIEW AND EDIT WHIFFLETREE MATERIAL

This section explains how to view and edit whiffletree material through *Edit Material*.

Window for *Edit Material* can be accessed by the following icon or *File Menu*.

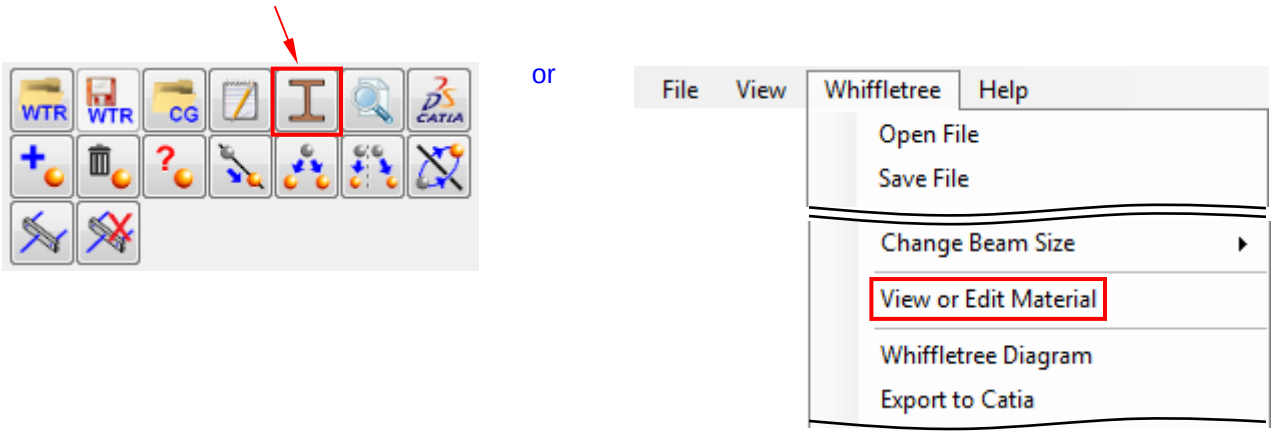


Figure 7-1

7.1 What is Material for?

3DWhiffletree program can automatically select the best material for beam and rod and display them on whiffletree diagrams. For the program to be able to select, users need to specify material of beam and rod. If you create multiple materials in the list, the program will choose from the weakest material that meets the strength requirement.

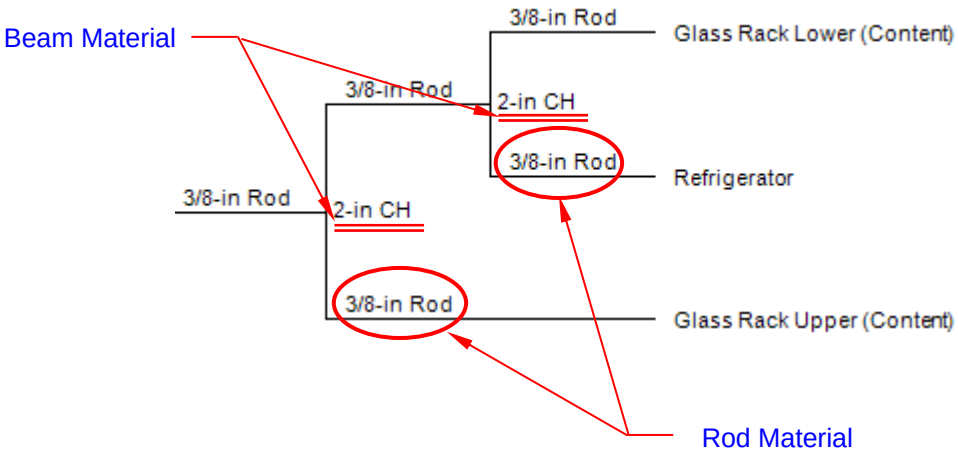
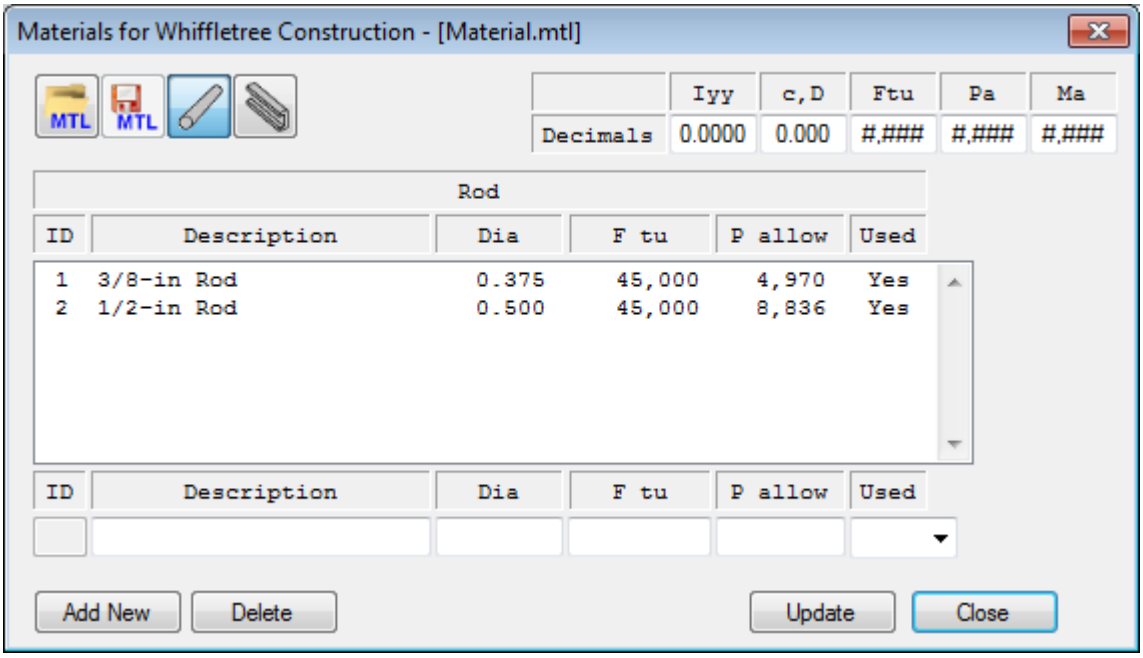


Figure 7-2

7.2 General View

There are two views: Rod and Beam. The view can be switched by selection Rod/Beam icons.

Rod View



Beam View

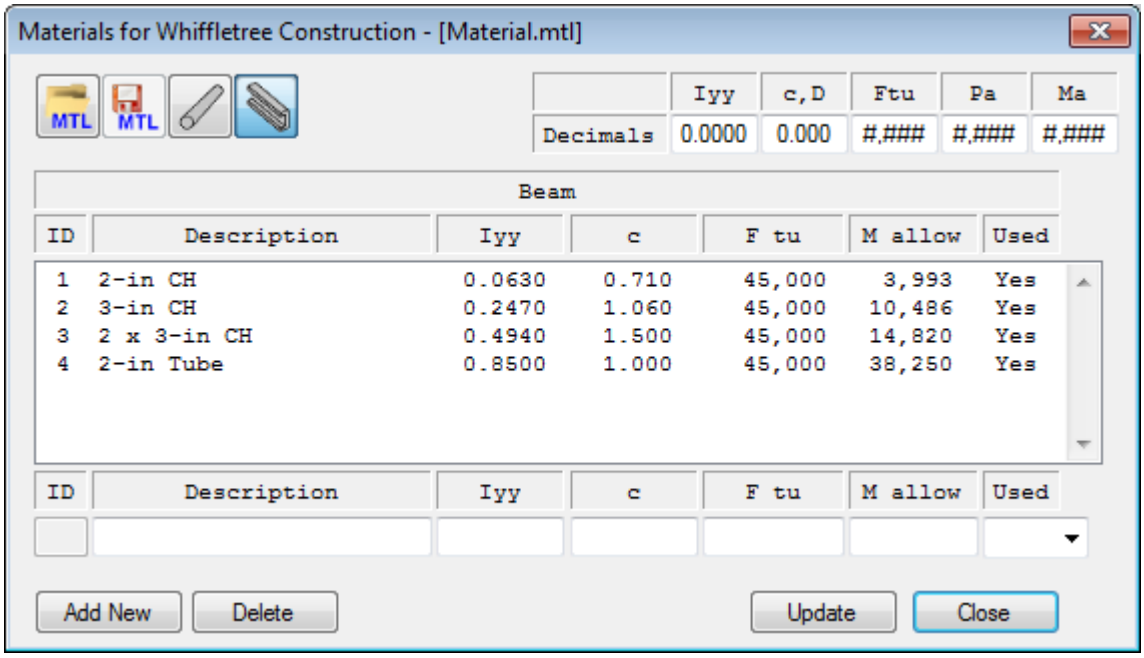


Figure 7-3

The below figure shows a typical view of *Material Edit Window* (this example shows Beam view).

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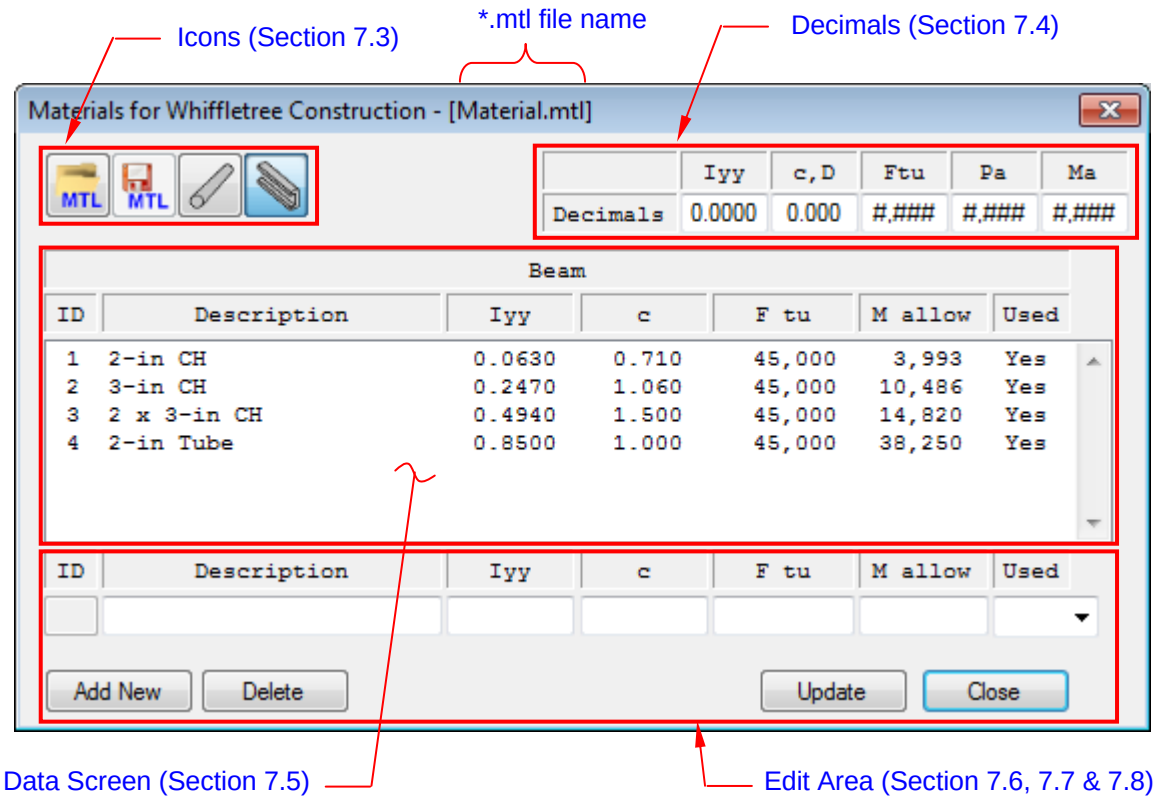

Figure 7-4

7.3 Icons

Open material (*.mtl) file (Section 7.3.1)

Save material (*.mtl) file (Section 7.3.2)

Switch to rod material view (Section 7.3.3)

Switch to beam material view (Section 7.3.3)

7.3.1 Open Whiffletree Material File (*.mtl)

Click

icon to open material (*.mtl) file that you have previously created. Default folder is the same folder where *3DWhiffletree.exe* is located. If you already have material data edited, then you will see the following message.

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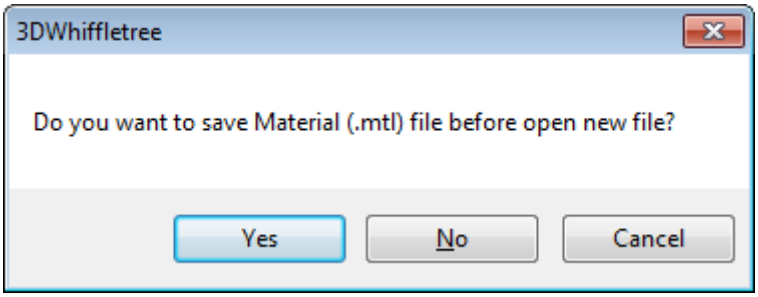

Figure 7-5

7.3.2 Save Whiffletree Material File (*.mtl)

Click

icon to save material (*.mtl) file. Default folder is the same folder where *3DWhiffletree.exe* is located. When saving the file, the program always ask you to name the file. Therefore, the save function works also as "*Save As*" command.

Both Rod and Beam data are saved in one file.

When closing *Material Edit Window* without saving material data, you will see the following warning message. You can come back to *Material Edit Window* later to save the data. Until then, you won't lose any data unless you exit 3DWhiffletree program. (There won't be any warning message when you exit *3DWhiffletree* data without saving material data, unlike the program does for the other files such as *.wtr data.)

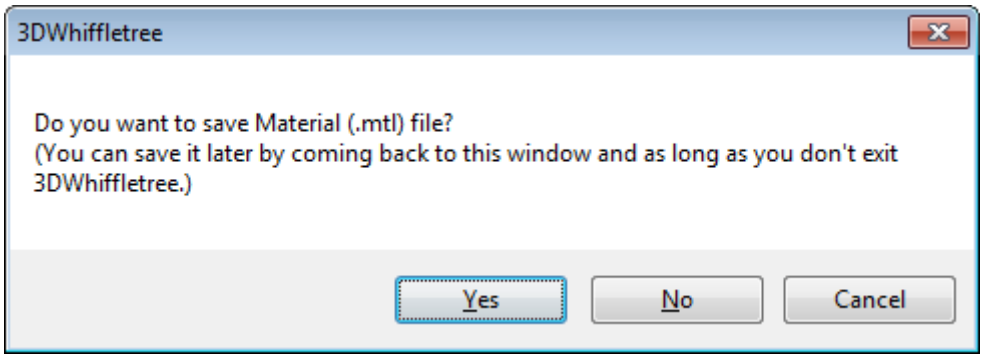

Figure 7-6

7.3.3 Switch View between Rod and Beam

Click and to switch view between Rod and Beam. Information is slightly different between Rod and Beam. See *Data Screen* (Section 7.5) for more details.

7.4 Decimals

	Iyy	c,D	Ftu	Pa	Ma
Decimals	0.0000	0.000	#,###	#,###	#,###

This is very similar to "*Units and Decimals*" explained for *Whiffletree Edit Window* (Section 6.8) except there is no "*Units*" to show for materials. The decimal is used only for a display purpose in *Data Screen*. See Table 6-1 for detail explanation of formatting rules/

To complete editing decimals, click Update to confirm changes.

7.5 Data Screen

7.5.1 Rod

Figure below shows a typical *Data Screen* for rod. Table 7-1 provides explanation of each item in *Data Screen*.

Rod

ID	Description	Dia	F tu	P allow	Used
1	3/8-in Rod	0.375	45,000	4,970	Yes
2	1/2-in Rod	0.500	45,000	8,836	Yes

Figure 7-7

Table 7-1

Items	Explanations
ID	*ID* is only for listing purpose. Not relevant to any computation.
Description	*Description* is used to identify the rod. It will also appear in whiffletree diagram when showing materials.
Dia	Diameter of rod. This is for information only and not a parameter of selecting rod at the time showing materials in whiffletree diagram.
F tu	Ultimate tensile stress of the rod material. This is for information only and not a parameter of selecting rod at the time showing materials in whiffletree diagram.
P allow	Allowable tensile load of the rod (maximum load that rod can take). This is only the parameter of selecting rod at the time showing materials in whiffletree diagram.
Used	The value is either "*YES*" or "*NO*" and it determines if the particular rod can be selected at the time showing materials in whiffletree diagram. For example, if you have a rod that is out of stock but want to keep the information in the list for future purpose, then set the value to "*NO*" so that it won't be selected as a valid material.

7.5.2 Beam

Figure below shows a typical *Data Screen* for beam. Table 7-2 provides explanation of each item in Data Screen.

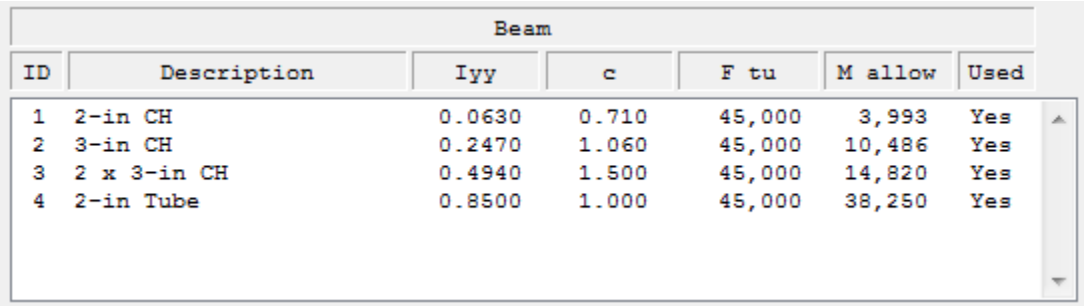

Figure 7-8

Table 7-2

Items	Explanations
ID	*ID* is only for listing purpose. Not relevant to any computation.
Description	*Description* is used to identify the beam. It will also appear in whiffletree diagram when showing materials.
Iyy	The second moment of inertia of the cross-sectional area computed about the neutral axis of the beam (see figure below). This is for information only and not a parameter of selecting rod at the time showing materials in whiffletree diagram.
c	The perpendicular distance from the neutral axis to a point farthest away from the neutral. This is for information only and not a parameter of selecting rod at the time showing materials in whiffletree diagram.
F tu	Ultimate tensile stress of the beam material. This is for information only and not a parameter of selecting rod at the time showing materials in whiffletree diagram.
M allow	Allowable bending moment of the beam (maximum bending moment that the beam can take). This is only the parameter of selecting beam at the time showing materials in whiffletree diagram.
Used	The value is either "*YES*" or "*NO*" and it determines if the particular rod can be selected at the time showing materials in whiffletree diagram. For example, if you have a beam that is out of stock but want to keep the information in the list for future purpose, then set the value to "*NO*" so that it won't be selected as a valid material.

Form the figure below, Iyy can be calculated as

$$I_{yy} = \iint z^2 dxdz$$ (The second moment of inertia)

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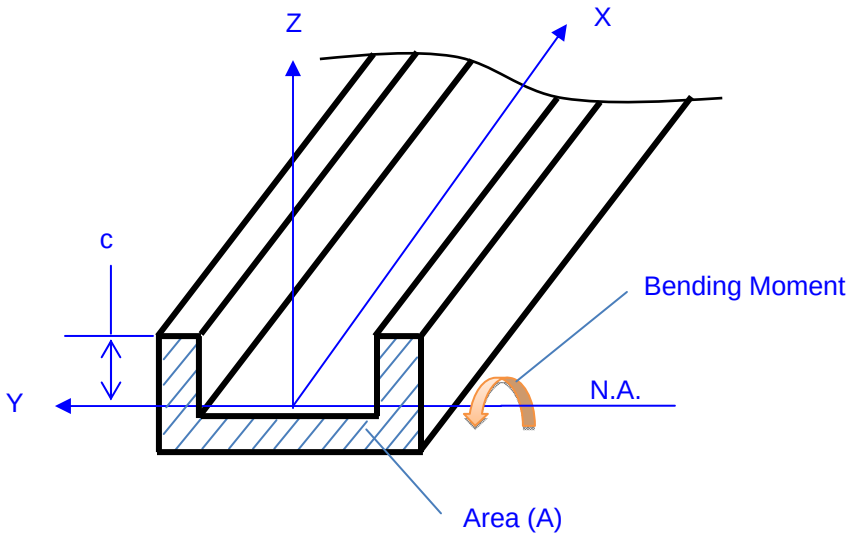

Figure 7-9

7.6 Add New

Take the following procedure to add new material.

1. Click or to switch view to desired material (rod or beam).
2. Enter information. (See sub sections for detail of each item). As minimum, only description is required to create a new material. If you don't enter description, you will see the following message.

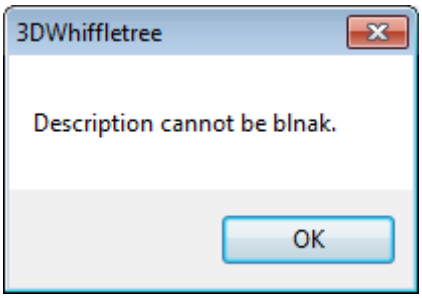

Figure 7-10

3. Click

to confirm new the new item. The new item will appear in *Data Screen*.

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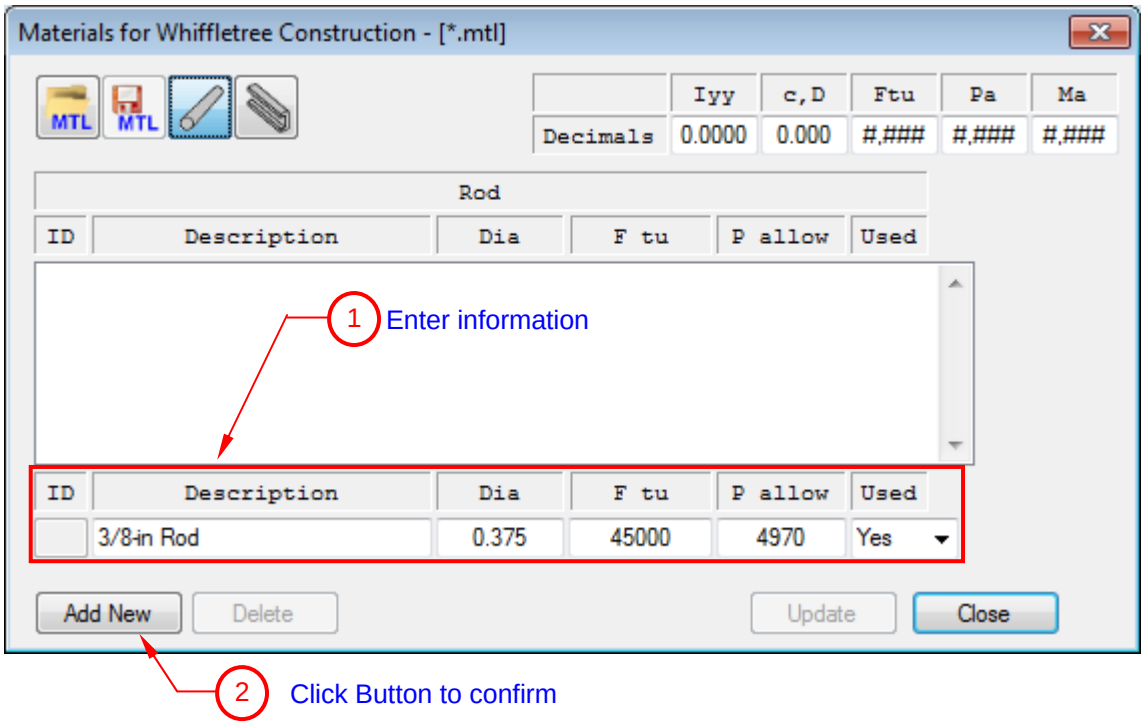
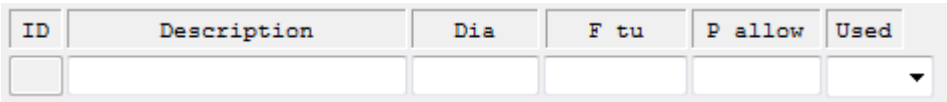


Figure 7-11

7.6.1 Rod



To add a new rod material, fill out the information per the notes given in the following table.

Table 7-3

Items	*Value*	*Explanations*
Description	Required	Enter description of the rod material. Any character lengths are accepted but simple expression is recommended as it will appear on whiffletree diagram.
Dia	Optional	Enter a diameter of rod.
F tu	Optional	Enter ultimate tensile stress of the rod material.
P allow	Optional	Enter ultimate tensile strength in terms of load (i.e., lb or N). If it is left blank, the value is automatically calculated as $P_{allow} = F_{tu} \cdot \frac{1}{4}\pi D^2$ If values are entered and the value does not match calculated value, user will see a message to select which values the user wants to use.
Used	Optional	Choose "YES" or "NO" from dropdown menu. If left blank, "YES" is assigned automatically.

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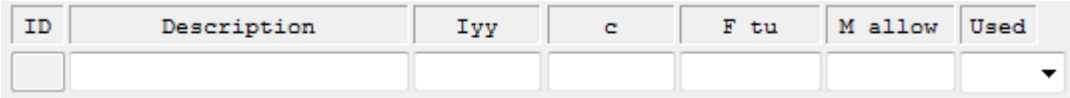
7.6.2 Beam



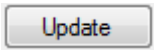
To add a new beam material, fill out the information per the notes given in the following table.

Table 7-4

Items	Value	Explanations
Description	Required	Enter description of the rod material. Any character lengths are accepted but simple expression is recommended as it will appear on whiffletree diagram.
Iyy	Optional	Enter the second moment of inertia of the beam cross section.
c	Optional	Enter distance from neutral axis to the furthest point of the beam in the cross section.
F tu	Optional	Enter ultimate tensile stress of the beam material.
M allow	Optional	Enter ultimate tensile strength in terms of bending moment (i.g.,in- lb or Nmm). If it is left blank, the value is automatically calculated as $M_{allow} = \frac{F_{tu} \cdot I_{yy}}{c}$ If values are entered and the value does not match calculated value, user will see a message to select which values the user wants to use.
Used	Optional	Choose "YES" or "NO" from dropdown menu. If left blank, "YES" is assigned automatically.

7.7 Update

The material in the list can be updated.

1. Select material in the list by clicking the item on *Data Screen*.
2. Items will appear in *Edit Area*.
3. Edit items you want to update.
4. If you want allowable values (P allow, M allow) being calculated automatically, leave the item block blank.
5. Click 

to confirm the change.

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6. Listed items in *Data Screen* will be updated. (Remember to save the *.mtl file if you want to save the change.)

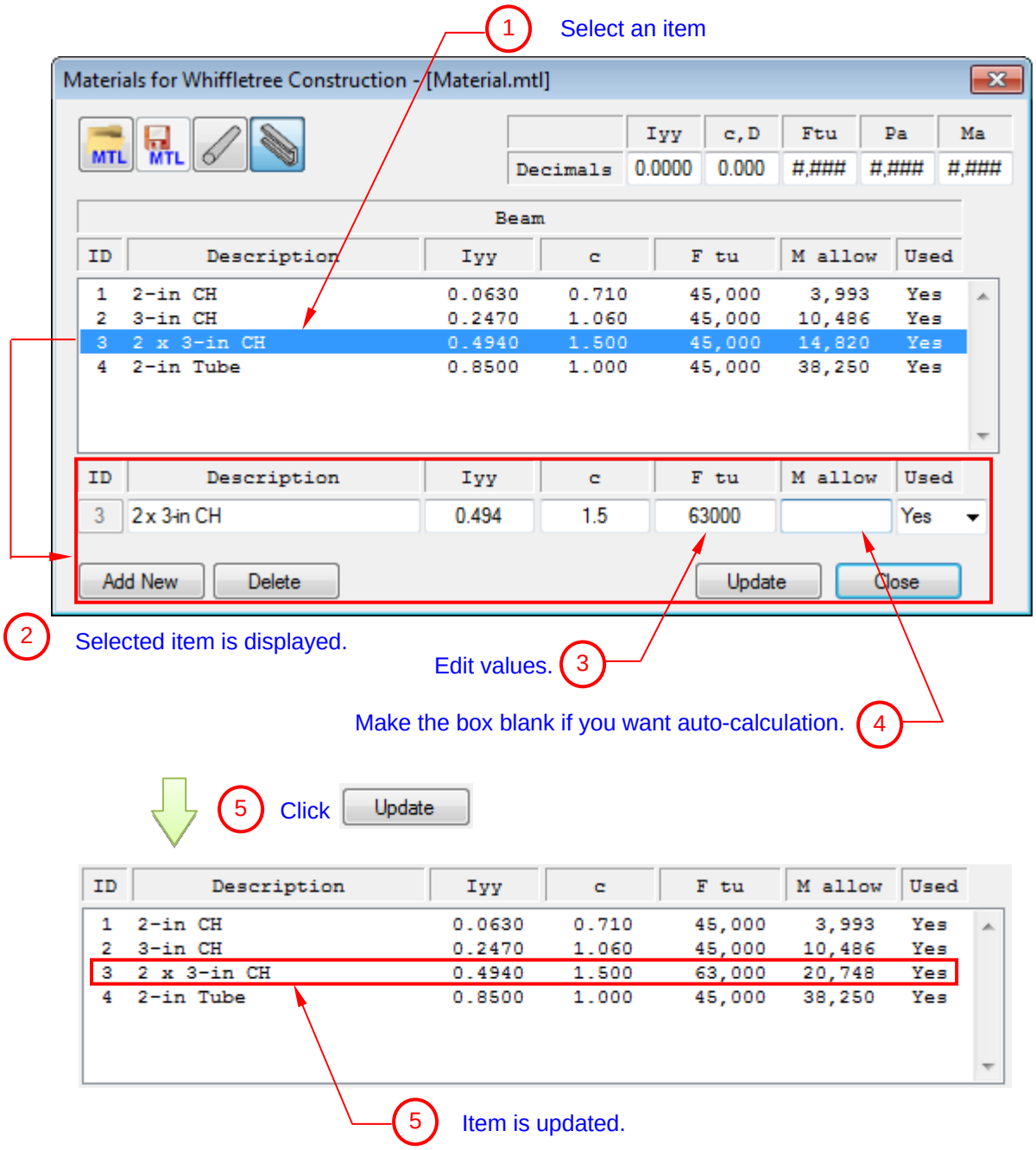

Figure 7-12

Remarks

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If "P allow" or "M allow" that user entered (except for blank entry) does not match the calculated value, the following message will appear asking user to select which values users want to use. This situation most commonly happens in the following situation

1. When user wants to update values but forget to update/enter allowable value
2. When user wants to enter his own allowable value.

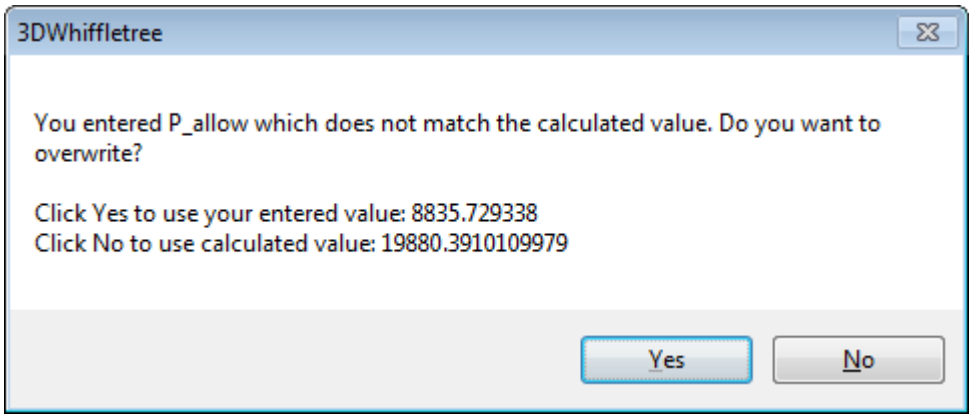

Figure 7-13

7.8 Delete

Items in the list can be also deleted.

1. Select item that you want to delete.
2. Items will appear in *Edit Area*.
3. Click

to delete. IDs are automatically updated in the list.
4. Listed items in *Data Screen* will be updated. (Remember to save

the *.mtl file if you want to save the change.)

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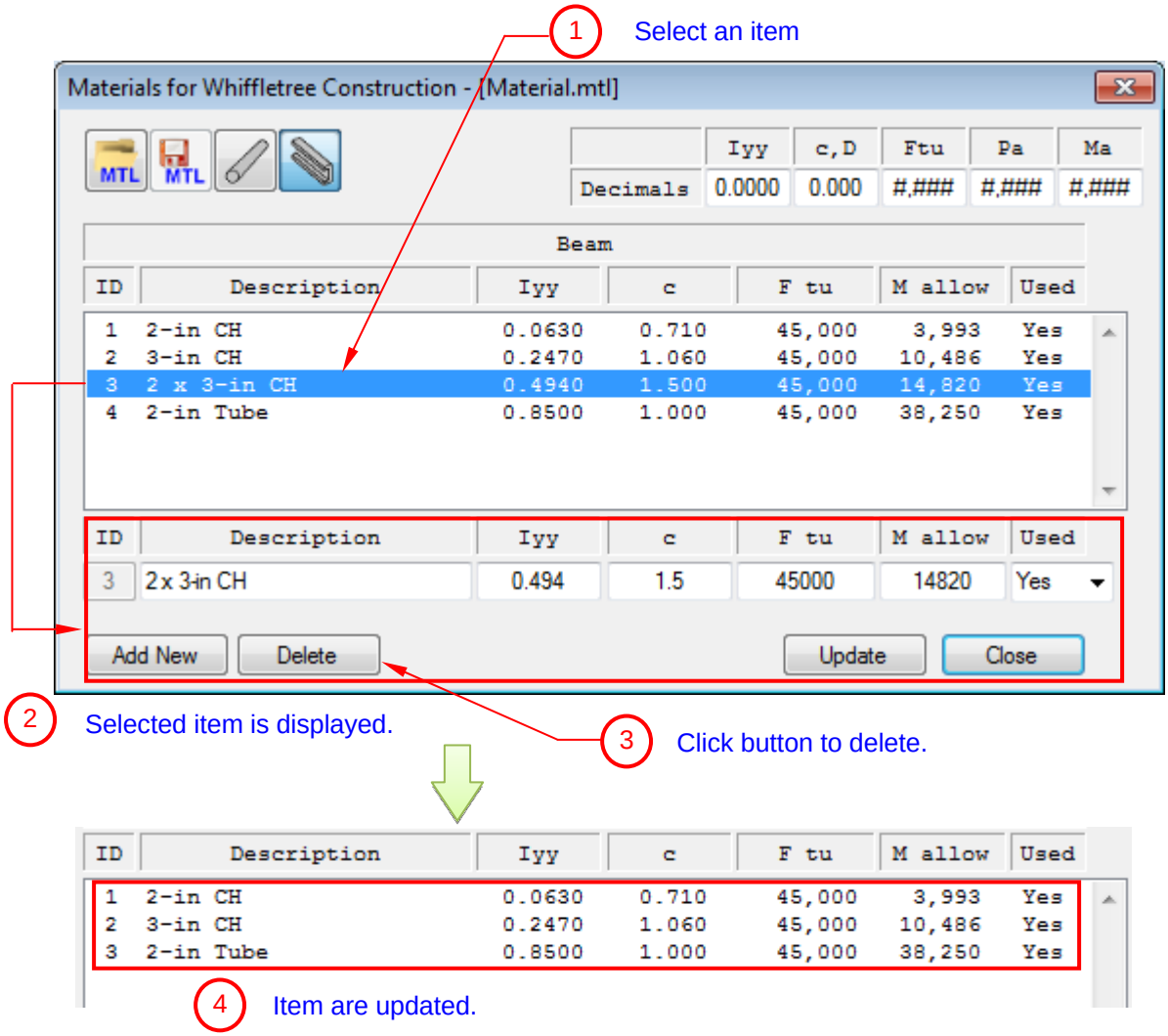

Figure 7-14

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8.0 VIEW WHIFFLETREE DIAGRAM

This section explains how to review whiffletree diagram in *Whiffletree Diagram Window*.

Whiffletree Diagram Window can be accessed by the following icon or *File Menu*.

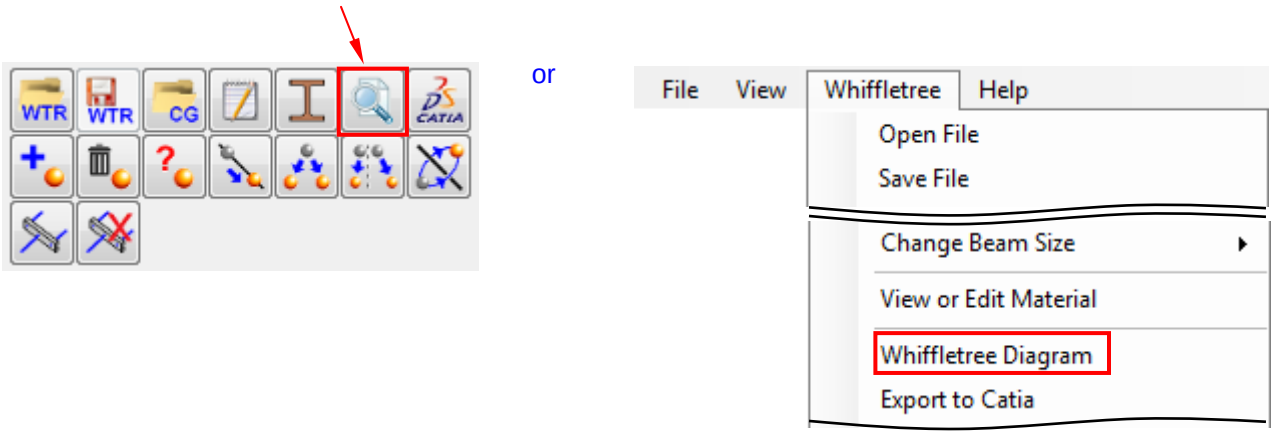

Figure 8-1

8.1 General View

The figure below shows a general view of *Whiffletree Diagram Window*.

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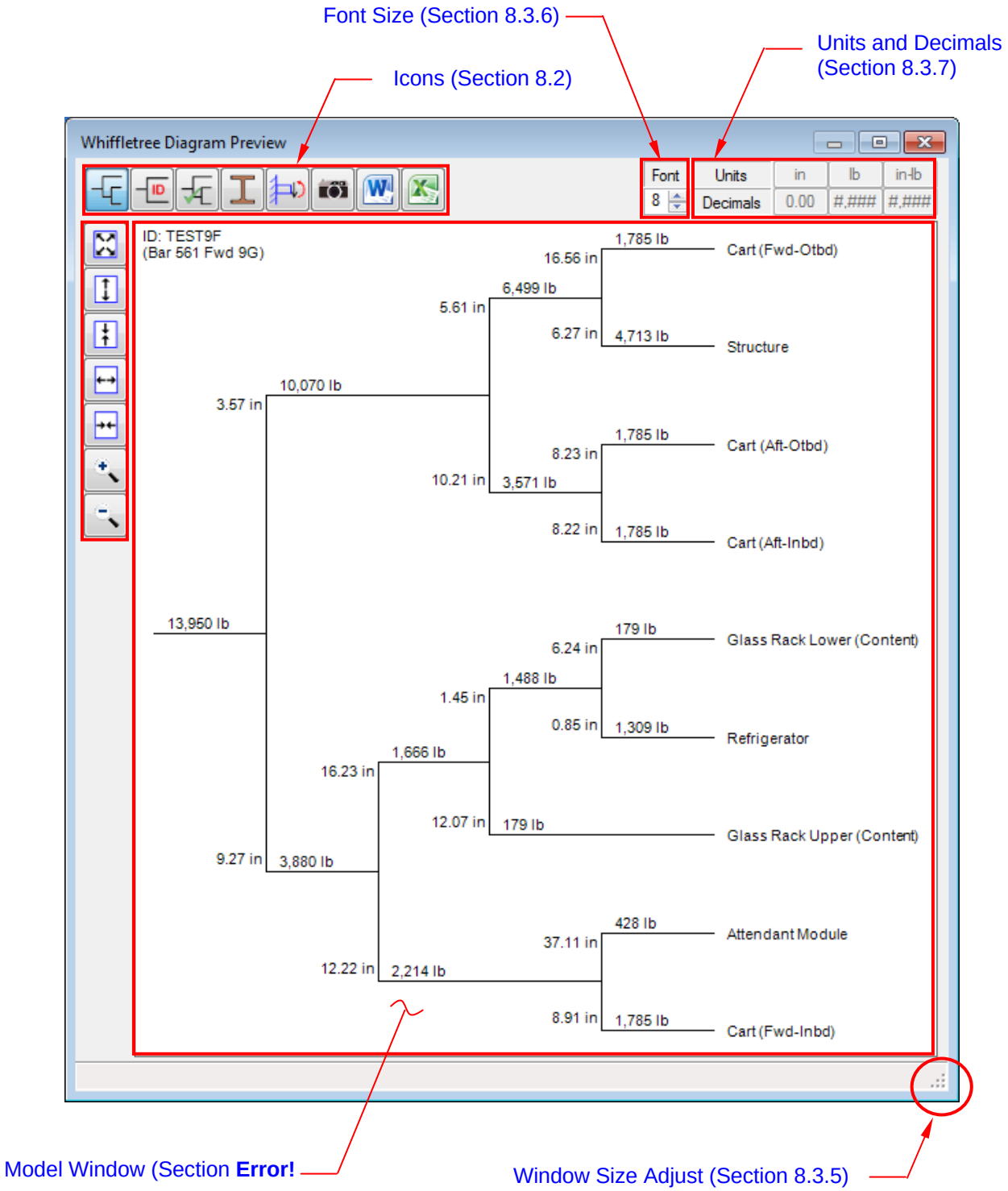

Figure 8-2

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8.2 Icons

Auto fit whiffletree diagram to the current window size (Section 8.3.2)

Enlarge whiffletree diagram in vertical direction (Section 8.3.2)

Contract whiffletree diagram in vertical direction (Section 8.3.2)

Enlarge whiffletree diagram in horizontal direction (Section 8.3.2)

Contract whiffletree diagram in horizontal direction (Section 8.3.2)

Zoom in whiffletree diagram (Section 8.3.3)
Shortcut Key: Scroll down the mouse wheel

Zoom out whiffletree diagram (Section 8.3.3)
Shortcut Key: Scroll up the mouse wheel

Show whiffletree labels (Section 8.4.1)

Show whiffletree IDs (Section 8.4.2)

Check whiffletree completeness (Section 8.4.3)

Show whiffletree materials (Section 8.4.4)

Show rod tensile load and beam bending moment (Section 8.4.5)

Copy image (Section 8.5)

Export whiffletree diagram into Microsoft Word 2010 (Section 8.6.1)

Export whiffletree diagram into Microsoft Excel 2010 (Section 8.6.2)

8.3 View Operation

This section explains operation related to whiffletree diagram view.

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8.3.1 Model Window

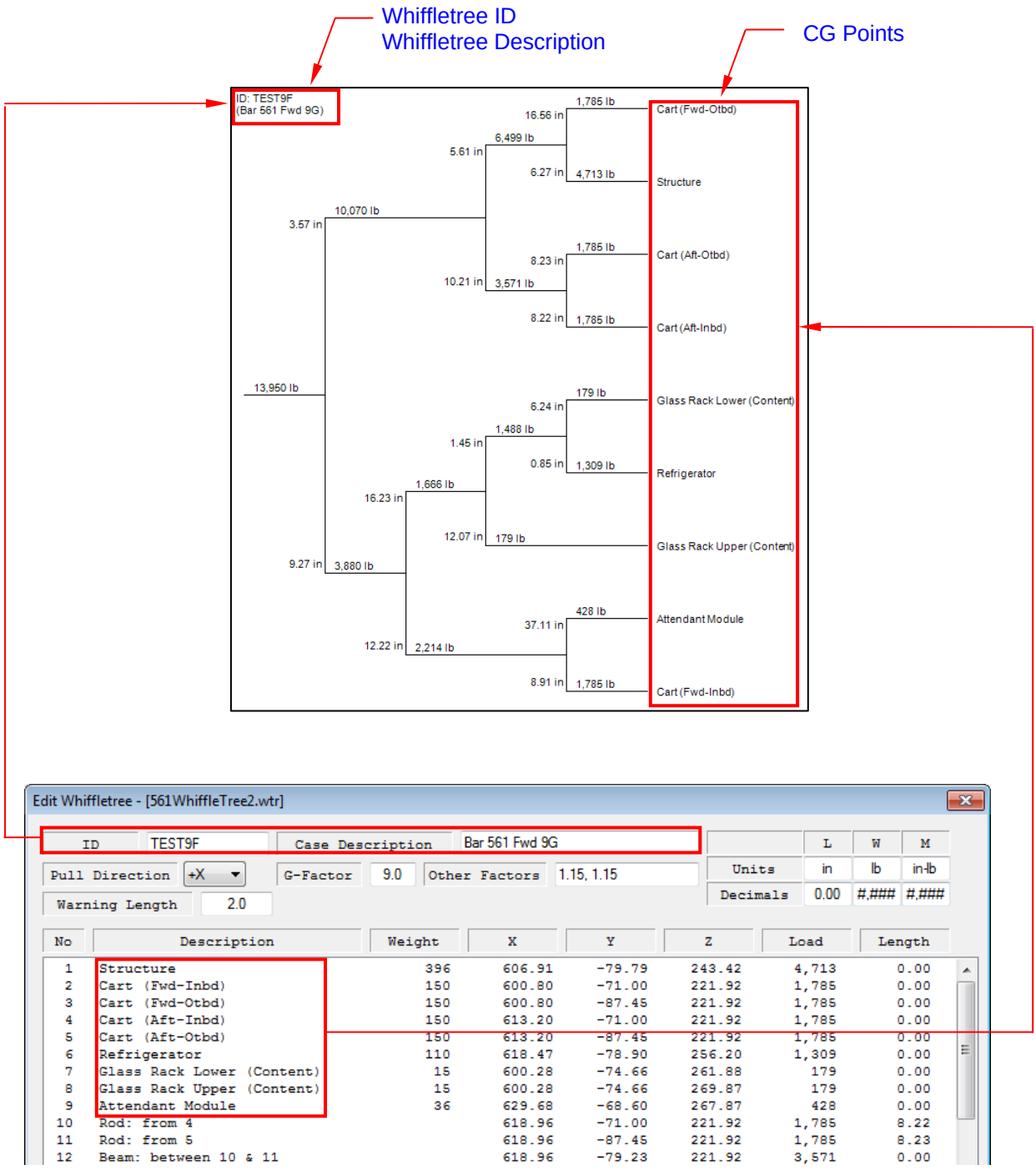


Figure 8-3

8.3.2 Fit Buttons

Auto fit and center

This button will center the whiffletree diagram and auto-fit the diagram to the current window size. This is the default setting when opening *Whiffletree Diagram Window*.

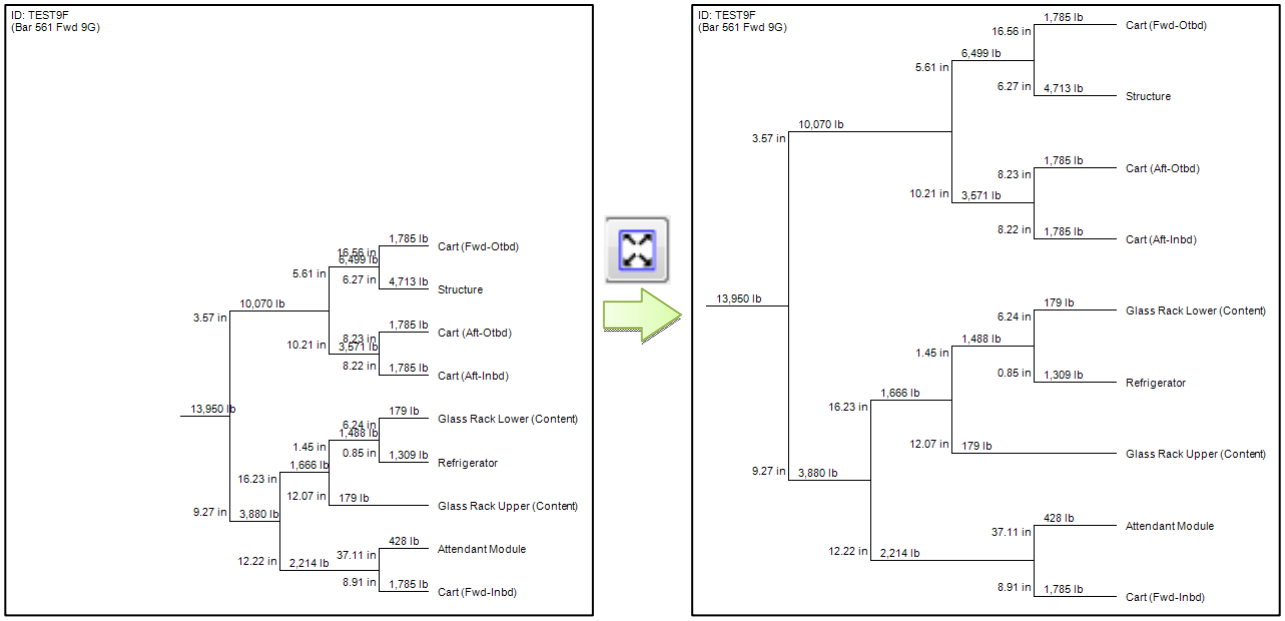
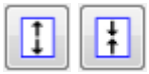


Figure 8-4



Adjust vertical size

This button will adjust whiffletree diagram in vertical direction.

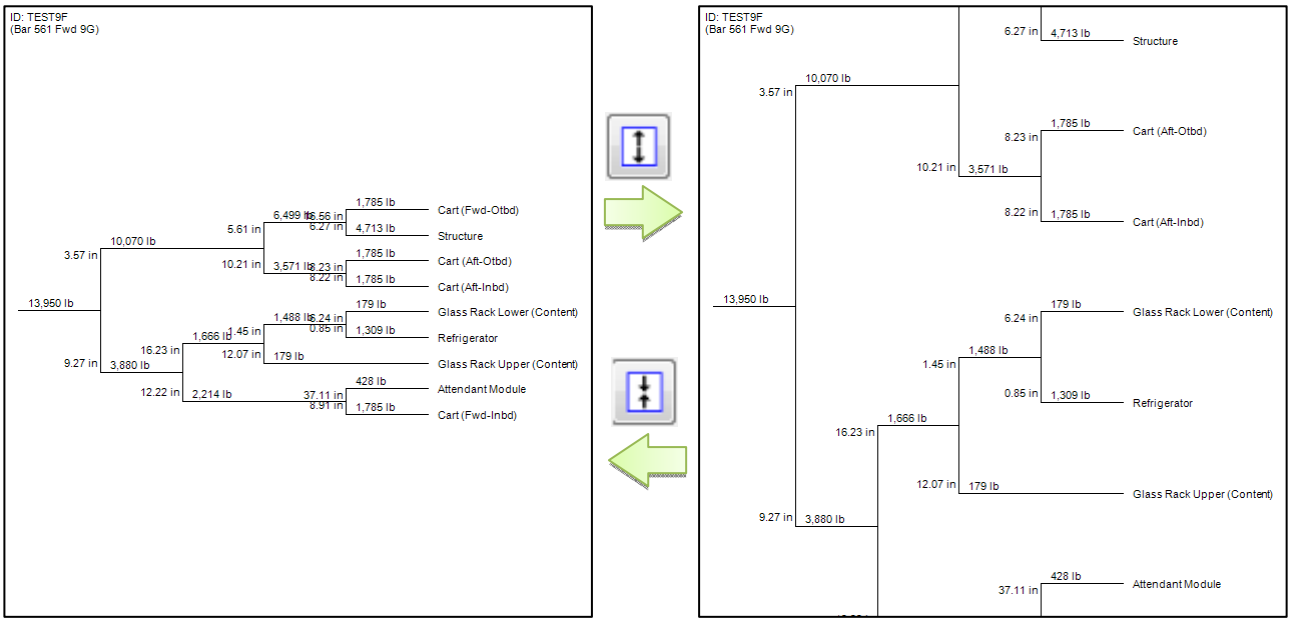


Figure 8-5

Adjust horizontal size

This button will adjust whiffletree diagram in horizontal direction.

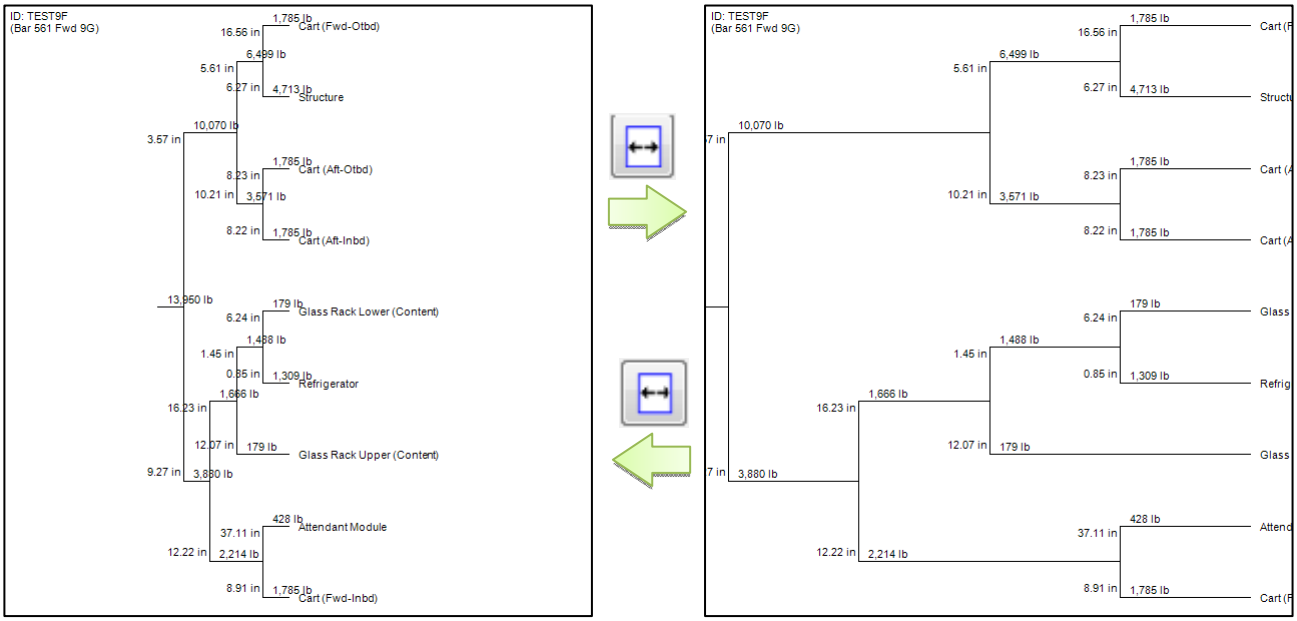


Figure 8-6

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8.3.3 Zoom In and Out Buttons

Zoom in and out

This button will zoon in and out the whiffletree diagram. It does not change font size. See Section 8.3.6 for how to change font size in whiffletree diagram.

8.3.4 Mouse Controls

Left Mouse Drag	Pan-move the whiffletree diagram. The pan-move is only available by mouse.
Middle Button Wheel	Zoom in and out the whiffletree diagram.

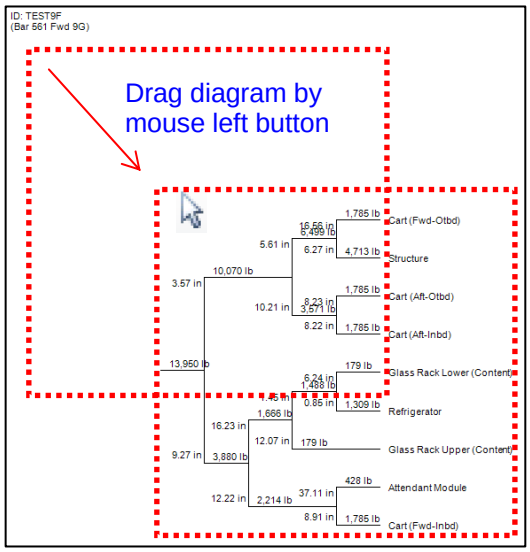

Figure 8-7

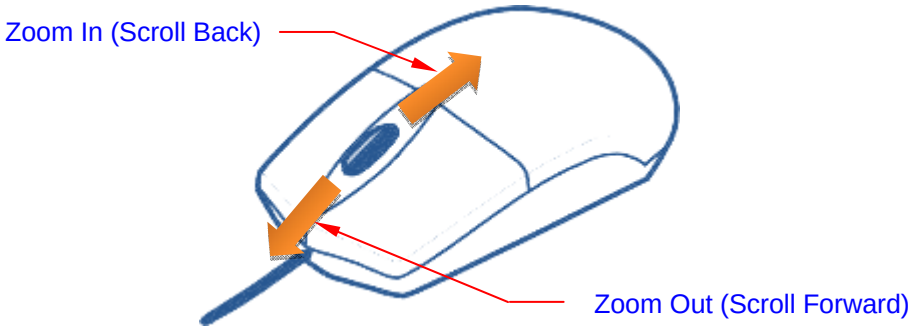

Figure 8-8

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8.3.5 Change Window Size

Sometime figures overlap due to the size of window if you build big whiffletree constructions. In such cases you can adjust window size by dragging a corner of window (or right vertical edge or bottom horizontal edge) to adjust window size until overlapping figures are gone.

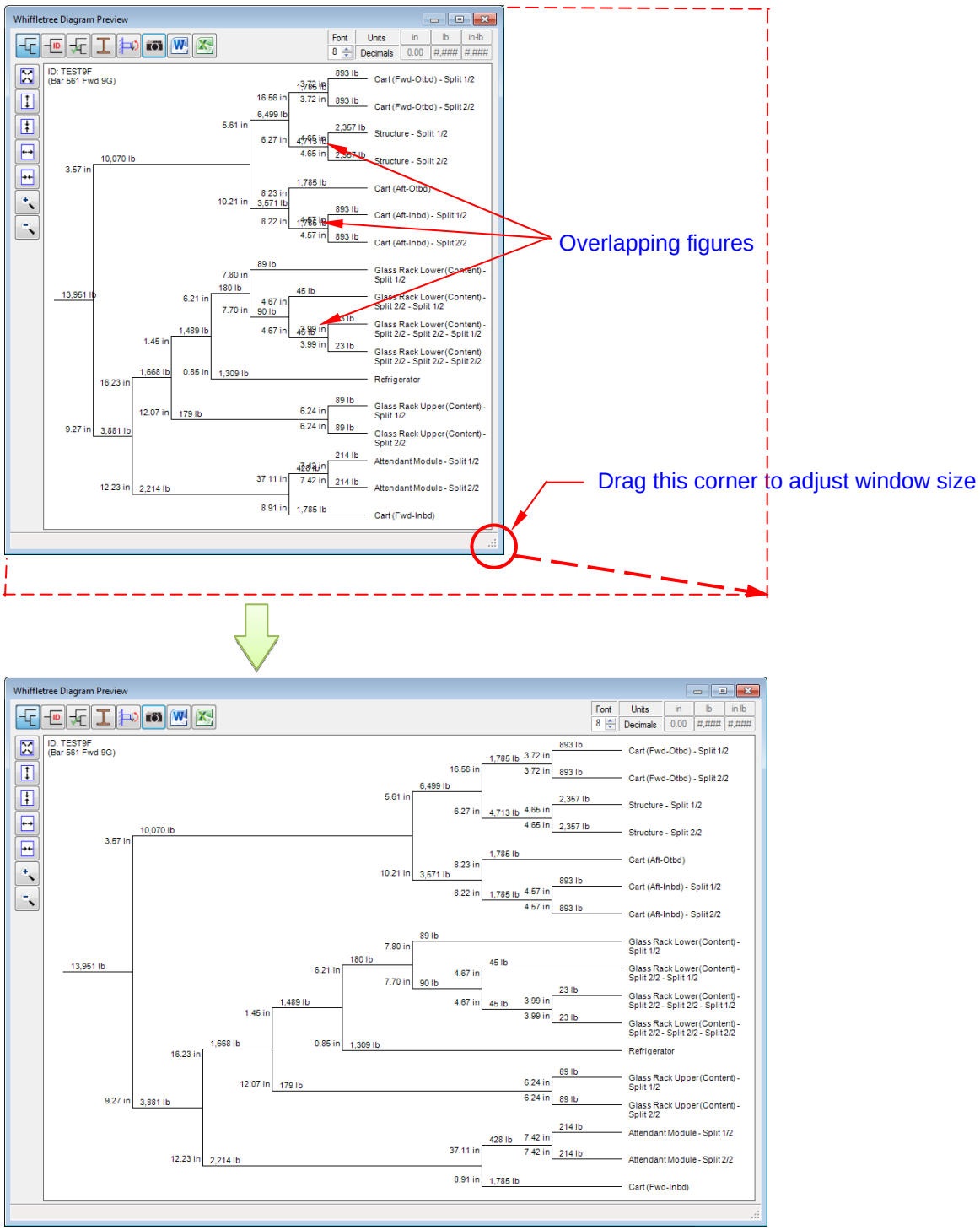

Figure 8-9

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8.3.6 Change Font Size

Font size in the whiffletree diagram can be changed to any size between 1 and 10. The default size is set to 8.

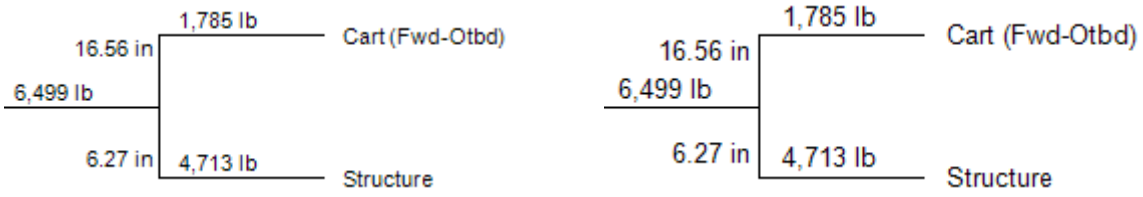
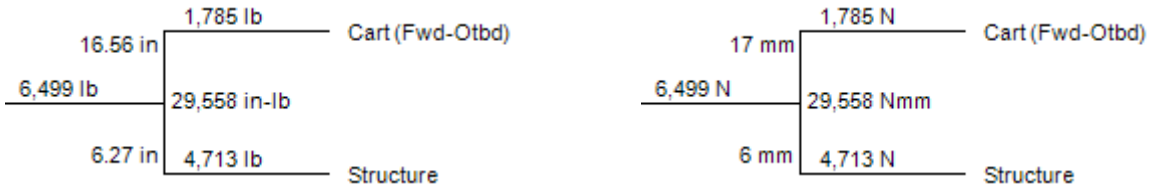


Figure 8-10

8.3.7 Unit and Decimals

Units	in	lb	in-lb
Decimals	0.00	#,###	#,###

The current format of units and decimal display are shown. As they are shown in gray, they cannot be changed from *Whiffletree Diagram Window*. To change the units and decimal format, go to *Whiffletree Edit Window* to update values (Section 6.8) and come back to *Whiffletree Diagram Window*.



Units	in	lb	in-lb
Decimals	0.00	#,###	#,###

Units	mm	N	Nmm
Decimals	0	#,###	#,###

Figure 8-11

8.3.8 Additional Remarks about View Operation

You can NOT save view setting.

The view setting cannot be saved to whiffletree data (*.wtr) file. For example, following changes made to whiffletree diagram will not be saved. Once you exit *3DWhiffletree* and next time you open the whiffletree data file, all changes will be back to default values even though you save whiffletree data (*.wtr) file.

- Size and Position of Whiffletree Diagram
- Size of Font
- Size of *Whiffletree Diagram Window*

8.4 Whiffletree Diagrams Functions

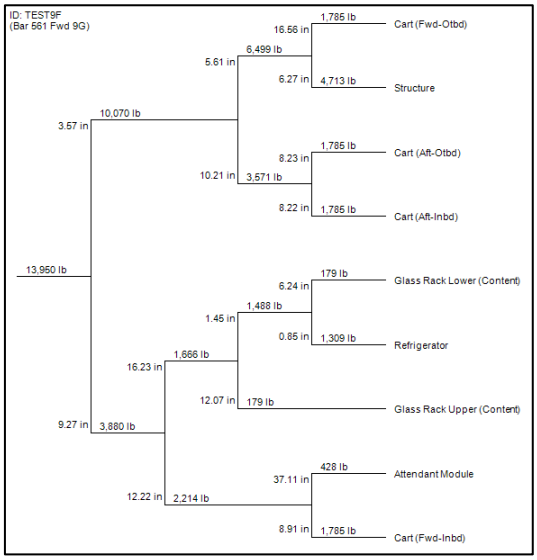
This section explains several functions to display whiffletrees in different ways.

8.4.1 Show Basic Whiffletree

By default, this button is on when *Whiffletree Diagram Window* is opened. This button automatically turns off when showing materials or bending moment. Usually, users do not need to touch this button unless they want to turn off basic whiffletree items for some purposes. (You cannot get rid of item names or basic whiffletree structures.)

ON

OFF



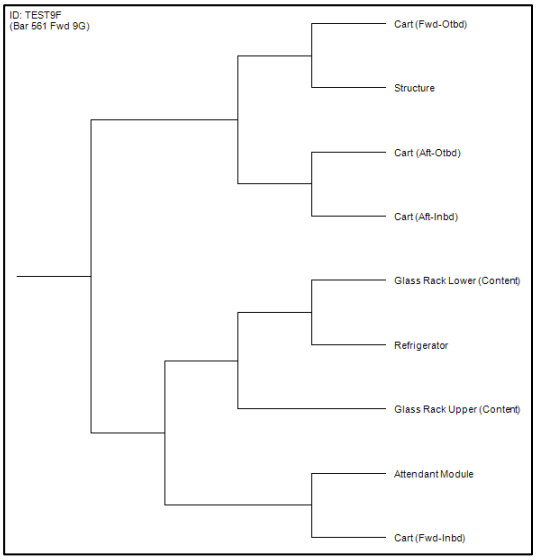


Figure 8-12

8.4.2 Show Whiffletree ID

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Whiffletree beam IDs can be turned on to identify each beam to help manufacturing and inspection.

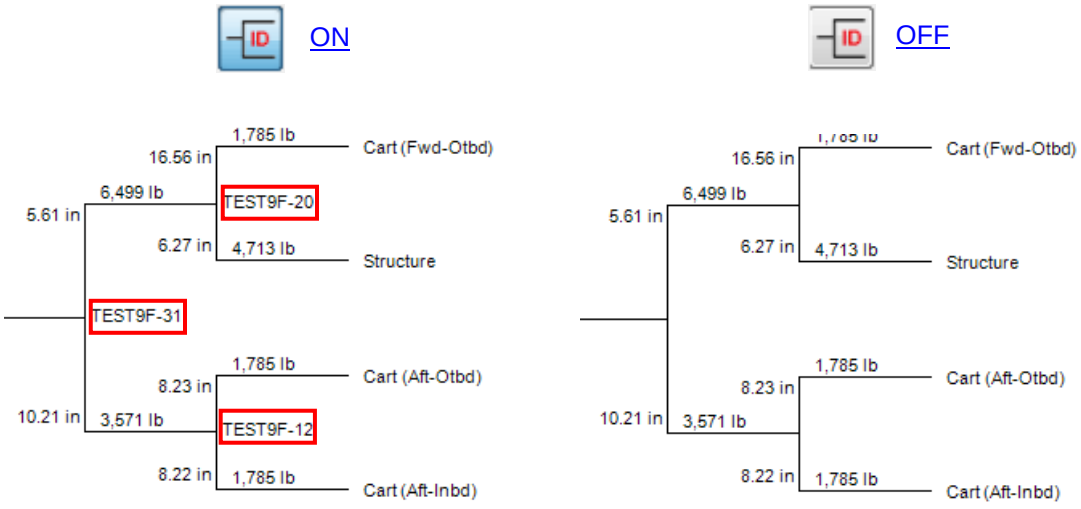

Figure 8-13

Remarks

1. ID can be set in *Whiffletree Edit Window* (Section 6.2).

2. Dash numbers after ID shown on the whiffletree diagram are automatically assigned and cannot be edited.

8.4.3 Check Whiffletree Completeness

It is always good to check whiffletree completeness when having its diagram. Clicking the button brings a new window with summary of whiffletree. It will show a summary of 4 check items:

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Table 8-1

Items	Explanations
Connection	This checks if all *CG Points* are connected. If "*Non Connected CG*" is zero, then, whiffletree is considered completed.
Overall Load	This compares the final load on the whiffletree against calculated overall load from weight times factors.
Overall CG	This compares the final loading point against the calculated overall cg location of the all *CG Points*. The overall cg will not match in the loading component, but other component should match. If the connection check shows that whiffletree is not completed, then, it does not provide comparison results.
Beam Moment Arm	This shows the current *Warning Length* for moment arm and number of arms that are shorter than the defined warning length.

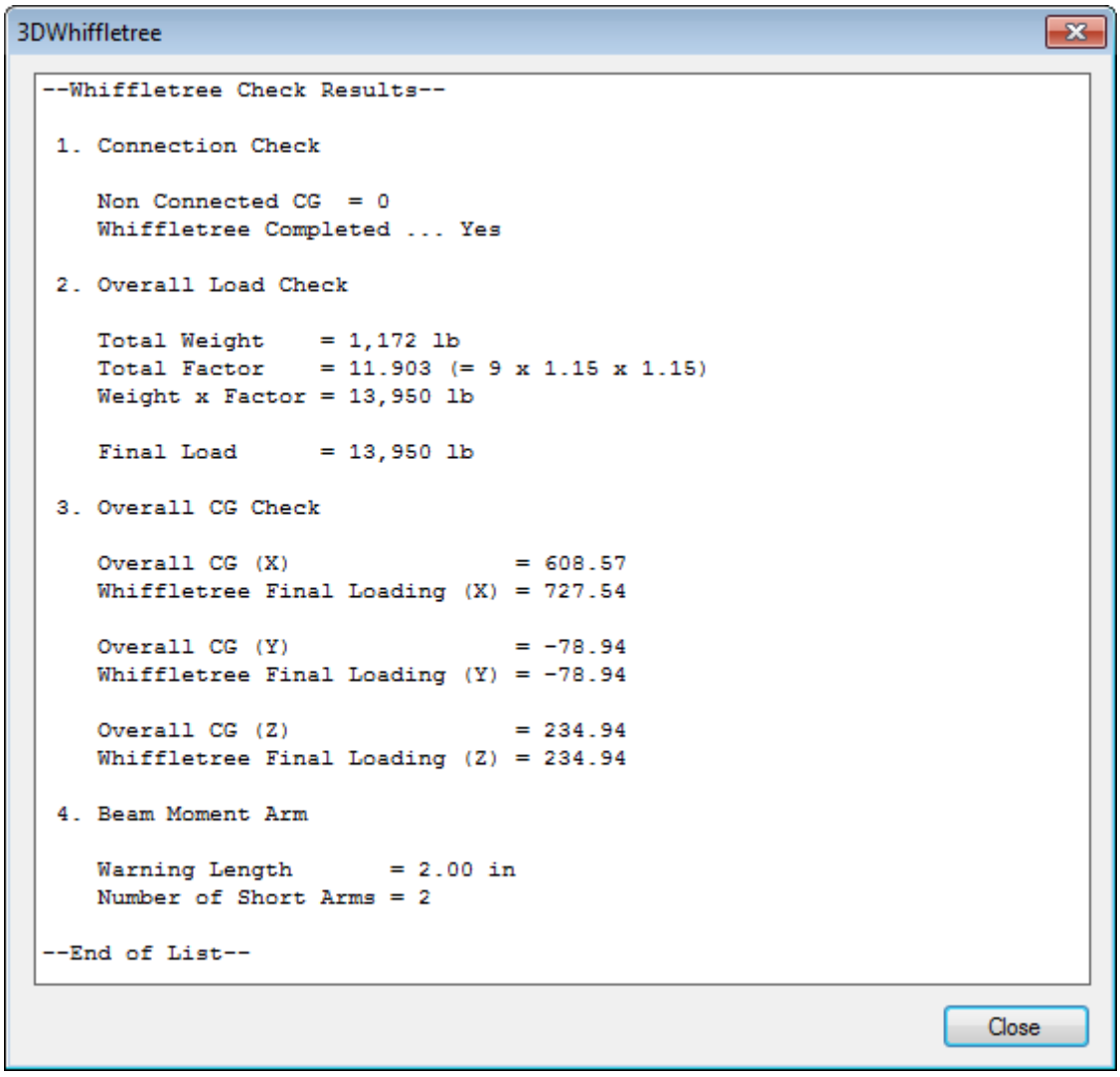

Figure 8-14

8.4.4 Show Whiffletree Materials

This button will show whiffletree materials in the diagram. Following rules apply

1. Rod and beam materials need to be defined prior to show whiffletree diagram. See Section 7.0 for how to define rod and beam materials.

2. Rod and beam are selected based on the tensile load in the rod or bending moment in the beam. Rod or beam with the lowest allowable above the required load or bending moment will be chosen.

3. No materials will be selected if "*Used*" value is set to "*NO*" in material data (Table 7-4)

4. If there is no rod or beam available to meet required load or bending moment, then "*No Rod*" or "*No Beam*" in red color will be displayed.

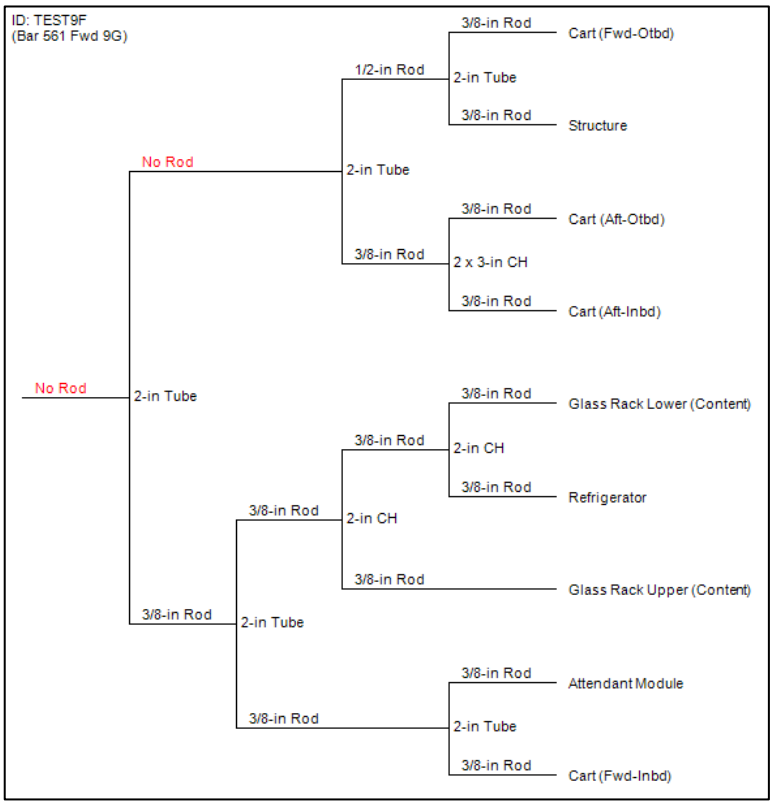

Figure 8-15

8.4.5 Shown Tension Load and Bending Moment

To verify that the correct materials are chosen, you can see load in each rod and bending moment in each beam.

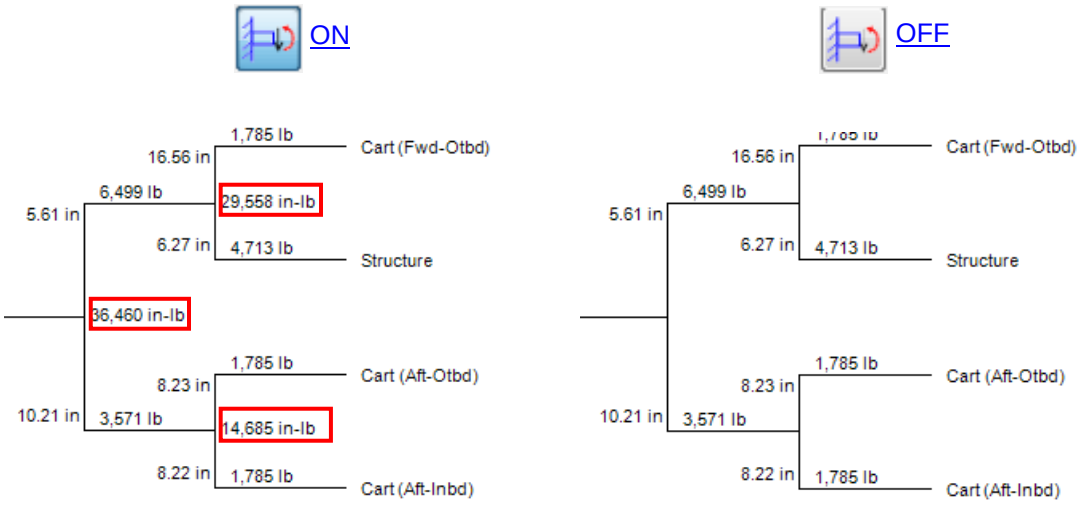

Figure 8-16

8.5 Copy Image

Clicking this button will copy the whiffletree diagram image (screenshot) into your computer's clipboard.

8.6 Export Diagram

Whiffletree diagram along with detail data table can be exported into *Microsoft Word* or *Microsoft Excel*. The difference in the output between *Word* and *Excel* is shown in the table below.

Table 8-2

Export to	*Differences*
Word	• Data table is given in *Word* table format (editable). • Whiffletree Diagram is given as a screenshot (non-editable).
Excel	• Data table is given in *Excel* cells (editable). • Whiffletree diagrams are drawn by using cell boarders. • Values in the whiffletree are given in text as cell values (editable) • *Excel* format has more control and freedom to edit or touchup values in the whiffletree diagram.

8.6.1 Export to Word

Clicking the button will start exporting diagram into *Word* file. You'll see progress in the *Whiffletree Model Window*. It should only take several seconds depending on the size of whiffletree and should not be long.

Output *Word* file includes:

- Whiffletree Summary
- Whiffletree Data Table
- Whiffletree Diagram

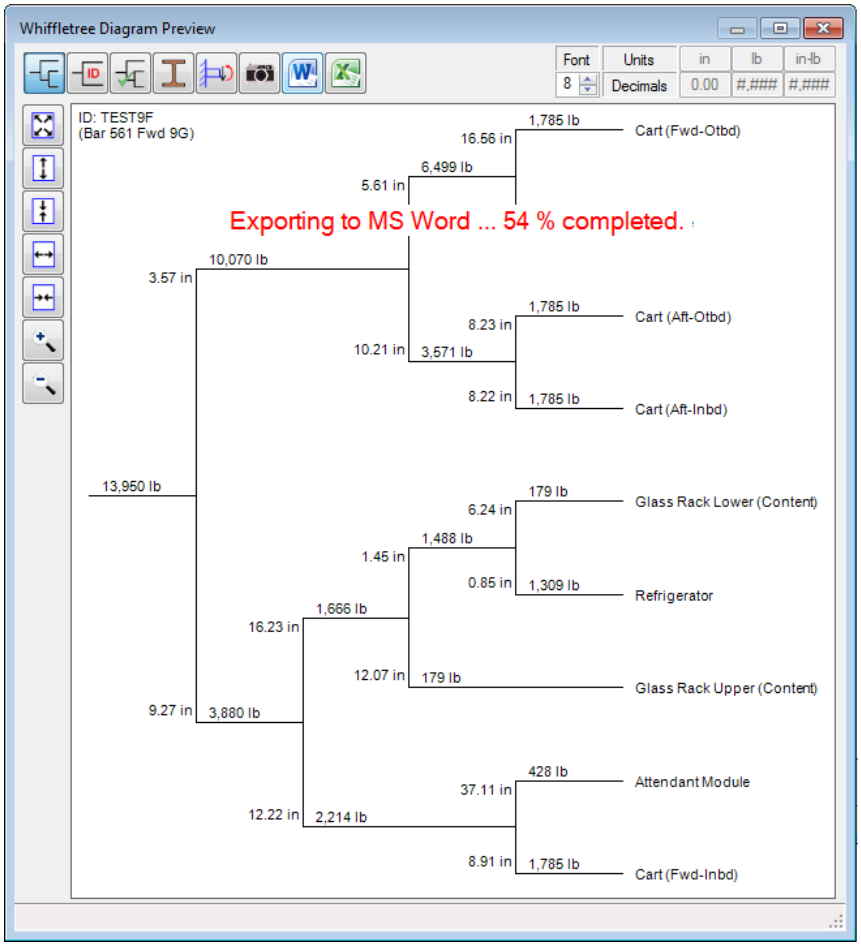

Figure 8-17

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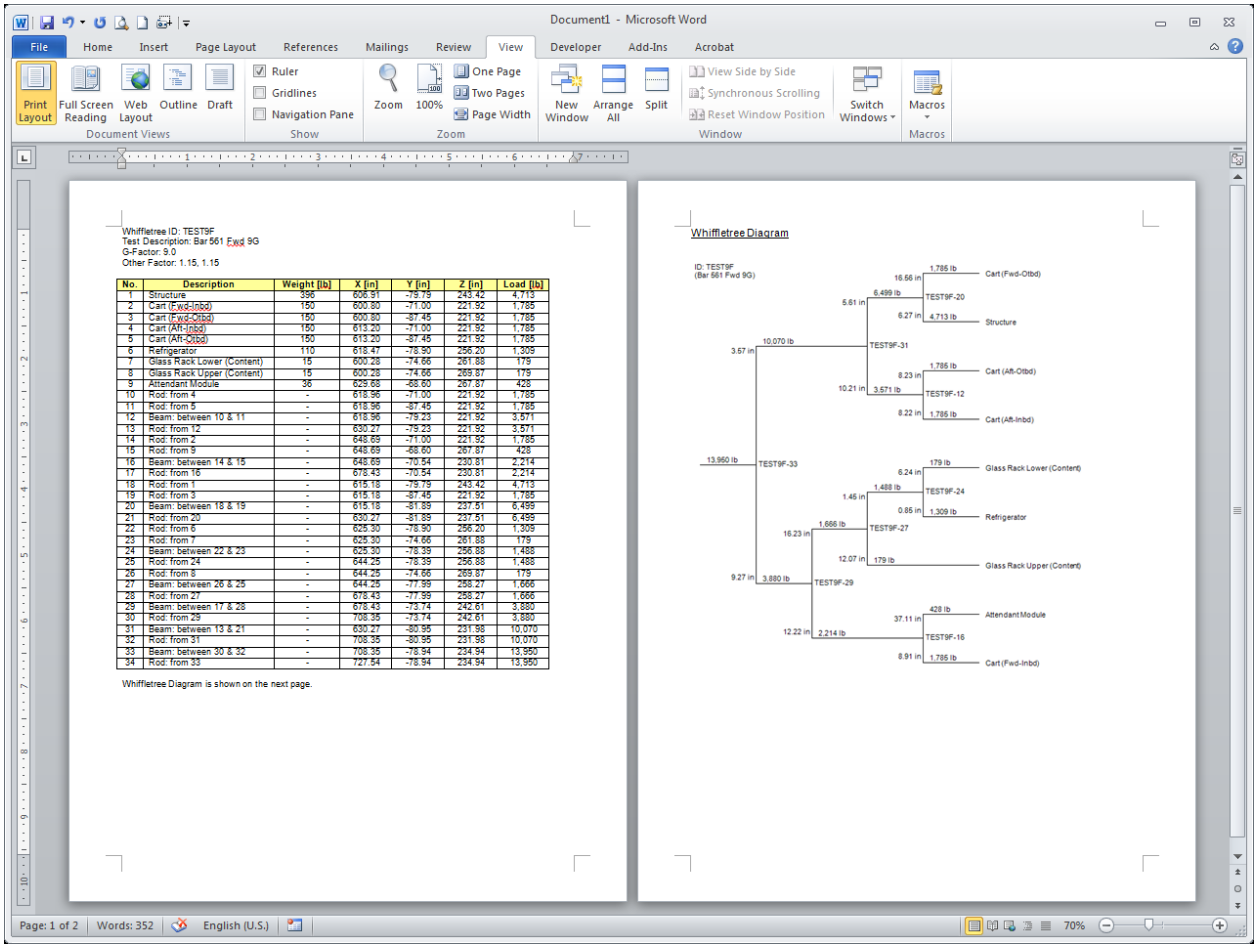

No.	Description	Weight [lb]	X [in]	Y [in]	Z [in]	Load [lb]
1	Structure	396	606.91	-79.79	243.42	4,713
2	Cart (Fwd-Inbd)	150	600.80	-71.00	221.92	1,785
3	Cart (Fwd-Otbd)	150	600.80	-87.45	221.92	1,785
4	Cart (Aft-Inbd)	150	613.20	-71.00	221.92	1,785
5	Cart (Aft-Otbd)	150	613.20	-87.45	221.92	1,785
6	Refrigerator	110	618.47	-76.90	256.20	1,309
7	Glass Rack Lower (Content)	15	600.28	-74.66	261.88	179
8	Glass Rack Upper (Content)	15	600.28	-74.66	269.87	179
9	Attendant Module	36	625.68	-68.60	267.87	428
10	Rod: from 4	-	618.96	-71.00	221.92	1,785
11	Rod: from 5	-	618.96	-87.45	221.92	1,785
12	Beam: between 10 & 11	-	618.96	-79.23	221.92	3,571
13	Rod: from 12	-	630.27	-79.23	221.92	3,571
14	Rod: from 2	-	648.69	-71.00	221.92	1,785
15	Rod: from 9	-	648.69	-68.60	267.87	428
16	Beam: between 14 & 15	-	648.69	-70.54	230.81	2,214
17	Rod: from 16	-	678.43	-70.54	230.81	2,214
18	Rod: from 1	-	615.18	-79.79	243.42	4,713
19	Rod: from 3	-	615.18	-87.45	221.92	1,785
20	Beam: between 18 & 19	-	615.18	-81.89	237.51	6,499
21	Rod: from 20	-	630.27	-81.89	237.51	6,499
22	Rod: from 6	-	625.30	-76.90	256.20	1,309
23	Rod: from 7	-	625.30	-74.66	261.88	179
24	Beam: between 22 & 23	-	625.30	-76.39	256.88	1,488
25	Rod: from 24	-	644.25	-76.39	256.88	1,488
26	Rod: from 8	-	644.25	-74.66	269.87	179
27	Beam: between 26 & 25	-	644.25	-77.99	258.27	1,666
28	Rod: from 27	-	678.43	-77.99	258.27	1,666
29	Beam: between 17 & 28	-	678.43	-73.74	242.61	3,880
30	Rod: from 29	-	708.35	-73.74	242.61	3,880
31	Beam: between 13 & 21	-	630.27	-80.95	231.98	10,070
32	Rod: from 31	-	708.35	-80.95	231.98	10,070
33	Beam: between 30 & 32	-	708.35	-78.94	234.94	13,950
34	Rod: from 33	-	727.54	-78.94	234.94	13,950

Figure 8-18

8.6.2 Export to Excel

Clicking the button will start exporting diagram into *Excel* file. You'll see progress in the *Whiffletree Model Window* but generally output will be complete in a second.

Output *Word* file includes:

- Whiffletree Summary
- Whiffletree Data Table
- Whiffletree Diagram

Because the exported whiffletree diagram and its values are not screenshot, you can edit or touchup the values when desired.

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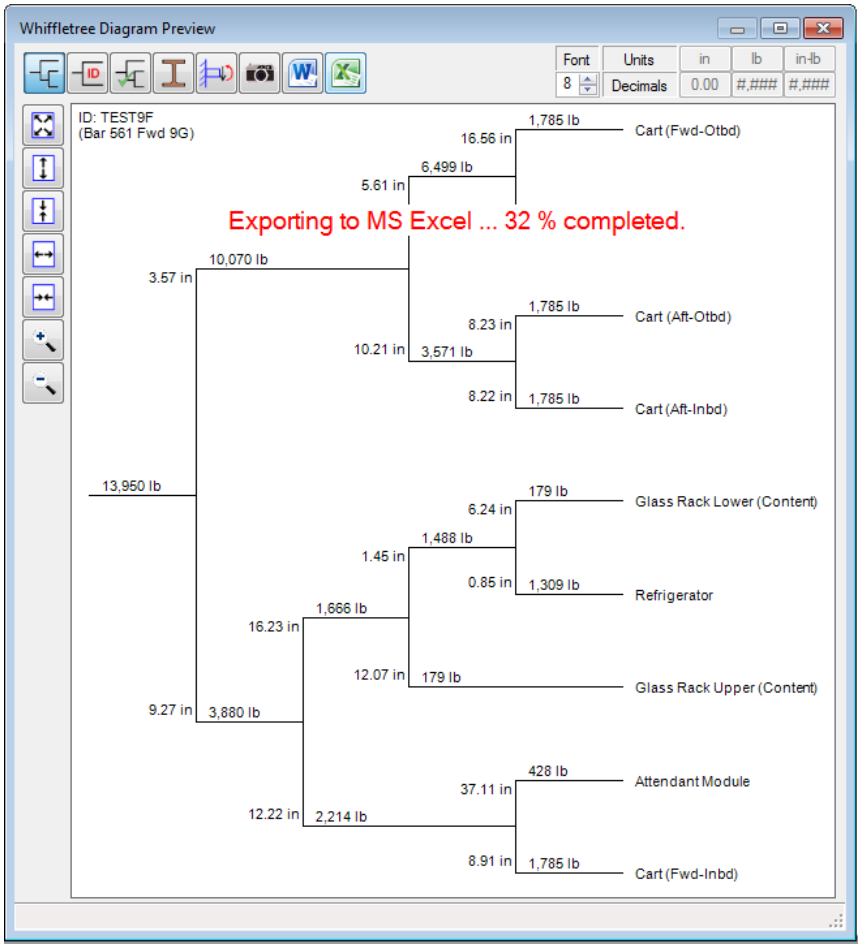

Figure 8-19

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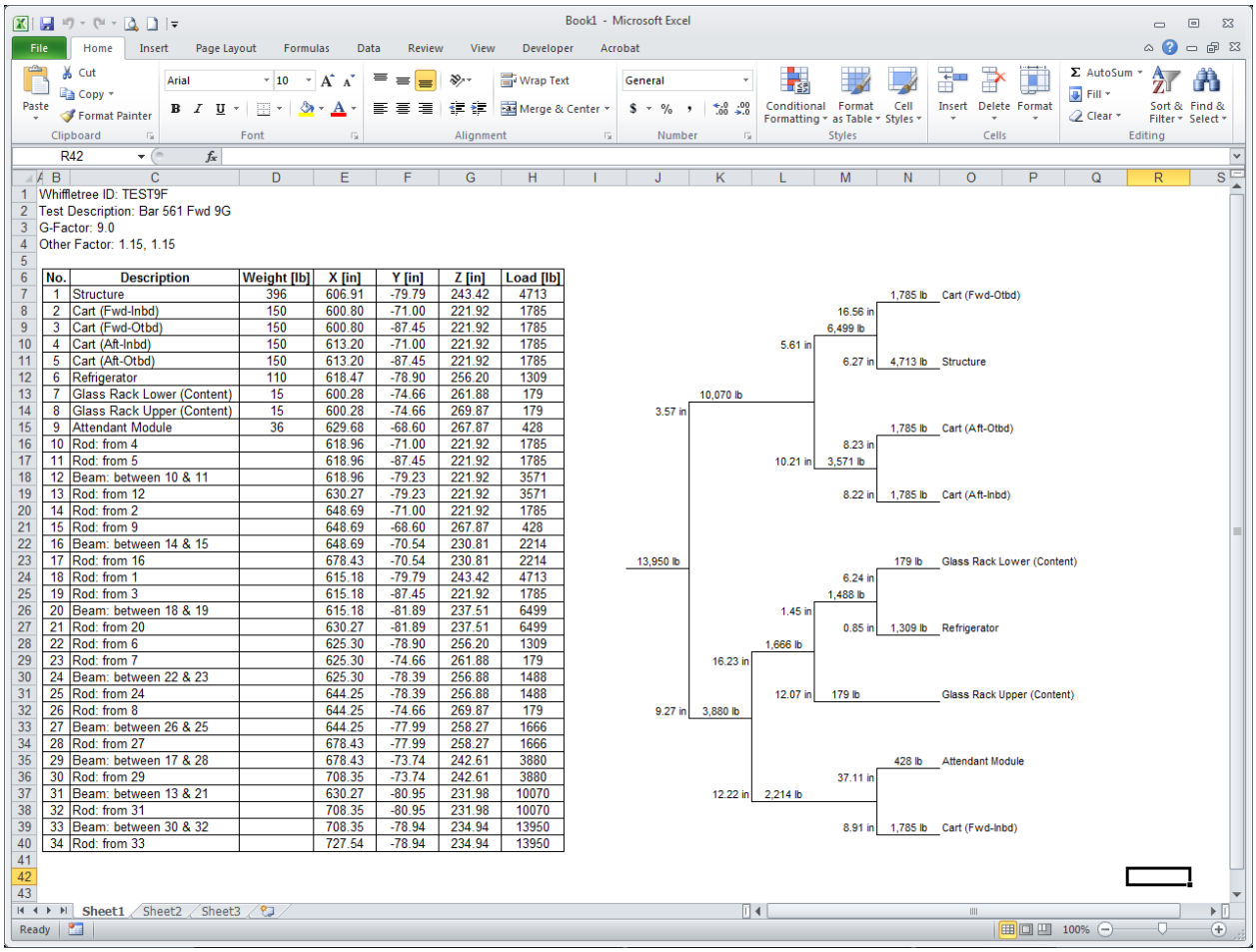

No.	Description	Weight [lb]	X [in]	Y [in]	Z [in]	Load [lb]
1	Structure	396	606.91	-79.79	243.42	4713
2	Cart (Fwd-Inbd)	150	600.80	-71.00	221.92	1785
3	Cart (Fwd-Otbd)	150	600.80	-87.45	221.92	1785
4	Cart (Aft-Inbd)	150	613.20	-71.00	221.92	1785
5	Cart (Aft-Otbd)	150	613.20	-87.45	221.92	1785
6	Refrigerator	110	618.47	-78.90	256.20	1309
7	Glass Rack Lower (Content)	15	600.28	-74.66	261.88	179
8	Glass Rack Upper (Content)	15	600.28	-74.66	269.87	179
9	Attendant Module	36	629.68	-68.60	267.87	428
10	Rod: from 4		618.96	-71.00	221.92	1785
11	Rod: from 5		618.96	-87.45	221.92	1785
12	Beam: between 10 & 11		618.96	-79.23	221.92	3571
13	Rod: from 12		630.27	-79.23	221.92	3571
14	Rod: from 2		648.69	-71.00	221.92	1785
15	Rod: from 9		648.69	-68.60	267.87	428
16	Beam: between 14 & 15		648.69	-70.54	230.81	2214
17	Rod: from 16		678.43	-70.54	230.81	2214
18	Rod: from 1		615.18	-79.79	243.42	4713
19	Rod: from 3		615.18	-87.45	221.92	1785
20	Beam: between 18 & 19		615.18	-81.89	237.51	6499
21	Rod: from 20		630.27	-81.89	237.51	6499
22	Rod: from 6		625.30	-78.90	256.20	1309
23	Rod: from 7		625.30	-74.66	261.88	179
24	Beam: between 22 & 23		625.30	-78.39	256.88	1488
25	Rod: from 24		644.25	-78.39	256.88	1488
26	Rod: from 8		644.25	-74.66	269.87	179
27	Beam: between 26 & 25		644.25	-77.99	258.27	1666
28	Rod: from 27		678.43	-77.99	258.27	1666
29	Beam: between 17 & 28		678.43	-73.74	242.61	3880
30	Rod: from 29		708.35	-73.74	242.61	3880
31	Beam: between 13 & 21		630.27	-80.95	231.98	10070
32	Rod: from 31		708.35	-80.95	231.98	10070
33	Beam: between 30 & 32		708.35	-78.94	234.94	13950
34	Rod: from 33		727.54	-78.94	234.94	13950

Figure 8-20

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9.0 EXPORT TO CATIA

This section explains how to export whiffletrees in *CATIA*.

CATIA Export function can be accessed by the following icon or *File Menu*.

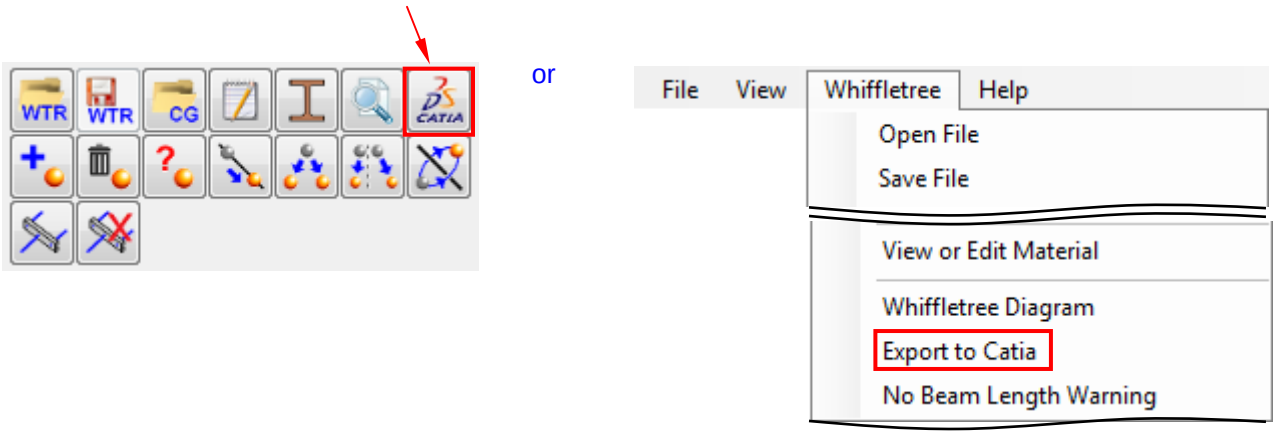

Figure 9-1

9.1 About CATIA Export

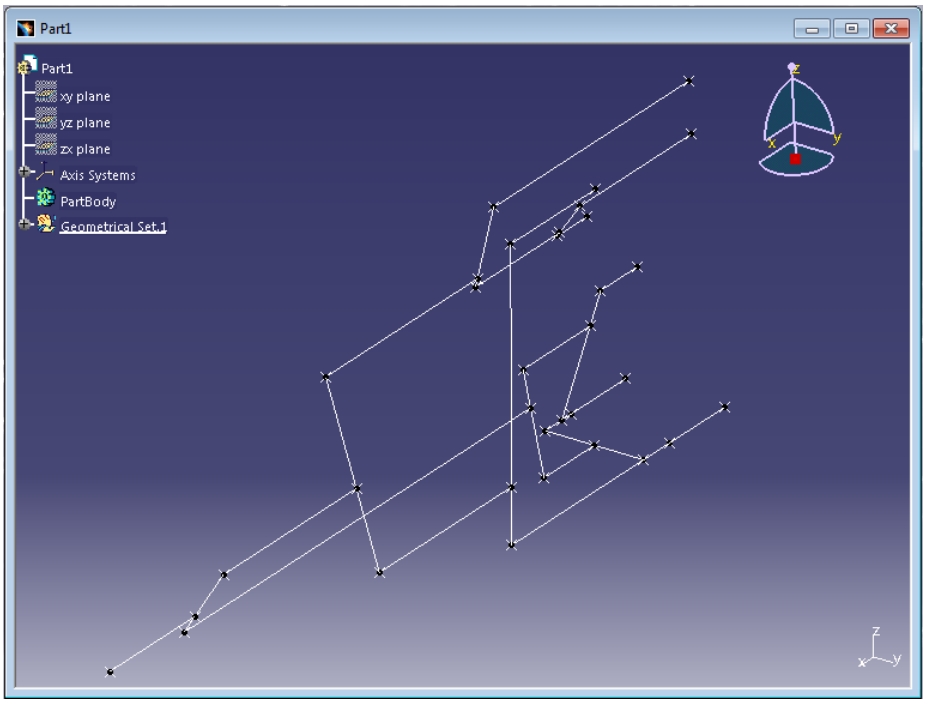

Figure 9-2

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3DWhiffletree can export whiffletree geometric data into *CATIA* as *CATIA Part* with points and lines as shown in the figure above.

You need:

1. *CATIA* installed on your computer (tested with V5 R21),
2. *CATIA* launched, and
3. *CATIA Part Design* is opened and window is activated.

Warnings:

Part must have "Axis system". To verify if your part has an Axis stem, check the part tree and make sure you can see "Axis systems" as follows:

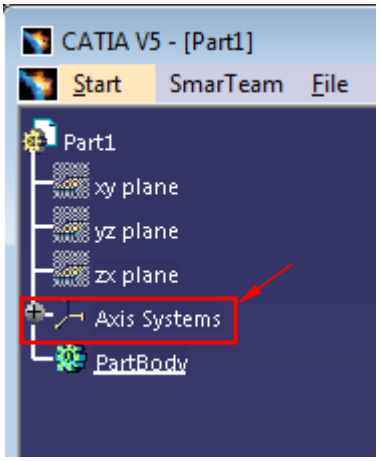

Figure 9-3

If not, take the following steps:

1) In Catia, go to ***Tools*** >> ***Options***.
2) From menu trees on left, select ***Infrastructures*** >> ***Part Infrastructures***
3) Select ***Part Document*** tab on top
4) Make sure the checkbox for ***Create an axis system*** is checked under ***When Creating Part***.
5) Close the option window, then open a new Part. Verify if you see ***Axis system*** in your part tree. Now you should be ready for exporting whiffletree to Catia.

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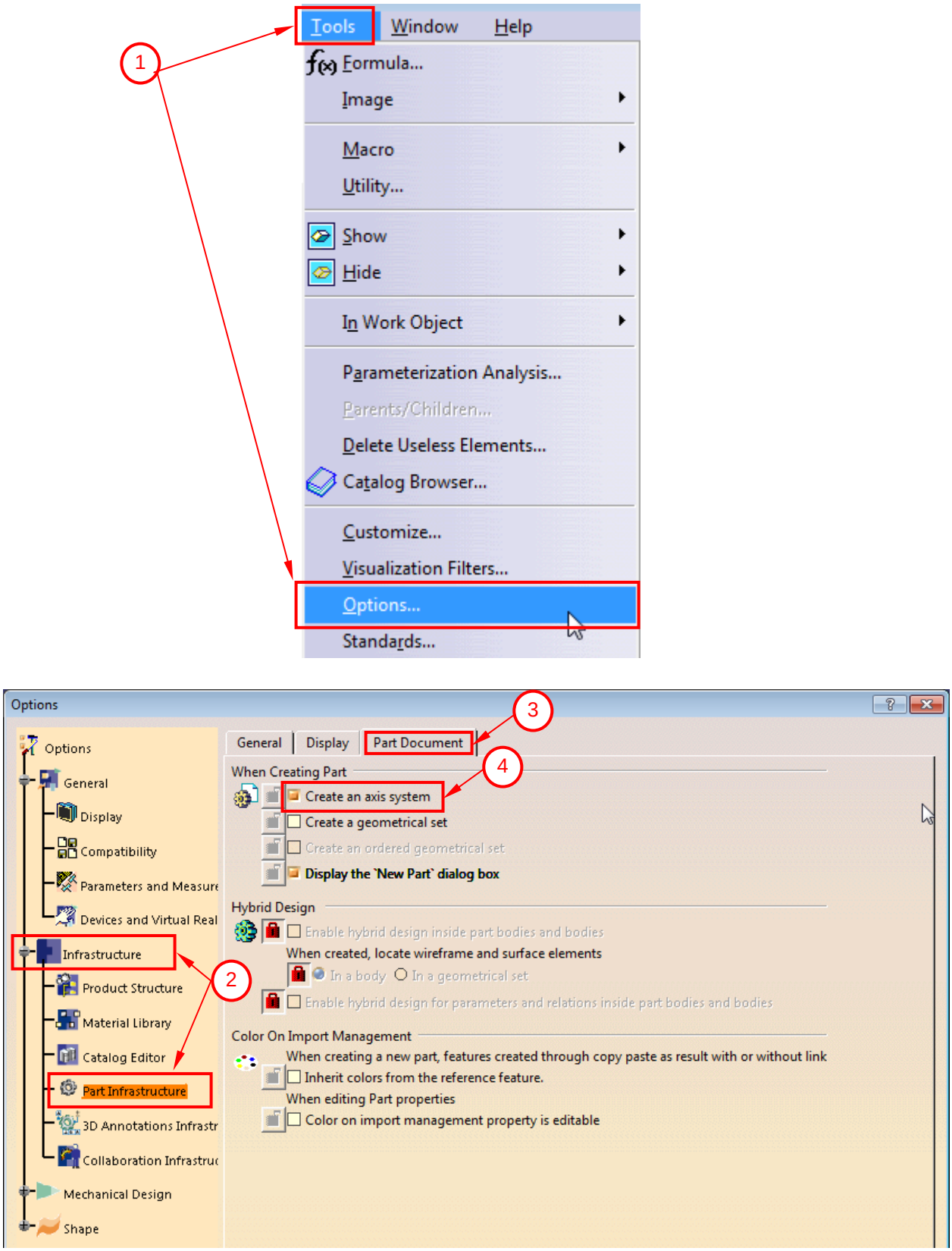

Figure 9-4

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Once you create a *CATIA Part Design* for your whiffletree models, you can bring it into your *CATIA Product* model to check physical properties such as interferences.

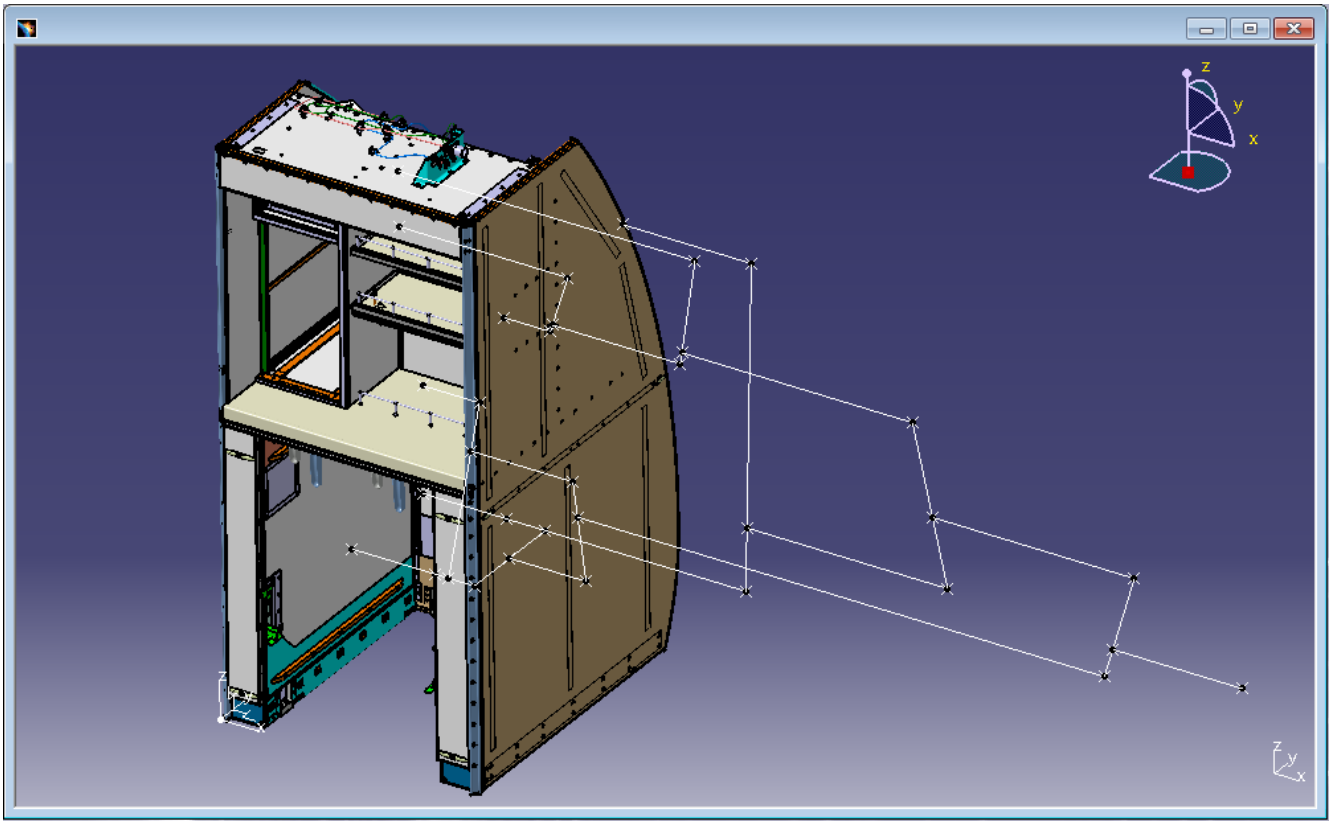

Figure 9-5

9.2 Export Window

The figure below shows a typical window for exporting whiffletree into *CATIA*.

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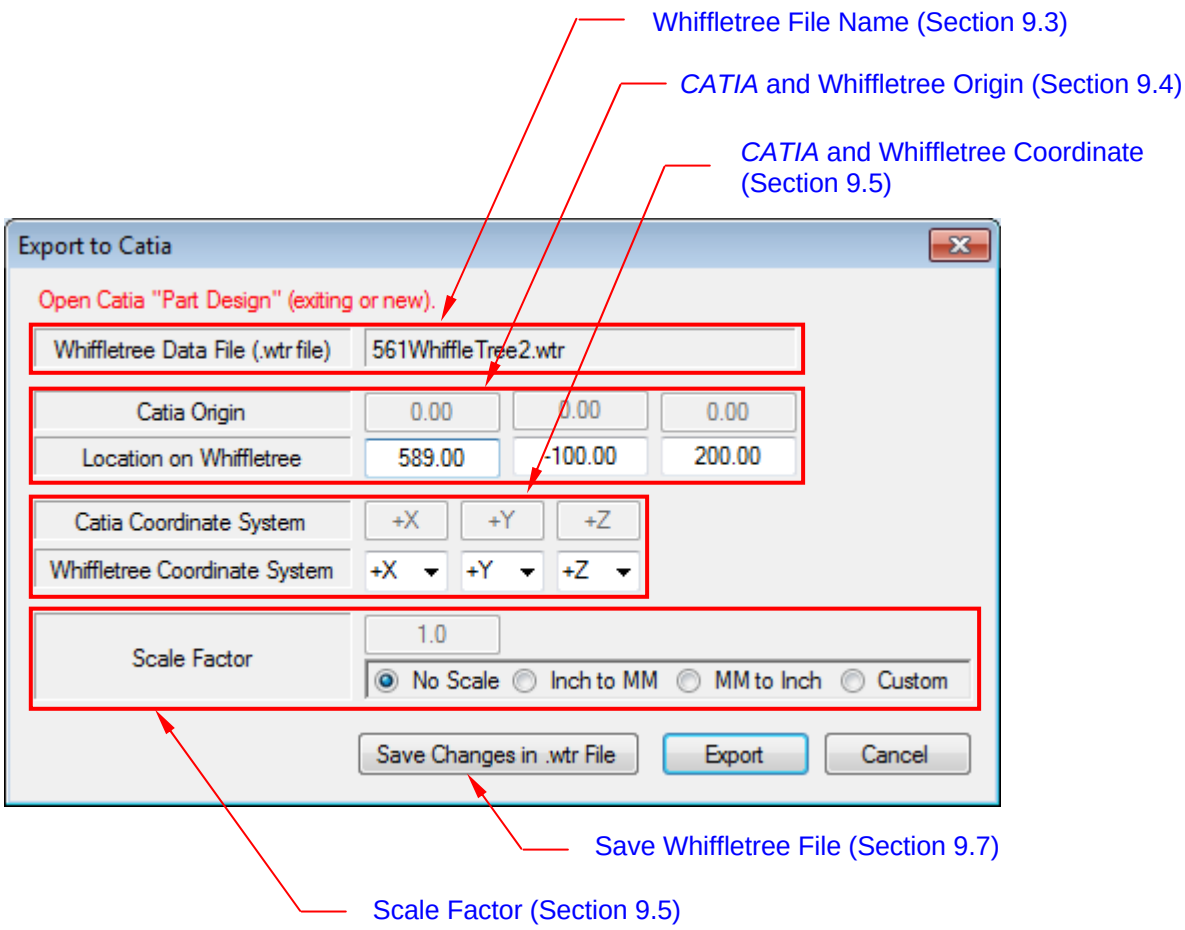

Figure 9-6

9.3 Whiffletree Data File

Whiffletree Data File (.wtr file)	561WhiffleTree2.wtr

This shows current whiffletree file (*.wtr). If no file is opened or saved, the file name is shown as "*NA*".

9.4 CATIA Origin and Location on Whiffletree

Catia Origin	0.00	0.00	0.00
Location on Whiffletree	589	-100	200

CATIA assembly origin is often different from FEM (or whiffletree) origin. To locate whiffletree diagram at correct location in *CATIA* assembly, specify where *CATIA* origin is located in in whiffletree coordinate

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system. In other words, specify location of whiffletree diagram where the location is same as *CATIA* coordinate (0, 0, 0). Note that *CATIA* origin is always (0,0,0) and cannot be changed.

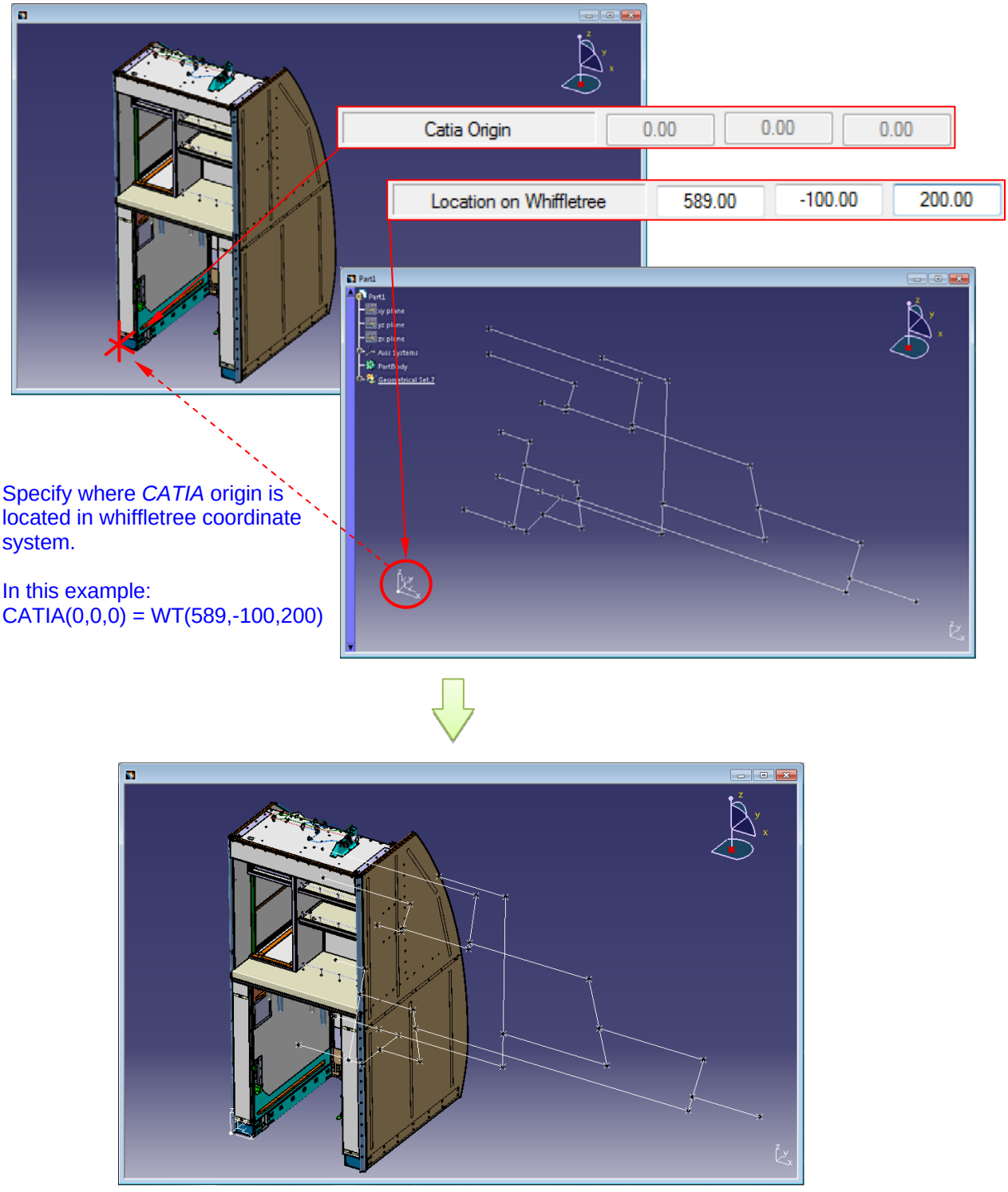

Figure 9-7

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9.5 CATIA Coordinate and Whiffletree Coordinate

Sometimes *CATIA* coordinate is different from whiffletree coordinate. For example, x-axis of the whiffletree may be y-axis in *CATIA* coordinate. In such a case, you can specify whiffletree coordinate system to match that of *CATIA* coordinate system.

The below example shows different exported whiffletree when whiffletree x-axis is flipped.

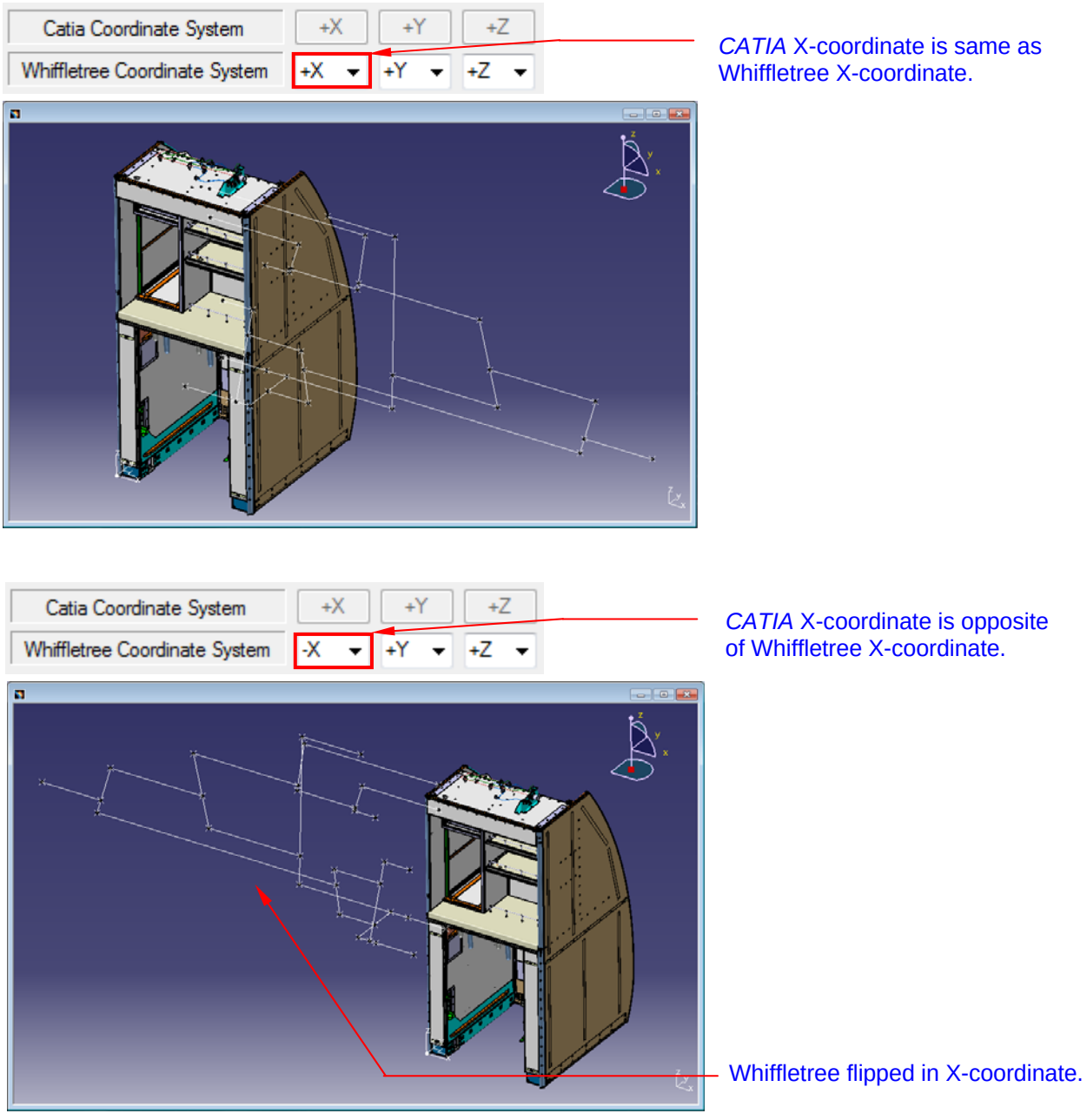

Figure 9-8

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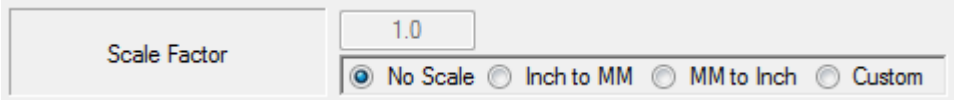
9.6 Scale Factor

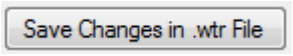


The scale factor will convert units between *3DWhiffletree* and *CATIA*. There are predefined scale factors as well as user-entered value. Following table summarizes the different scale factors.

Table 9-1

Items	Explanations
No Scale	Scale Factor = 1.0 There won't be any scales performed.
Inch to MM	Scale Factor = 25.4 1 unit in Whiffletree becomes 25.4 units in *CATIA*.
MM to Inch	Scale Factor = 0.03937 1 unit in Whiffletree becomes 0.03937 unit in *CATIA*.
Custom	User can enter any scale factors.

9.7 Save Changes in .wtr File



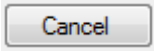
This button will save information defined in *CATIA Export Window* such as location of whiffletree and coordinate system.

Remarks:

1. Information in *CATIA Export Window* can be only saved through this window. Saving the file from

(main window) will not save information in *CATIA Export Window*.

2. The save button is only available if any exiting file is opened or whiffletree file has been saved. When file name is shown as "*NA*", the button is not enabled.

3. If you click 

without saving changes, you will see the following warning message. Clicking *No* will let you stay in the window. Clicking *Yes* will close the window without saving changes you made.

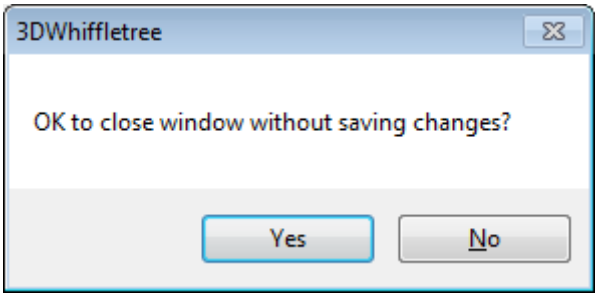


Figure 9-9

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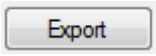
9.8 Export



This button will create whiffletree diagram in *CATIA Part Design*.

Remarks:

1. Make sure that you have *CATIA Part Design* open and activated as follows

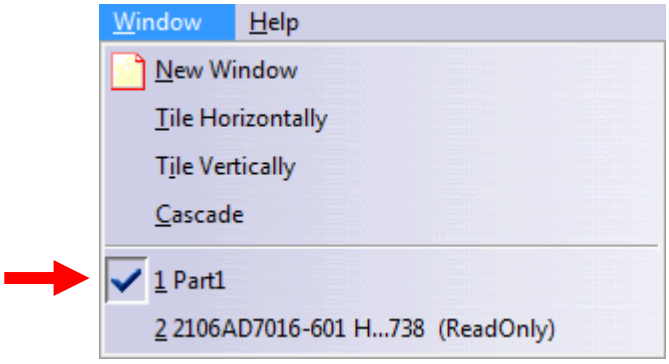
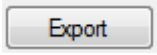


Figure 9-10

2. After clicking 

, you may see the following message.

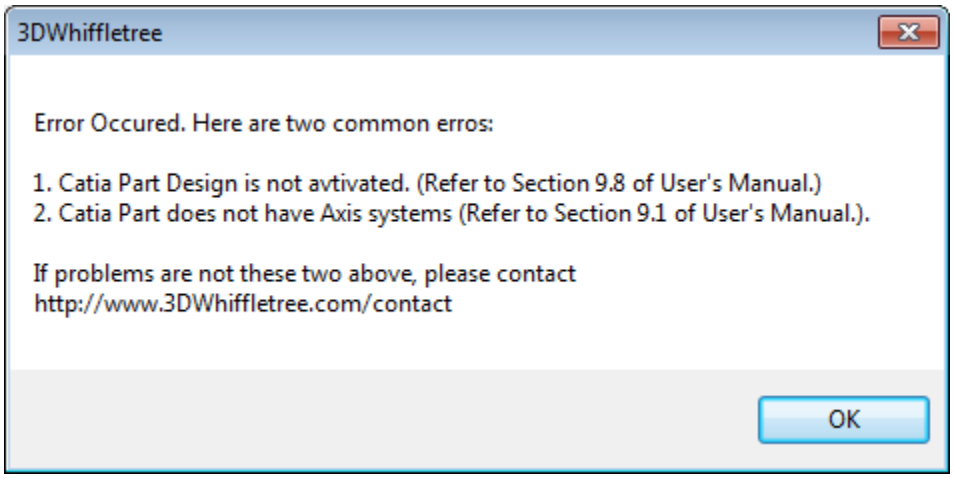


Figure 9-11

Common errors are:

i) *CATIA Part Design* is not activated. If so, check *CATIA* window.
ii) *CATIA Part* does not have Axis systems. Refer to Section 9.1 for how to add Axis stems in your part.

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3. If there is no error, *CATIA* will start importing whiffletree data and create points and lines in *CATIA Part Design*. The following message will appear if whiffletree data are successfully exported into CATIA.

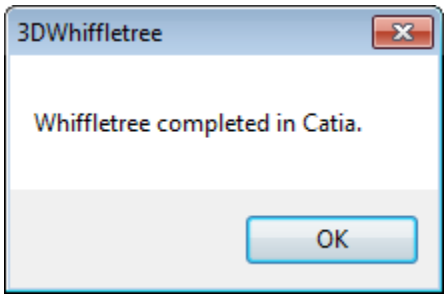

Figure 9-12