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## **Introduction**

### **CATIA Version 5 Composites**

Upon completion of this course, the student should have a full understanding of the following topics:

- Defining composite parameters
- Creating and modifying zones
- Creating and modifying grid panels
- Creating and modifying plies
- Generating solids based off of zones or plies
- Analyzing and inspecting composite parts
- Creating manufacturing processes for composite parts
- Exporting ply definition

## Composites

This course will cover all of the options found in the Composites Design and Composite Grid Design workbenches. The first portion of the book will focus on the design options available within the Composite Design workbench. The second portion of the book will delve into the manufacturing side of composite parts and how they will be created. Finally, the grid method will be discussed in the Composite Grid Design workbench. In order to have access to the Composites workbenches, you will need to turn on the CPE and CPM licenses under *Tools, Options, General, Licensing*.

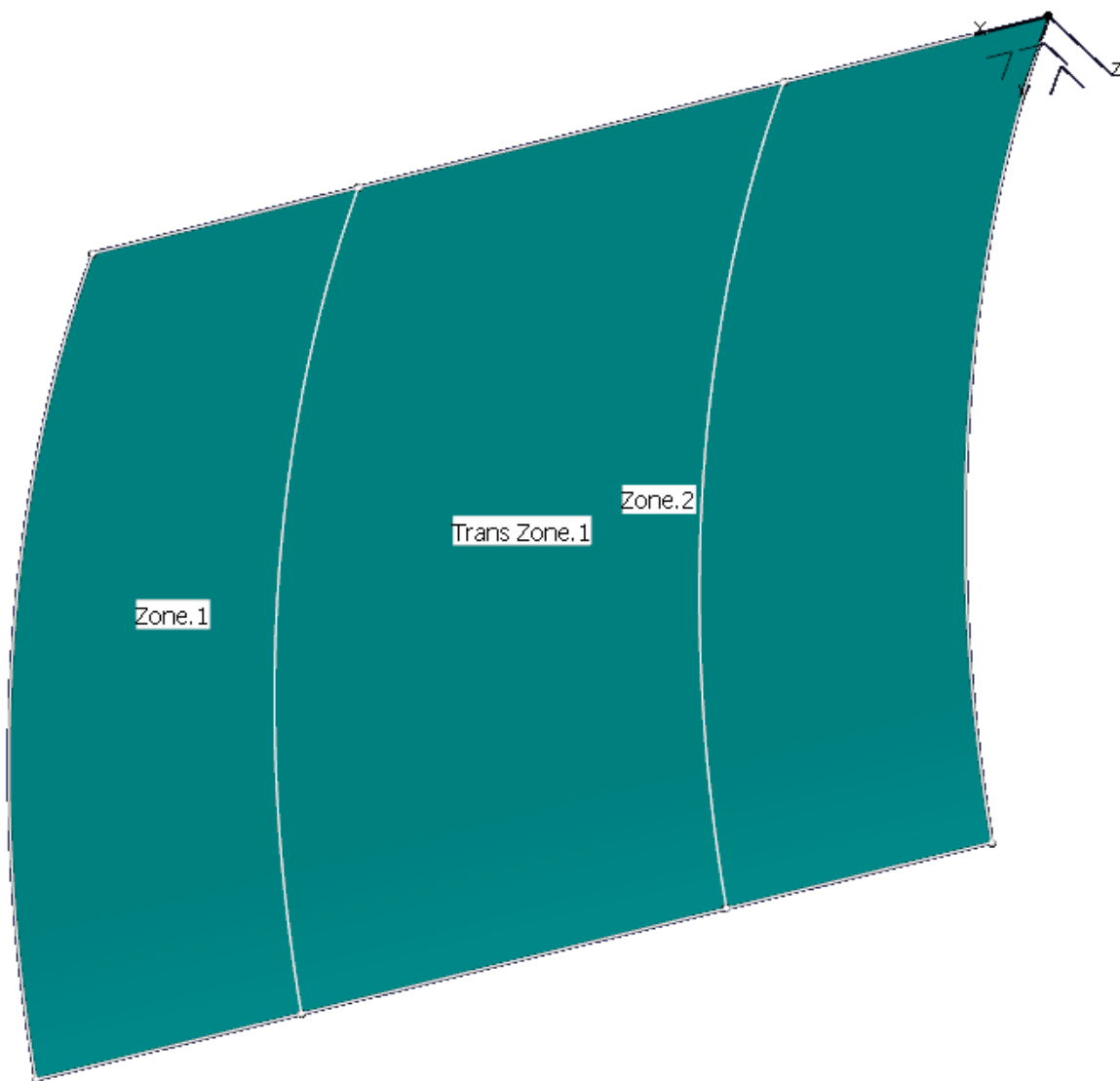
## Ply Creation

This section will discuss creating and modifying plies both automatically and manually. The plies created here will represent the actual plies that will be necessary in order to build the composite part.

### Importing a Laminate

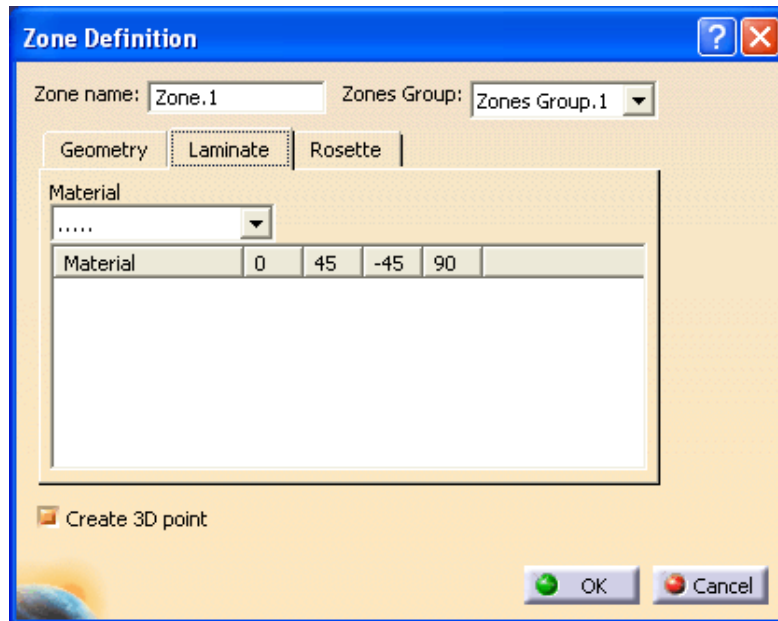
When a zone is defined, the laminate can be specified by manually entering the number of plies in each direction. Rather than entering each laminate definition manually, the definitions may be imported from an excel spreadsheet.

**Open the Importing a Laminate model.** The zones have already been defined on this model. It should appear as shown.



Double select on *Zone.1* in the specification tree. The *Zone Definition* window appears.

Switch to the *Laminate* tab. Notice nothing has been defined.



Select *Cancel*. The second zone laminate definition is not specified either.

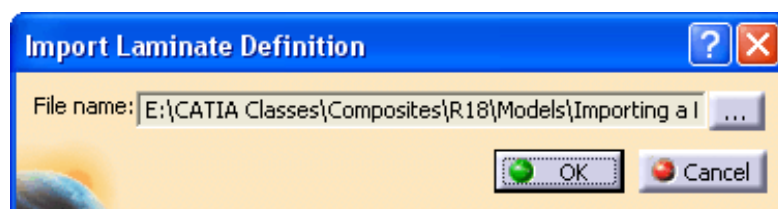
Open the *Import Laminate Definition* document. This is a predefined excel spreadsheet containing the laminate definition. It should appear as shown.


	A	B	C	D
1	Material	Direction	Zone.1	Zone.2
2	A - Glass Fiber	0	2	2
3	A - Glass Fiber	45	4	1
4	A - Glass Fiber	-45	4	1
5	A - Glass Fiber	90	2	2
6				

The material, directions and plies can all be modified for each zone within the excel spreadsheet. Keep in mind, the composite parameters defined in the part, must match the spreadsheet. If you have directions of 0, 45, -45 and 90 in the spreadsheet, you must have those same directions in the composite parameters.

Close the spreadsheet.

Select the *Import Laminate* icon.  The *Import Laminate Definition* window appears.

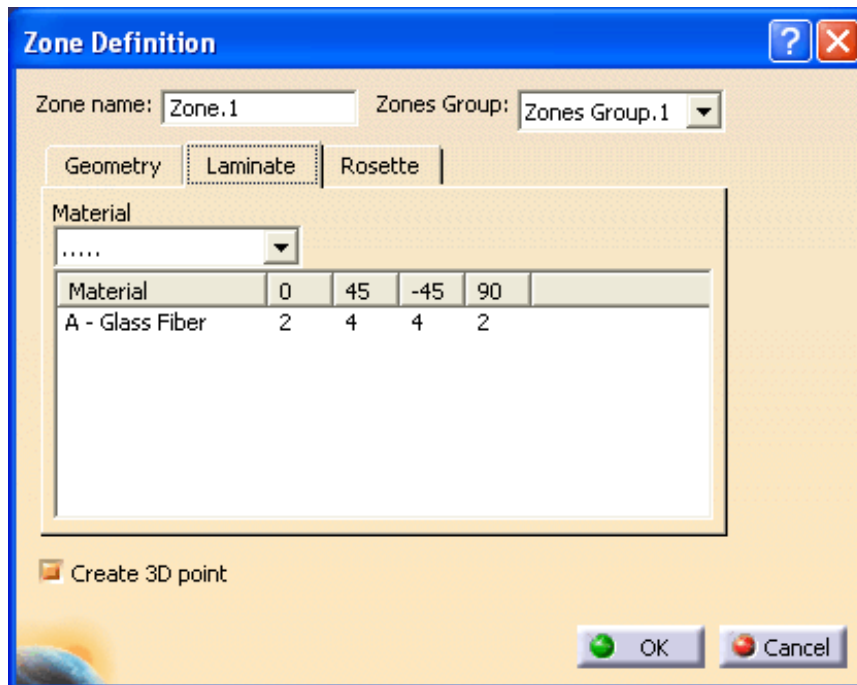


Select the **Browse icon**.  This will allow you to define the correct spreadsheet to use to define the laminate.

**Browse to the models directory and select the Import Laminate Definition document and select *Open*.**

Select **OK**.

**Double select *Zone.1* in the specification tree and switch to the *Laminate* tab again.**  
Notice the laminate definition is defined.



Select **OK**.

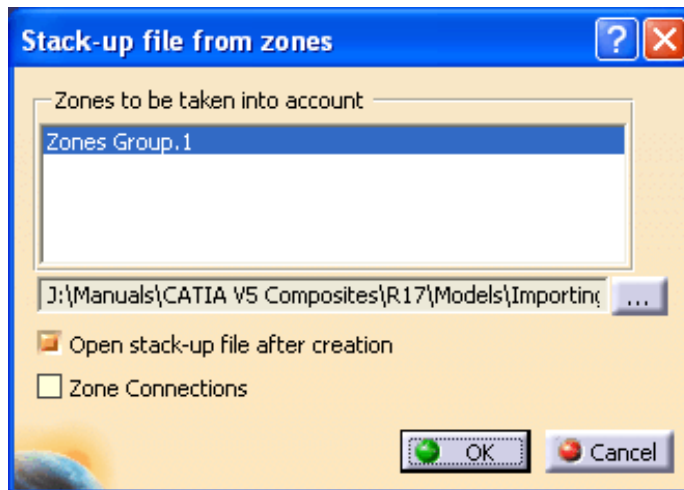
The other zone is also defined. If you decided to make a change to the laminate definition at this point, you could either do it manually or you could change the spreadsheet and then import the laminate again.




## Stack Up File From Zones

This option allows you to create a stack up file based on predefined zones. The file will contain the stacking order of the plies within the composite part. This provides a way to look at the way the plies will be created before actually creating them.

Select the **Stack Up from Zones** icon.  The *Stack-up file from zones* window appears.



<i>Zones to be taken...</i>	Specifies the zones that will be referenced in the stack up
<i>Browse button</i> 	Specifies where the file will be saved
<i>Open stack-up file...</i>	Specifies that the newly generated file will automatically be opened upon creation
<i>Zone Connections</i>	Includes the zone connection sizes in the file

Select the **Browse** icon and go to a location in your area. Name the file **Stack Up From Zones** and select *Open*. This specifies where the file will be stored.

Turn on the *Open stack-up file after creation* option and select *OK*. The stack up file is created and should be opened automatically.

	A	B	C	D	E	F	G
1	Sequence	Ply	Geo-Lvl	Material	Zone.1	Zone.2	
2	Sequence	Ply.1	6	A - Glass Fiber	45		
3	Sequence	Ply.2	5	A - Glass Fiber	-45		
4	Sequence	Ply.3	4	A - Glass Fiber	-45		
5	Sequence	Ply.4	3	A - Glass Fiber	45		
6	Sequence	Ply.5	2	A - Glass Fiber	45		
7	Sequence	Ply.6	1	A - Glass Fiber	-45		
8	Sequence	Ply.7	6	A - Glass Fiber	45	45	
9	Sequence	Ply.8	5	A - Glass Fiber	0	0	
10	Sequence	Ply.9	4	A - Glass Fiber	0	0	
11	Sequence	Ply.10	3	A - Glass Fiber	-45	-45	
12	Sequence	Ply.11	2	A - Glass Fiber	90	90	
13	Sequence	Ply.12	1	A - Glass Fiber	90	90	
14							
15	Zones Groups						
16	Zones Gro	Zone.1	Zone.2				
17							

The spreadsheet shows all of the plies that would be created based off of the defined zones at this point.

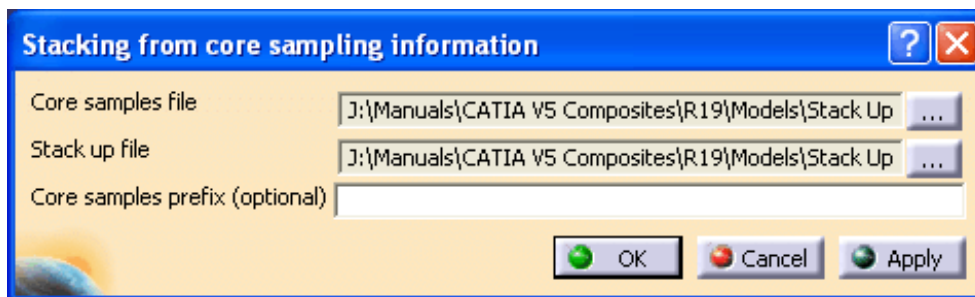
**Save and close both documents.**

## Stack Up File From Core Samples

This option allows you to create a stack up file and core sampling based on predefined zones and existing plies. The file will contain the stacking order of the plies within the composite part. The core sampling file displays the location of the core sampling itself for each zone.

**Open the Stack Up File From Core Sampling document.** The plies have already been generated for this file.

**Select the Stack Up File from Core Sampling icon.**  The *Stacking from core sampling information* window appears.



*Core samples file* Specifies where the core samples file will be stored

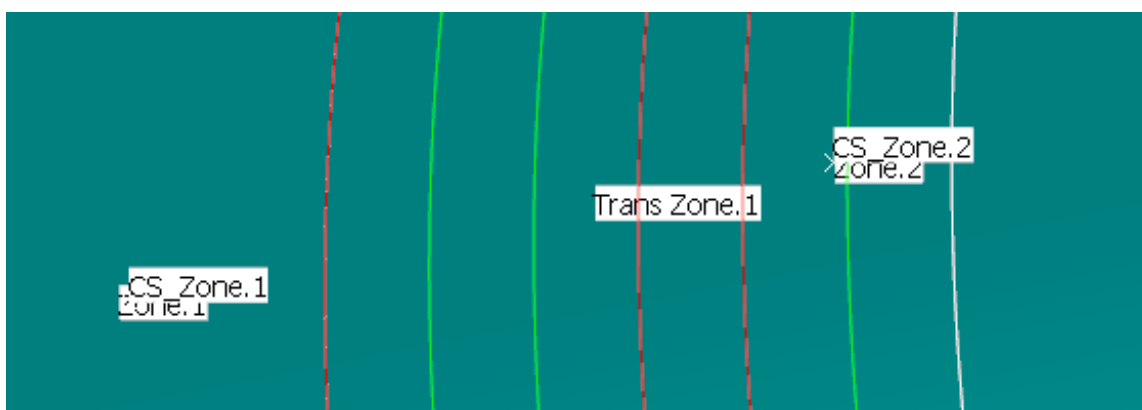
*Stack up file* Specifies where the stack up file will be stored

*Core samples prefix* Defines a prefix for the core samples that will be created in the model

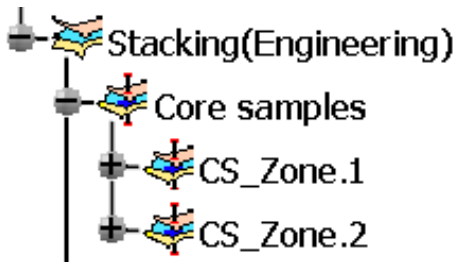
**Select the Browse icon for the *Core samples file* and go to a location in your area. Name the file Core Sample and select *Open*.** This specifies where the file will be stored.

**Select the Browse icon for the *Stack up file* and go to a location in your area. Name the file Stack Up and select *Open*.** This specifies where the file will be stored.

**Key in CS for the *Core samples prefix* and select *OK*.** The files are generated along with core samples in the model. The locations of the core samples are shown in the display.



The core samples should appear as shown in the specification tree as well. These will be discussed in more detail later on.



**Go to your area and open both the Core Sample file and the Stack Up file.** The Core Sample file should appear as shown.

Core Sample [Compatibility Mode]					
	A	B	C	D	
1	Core Sample Points	X	Y	Z	
2	CS_Zone.1	31 in	-36 in	4.6719e-007 in	
3	CS_Zone.2	13 in	-36 in	2.86131e-007 in	
4					

The Stack Up file should appear as shown.

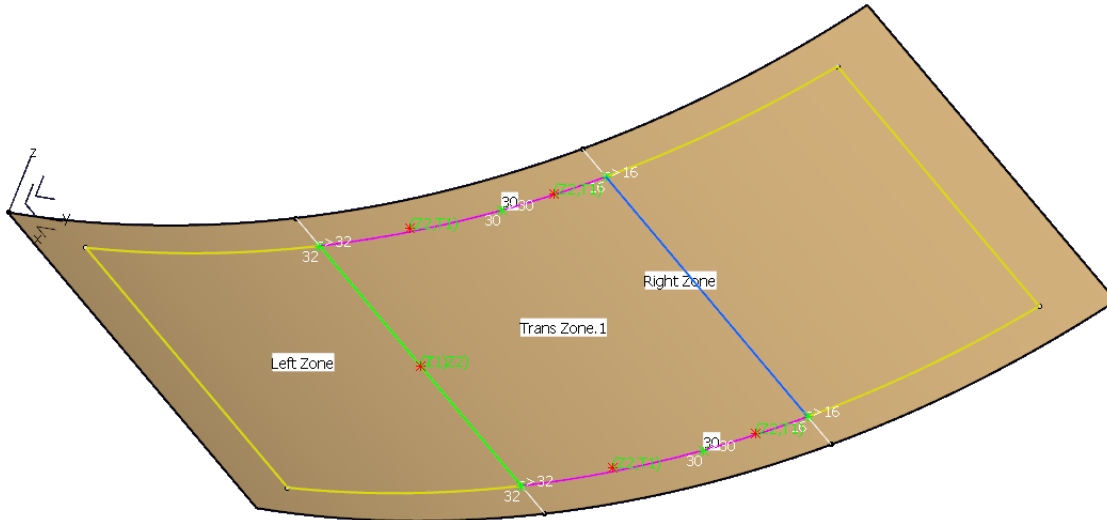
Stack Up [Compatibility Mode]						
	A	B	C	D	E	F
1	Sequence	Ply	Geo-Lvl	Material	CS_Zone.1	CS_Zone.2
2	Sequence.1	Ply.1	0	A - Glass Fiber	45	
3	Sequence.2	Ply.2	0	A - Glass Fiber	-45	
4	Sequence.3	Ply.3	0	A - Glass Fiber	-45	
5	Sequence.4	Ply.4	0	A - Glass Fiber	45	
6	Sequence.5	Ply.5	0	A - Glass Fiber	45	
7	Sequence.6	Ply.6	0	A - Glass Fiber	-45	-45
8	Sequence.7	Ply.7	0	A - Glass Fiber	45	45
9	Sequence.8	Ply.8	0	A - Glass Fiber	0	0
10	Sequence.9	Ply.9	0	A - Glass Fiber	0	0
11	Sequence.10	Ply.10	0	A - Glass Fiber	-45	-45
12	Sequence.11	Ply.11	0	A - Glass Fiber	90	90
13	Sequence.12	Ply.12	0	A - Glass Fiber	90	90

**Save and close the documents.**

### Plies Creation From Zones

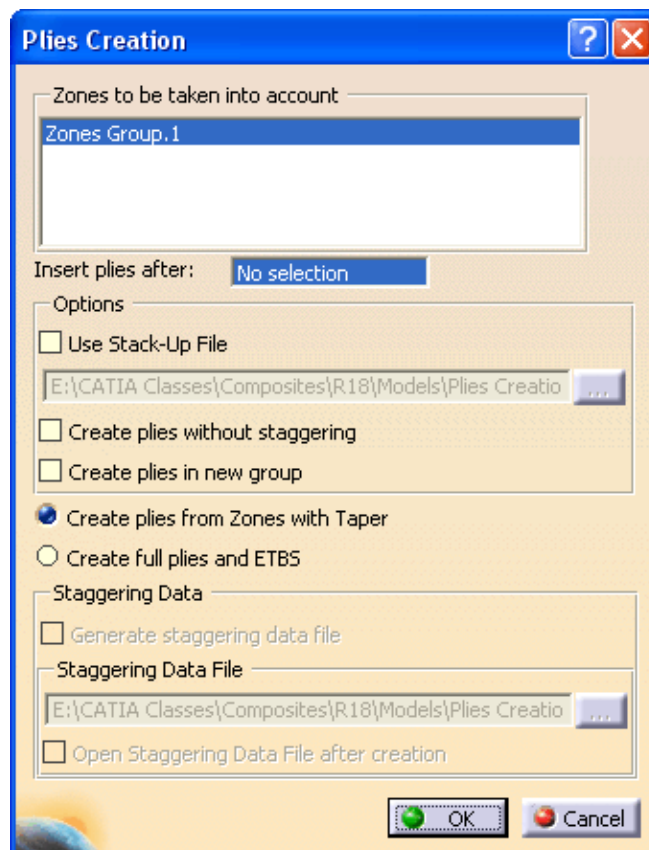
This option automatically generates plies based on predefined zones.

**Open the Plies Creation document.** All of the preliminary design has already been done on this model.



**Expand the *Composites PD* branch and hide the *Connection generator* branch in the tree.** This will make it easier to select the wireframe elements later on in this exercise.

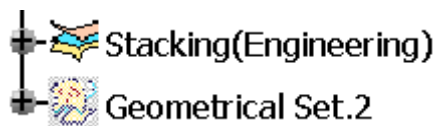
Select the **Plies Creation from Zones icon**.  The *Plies Creation* window appears.



<i>Zones to be taken...</i>	Specifies the zones that will be used to create plies
<i>Insert plies after</i>	Defines where the plies will be inserted into the specification tree
<i>Use Stack-Up File</i>	Specifies the plies will be created based on a predefined stack up file
<i>Create plies without...</i>	Specifies no staggering will be used in the creation of the plies
<i>Create plies in new group</i>	Specifies a the plies will automatically be created in a new group
<i>Create plies from Zones...</i>	Specifies that taper will be used in the creation of the plies within the transition zones
<i>Create full plies and...</i>	Specifies that the plies will be created with the corresponding edges to be staggered. The ETBS can be used to define limit contours for modifying the plies later on.

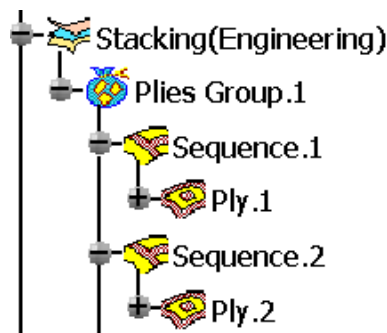
*Staggering Data* When using the *Create full plies and ETBS* option, you may choose to generate a staggering data file containing all of the edges to be staggered

**Turn on the *Create plies in new group* option and be sure the *Create plies from Zones with Taper* option is active and select *OK*.** The plies are generated. Two new branches appear in the specification tree.

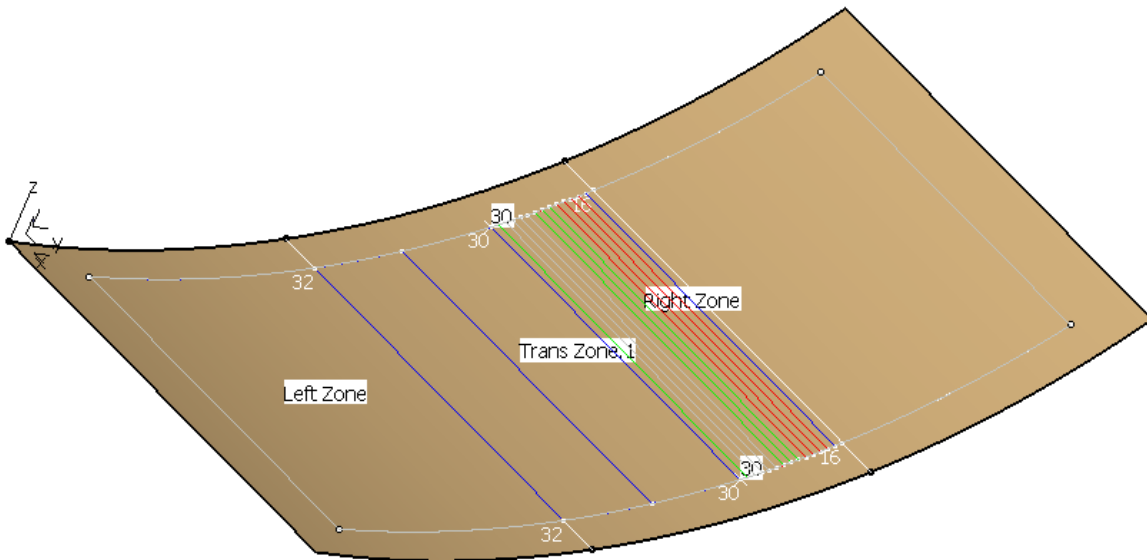


The *Stacking* branch contains the new group and all of the plies. The geometrical set contains datum curves that represent the outside edges of the plies.

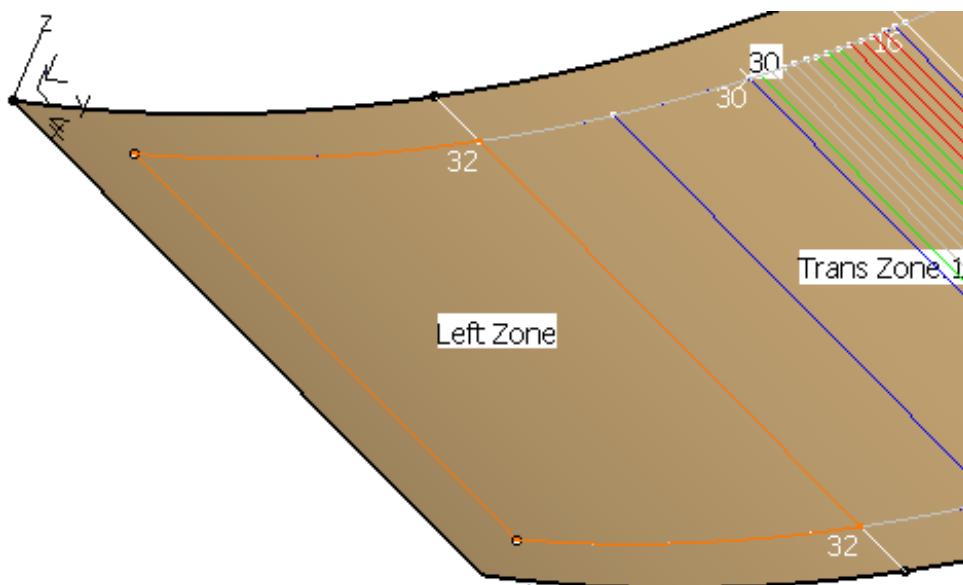
**Expand the *Stacking* branch.** It should appear as shown. Notice the plies are contained within a plies group. The order of the plies under the *Stacking* branch determines the order that they will stacked on the definition surface.



The staggering locations are displayed on the surface as well.



Select *Ply.1* in the specification tree. Notice the ply highlights in the display.

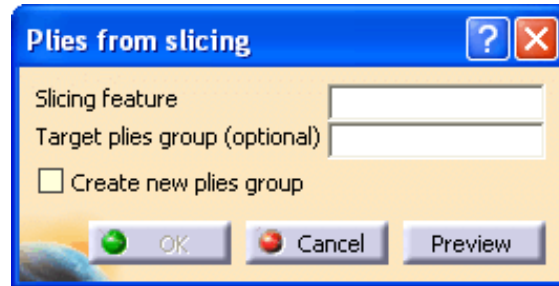


Each ply is represented in the specification tree and its outline will highlight in the display if you select it from the tree. By default, the plies are created from smallest to largest. This is typically not how you will want them to be ordered. Later, you will actually explode the plies so you can see them as well as reorder them.

## Plies Creation From Slicing

This option allows you to generate plies from a slicing.

Select the **Plies Creation from Slicing** icon.  The *Plies from Slicing* window appears.



*Slicing feature*

Specifies the slicing to create the plies from

*Target plies group*

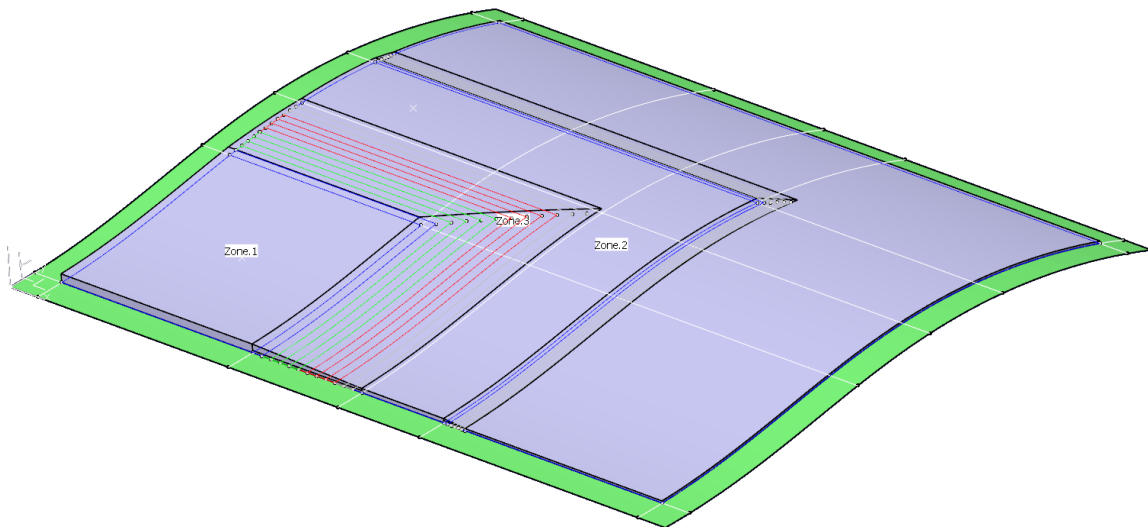
Specifies the plies group the new plies should be stored within

*Create new plies group*

Allows you to create a new plies group to store the new plies

Select *Slicing Curves Group of Zones Group.1* from the specification tree.

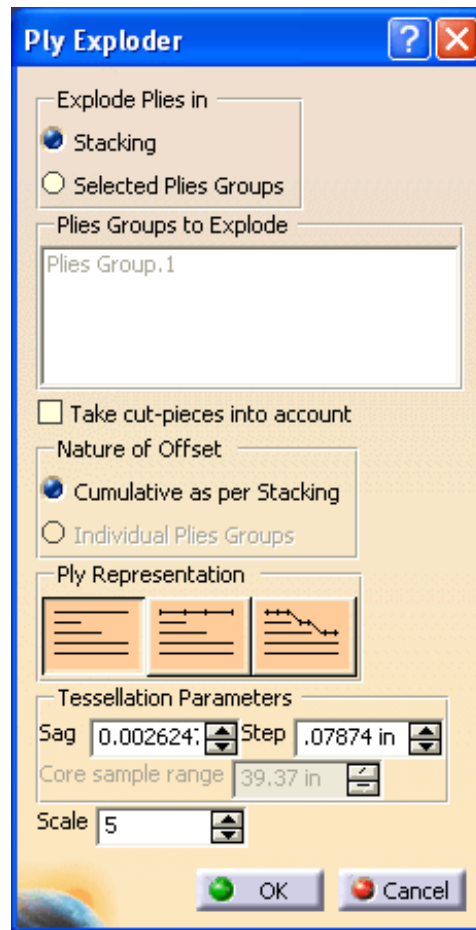
Turn on the *Create new plies group* option and select **OK**. The plies are generated.



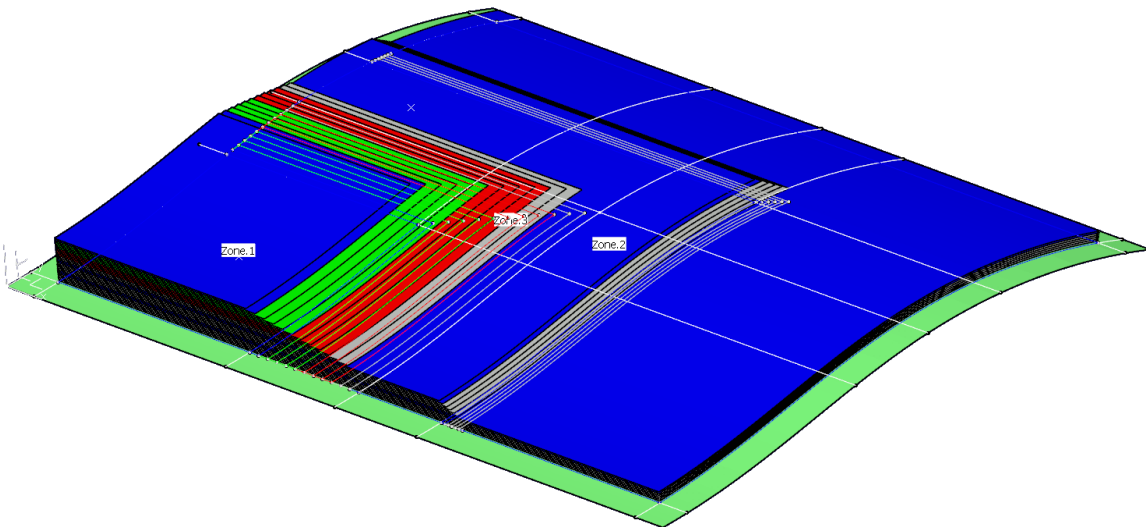
Hide the *Solid from Zones* partbody in the tree.



Select the Ply Exploder icon.  The *Ply Exploder* window appears.



Set the options as shown above and select **OK**. The plies appear as shown.

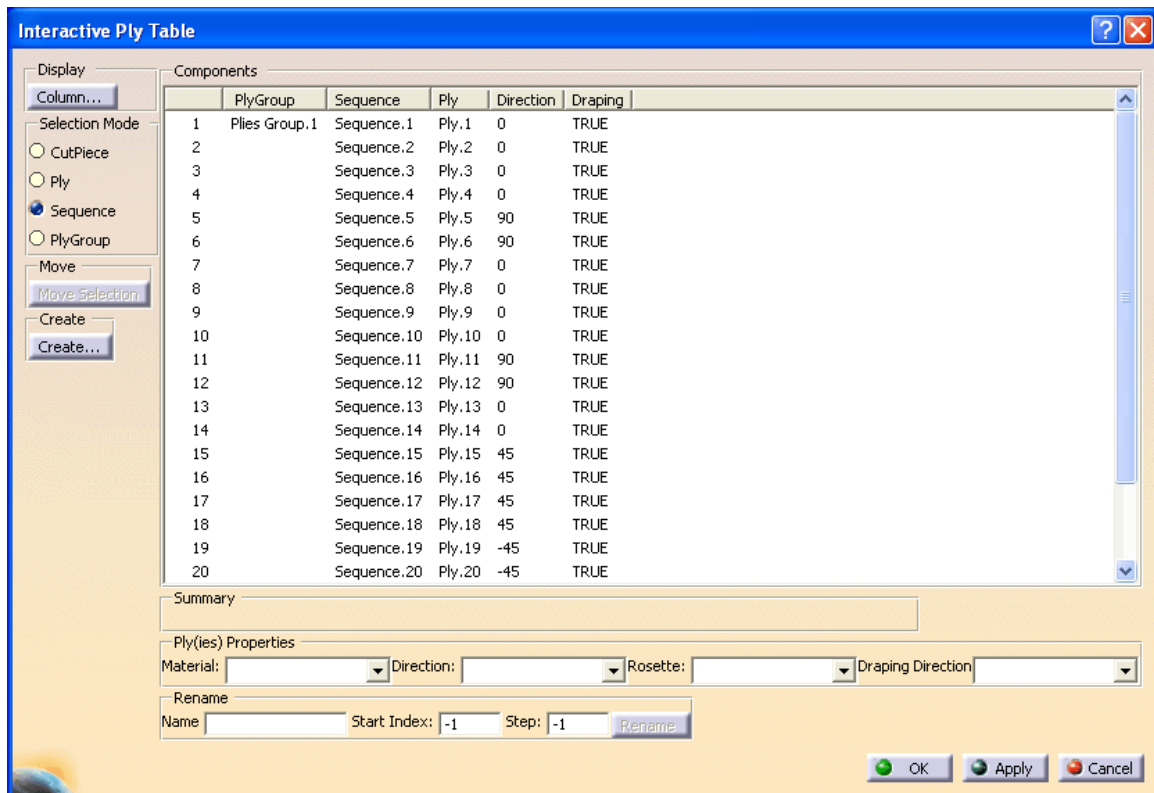


The plies will need to be rearranged both by size and by orientation to display the final laminate.

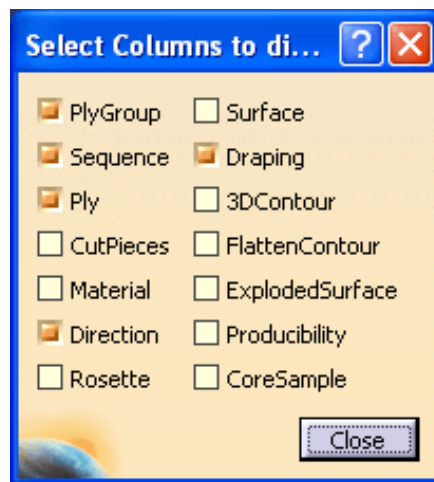
### Interactive Ply Table

This option allows you to create a ply table within CATIA where you will be able to modify the material, direction, rosette, draping direction and stacking order.

Select the **Interactive Ply Table** icon.  The *Interactive Ply Table* window appears.

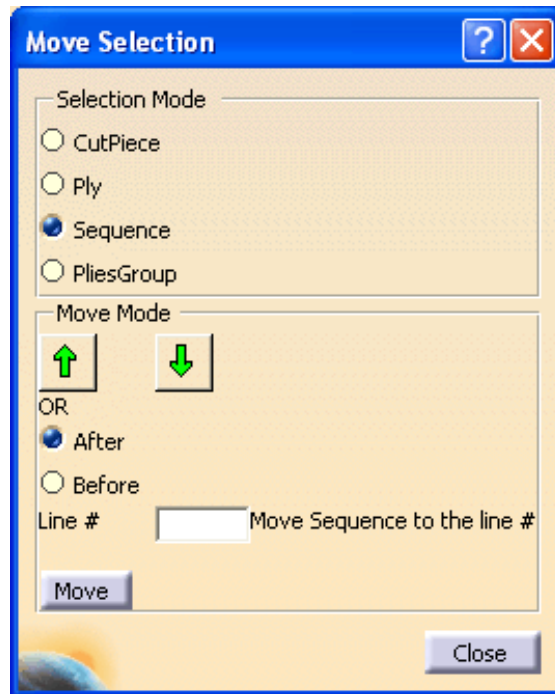


*Column* Allows you to specify which columns are displayed in the window.

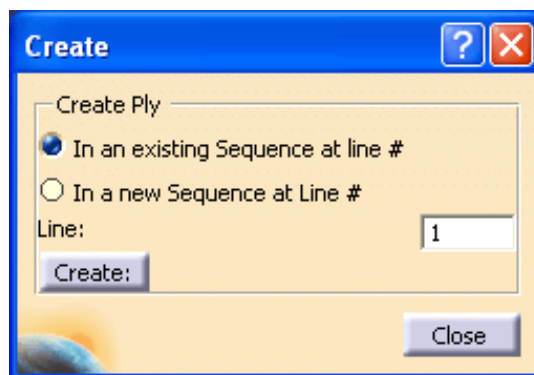


*Selection Mode* Allows you specify whether the elements in the window will be selected by *Cut Piece*, *Ply*, *Sequence* or *Ply Group*

*Move Selection* Allows you to move a row within the table



*Create* Allows you to create a new ply in the table

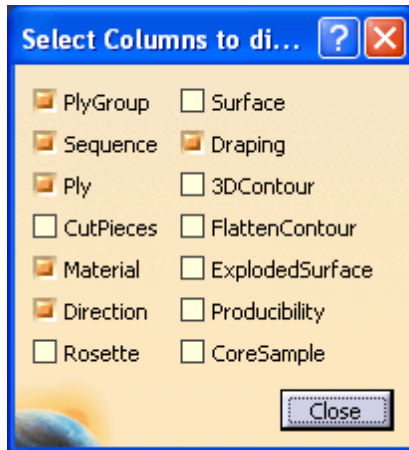


*Components* Displays the ply stackup in the window

*Ply Properties* Allows you to modify the *Material*, *Direction*, *Rosette* and *Draping Direction* of the selected ply

*Rename* Allows you to modify the *Name*, *Start Index* and *Step* of the selected ply

Select the **Column** button. The *Column* window appears.

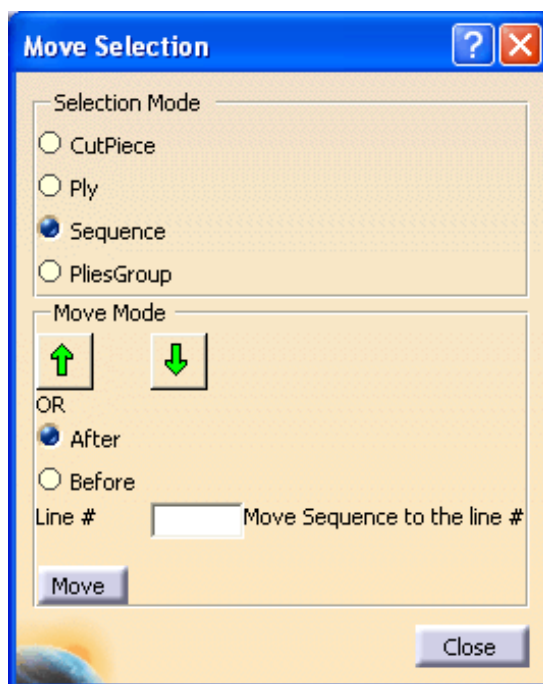


Turn on the options as shown above and select **Close**. The columns in the *Interactive Ply Table* window should update.

Be sure the **Selection Mode** is set to **Sequence** and select **Sequence.5** from the table. It should highlight in the window as well as the display.

	PlyGroup	Sequence	Ply	Material	Direction	Draping
1	Plies Group.1	Sequence.1	Ply.1	Fiberite Graphite Unitape	0	TRUE
2		Sequence.2	Ply.2	Fiberite Graphite Unitape	0	TRUE
3		Sequence.3	Ply.3	Fiberite Graphite Unitape	0	TRUE
4		Sequence.4	Ply.4	Fiberite Graphite Unitape	0	TRUE
5		Sequence.5	Ply.5	Fiberite Graphite Unitape	90	TRUE
6		Sequence.6	Ply.6	Fiberite Graphite Unitape	90	TRUE
7		Sequence.7	Ply.7	Fiberite Graphite Unitape	0	TRUE

Select the **Move Selection** button. The *Move Selection* window appears.



Select the **Move Up** icon in the window until *Sequence.5* is in the second position in the stackup.  It should appear as shown.

	PlyGroup	Sequence	Ply	Material	Direction	Draping
1	Plies Group.1	Sequence.1	Ply.1	Fiberite Graphite Unitape	0	TRUE
2		Sequence.5	Ply.5	Fiberite Graphite Unitape	90	TRUE
3		Sequence.2	Ply.2	Fiberite Graphite Unitape	0	TRUE
4		Sequence.3	Ply.3	Fiberite Graphite Unitape	0	TRUE

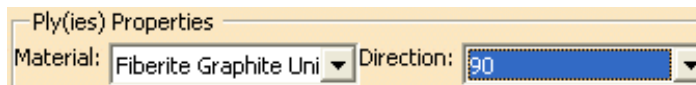
Select *Sequence.4* and *Sequence.6* from the table. You will have to use the Ctrl key.

	PlyGroup	Sequence	Ply	Material	Direction	Draping
1	Plies Group.1	Sequence.1	Ply.1	Fiberite Graphite Unitape	0	TRUE
2		Sequence.5	Ply.5	Fiberite Graphite Unitape	90	TRUE
3		Sequence.2	Ply.2	Fiberite Graphite Unitape	0	TRUE
4		Sequence.3	Ply.3	Fiberite Graphite Unitape	0	TRUE
5		Sequence.4	Ply.4	Fiberite Graphite Unitape	0	TRUE
6		Sequence.6	Ply.6	Fiberite Graphite Unitape	90	TRUE
7		Sequence.7	Ply.7	Fiberite Graphite Unitape	0	TRUE

Key in 24 for the *Line #* in the *Move Selection* window. Be sure the *After* option is selected and select the *Move* button. The two sequences are moved into the last position in the stackup.

Select *Close* in the *Move Selection* window.

Select *Sequence.1* in the table. Change the *Direction* to be 90. You will do this in the *Ply(ies) Properties* area of the window.



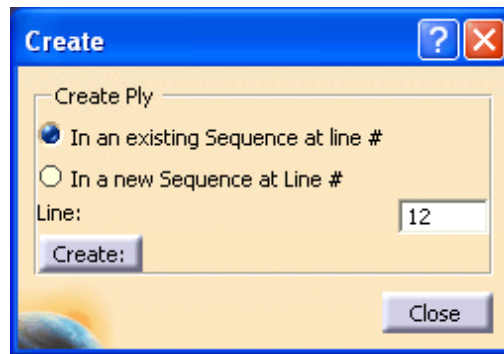
Change the *Direction* of *Sequence.5* to be 0. It should appear as shown.

	PlyGroup	Sequence	Ply	Material	Direction	Draping
1	Plies Group.1	Sequence.1	Ply.1	Fiberite Graphite Unitape	90	TRUE
2		Sequence.5	Ply.5	Fiberite Graphite Unitape	0	TRUE
3		Sequence.2	Ply.2	Fiberite Graphite Unitape	0	TRUE

Select the 12<sup>th</sup> component from the table. This should be *Sequence.14* as shown.

11		Sequence.13	Ply.13	Fiberite Graphite Unitape	0	TRUE
12		Sequence.14	Ply.14	Fiberite Graphite Unitape	0	TRUE
13		Sequence.15	Ply.15	Fiberite Graphite Unitape	45	TRUE

Select the **Create** button in the window. The *Create* window appears.



Select the **In a new Sequence at Line #** option and select the **Create** button. A new sequence and ply are created in the table.

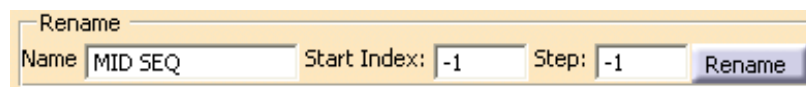
12	Sequence.14	Ply.14	Fiberite Graphite Unitape	0	TRUE
13	Sequence.25	Ply.25			TRUE
14	Sequence.15	Ply.15	Fiberite Graphite Unitape	45	TRUE

Select **Close** in the *Create* window.

Set the **Material** for the new ply to be *Fiberite Graphite Unitape* and the **Direction** to be **90**. It should appear as shown.

12	Sequence.14	Ply.14	Fiberite Graphite Unitape	0	TRUE
13	Sequence.25	Ply.25	Fiberite Graphite Unitape	90	TRUE
14	Sequence.15	Ply.15	Fiberite Graphite Unitape	45	TRUE

With the new sequence selected, key in **MID SEQ** for the **Name** field.



Select the **Rename** button. The sequence is renamed in the table.

12	Sequence.14	Ply.14	Fiberite Graphite Unitape	0	TRUE
13	MID SEQ-1	Ply.25	Fiberite Graphite Unitape	90	TRUE
14	Sequence.15	Ply.15	Fiberite Graphite Unitape	45	TRUE

Select the **Ply** option under the **Selection Mode** section. Change the **Name** field to be **MID PLY** and select the **Rename** button. The ply name is changed. You may have to stretch out the column to read it.

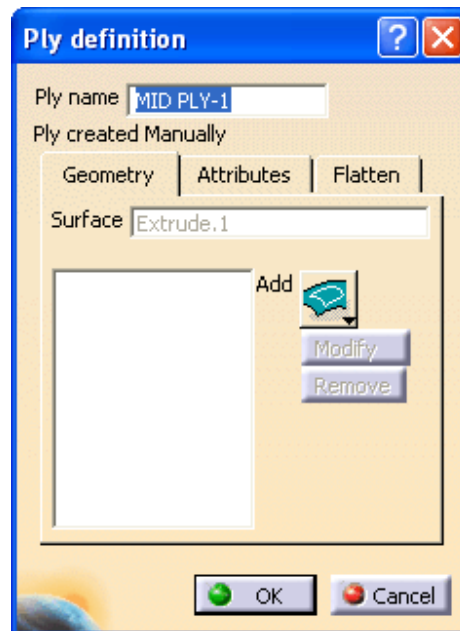
12	Sequence.14	Ply.14	Fiberite Graphite Unitape	0	TRUE
13	MID SEQ-1	MID PLY-1	Fiberite Graphite Unitape	90	TRUE
14	Sequence.15	Ply.15	Fiberite Graphite Unitape	45	TRUE

Select **OK**. The changes in the *Interactive Ply Table* are applied.

Expand the *Stacking* branch until you can see the **MID PLY-1** as shown.



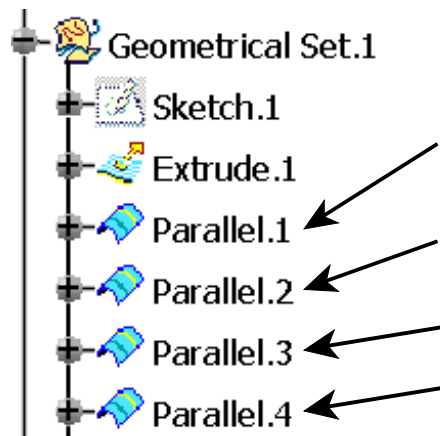
Double select on **MID PLY-1**. The *Ply Definition* window appears.



Notice the ply has not contour definition. This is because you created the ply in the *Interactive Ply Table* where you cannot define the shape of the ply. Anytime you create a ply in the ply table, you must remember to define its contour when you are finished.

Select the **Add icon**.  The *Contour* window appears.

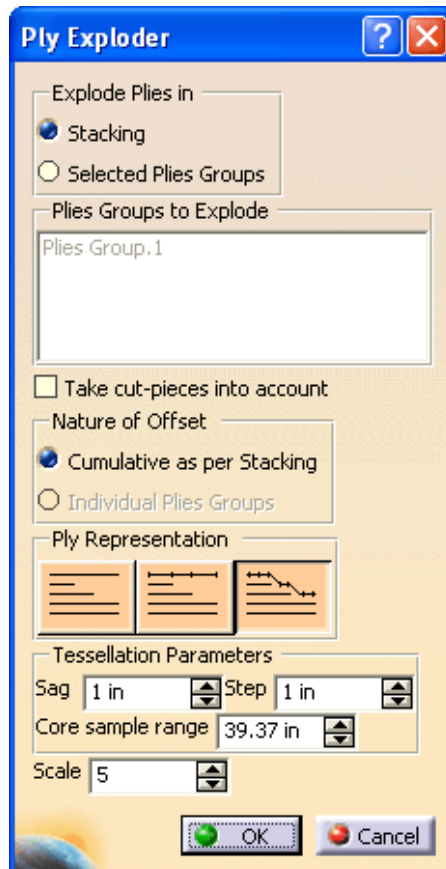
Select **Parallel.1, Parallel.2, Parallel.3** and **Parallel.4** from **Geometrical Set.1** in the specification tree to define the contour for the ply. This will specify that it is a full ply.



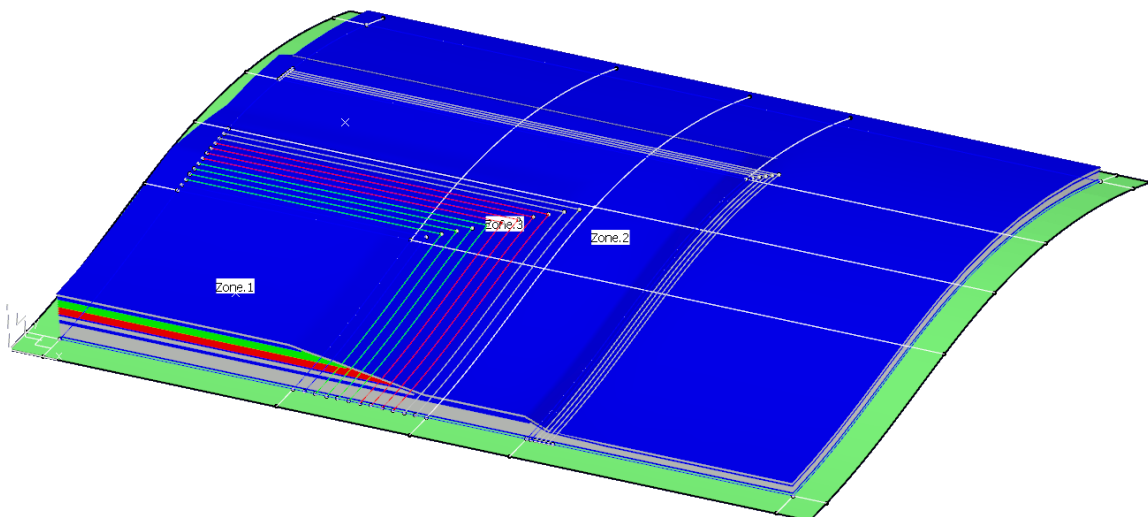
Be sure you have the green check mark in the *Contour* window and select *OK*. The contour is defined.

Select *OK* in the *Ply Definition* window.

Select the **Ply Exploder** icon.  The *Ply Exploder* window appears.



Set the options as shown above and select *OK*. The plies are displayed.



Save and close the document.