

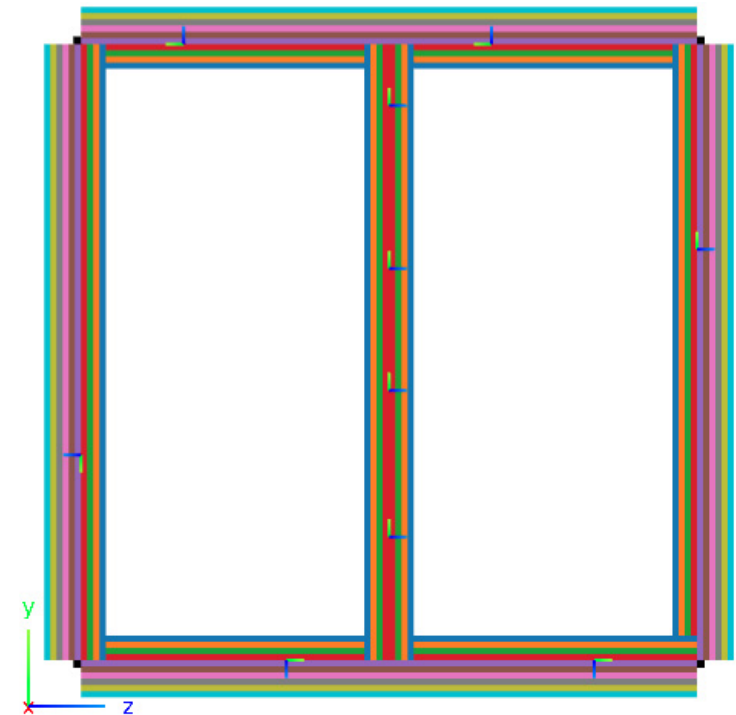
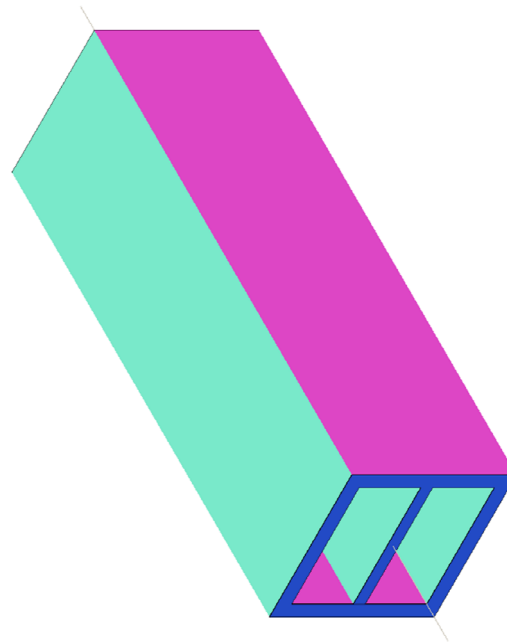
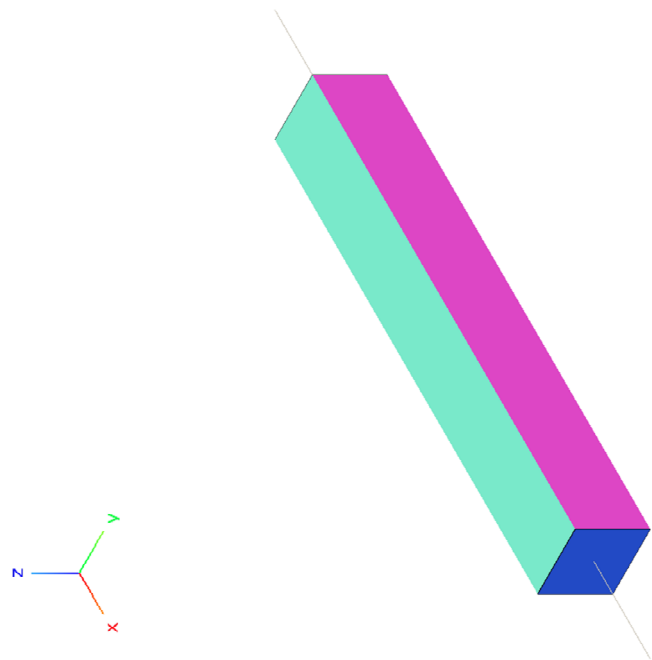
Workshop – Composite Arbitrary Beam Cross Section

A PBMSECT/PBRSECT TUTORIAL

Goal: Create a PBMSECT that describes a composite arbitrary beam cross section

Before

After



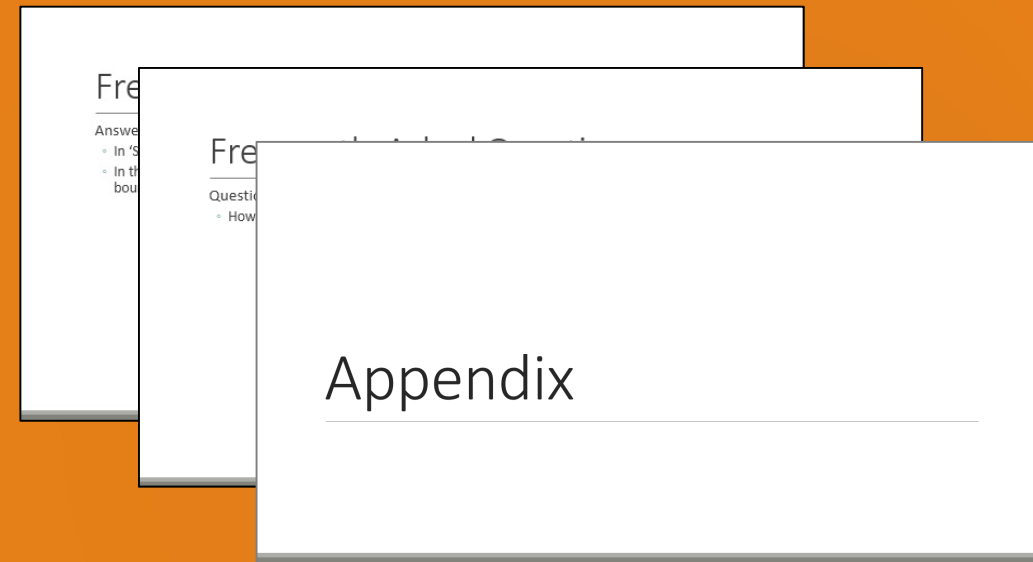
Angles of Plies

Angle	Color
0.	Blue
1.	Orange
2.	Green
3.	Red
4.	Purple
-5.	Brown
-6.	Pink
-7.	Gray
-8.	Yellow
-9.	Cyan

More Information Available in the Appendix

The Appendix includes information regarding the following:

- Ply Coordinate System
- Unwanted Free Edges in the Cross Section's Mesh
- Avoid CORE/LAYER and SET1 Conflicts
- Considerations for Outer Perimeter and Branch Lines
- Offset Z0 Considerations



Contact me

- Nastran SOL 200 training
- Nastran SOL 200 questions
- Structural or mechanical optimization questions
- Access to the SOL 200 Web App

christian@ the-engineering-lab.com

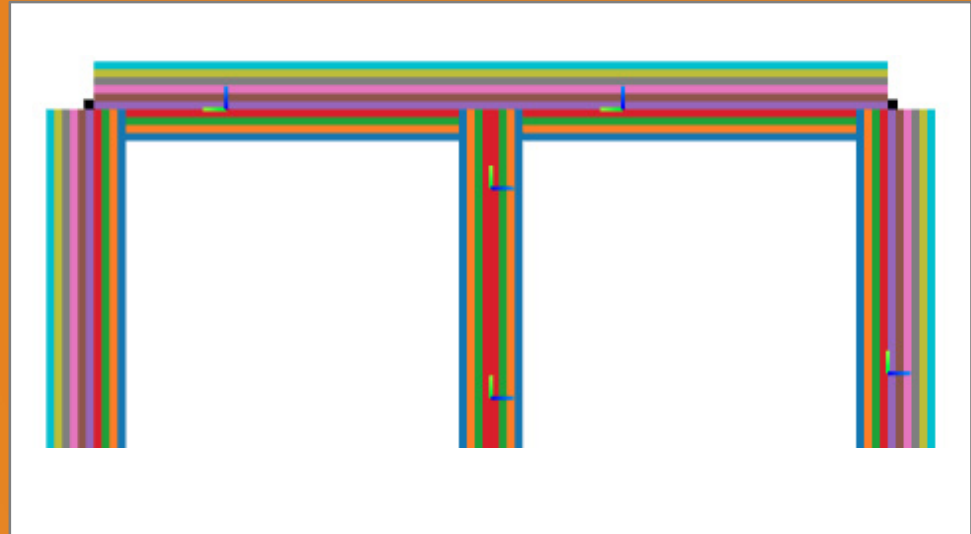
Tutorial

Tutorial Overview

1. Start with a .bdf or .dat file
2. Use the PBMSECT Web App to:
 - Create a new arbitrary beam cross section (ABCS)
 - Assign composite laminates to different walls of the ABCS
 - Download an updated BDF file
 - Verify the cross section's FEM is valid
 - MSC Nastran is used to generate the file AAA_xyyyy_zz.bdf
 - Patran is used to view the FEM of the cross section contained in AAA_xyyyy_zz.bdf
3. Use the Viewer to view the updated beam elements with the newest ABCS

Special Topics Covered

Composite Arbitrary Beam Cross Section - The PBMSECT entry supports the use of PCOMP and PCOMPG entries. A composite beam may be created and the procedure is detailed in this tutorial.



SOL 200 Web App Capabilities

The Post-processor Web App and HDF5 Explorer are free to MSC Nastran users.

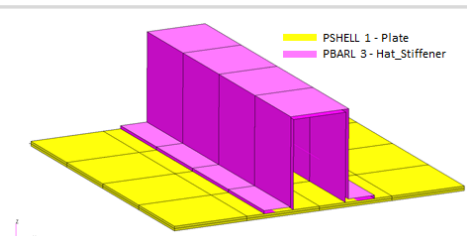
Compatibility

- Google Chrome, Mozilla Firefox or Microsoft Edge
- Windows and Red Hat Linux
- Installable on a company laptop, workstation or server. All data remains within your company.

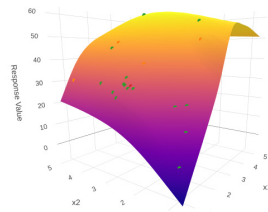
Benefits

- REAL TIME error detection. 200+ error validations.
- REAL TIME creation of bulk data entries.
- Web browser accessible
- Free Post-processor web apps
- +80 tutorials

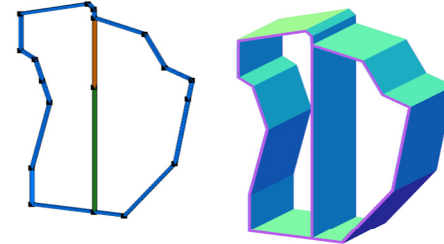
Web Apps



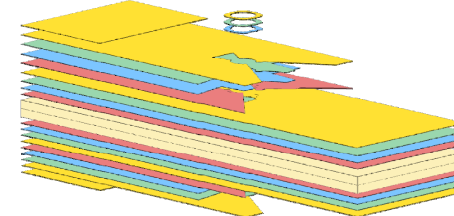
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200.
Support for size, topology, topometry, topography, multi-model optimization.



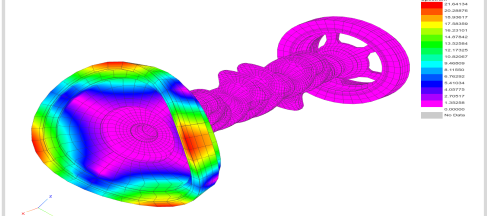
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



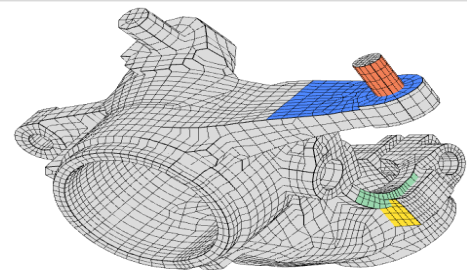
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



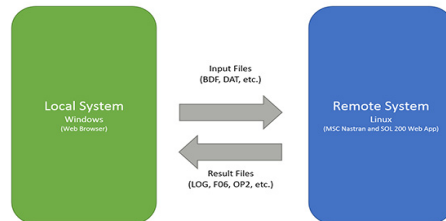
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



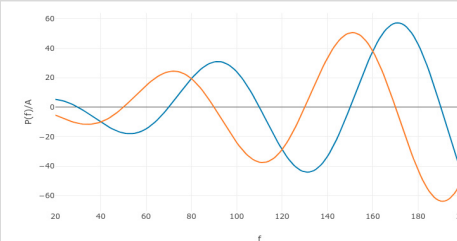
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



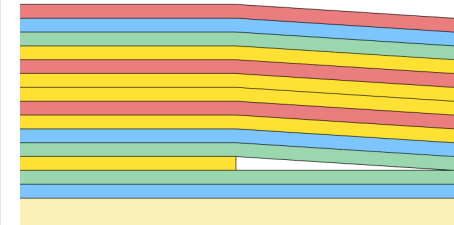
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



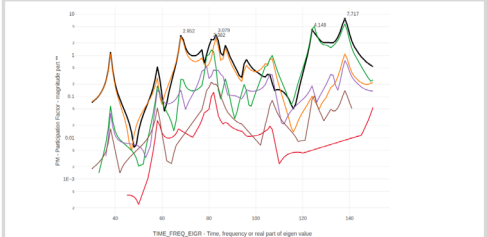
Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



Dynamic Loads Web App
Generate RLOAD1, RLOAD2 and DLOAD entries graphically



Stacking Sequence Web App
Optimize the stacking sequence of composite laminate plies

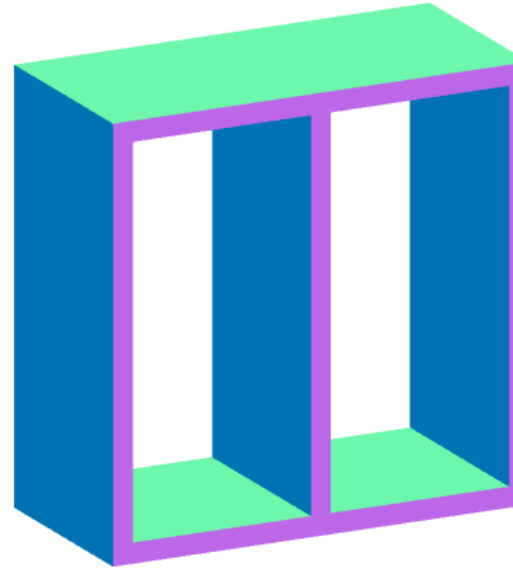


Before Starting

- When creating an arbitrary cross section (ABCS), there are many different configurations of the entries that will yield the same ABCS.
- For the ABCS shown on the right, 4 different configurations of the PBMSECT, POINT and SET1 entries are displayed. Each configuration yields the same ABCS with these properties.
 - Area: 9.9000E+01
 - I1: 5.9182E+03
 - I2: 5.3482E+03
 - I12: 0.0
 - J: 8.2246E+03
- When you go through this tutorial, expect to get different IDs and sequences of entries. This is OK as long as your final arbitrary cross section matches what is shown in this tutorial.

```
PBMSECT 1      0888      CP
          OUTP=101,BRP(1)=102,T=1.0
POINT 1000001      0.0      -10.
POINT 1000002      0.0      10.
POINT 1000003      10.      10.
POINT 1000004      10.      -10.
POINT 1000005      -10.      10.
POINT 1000006      -10.      -10.
SET1 101      1000001 1000002 1000003 1000004
SET1 102      1000002 1000005 1000006 1000001
```

```
PBMSECT 1      0888      CP
          OUTP=101,BRP(1)=102,T=1.0
POINT 1000001      0.0      10.
POINT 1000002      -10.      10.
POINT 1000003      -10.      -10.
POINT 1000004      0.0      -10.
POINT 1000005      10.      -10.
POINT 1000006      10.      10.
SET1 101      1000001 1000002 1000003 1000004 1000005 1000006
SET1 102      1000004 1000001
```



```
PBMSECT 1      0888      CP
          OUTP=101,BRP(1)=102,T=1.0
POINT 1000001      -10.      10.
POINT 1000002      0.0      10.
POINT 1000003      0.0      -10.
POINT 1000004      -10.      -10.
POINT 1000005      10.      -10.
POINT 1000006      10.      10.
SET1 101      1000001 1000002 1000003 1000004
SET1 102      1000003 1000005 1000006 1000002
```

```
PBMSECT 1      0888      CP
          OUTP=101,BRP(1)=102,T=1.0,T(1)=[1.0,PT=(1000001,1000001)],T(2)=[
1.0,PT=(1000001,1000004)]
POINT 1000001      0.0      10.
POINT 1000002      -10.      10.
POINT 1000003      -10.      -10.
POINT 1000004      0.0      -10.
POINT 1000005      10.      -10.
POINT 1000006      10.      10.
SET1 101      1000001 1000002 1000003 1000004 1000005 1000006
SET1 102      1000001 1000004
```


Locating the Web Apps

Throughout this tutorial the following web apps will be used

- Viewer
- PBMSECT web app

The following slides detail where to locate these web apps

Viewer and PBMSECT Web App

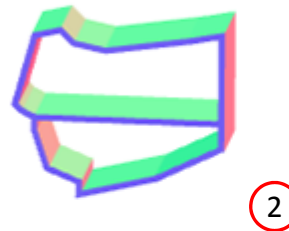
1. Navigate to the homepage
2. Click on the indicated link



Viewer and PBMSECT Web App

1. Click the icon titled Viewer to open the Viewer
2. Click the icon titled PBMSECT to open the PBMSECT web app

Beams

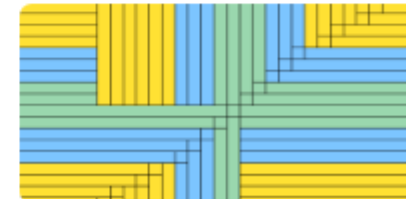


PBMSECT

Composites

Ply	Thick [°]	GPLY ID
1	45	121801
2	45	111801
3	0	141801
4	30	111801
5	0	141802
6	30	111801
7	0	141803
8	45	121802
9	45	111802

Stacking Sequence

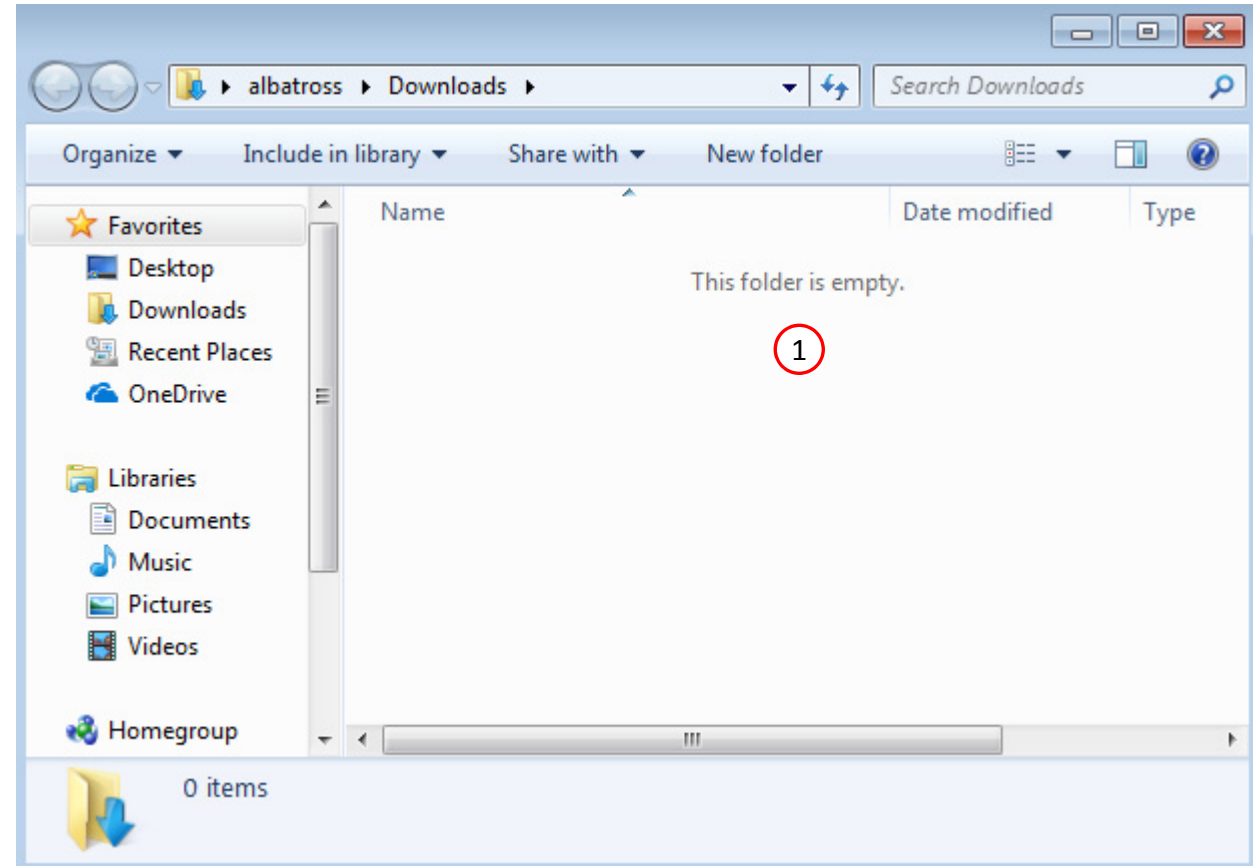


Viewer (.des, .ply000i)

Before Starting

1. Ensure the Downloads directory is empty in order to prevent confusion with other files

- Throughout this workshop, you will be working with multiple file types and directories such as:
 - .bdf/.dat
 - nastran_working_directory
 - .f06, .log, .pch, .h5, etc.
- To minimize confusion with files and folders, it is encouraged to start with a clean directory.



Go to the User's Guide

1. Click on the indicated link

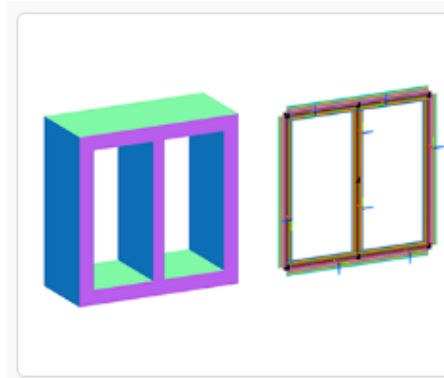
- The necessary BDF files for this tutorial are available in the Tutorials section of the User's Guide.



Obtain Starting Files

1. Find the indicated example
2. Click Link
3. The starting file has been downloaded

- When starting the procedure, all the necessary BDF files must be collected together.



1

Composite Arbitrary Beam Cross Section

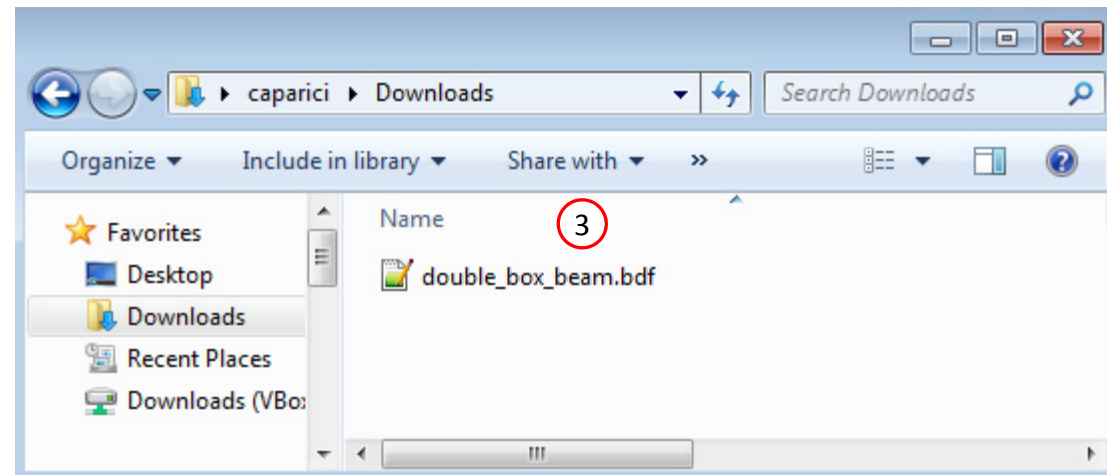
[Link](#)

Composite arbitrary beam cross section (ABCS) may be defined through the use of the PBMSECT and CBEAM3 entries. This tutorial details the use of the PBMSECT web app to construct a composite ABCS and generate the necessary PBMSECT, POINT and SET1 entries. Important considerations, such as ply coordinate systems and validating the FEM of the beam cross section, are discussed.

Starting BDF Files: [Link](#)

2

Solution BDF Files: [Link](#)



PBMSECT Web App

The PBMSECT web app will be used to define an arbitrary beam cross section by defining a PBMSECT, POINT and SET1 entries

1. Open the PBMSECT web app
2. Click Select files
3. Select double_box_beam.bdf
4. Click Open
5. Click Upload files

- The selected BDF file was created by a separate pre processor. The PBMSECT Web App only generates the following entries: PBMSECT, PBRSECT, POINT and SET1.

Select BDF Files

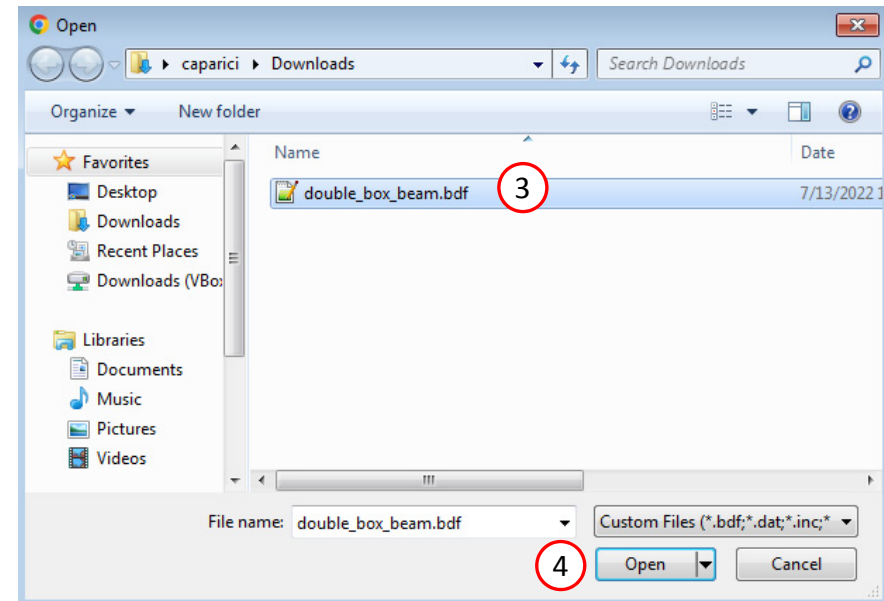
- 2 1. Select files double_box_beam.bdf

Inspecting: 100%

- 5 2. Upload files

Uploading: 100 %

☐ List of Selected Files



Create a New PBMSECT Entry

1. Click Create New Entry
2. Configure the Cross Section Options follows:
 - Entry: PBMSECT
 - PID: 9
 - MID: Unset
 - FORM: CP Closed Profile
 - CORE: Yes
 - NSM: Leave blank

Existing PBMSECT/PBRSECT Entries

Select a PBMSECT/PBRSECT ID to edit

+ Create New Entry

✕ Delete Selected Entry

1

Cross Section Options

Entry	<input type="text" value="PBMSECT"/>
PID	<input type="text" value="9"/>
MID	<input type="text" value="--- Select a MAT ID ---"/>
FORM	<input type="text" value="CP Closed Profile"/>
CORE	<input type="text" value="Yes - Use CORE (Only for PBMSECT OP or CP)"/>
NSM	<input type="text"/>

2

Points

1. Click Create Points (The button should be blue)
2. Adjust the Grid Helper as follows
 1. Width and Height: 20
 2. Number of Divisions: 10
3. Click on the points on the Grid Helper to create 7 white points approximately in the same locations as shown in the image.

Points

Actions

1

- ☒ Create Points
- ☐ Create Points on Line
- ☐ Remove Points

Settings - Grid Helper

2

- Width and Height
- 20
- Number of Divisions
- 10

Max allowable divisions: 50

Controls

Tools

- ☒ Center Model
- ☐ Fit Model
- ☐ Isometric View 1
- ☐ ZY View
- ☐ Background Color
- ☐ Label Color

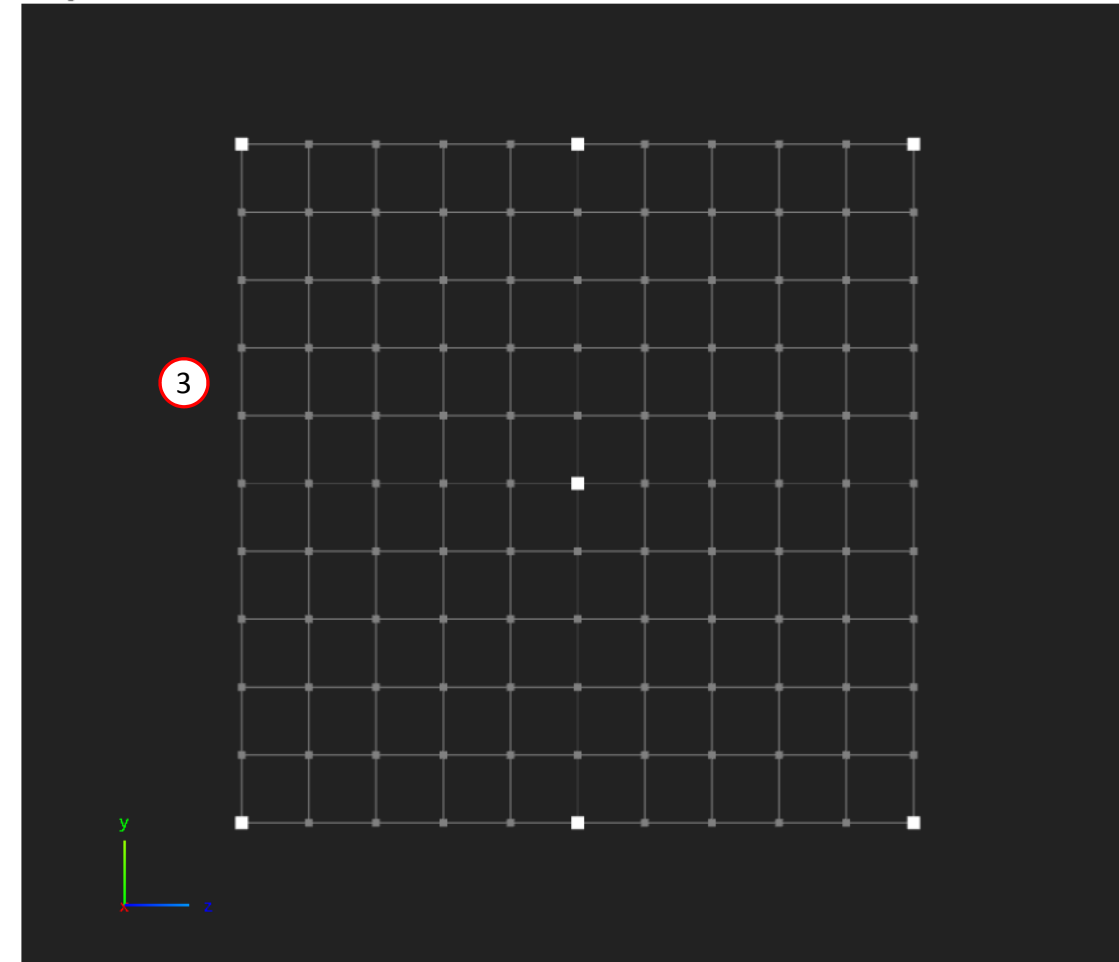
Display

- ☒ Labels
- ☐ Cross Section Preview
- ☐ Cross Section Actual
- ☐ Size Controls

Demos

- ☒ Clear Demo
- ☐ Demo 1
- ☐ Demo 2
- ☐ Demo 3
- ☐ Demo 4
- ☐ Demo 5

Editing PBMSECT 9



Developed by The Engineering Lab

Points

1. Click Labels to turn on the ID labels for the points
2. Find the ID for the indicated POINT and set its Z value to .000001. In this example POINT 9000005 is adjusted but your POINT ID may be different.

- Refer to the appendix to learn why this step is needed

Adjustments

Point ID ^	Z	Y
9000001	-10.	10.
9000002	0.0	10.
9000003	10.	10.
9000004	10.	-10.
9000005	0.000001	-10.
9000006	-10.	-10.
9000007	0.0	0.0

Controls

Tools

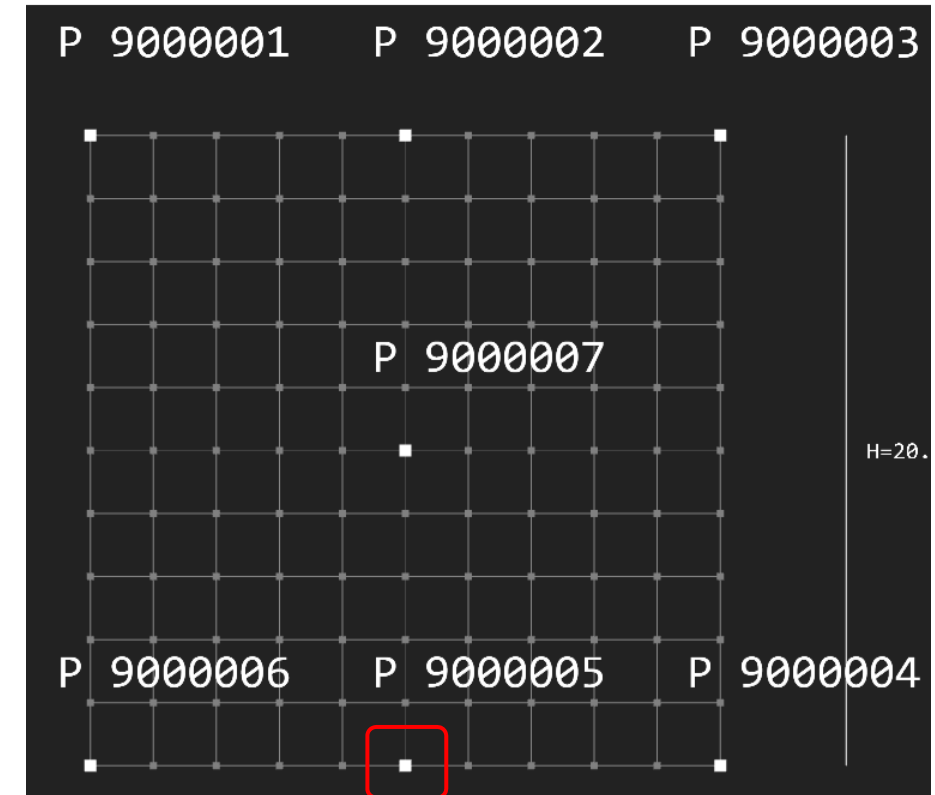
- Center Model
- Fit Model
- Isometric View 1
- ZY View
- Background Color
- Label Color

Display

- Labels**
- Cross Section Preview
- Cross Section Actual
- Size Controls

Demos

- Clear Demo
- Demo 1
- Demo 2
- Demo 3
- Demo 4
- Demo 5



Lines

1. Click Create Lines
2. Click on 2 points to create one line (Not shown)
3. Repeat the process to create a total of 8 lines

Lines

Actions

1

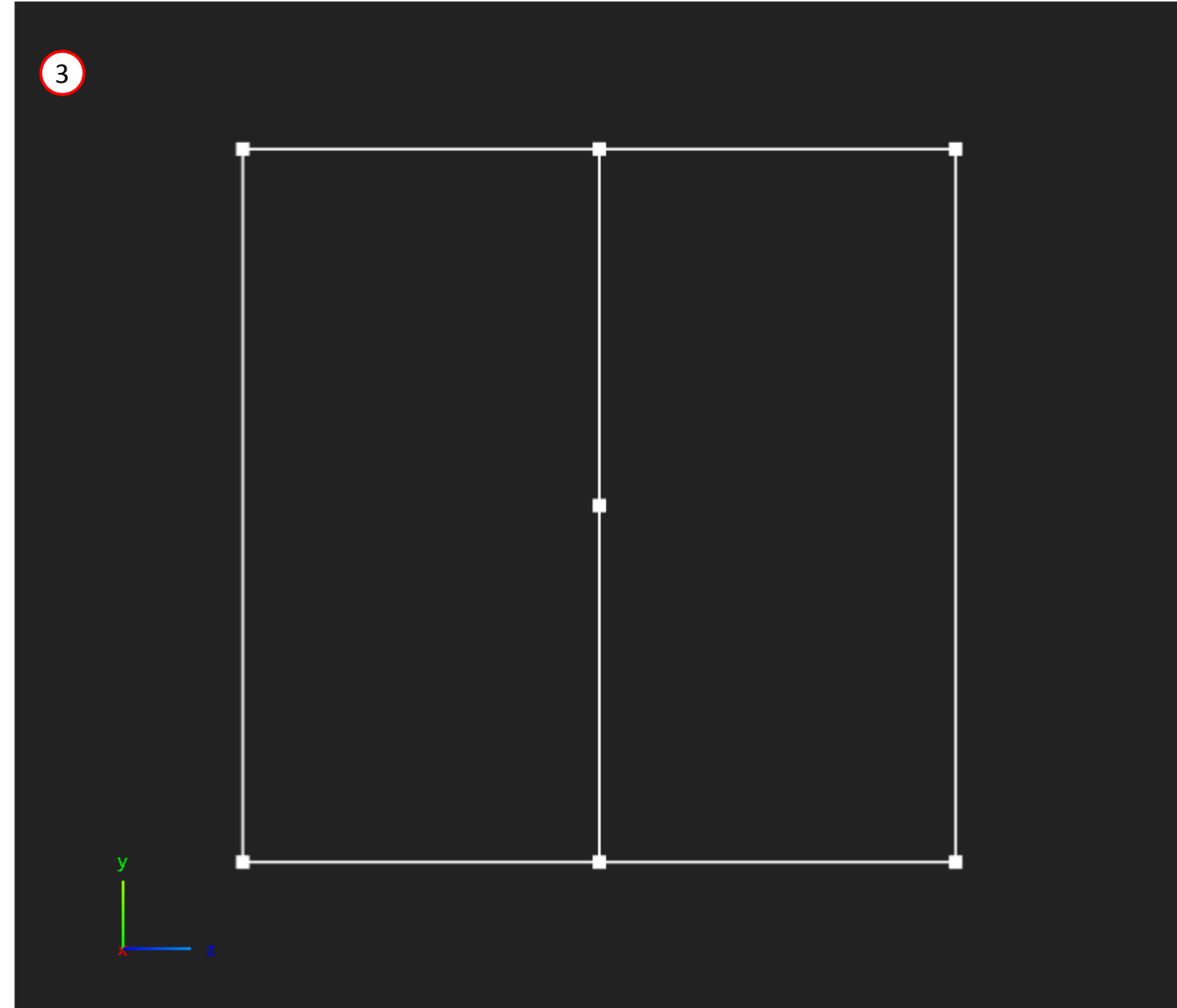
— Create Lines

✕ Remove Lines

☞ Select Lines of Outer Perimeter

☞ Deselect Lines of Outer Perimeter

Editing PBMSECT 9



Outer Perimeter

On this slide, the outer perimeter is defined, which corresponds to the OUTP keyword on the PBMSECT entry

1. Click Select Lines of Outer Perimeter
2. Click on the indicated lines to select the lines as part of the Outer Perimeter. Successful selection is indicated by a blue color.

IMPORTANT!

Defining the outer perimeter is the most critical step in defining the PBMSECT/PBRSECT entry. Constantly inspect the outer perimeter. Only one continuous outer perimeters is valid.

Lines

Actions

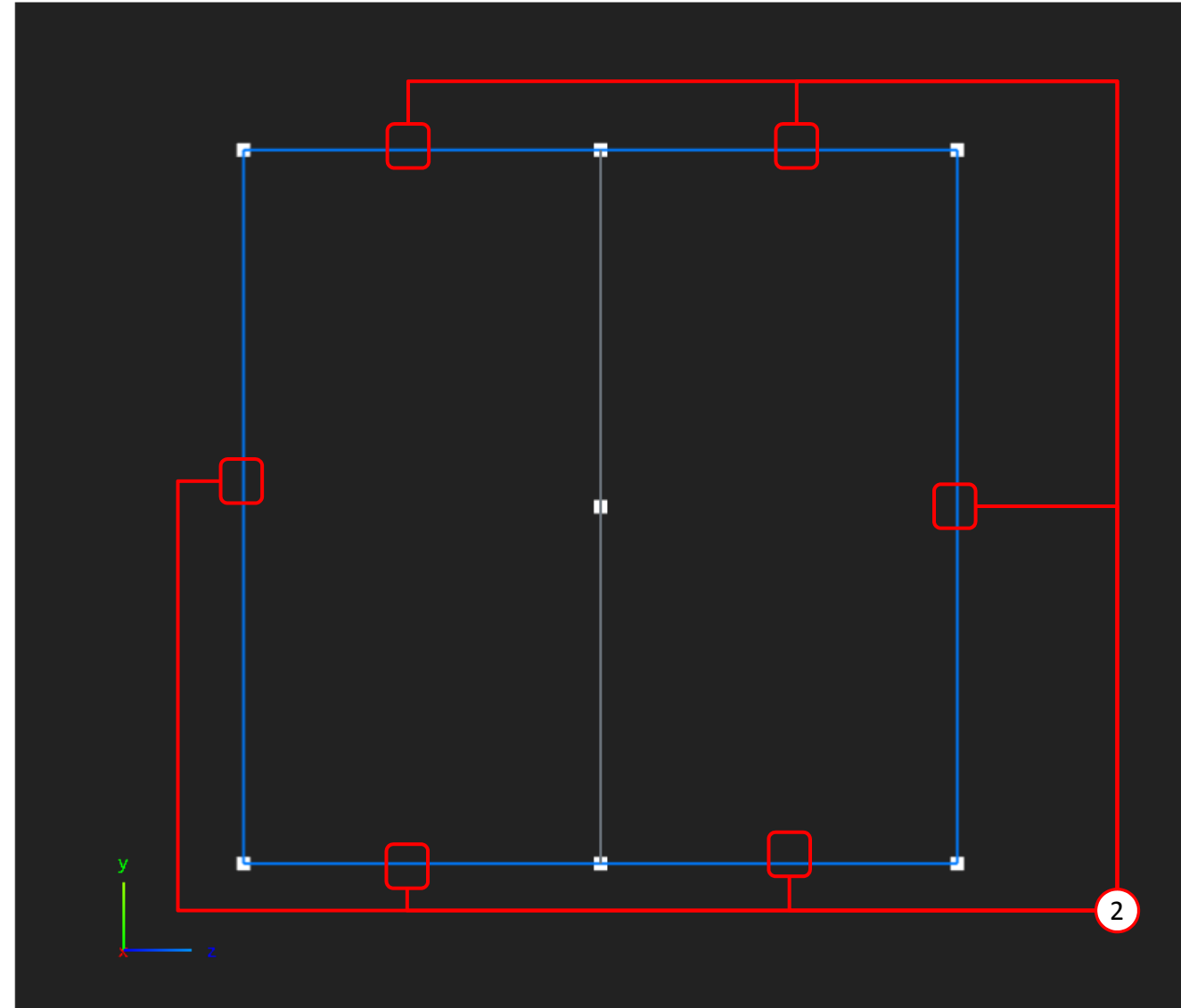
1

— Create Lines
✕ Remove Lines
👉 Select Lines of Outer Perimeter
👈 Deselect Lines of Outer Perimeter

Legend

Color	Description
Blue	Outer Perimeter (OUTP)
Pink	Possible lines for OUTP
Orange	Critical Points

Editing PBMSECT 9



Cross Section Preview

On this page, PCOMP entries that exist in the original BDF file are used to construct a composite arbitrary beam cross section.

1. Set the Default Core to 501, PCOMP
2. Click Cross Section Preview
3. A preview of the arbitrary beam cross section is displayed
4. Mark the checkbox for Layer, Top
5. For the outer perimeter lines (OUTP), set the top layer to 502, PCOMP
6. For the CORE of BRP 1 and 2, select 503, PCOMP
7. Optionally, click Labels. It may help to turn on the labels to see the line numbers as you configure the columns Core and Layer Top.
8. Refer to the section Corresponding Bulk Data Entries
9. In the PBMSECT entry, the CORE and LAYER keywords are used to define how the plies are placed along the lines

Lines

Create Lines

Remove Lines

Select Lines of Outer Perimeter

Deselect Lines of Outer Perimeter

Status: ☒

Angles of Plies

Theta	Color
0°	
1°	
2°	
3°	
4°	
-5°	
-6°	
-7°	
-8°	
-9°	

Adjustments

Default Core

501, PCOMP

Line Segments

☐ Layer, Bottom
 ☒ Core
 ☒ Layer, Top

Line ID	Type	Core	Layer Top
1	OUTP		502, PCOMP
2	OUTP		502, PCOMP
3	OUTP		502, PCOMP
4	OUTP		502, PCOMP
5	OUTP		502, PCOMP
6	OUTP		502, PCOMP
7	BRP 1	503, PCOMP	
8	BRP 2	503, PCOMP	

Controls

Tools

Center Model

Fit Model

Isometric View 1

ZY View

Background Color

Label Color

Display

Labels

Cross Section Preview

Cross Section Actual

Size Controls

Demos

Clear Demo

Demo 1

Demo 2

Demo 3

Demo 4

Demo 5

Corresponding Bulk Data Entries

```

$ 1 || 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10 |
PBMSECT 9          CP
      OUTP=901, BRP(1)=902, BRP(2)=903, CORE=501, CORE(7)=[503, PT=(9000007
      ,9000002)], CORE(8)=[503, PT=(9000005,9000007)], LAYER(4)=(502,904)
  
```

Questions? Email: christian@the-engineering-lab.com

HEXAGON
Technology Partner

21

Cross Section Preview

1. Lines 1, 2, 3, 4, 5, 6 are assigned the Default Core value of PCOMP 501
2. Lines 1, 2, 3, 4, 5, 6 are assigned an additional PCOMP 502 on top of PCOMP 501
3. Lines 7 and 8 are assigned PCOMP 503

The numbering of your lines may be different and this is OK. What matters is that your plies are stacked similar to the image shown to the right.

Adjustments

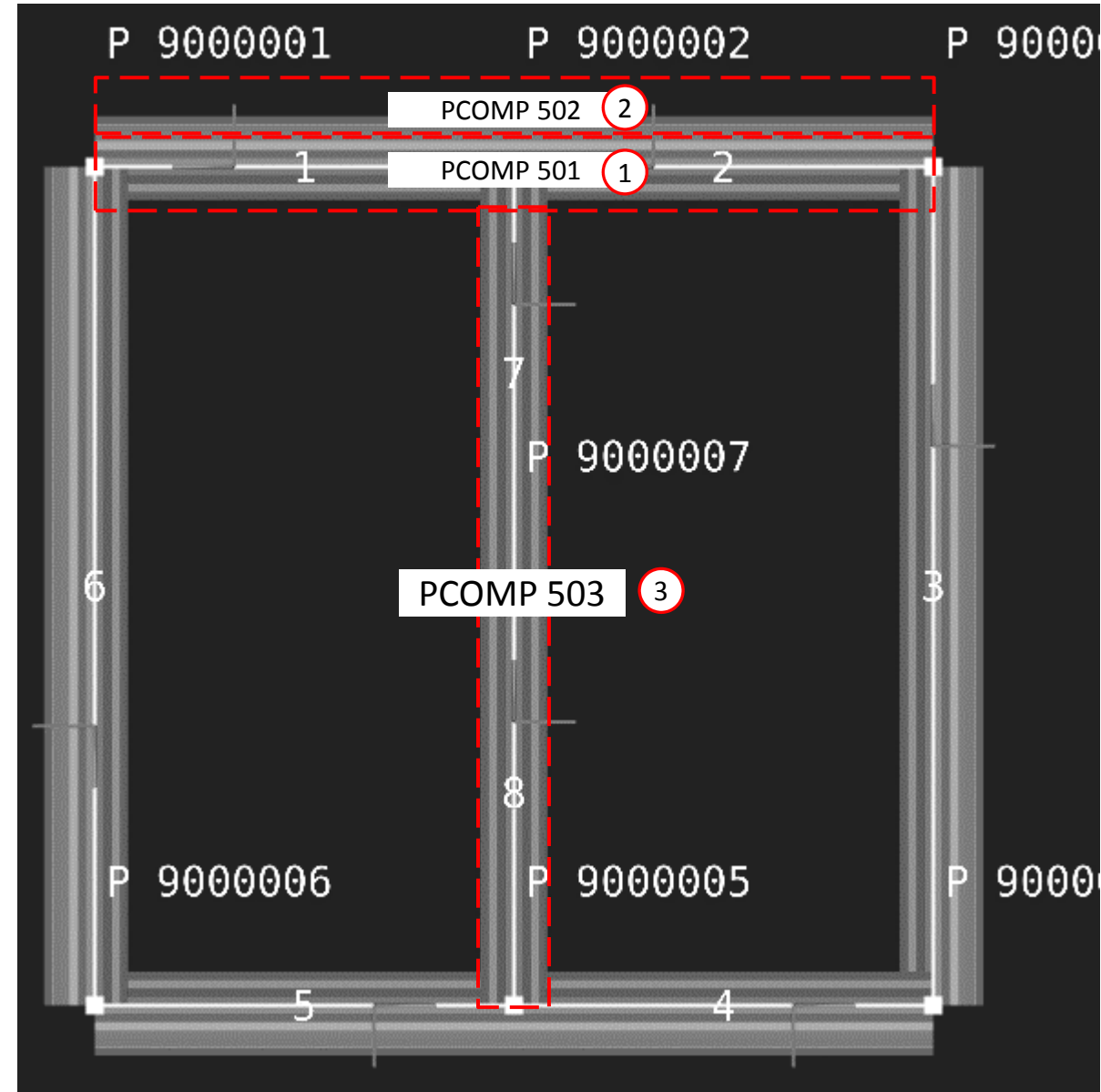
Default Core

501, PCOMP

Line Segments

☐ Layer, Bottom ☒ Core ☒ Layer, Top

Line ID	Type	Core	Layer Top
1	OUTP		502, PCOMP
2	OUTP		502, PCOMP
3	OUTP		502, PCOMP
4	OUTP		502, PCOMP
5	OUTP		502, PCOMP
6	OUTP		502, PCOMP
7	BRP 1	503, PCOMP	
8	BRP 2	503, PCOMP	



Cross Section Preview

1. Pay close attention to the ply coordinate systems of the outer lines. For this tutorial, ensure the y_3 axis is pointing outward.
2. Click Renumber Lines and Points to flip the ply coordinate systems. This flipping only occurs if the section is a closed profile. Alternatively, y_2 is determined by the order in which the lines are created, i.e. the order of points End A and End B.
3. Click off and on the Cross Section Preview to show the latest orientation of the laminate and ply coordinate system

- Each line segment is assigned a ply coordinate systems (y_1 , y_2 , y_3) and determines the orientation of the plies. Refer to the appendix to learn more about the ply coordinate systems

Custom IDs

☒ Renumber Lines and Points

Entry	Custom ID	Status	IDs Used by this PBMSECT/PBRSECT	IDs Used by other PBMSECT/PBRSECT
PBMSECT/PBRSECT	9	<input checked="" type="checkbox"/>	9	1
SET1	901	<input checked="" type="checkbox"/>	901, 902, 903	904
POINT	9000001	ⓘ Check separately to ensure POINT IDs do not with GRID IDs		

Controls

Tools

☒ Center Model

☐ Fit Model

☐ Isometric View 1

☐ ZY View

☐ Background Color

☐ Label Color

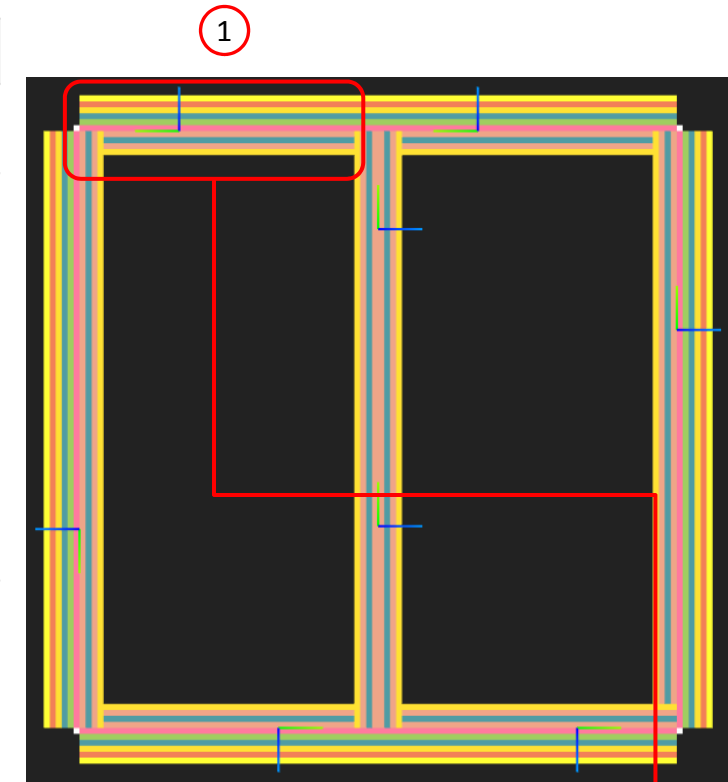
Display

☐ Labels

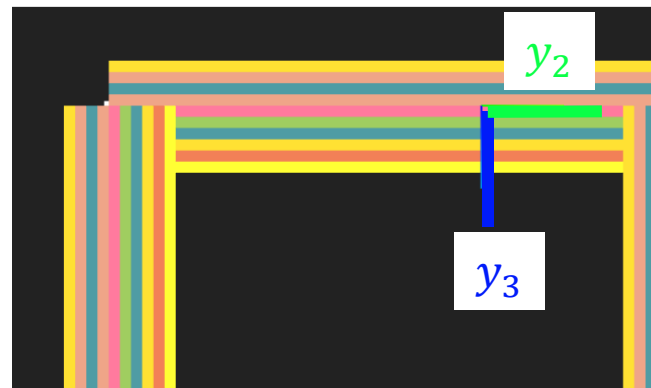
☒ Cross Section Preview

☐ Cross Section Actual

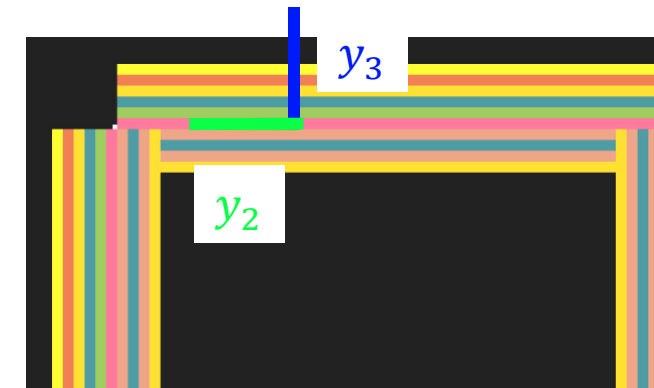
☐ Size Controls



Possible Orientation 1



Possible Orientation 2



Run MSC Nastran to Generate the Cross Section

The following requires MSC Nastran to be installed on the same machine as the SOL 200 Web App.

1. The respective entries that define the arbitrary beam cross section are displayed
2. Click Run MSC Nastran
 - The web app will run MSC Nastran in the background and determine the cross section generated by MSC Nastran. This MSC Nastran run should take no more than 10 seconds. MSC Nastran must be installed on the machine as the SOL 200 Web App.
3. If the run is successful, the MSC Nastran generated cross section is displayed
4. Inspect the F06 file to inspect the result of the run
5. The test BDF file used for this test run may be downloaded by clicking Download Test BDF File

Run MSC Nastran and Bulk Data Entries

5

Download Test BDF File

2

Run MSC Nastran

Complete

Corresponding Bulk Data Entries

1

```

$ 1 || 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10 ||
PBMSECT 9          CP
      OUTP=901,BRP(1)=902,BRP(2)=903,CORE=501,CORE(7)=[503,PT=(9000007
,9000002)],CORE(8)=[503,PT=(9000005,9000007)],LAYER(4)=(502,904)
POINT 9000001      -10.  10.
POINT 9000002        0.0  10.
POINT 9000003        10.  10.
POINT 9000004        10. -10.
POINT 9000005        0.0 -10.
POINT 9000006       -10. -10.
POINT 9000007        0.0   0.0
SET1  901    9000001 9000002 9000003 9000004 9000005 9000006
SET1  902    9000007 9000002
SET1  903    9000005 9000007
SET1  904    9000001 9000002 9000003 9000004 9000005 9000006 9000001

PCOMP  501          13000.  HILL
      301      .2    0.    YES
      301      .2    1.    YES
      301      .2    2.    YES
      301      .2    3.    YES
      301      .2    4.    YES
      301      .2   -5.    YES
          
```

F06

4

```

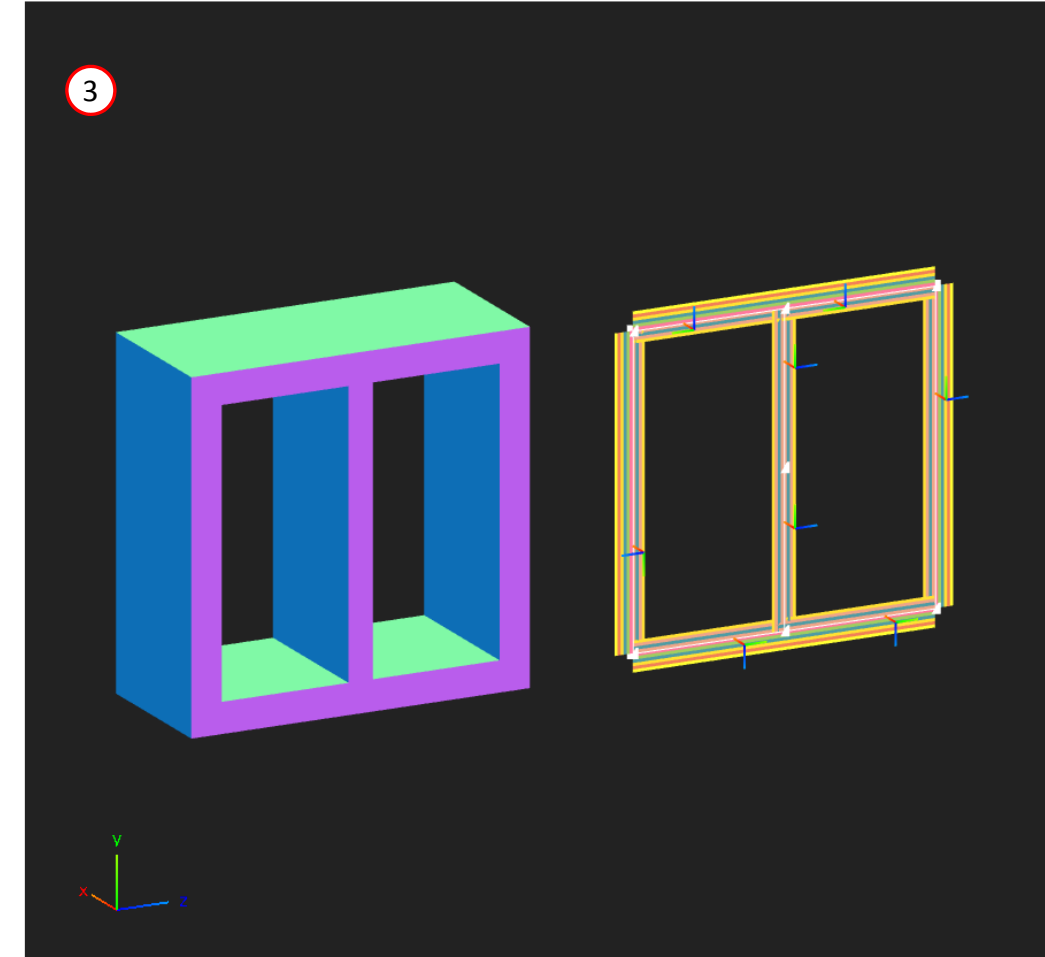
Command executed: /msc/MSC_Nastran/2022.1/bin/msc20221 nastran ./tmp/854e82ee40045005a441ff1e2

1

Warning: This computer program is protected by copyright law and interna
Unauthorized use, reproduction or distribution of this computer program, or
result in severe civil and criminal penalties.
Copyright (C) 2022 Hexagon AB and/or its subsidiaries. All rights res

*****
*****
**
**
*****
Hexagon AB
          
```

Editing PBMSECT 8



Download BDF Files

1. Navigate to the Download section
2. The Download Information section provides details regarding how the original BDF files will be edited and downloaded
3. Click Download BDF Files

Download Information

2

The following PBMSECT/PBRSECT entries, and respective POINT and SET1 entries, have been edited in this web app and will be updated in the downloaded BDF files.

Changes will be made at BEGINBU LK or near lines [12] in file double_box_beam.bdf.

Entry	PID
PBMSECT	9

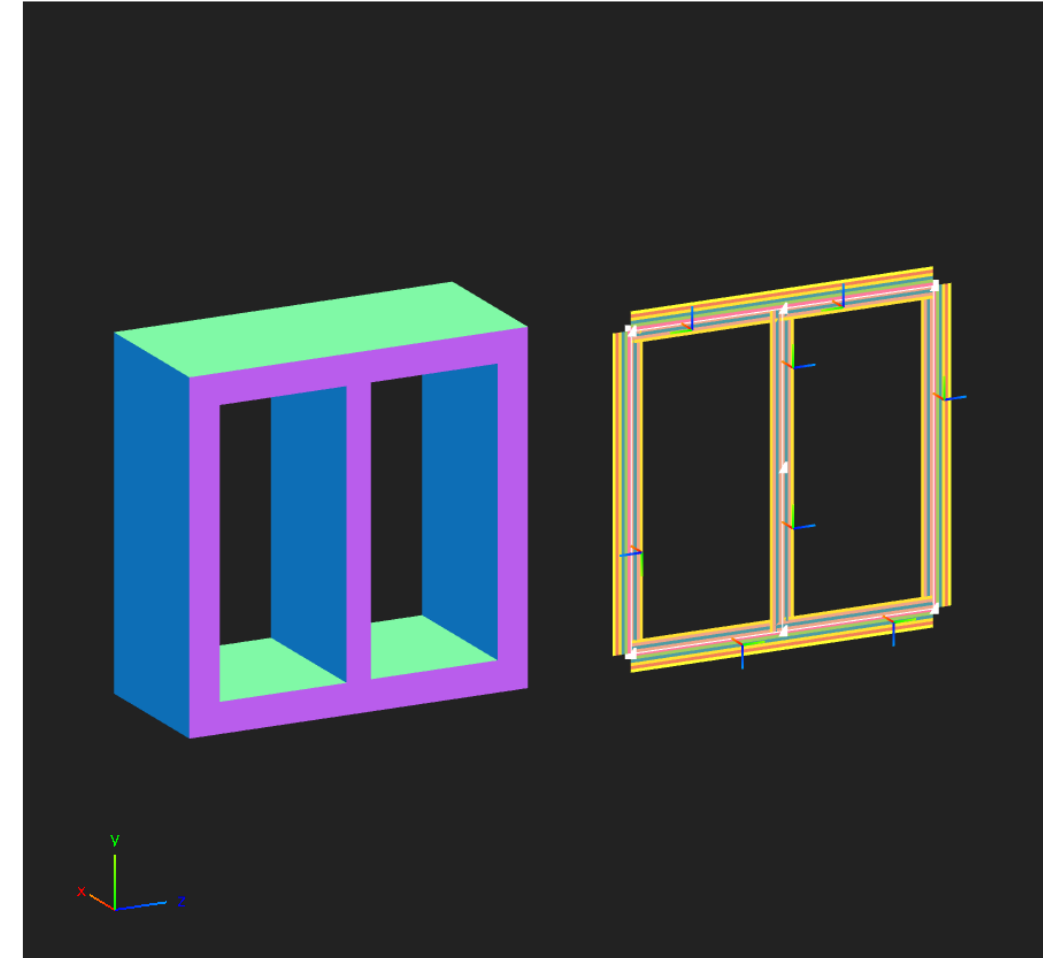
Download

1

Download BDF Files

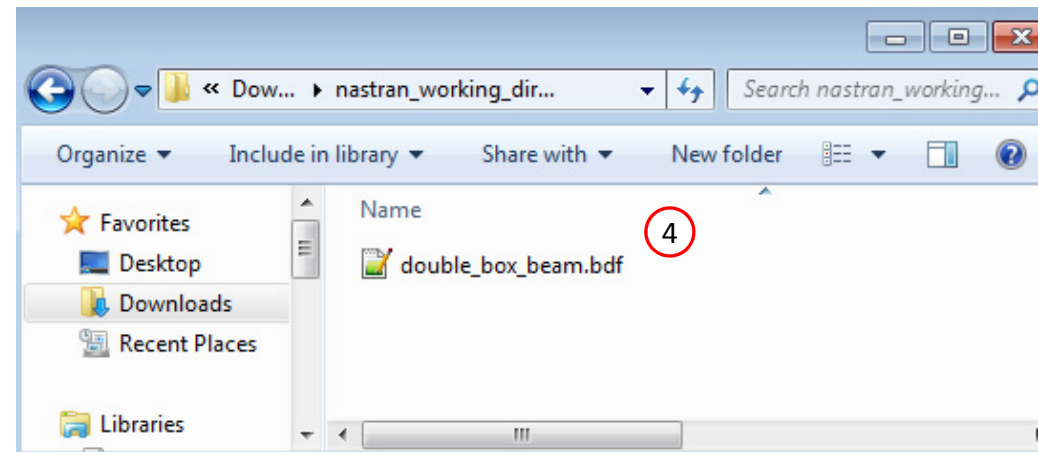
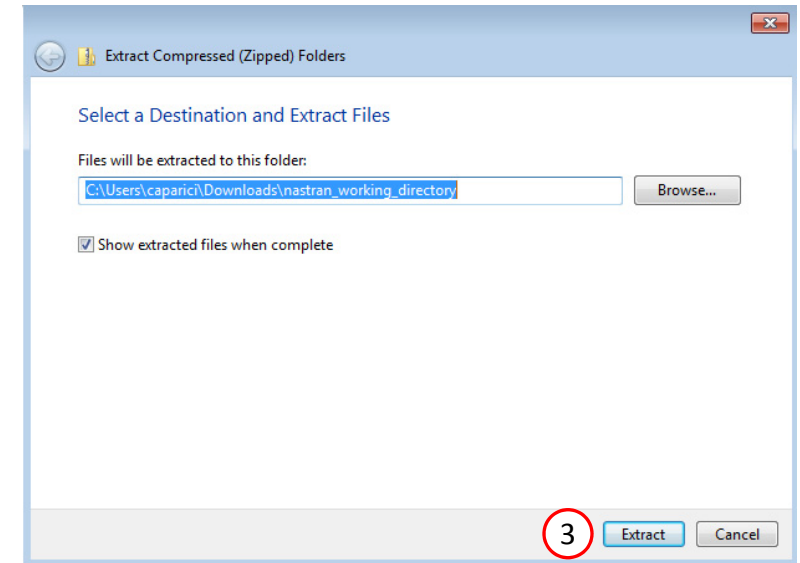
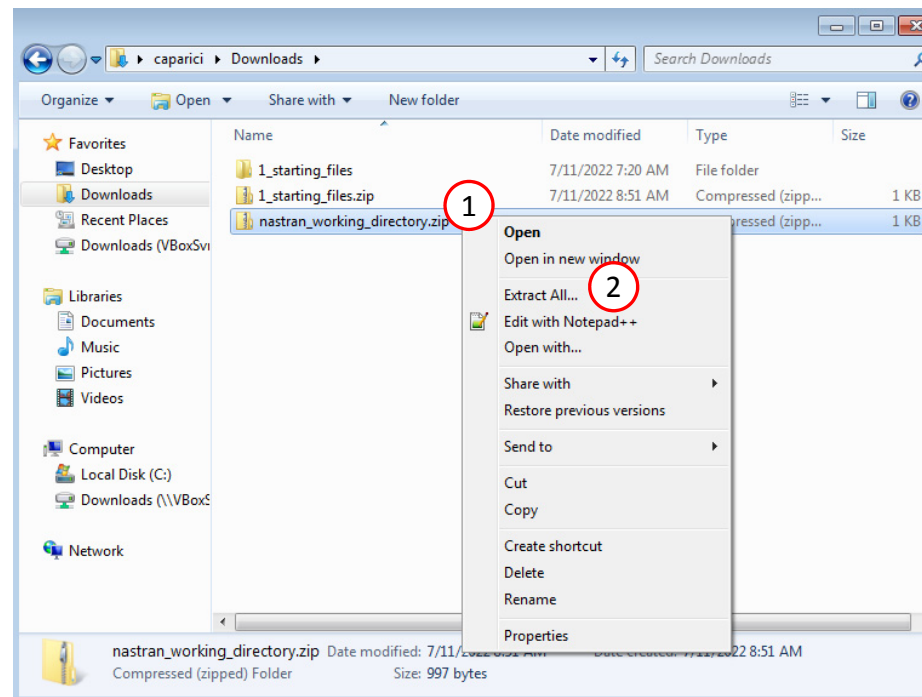
3

Editing PBMSECT 8



Extract the ZIP File

1. A new file `nastran_working_directory.zip` has been downloaded
2. Right click on the ZIP file and click Extract All
3. Click Extract
4. A new folder `nastran_working_directory` is created and inside is the updated `double_box_beam.bdf` file



Compare the Original and New BDF Files

There is one CBEAM3 element in the file double_box_beam.bdf. This CBEAM3 is configured to use PBEAM3 8, but now the CBEAM3 should use the new PBMSECT entry. The IDs of the PBMSECT and PBEAM3 must be switched.

1. Open the new file double_box_beam.bdf in a text editor (Not shown)
2. Change the ID of the PBMSECT to 8
3. Change the ID of the PBEAM3 to 1
4. Save the edits (not shown)

Before

BEGIN BULK

```
PBMSECT 9 CP
      OUTP=901, BRP (1)=902, BRP (2)=903, CORE=501, CORE (7)=[503, PT=(9000007
      , 9000002) ], CORE (8)=[503, PT=(9000005, 9000007) ], LAYER (4)=(502, 904)
POINT 9000001 -10. 10.
```

Some text not shown

\$	1	2	3	4	5	6	7	8	9
10									
PBEAM3	8	1	100.	.01	.01	0.0	.02		+
+	5.	5.0	5.0	-5.0	-5.0	5.0	-5.0	-5.0	

ENDDATA

After

BEGIN BULK

```
PBMSECT 8 CP
      OUTP=901, BRP (1)=902, BRP (2)=903, CORE=501, CORE (7)=[503, PT=(9000007
      , 9000002) ], CORE (8)=[503, PT=(9000005, 9000007) ], LAYER (4)=(502, 904)
POINT 9000001 -10. 10.
```

Some text not shown

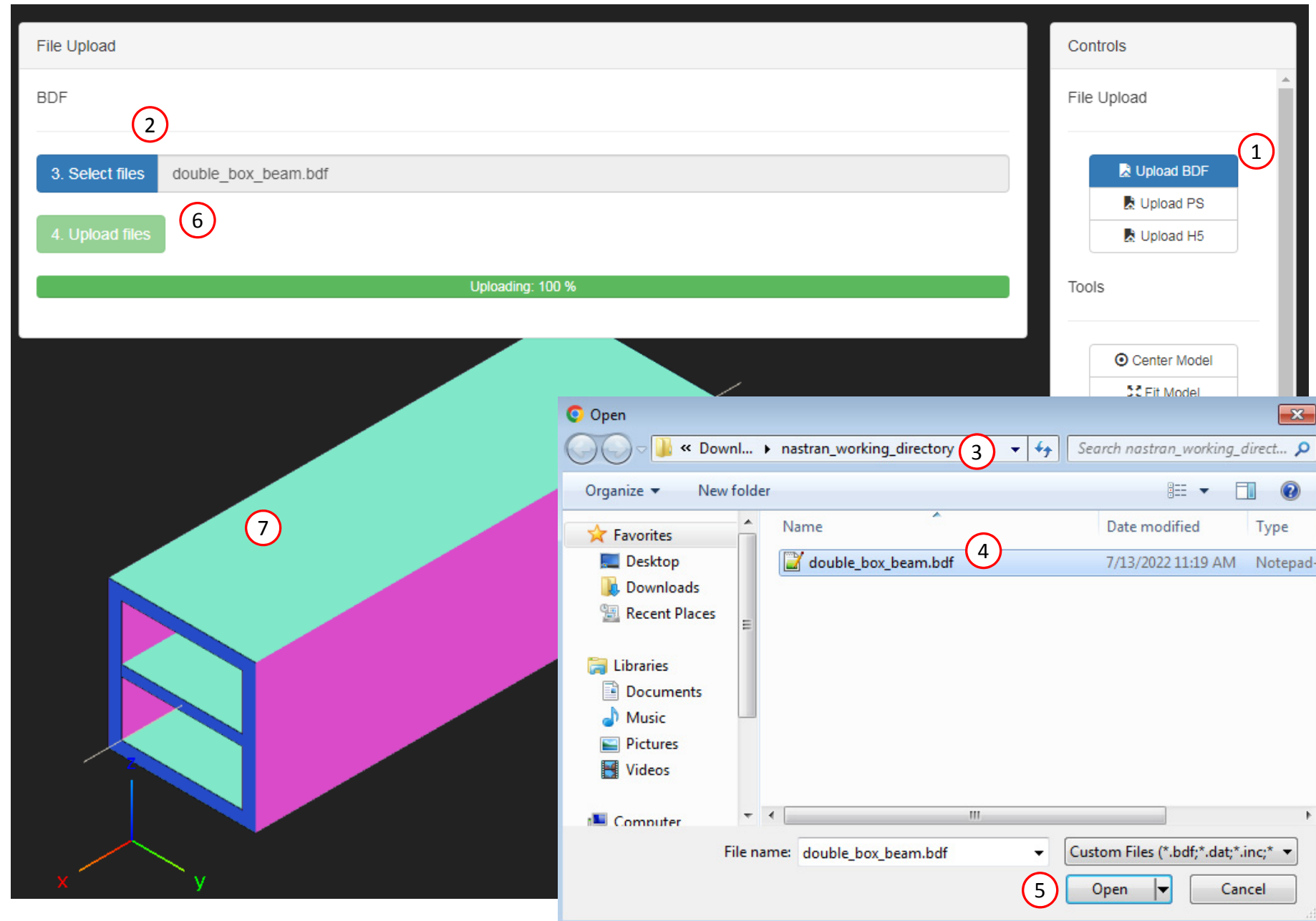
\$	1	2	3	4	5	6	7	8	9
10									
PBEAM3	1	1	100.	.01	.01	0.0	.02		+
+	5.	5.0	5.0	-5.0	-5.0	5.0	-5.0	-5.0	

ENDDATA

View the Model in the Viewer

Open the Viewer in a new web browser tab or window (Not shown)

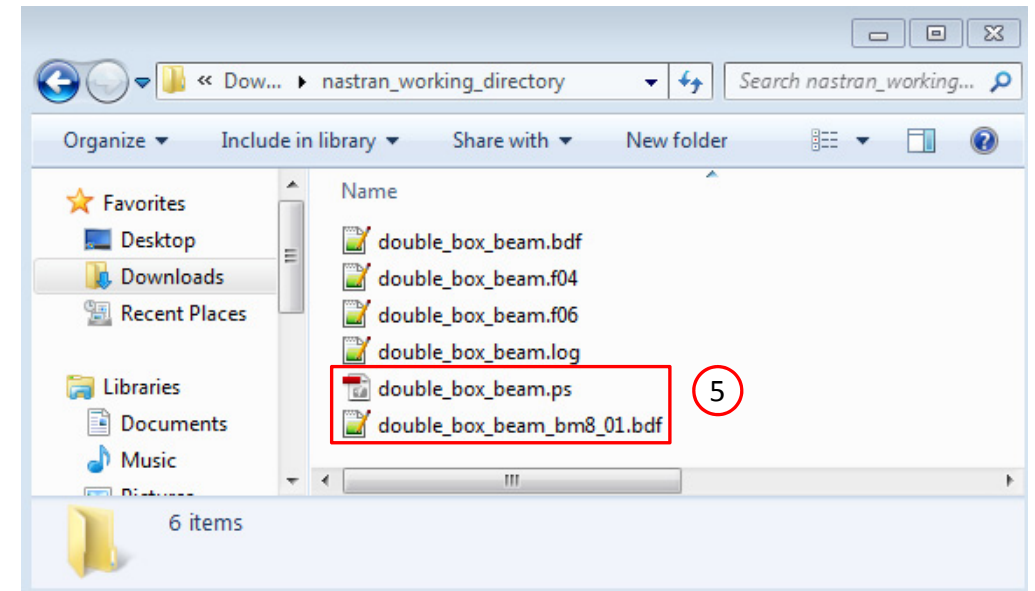
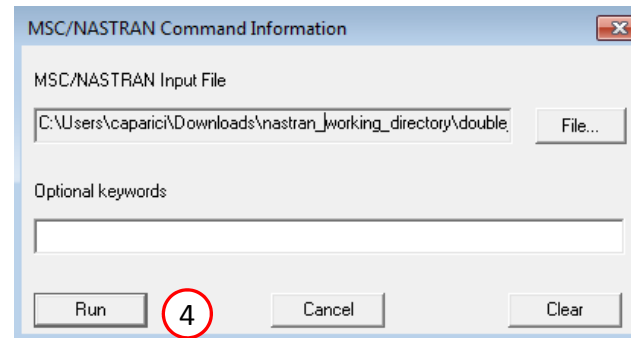
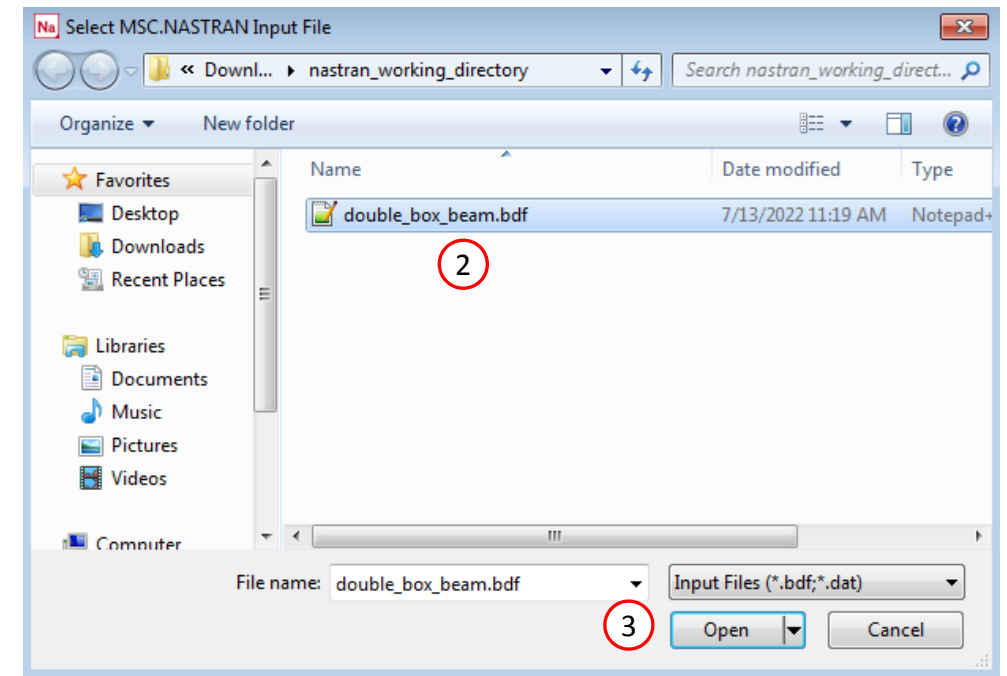
1. Click Upload BDF
2. Click Select files
3. Navigate to the directory nastran_working_directory
4. Select double_box_beam.bdf
5. Click Open
6. Click Upload files
7. The MSC Nastran model has been uploaded to the Viewer
 - Notice the cross section is now the ABCS that was defined in the PBMSECT web app



Manually Generating the PS and BDF Files

1. Double click the MSC Nastran desktop shortcut
2. Select this file
nastran_working_directory/double_box_beam.bdf
3. Click Open
4. Click Run
5. The PS and BDF files have been generated by MSC Nastran. The BDF files generated follow this naming pattern:
AAA_xyyyy_zz.bdf .

If the PS and BDF files have not been produced, then a USER FATAL MESSAGE or SYSTEM FATAL MESSAGE may have been encountered. Inspect the F06 file for these messages. Correct the issues and try running MSC Nastran again.



Verify the Angles with Patran

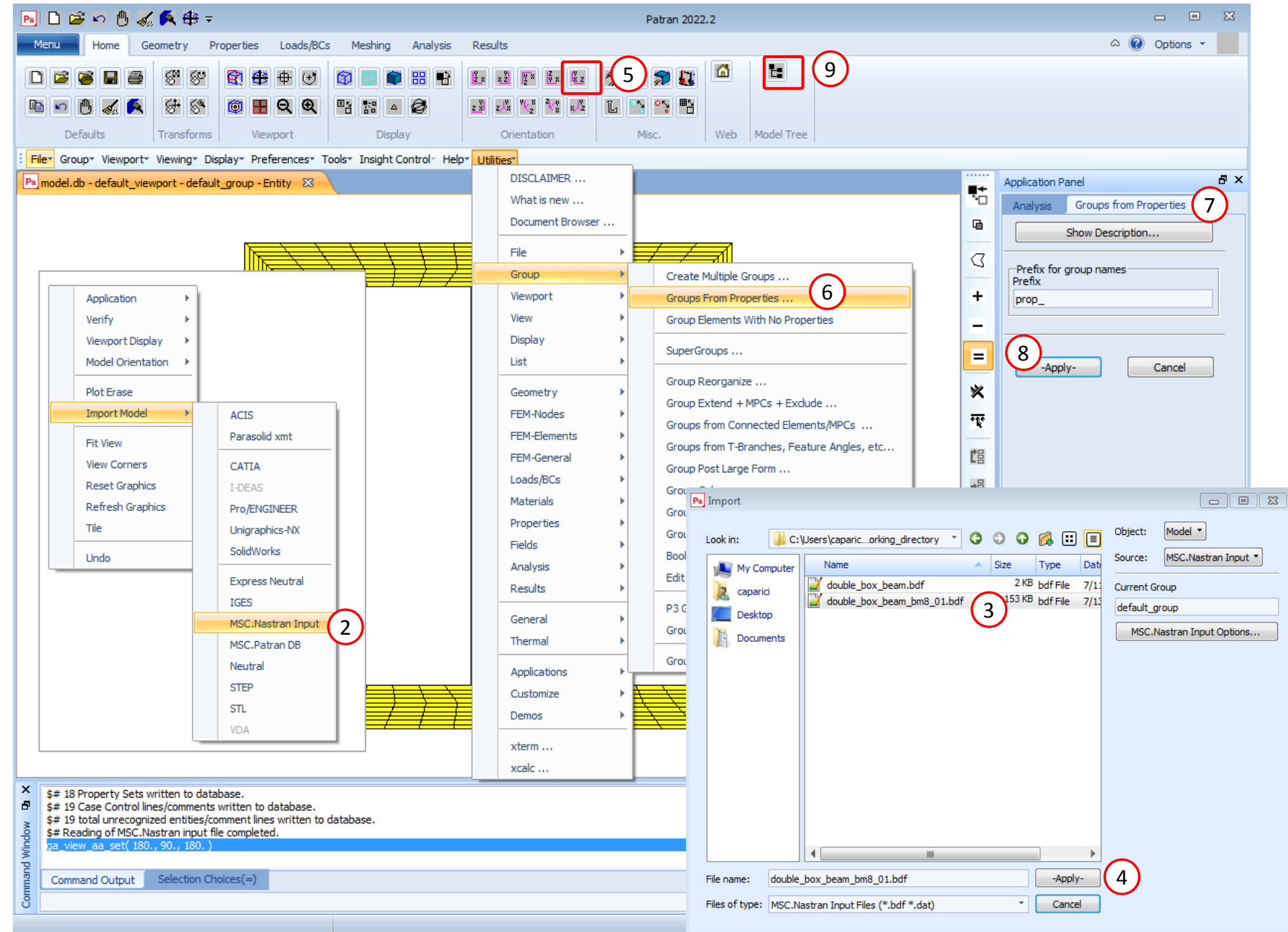
1. The file model_bm8_01.bdf contains information regarding the angles of each ply. Open this BDF file in a text editor.
2. Pre/post processors have existing capabilities to display the thickness values of PSHELL entries and this same capability is used to display the ply angles. The file model_bm8_01.bdf contains artificial PSHELL entries that store the ply angles in field 4 of the PSHELL entry. Field 4 is normally a field that stores the thickness value but these artificial PSHELL entries are storing the ply angles.
3. Since thickness values must always be positive, field 4 has a requirement that its value always be positive. Negative angles are expressed in a special format. Negative angle values are offset by +180 degrees. For example, if a ply angle is -5 degrees, its respective PSHELL entry stores a value of $(+180 - 5) = +175$.

model_bm8_01.bdf

CQUAD4	10650	50306	10716	10600	10601	10717	1
CQUAD4	10651	50307	10717	10601	10602	10718	
CQUAD4	10652	50308	10718	10602	10603	10719	
PSHELL	50101	301	0.000	2			
PSHELL	50102	301	1.000				
PSHELL	50103	301	2.000				
PSHELL	50104	301	3.000				
PSHELL	50105	301	4.000				
\$PSHELL	50106	301	-5.000				
PSHELL	50106	301	175.000	3			
\$PSHELL	50107	301	-6.000				
PSHELL	50107	301	174.000				
\$PSHELL	50108	301	-7.000				
PSHELL	50108	301	173.000				
\$PSHELL	50201	301	-8.000				
PSHELL	50201	301	172.000				
\$PSHELL	50202	301	-9.000				
PSHELL	50202	301	171.000				
PSHELL	50301	301	0.000				
PSHELL	50302	301	1.000				
PSHELL	50303	301	2.000				
PSHELL	50304	301	3.000				
PSHELL	50305	301	3.000				
PSHELL	50306	301	2.000				
PSHELL	50307	301	1.000				
PSHELL	50308	301	0.000				
GRID*		10001				9.20000000E+00	
*		-9.20000000E+00					
GRID*		10002				9.40000000E+00	

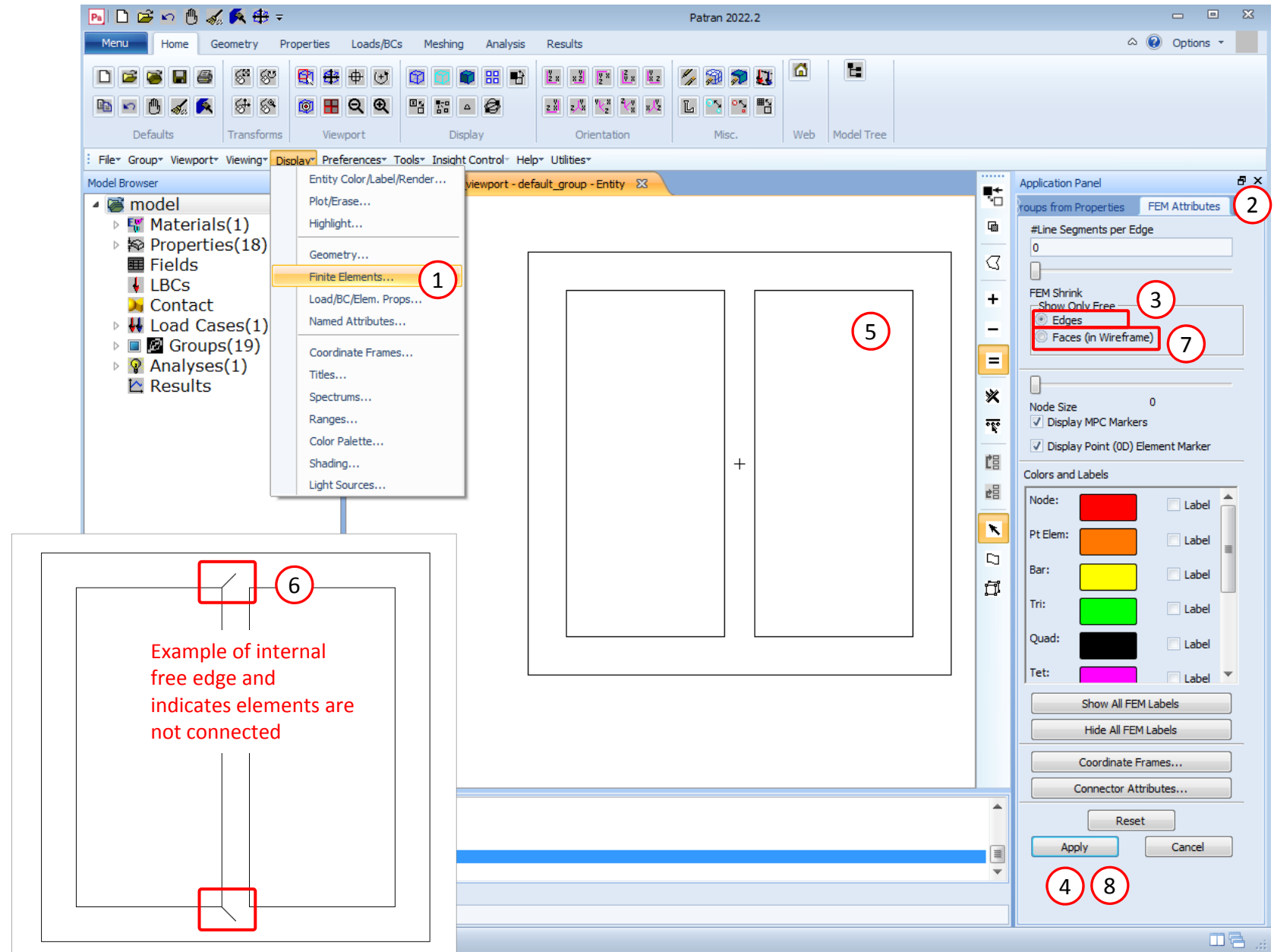
Verify the Angles with Patran

1. Start a new Patran database (File > New) (Not shown)
2. Right click on the viewport > Import Model > MSC.Nastran Input
3. Select this file
nastran_working_directory/double_box_beam_bm8_01.bdf
4. Click Apply and the BDF file is imported to Patran
5. Click Left side view
6. Go to Utilities > Group > Groups From Properties
7. A new panel name Groups from Properties is opened
8. Click Apply
9. Click the Model Tree



Verify the Angles with Patran

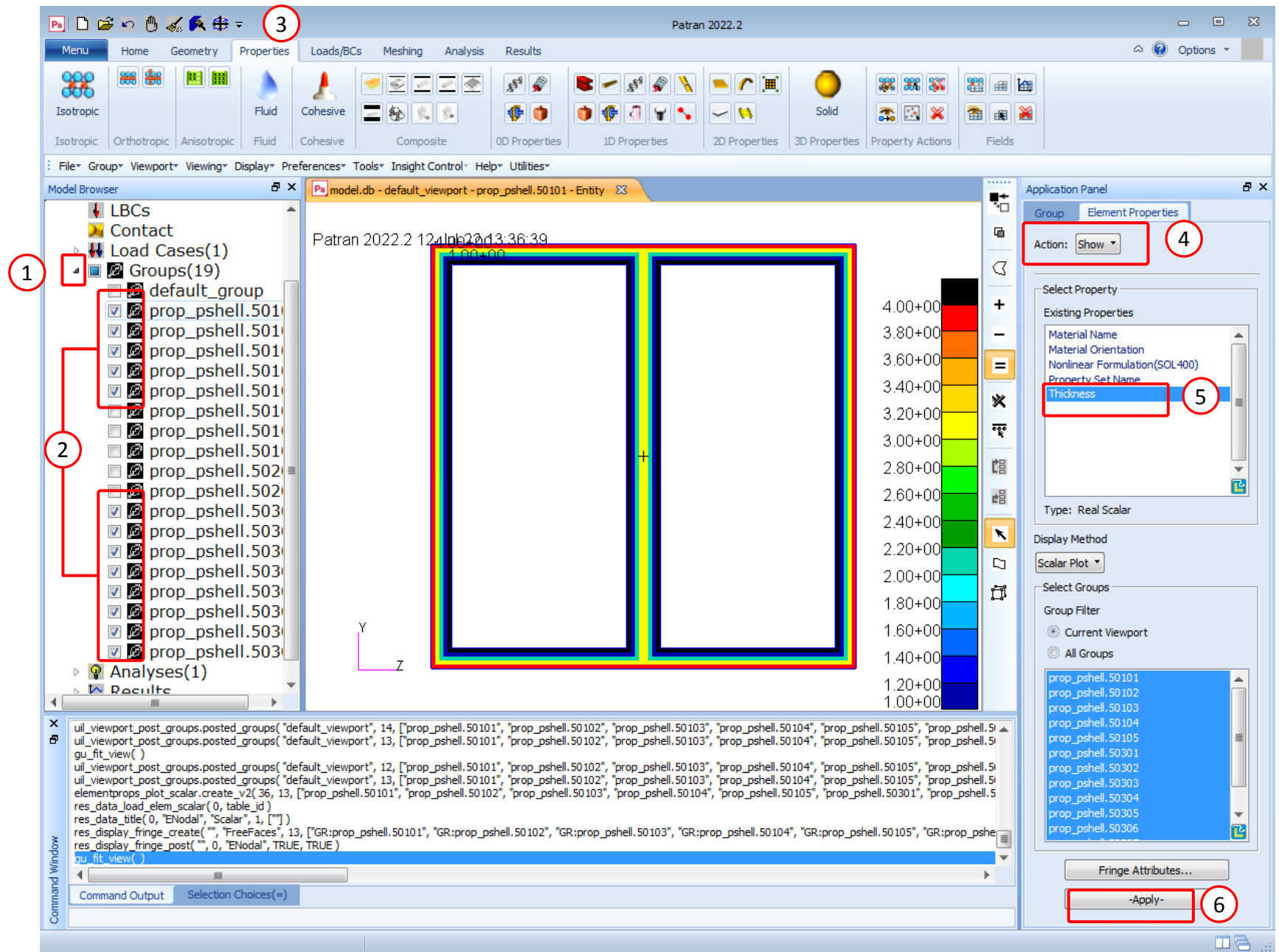
1. Go to Display > Finite Elements
2. A new panel name FEM Attributes is opened
3. Set Show Only Free to Edges
4. Click Apply
5. Inspect the free edges and ensure there are no free edges in the inside of the FE mesh. The only free edges allowed are the boundaries of the cross section.
6. Examples are shown of what internal free edges look like. If you find internal edges, take time to resolve these internal free edges.
7. Set Show Only Free to Face (In Wireframe)
8. Click Apply



Verify the Angles with Patran

1. Click on the arrow to expand the Groups branch
2. Mark the checkboxes for some of the Groups to view the ply angles
3. Click Properties
4. Set Action to Show
5. Select Thickness
6. Click Apply

The cross section is now colored differently depending on the ply's angle.

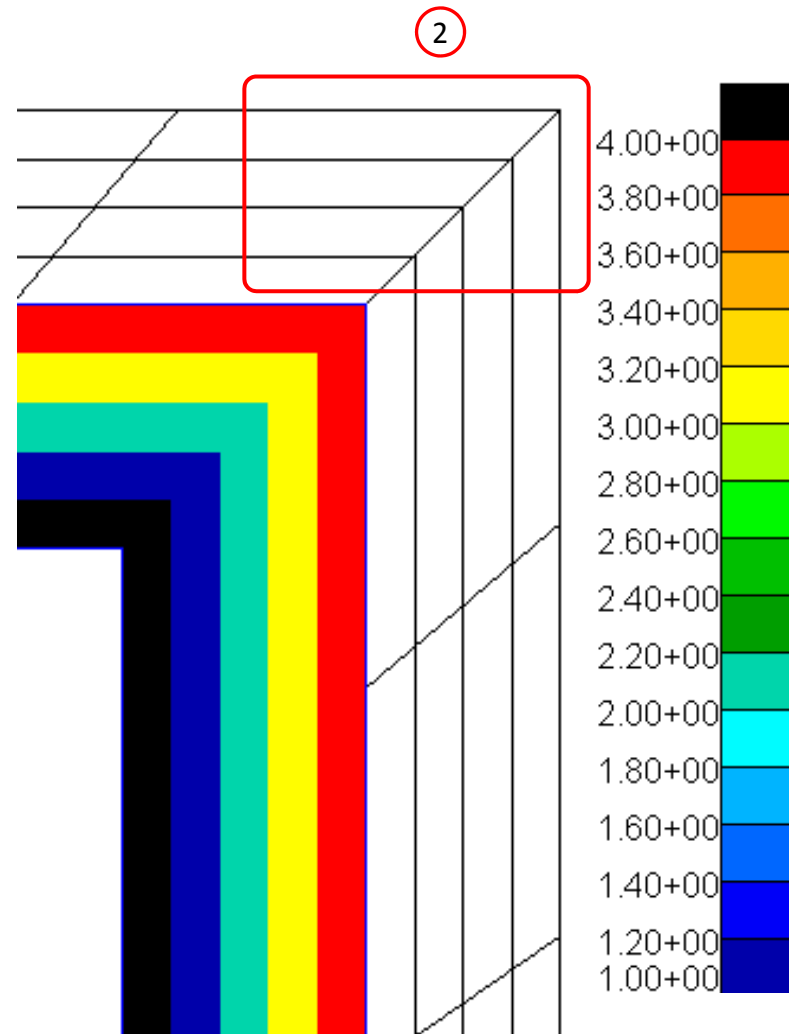


Verify the Angles with Patran

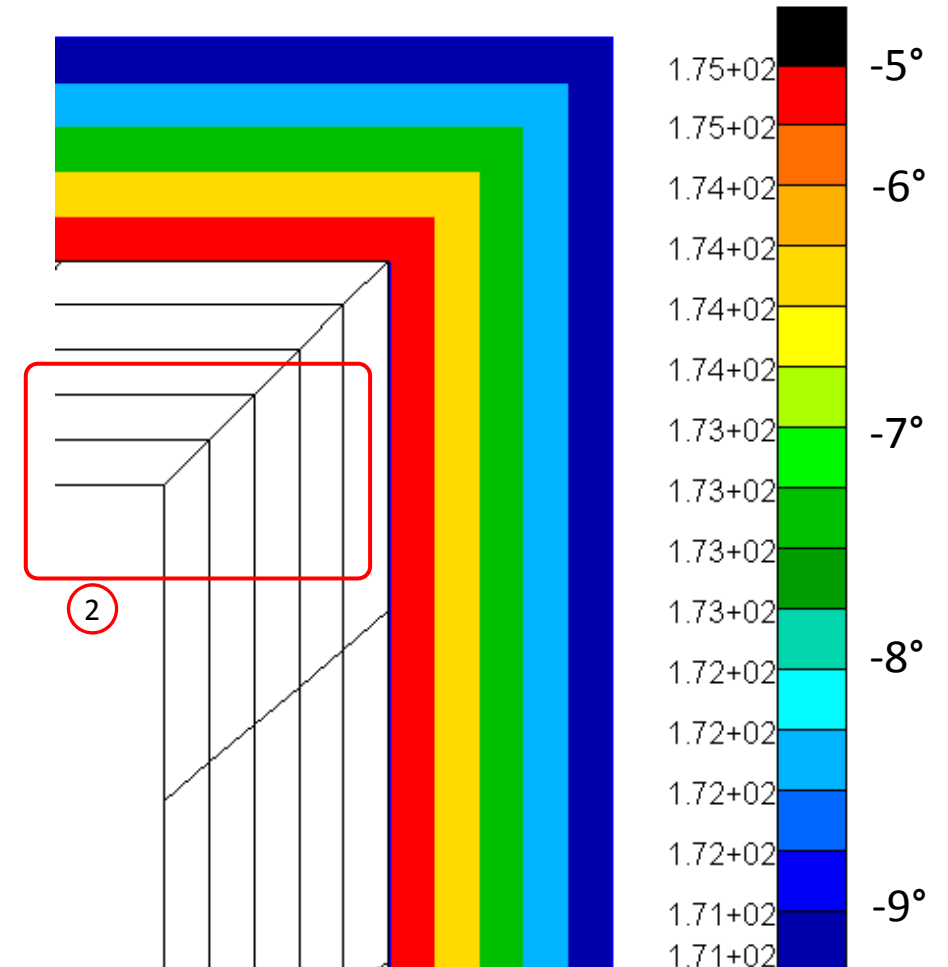
1. Select different checkboxes in the Groups branch to display different plies (Not shown). You may need to redisplay the thickness fringe plot as instructed on the previous slide.
2. When you replicate this example, the indicated region will not necessarily be displayed.

To the right are some possible displays of your ply angle values.

Plies for 0 (black), 1 (blue), 2 (turquoise), 3 (yellow) and 4 (red) degrees are displayed



Plies for -5, -6, -7, -8 and -9 degrees are displayed. Recall that negative angles are stored by using a +180 degree offset. For example, -5° degrees is stored as 175°.



Create a Session (SES) File

The previous steps may be automated with the session (SES) script file. First create a new Patran database. (Not shown)

1. Create a new text file named `display_ply_angles.ses`
2. Open this SES file in a text editor
3. Replace the text with the path to your BDF file `model_bm8_01.bdf`. If the path spans more than 80 characters, use `@` characters to separate the path into a new line.
4. Save the SES file (Not shown)

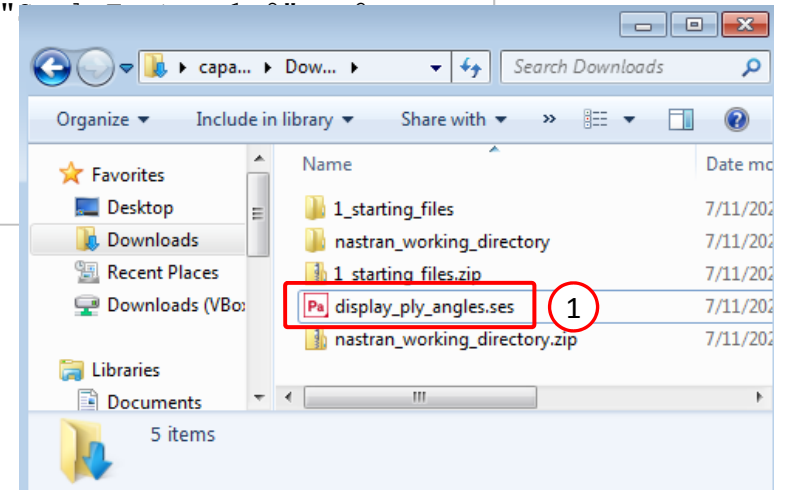
- The lines in the SES file should be at most 80 characters in length, this includes space characters.
- If a command spans more than 80 characters, the character `@` is inserted at the end of each line, so as to break up the command into multiple lines.
- In this example, the command `nastran_input_import` is broken up into multiple lines.
- Ensure the path to the BDF file is added with surrounding apostrophe characters.

display_ply_angles.ses

```
nastran_input_import( @
"C:\Users\caparici\Downloads\nastran_working_directory\@
double_box_beam_bm8_01.bdf"@
, "default_group", 11, [ @
TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, FALSE, TRUE, TRUE], [0, 0, 0, @
0, 0, 0, 0, 0, 0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0], [-20000000000, @
-20000000000, -20000000000, -20000000000, -20000000000, -20000000000, @
-20000000000, 0, 0, 0] )

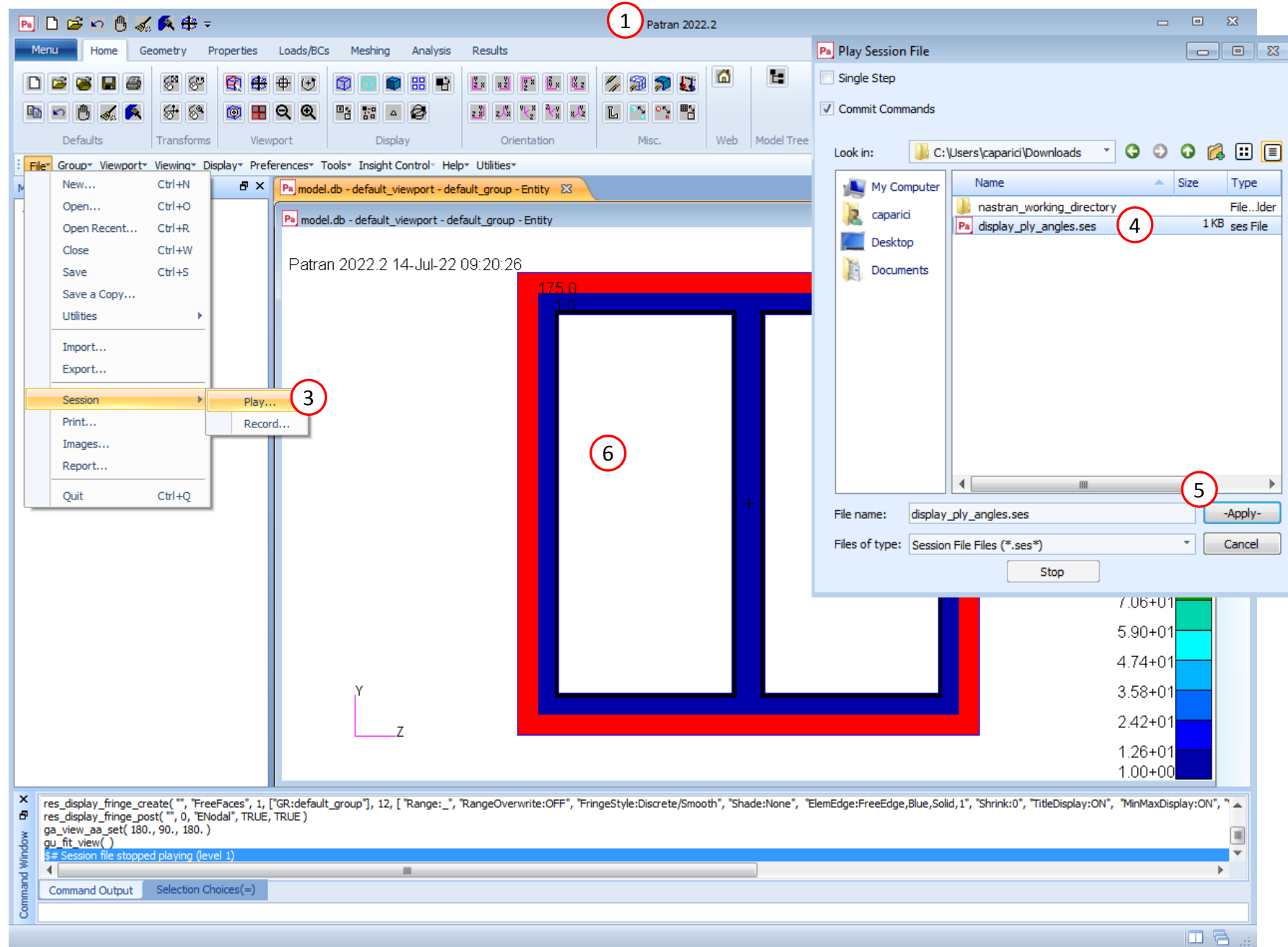
bv_groups_from_properties( "prop_" )

INTEGER table_id
REAL min
REAL max
elementprops_plot_scalar.create_v2( 36, 1, ["default_group"], "Thickness", @
table_id, min, max )
res_data_load_elem_scalar( 0, table_id )
res_data_title( 0, "ENodal", "Scalar", 1, ["" ] )
res_display_fringe_create( "", "FreeFaces", 1, ["GR:default_group"], 12, [ @
"Range:", "RangeOverwrite:OFF", "FringeStyle:Discrete/Smooth", "Shade:None", @
"ElemEdge:FreeEdge,Blue,Solid,1", "Shrink:0", "TitleDisplay:ON", @
"MinMaxDisplay:ON", "ValueDisplay:OFF", "Filter:None", "
"LabelStyle:Fixed,12,White,1"], TRUE )
res_display_fringe_post( "", 0, "ENodal", TRUE, TRUE )
ga_view_aa_set( 180., 90., 180. )
gu_fit_view( )
```



Verify the Angles with Patran

1. Open Patran
2. Start a new Patran database by clicking File > New... (Not shown)
3. Play the SES file created on the previous slide. Go to File > Session > Play
4. Navigate and select the SES file
5. Click Apply
6. The BDF file is imported, the groups are automatically created and thickness (angle) values are displayed



End of Tutorial

Appendix

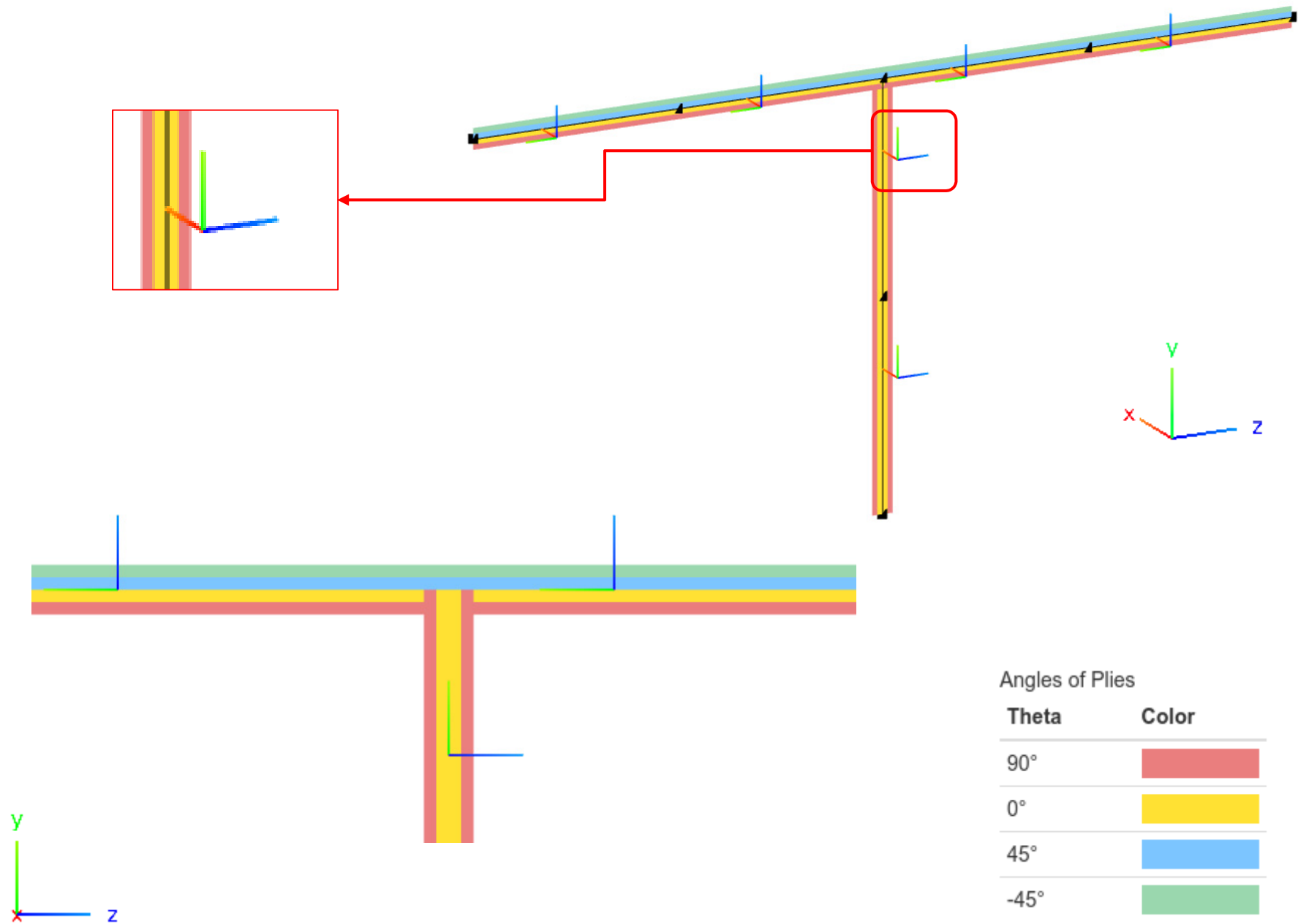
Appendix Contents

- Ply Coordinate System
- Unwanted Free Edges in the Cross Section's Mesh
- Avoid CORE/LAYER and SET1 Conflicts
- Considerations for Outer Perimeter and Branch Lines
- Offset Z0 Considerations

Ply Coordinate System

Ply Coordinate System

1. When viewing the preview of the composite arbitrary beam cross section, there will be ply coordinate systems displayed for each line



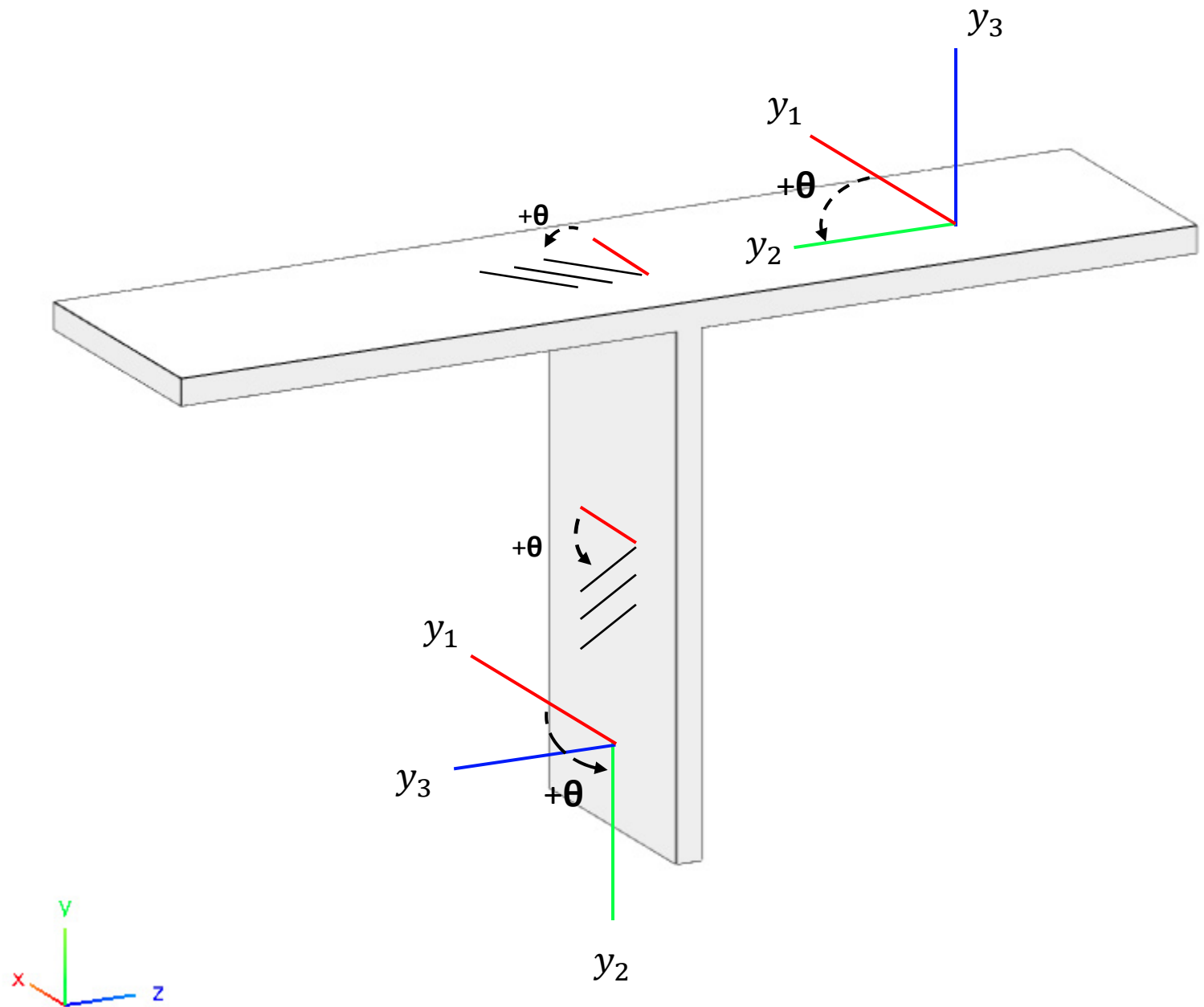
Ply Coordinate System

1. Each line segment is assigned a ply coordinate systems (y_1 , y_2 , y_3) and determines the orientation of the plies. See reference 1 for more details.
2. Plies are stacked in ascending order in the $+y_3$ direction

The y_1 axis will always be in the same direction as the beam element's x-axis. The y_2 axis is determined by the order in which the lines are connected.

References

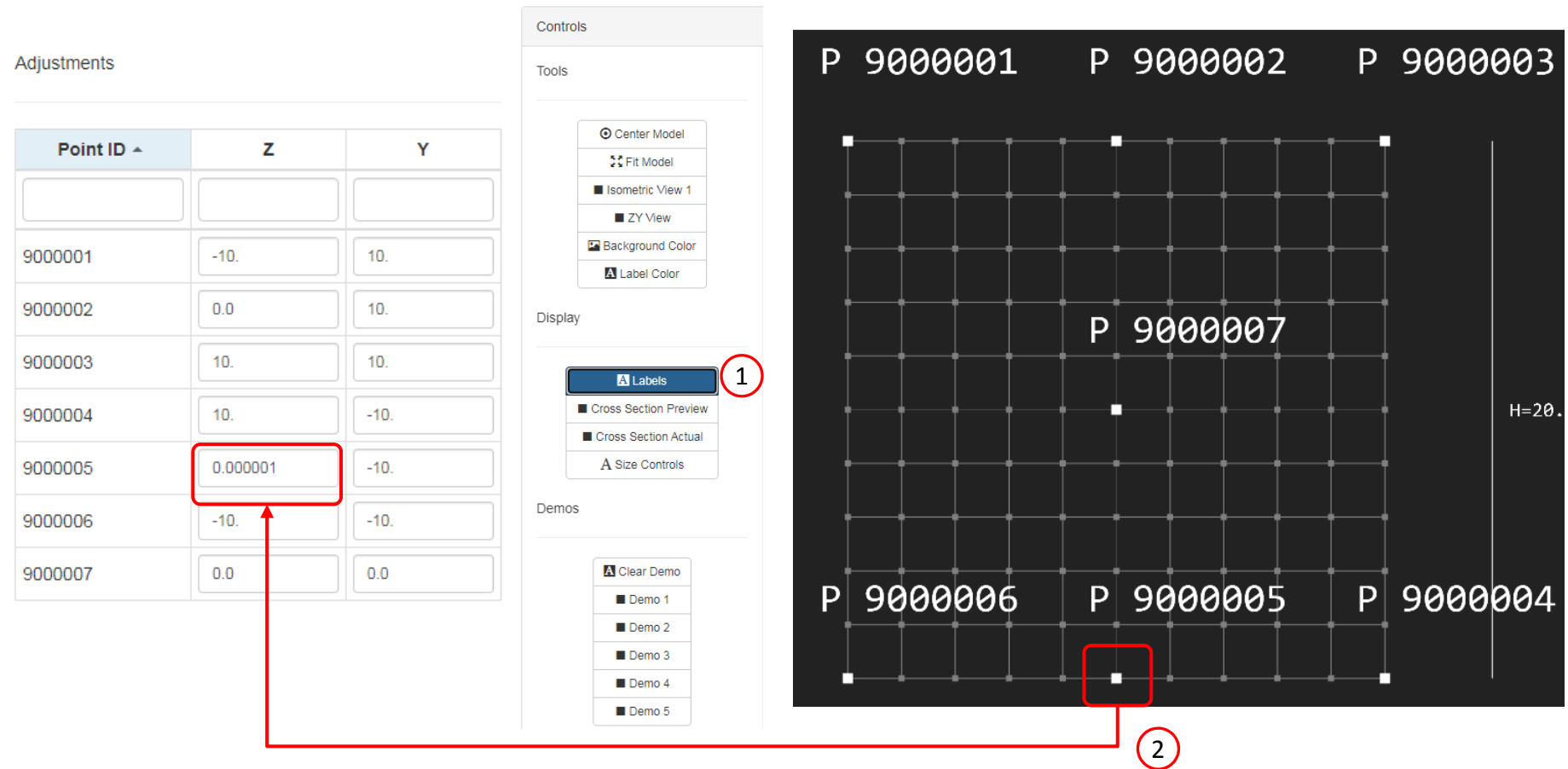
1. W. Yu, VABS Manual for Users, March 2011, Utah State University.



Unwanted Free Edges in the Cross Section's Mesh

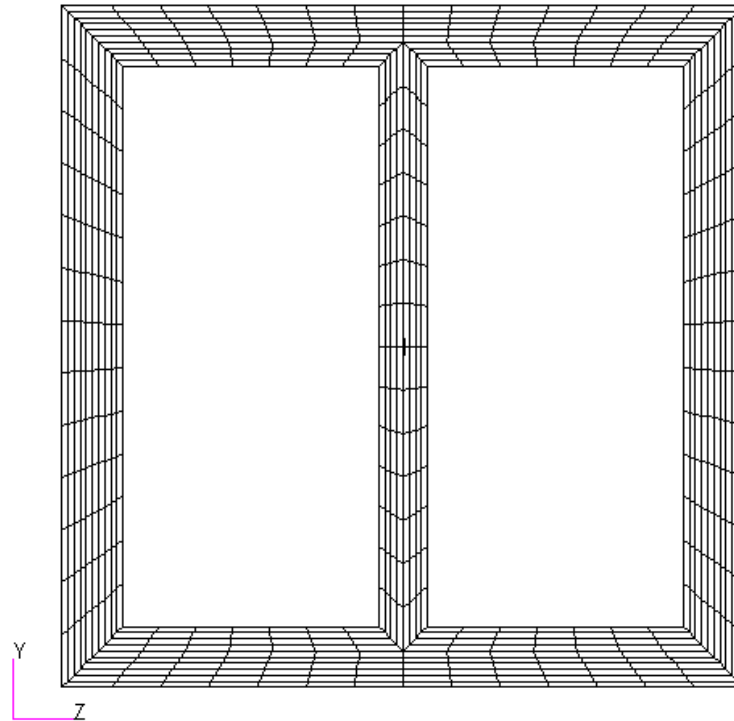
Unwanted Free Edges in the Cross Section's Mesh

1. During the workshop, the z value of a POINT was offset by a small pertubation. Why was this done?

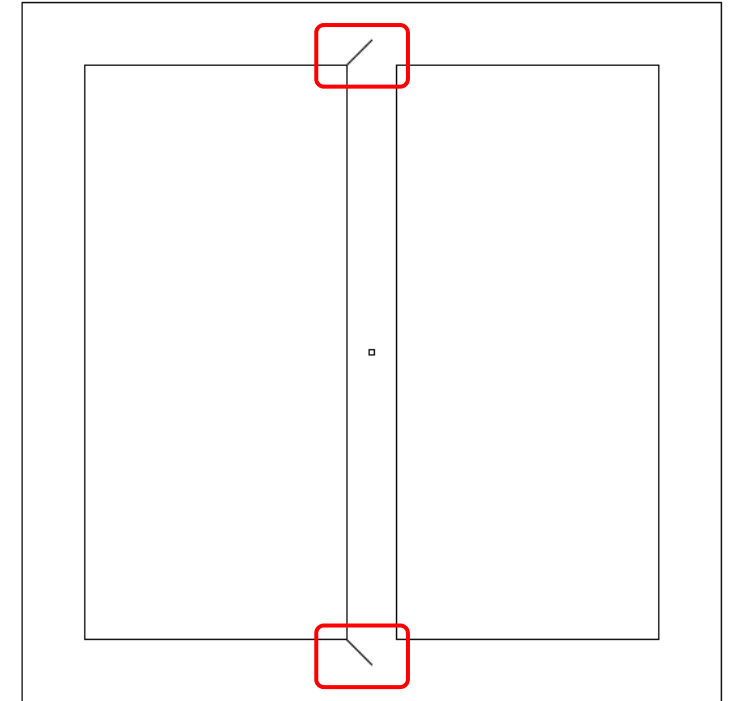


Unwanted Free Edges in the Cross Section's Mesh

1. When the BDF file is executed with MSC Nastran, a BDF file of the form AAA_xyyy_zz.bdf is created and includes a mesh for the arbitrary beam cross section
2. This mesh will sometimes have unwanted free edges



Display of the cross section's mesh

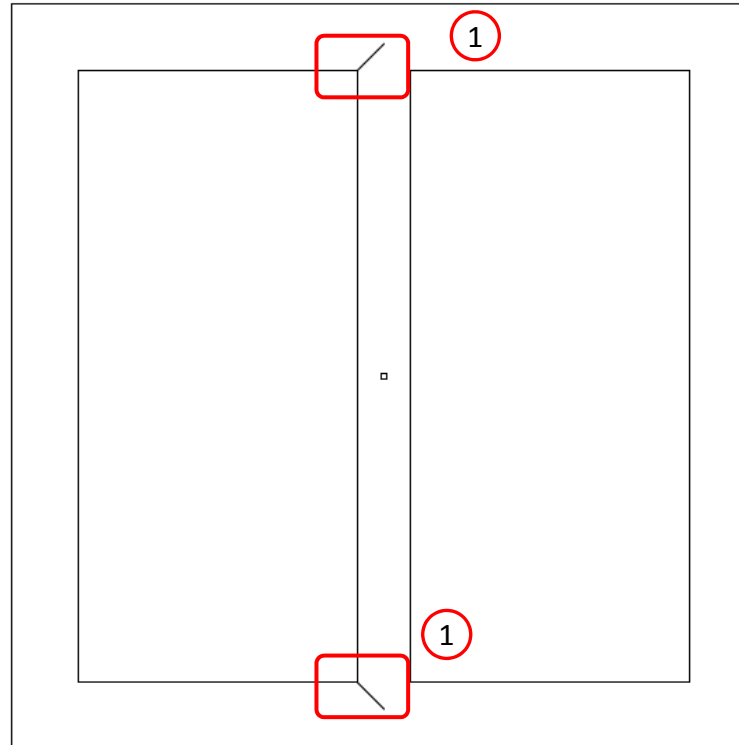


A view of the mesh's free edges reveals unwanted free edges in the interior of the mesh

Unwanted Free Edges in the Cross Section's Mesh

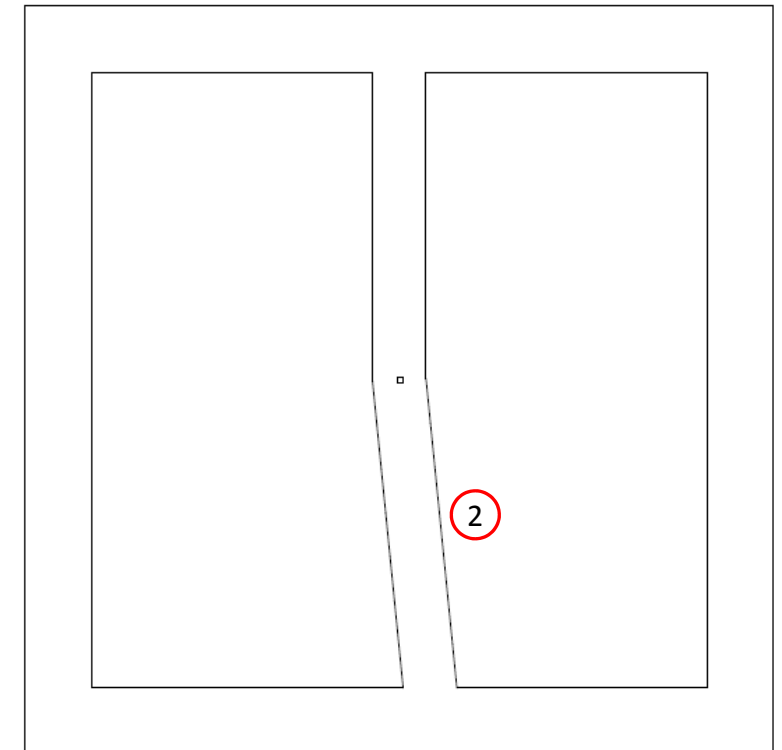
1. If a line segment is perfectly vertical, the FE mesh generated sometimes contains unwanted free edges
2. By adjusting one a POINT by a small perturbation, the line is no longer perfectly vertical and the unwanted free edges are absent. Note that the offset used was .000001, which is a negligible amount. The image shown is not to scale.

Without Small Perturbation



PBMSECT	8							
End A	composite							
2.0164E+09	0.0000E+00	8.7256E+06	8.1689E+08	0.0000E+00	1.5123E+06			
0.0000E+00	2.4365E+07	0.0000E+00	0.0000E+00	-3.8729E+08	0.0000E+00			
8.7256E+06	0.0000E+00	3.4090E+07	-9.9409E+04	0.0000E+00	-3.7659E+08			
8.1689E+08	0.0000E+00	-9.9409E+04	6.2805E+09	0.0000E+00	-1.2625E+06			
0.0000E+00	-3.8729E+08	0.0000E+00	0.0000E+00	1.2743E+11	0.0000E+00			
1.5123E+06	0.0000E+00	-3.7659E+08	-1.2625E+06	0.0000E+00	1.1888E+11			

With Small Perturbation (Not to Scale)

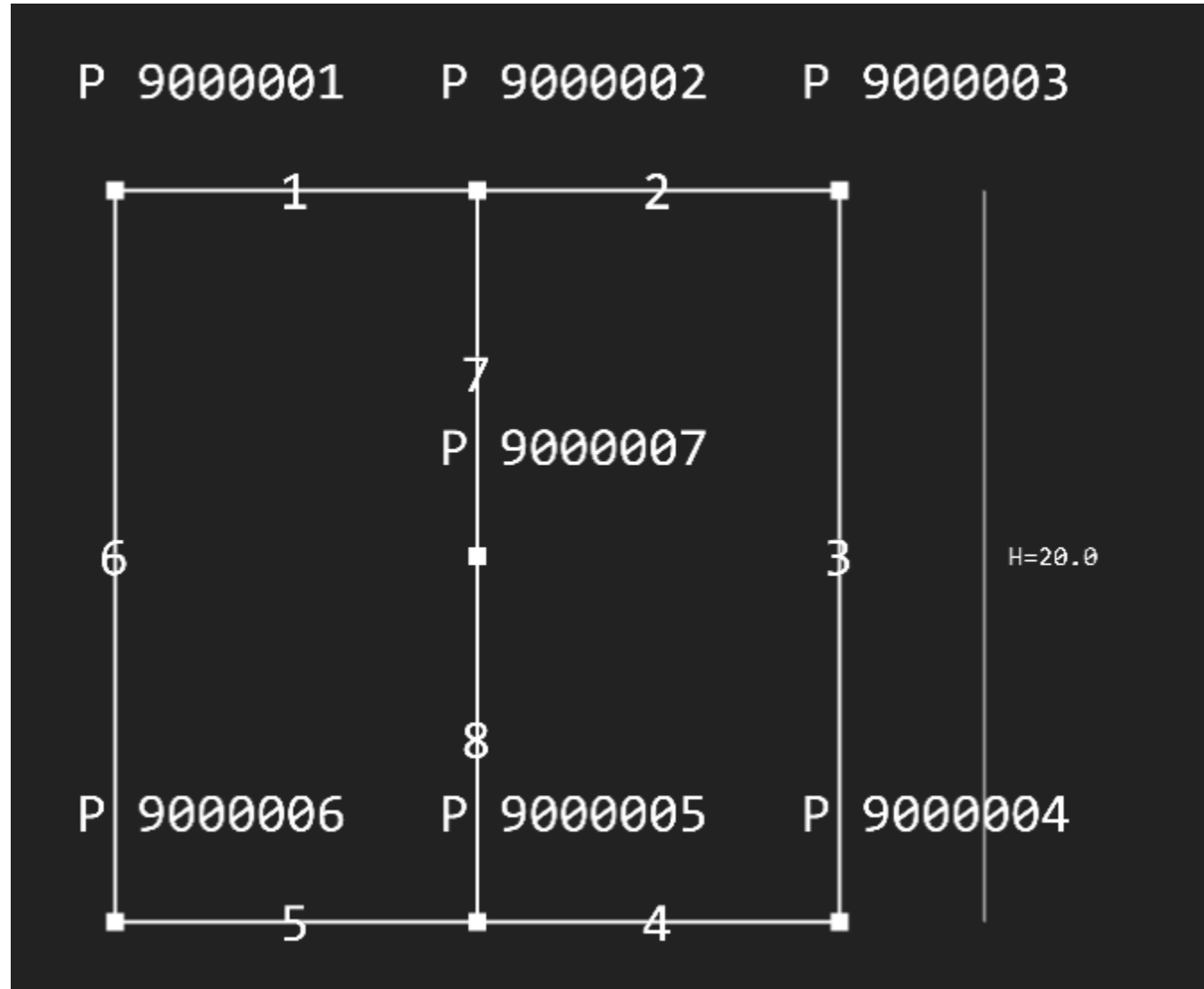


PBMSECT	8							
End A	composite							
2.0172E+09	-3.3683E+05	8.7198E+06	8.1661E+08	6.6706E+05	4.2174E+05			
-3.3683E+05	2.4401E+07	-1.7899E+05	9.2913E+04	-3.8715E+08	-1.2535E+06			
8.7198E+06	-1.7899E+05	3.4065E+07	-8.0120E+05	-1.1126E+06	-3.7819E+08			
8.1661E+08	9.2913E+04	-8.0120E+05	6.2838E+09	5.0917E+06	4.2376E+07			
6.6706E+05	-3.8715E+08	-1.1126E+06	5.0917E+06	1.2746E+11	4.3614E+08			
4.2174E+05	-1.2535E+06	-3.7819E+08	4.2376E+07	4.3614E+08	1.1892E+11			

Avoid CORE/LAYER and SET1 Conflicts

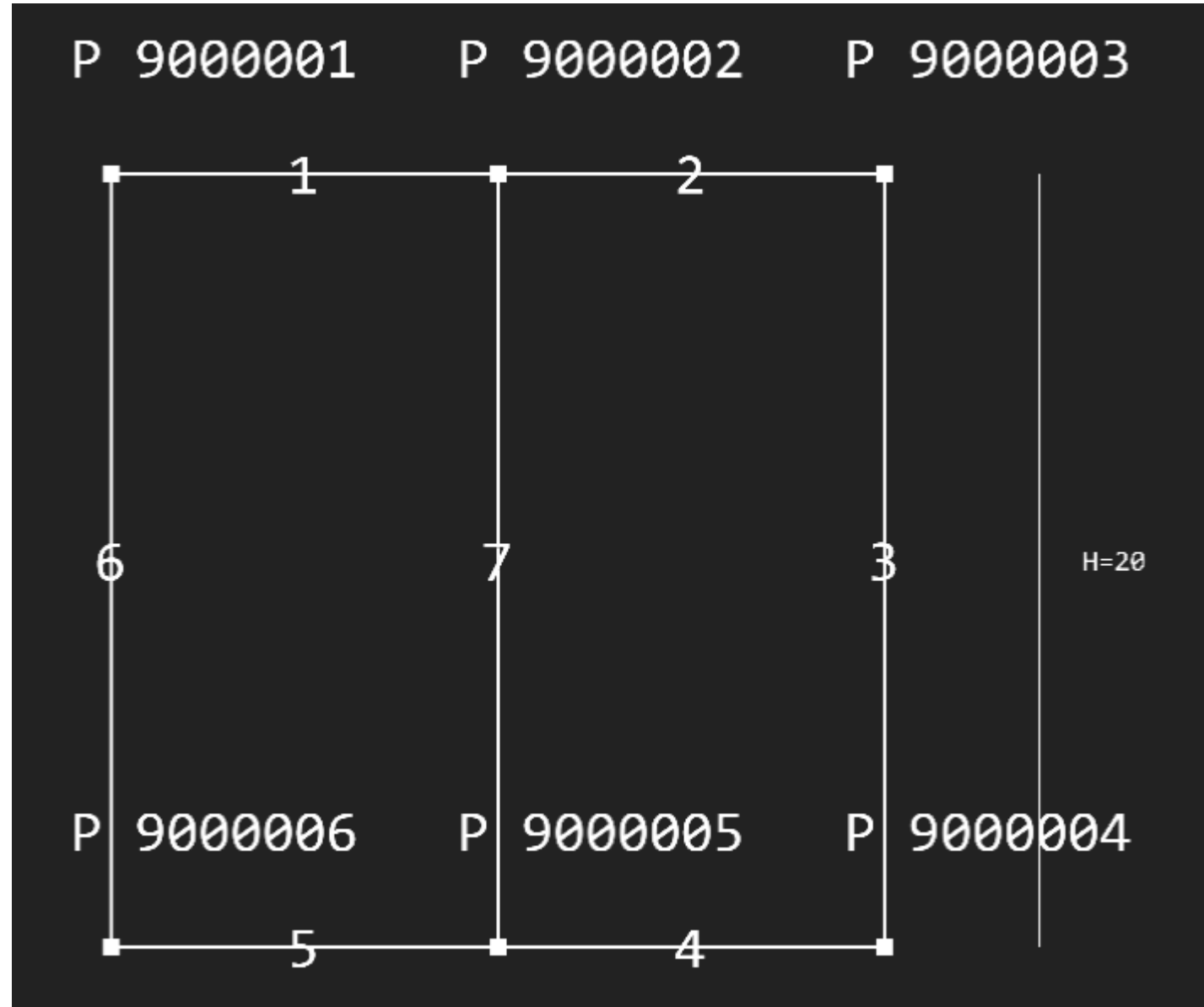
Avoid CORE/LAYER and SET1 Conflicts

1. Consider lines 7 and 8. You might ask why do I need 2 lines when 1 line should be sufficient?



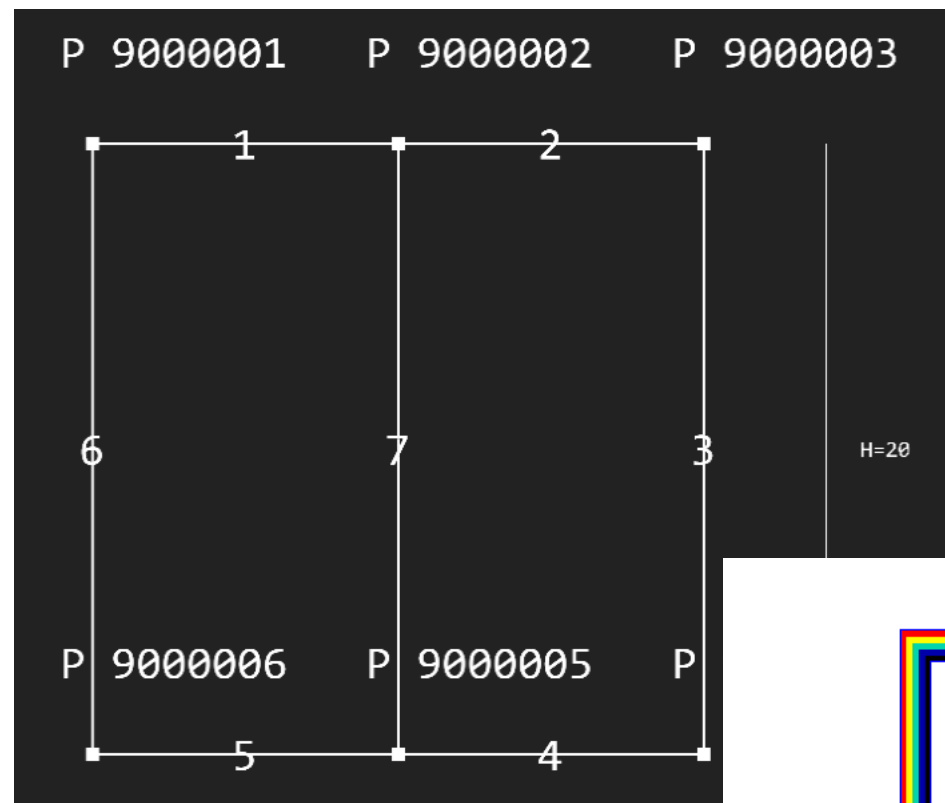
Avoid CORE/LAYER and SET1 Conflicts

1. Suppose this example was repeated with line 7 removed and POINT 9000007 removed



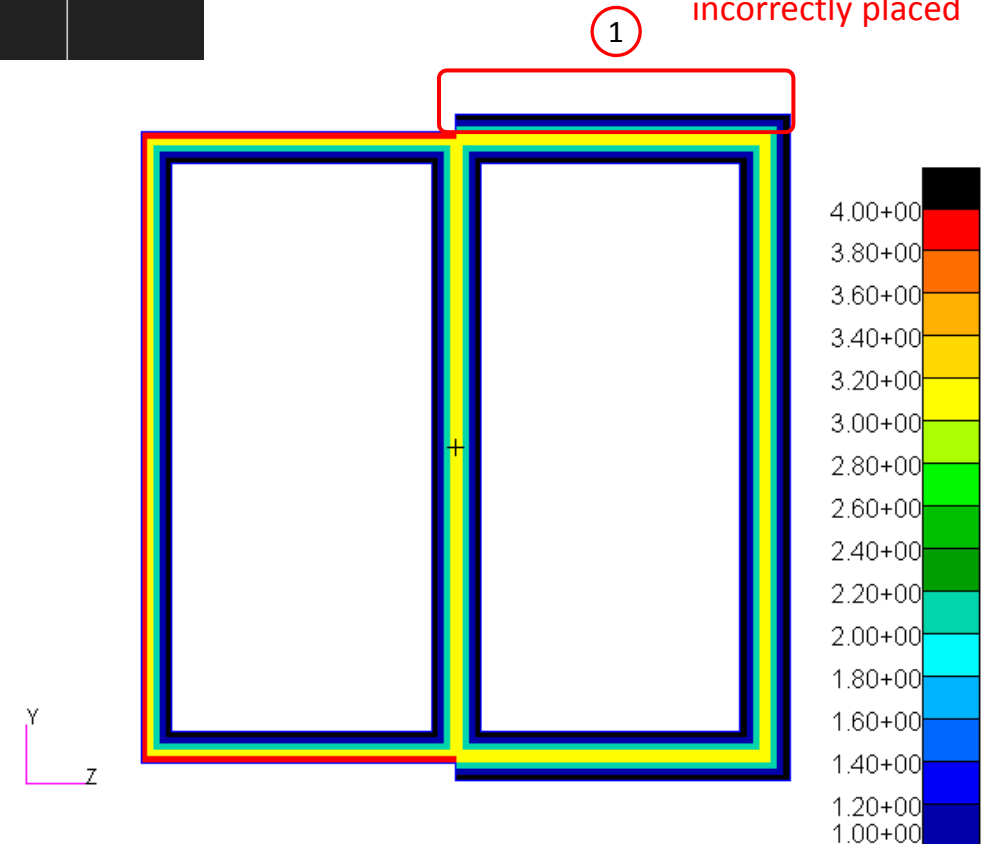
Avoid CORE/LAYER and SET1 Conflicts

1. If only one line is used, plies are incorrectly added



NOT OK

Plies with angles 1, 2
and 3 degrees are
incorrectly placed



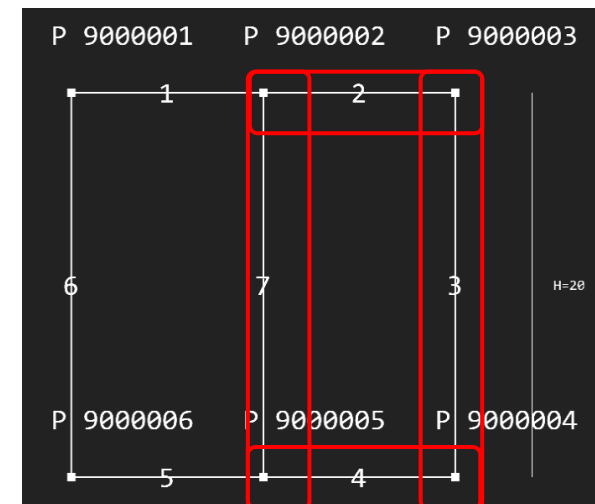
Avoid CORE/LAYER and SET1 Conflicts

This happens for the following reason.

1. PCOMP 503 is to be placed between POINTs 9000002 and 9000005. MSC Nastran's internal algorithm looks through each SET1 for these 2 points. For each SET1 it finds with these 2 points, PCOMP 503 is placed along those points.
2. In this example, SET1 901 and 902 have POINTs 9000002 and 9000005, so the algorithm places PCOMP 503 along POINTs 9000002, 9000003, 9000004, 9000005 and 9000002, 9000005.

The intent is to only lay PCOMP 503 along the vertical line, i.e. POINTs 9000002 and 9000005.

```
PBMSECT 8                                CP
      OUTP=901, BRP (1)=902, CORE=501, CORE (7)=[503, PT=(9000002, 9000005) ],
      LAYER (3)=(502, 903)
POINT  9000001      -10.    10.
POINT  9000002       0.0    10.
POINT  9000003       10.    10.
POINT  9000004       10.   -10.
POINT  9000005      0.000001 -10.
POINT  9000006      -10.   -10.
SET1    901      9000001 9000002 9000003 9000004 9000005 9000006
SET1    902      9000002 9000005
SET1    903      9000001 9000002 9000003 9000004 9000005 9000006 9000001
```



PCOMP 503 is placed along lines 2, 3, 4 and 7, but the goal is to place PCOMP 503 only along line 7

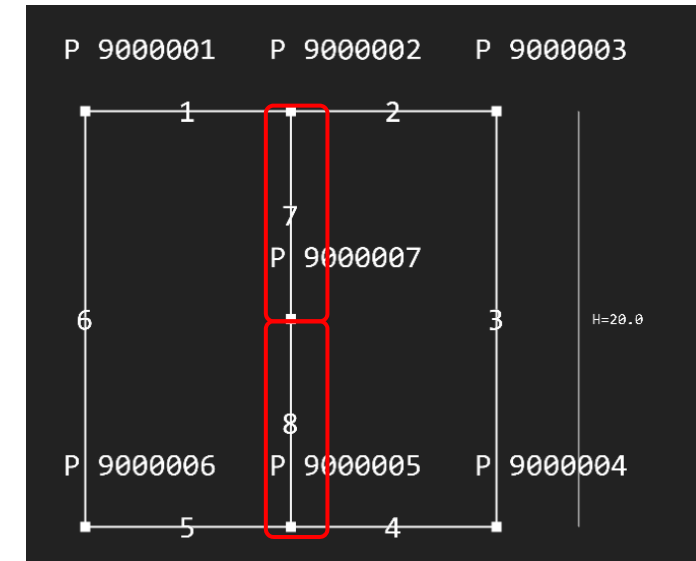
Avoid CORE/LAYER and SET1 Conflicts

In this tutorial. POINT 9000007 is added to avoid laying the PCOMP 503 across the wrong POINTs.

```
PBMSECT 8                                CP
      OUTP=901, BRP(1)=902, BRP(2)=903, CORE=501,
      CORE(7)=[503, PT=(9000007, 9000002)],
      CORE(8)=[503, PT=(9000005, 9000007)], LAYER(4)=(502, 904)

POINT 9000001 -10. 10.
POINT 9000002 0.0 10.
POINT 9000003 10. 10.
POINT 9000004 10. -10.
POINT 9000005 0.000001 -10.
POINT 9000006 -10. -10.
POINT 9000007 0.0 0.0

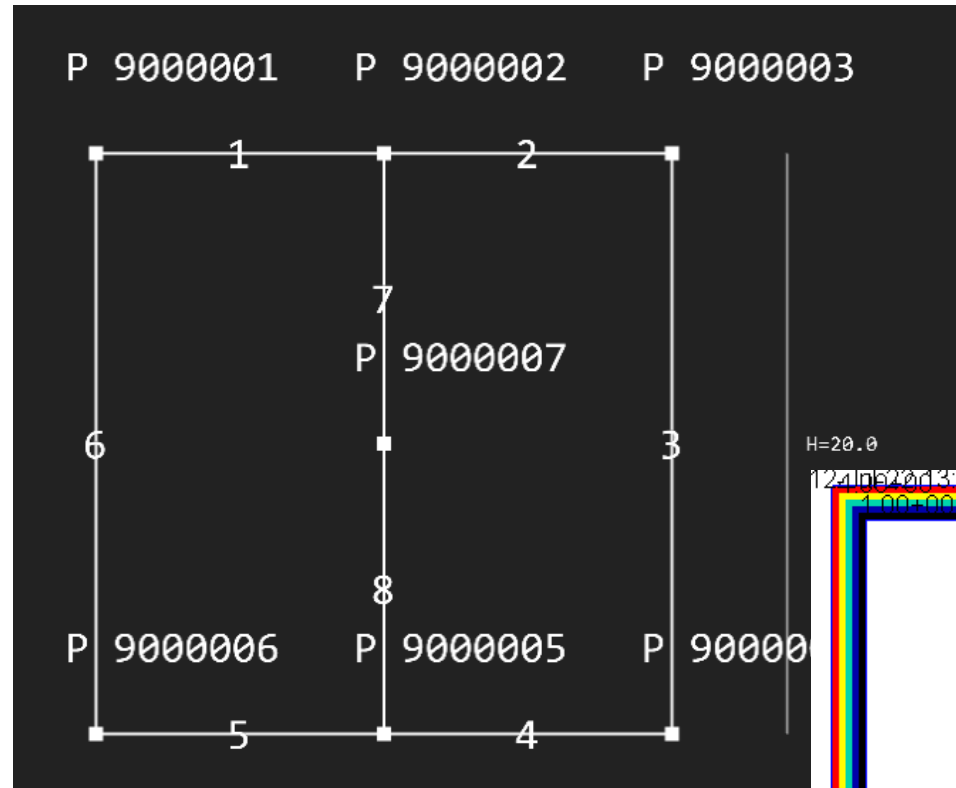
SET1 901 9000001 9000002 9000003 9000004 9000005 9000006
SET1 902 9000007 9000002
SET1 903 9000005 9000007
SET1 904 9000001 9000002 9000003 9000004 9000005 9000006 9000001
```



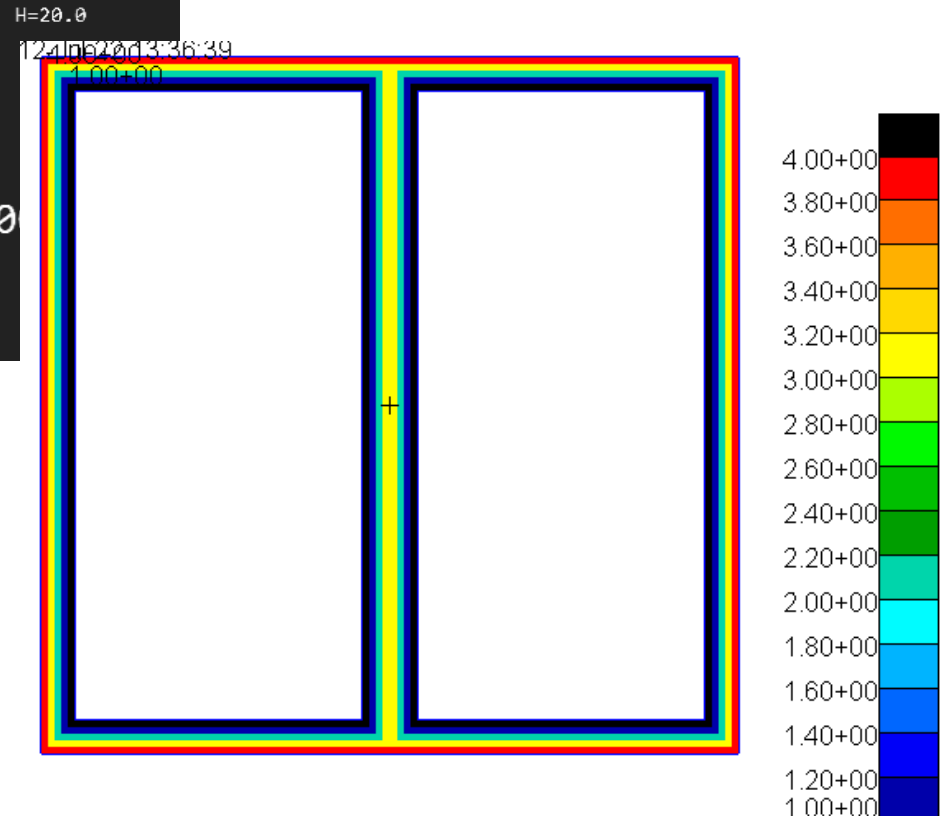
PCOMP 503 is
placed along lines
7 and 8.

Avoid CORE/LAYER and SET1 Conflicts

1. The display of the ply angles appears more favorable



OK

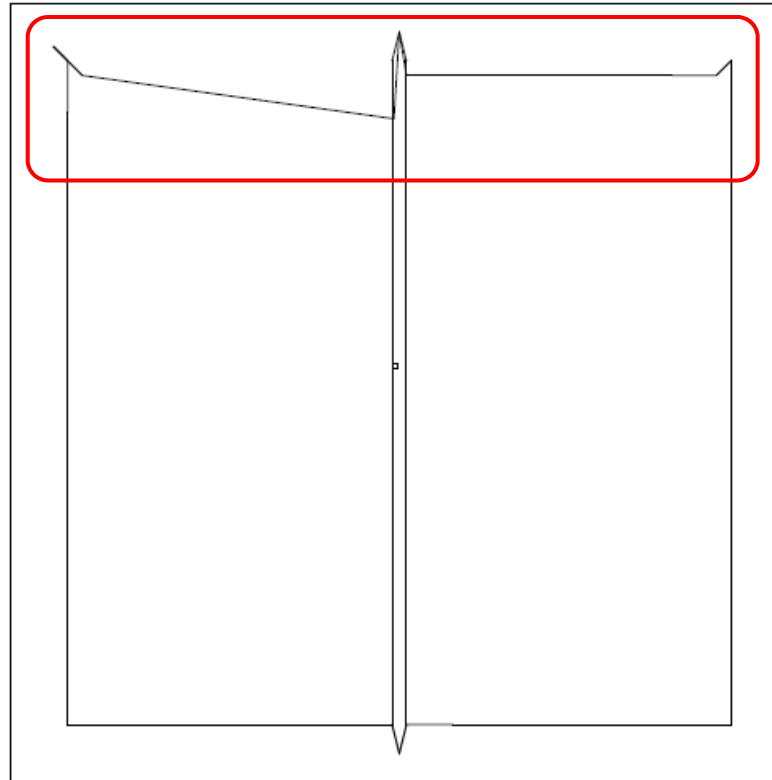


Considerations for Outer Perimeter and Branch Lines

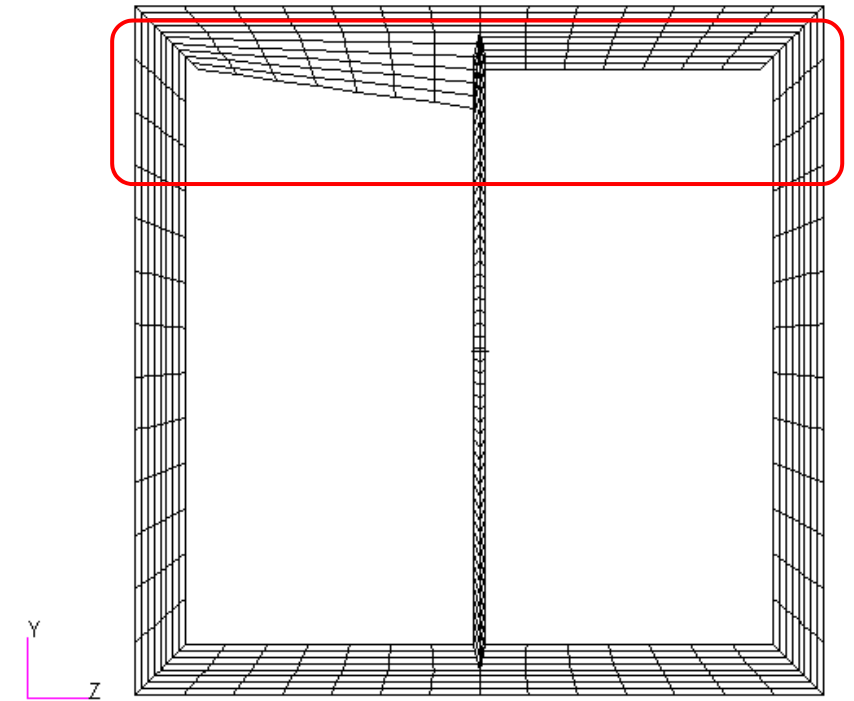
Considerations for Outer Perimeter and Branch Lines

1. In some cases, the cross section will have unusual edges. This issue has many causes, some of the 2 most common are:
 - The number of plies between the OUTP and BRP lines are not consistent
 - The use of the LAYER keyword creates algorithm conflicts

model.ps



model_bm9_01.bdf

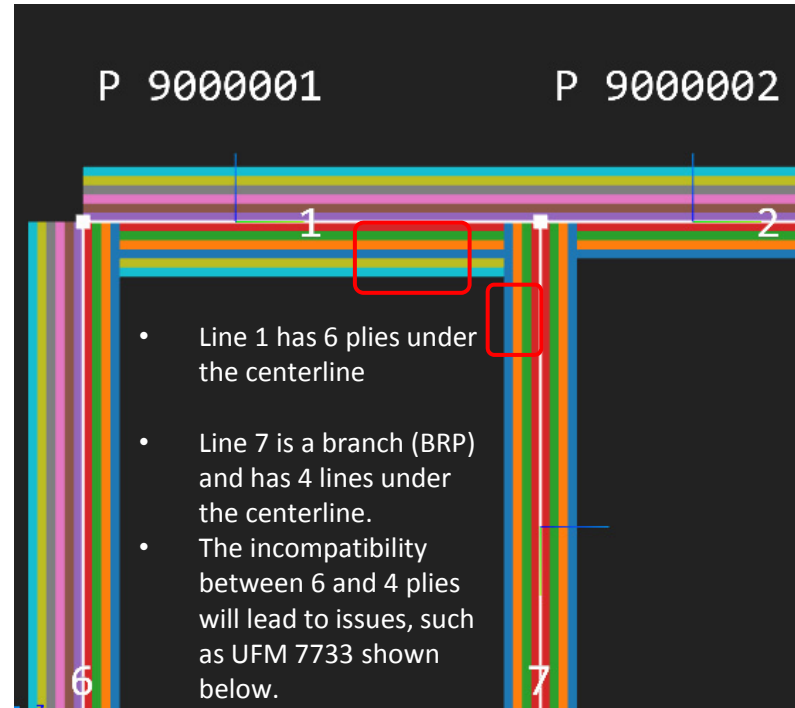


```
PBMSECT      9
End A      composite
1.5516E+09  7.4847E+06  1.1207E+07  -3.9077E+08  -1.2227E+08  -2.5390E+07
7.4847E+06  1.7032E+07  4.3632E+05  -6.4685E+06  2.3331E+08  3.0019E+06
1.1207E+07  4.3632E+05  1.8595E+07  3.7334E+06  8.1960E+05  1.7758E+08
-3.9077E+08  -6.4685E+06  3.7334E+06  3.6758E+09  -1.3862E+08  6.1377E+07
-1.2227E+08  2.3331E+08  8.1960E+05  -1.3862E+08  1.0102E+11  1.2132E+09
-2.5390E+07  3.0019E+06  1.7758E+08  6.1377E+07  1.2132E+09  9.3929E+10
```

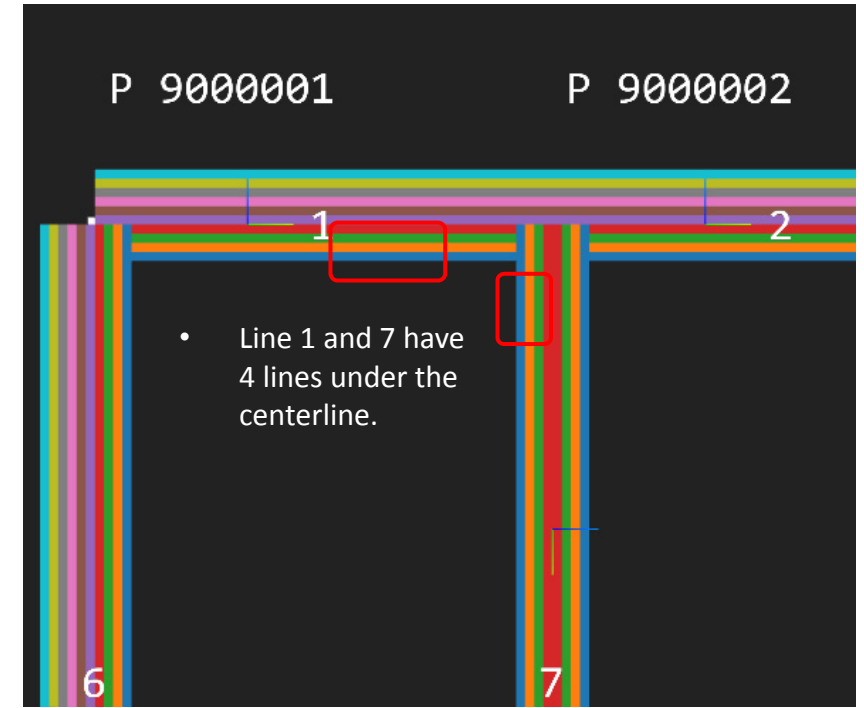
The number of plies between the OUTP and BRP lines are not consistent

1. Per the guidelines in the MSC Nastran Linear Statics Analysis User's Guide,
 - "6. During transition from OUTP to BRP (or vice versa), all plies above or below the centerline, defined via OUTP/BRP/SET1 entries, must be carried over."
 - Ensure when going from a line on the outer perimeter (OUTP) to a line on a branch (BRP), the lines have the same number of plies on common sides of the centerline
 - Inconsistent number of plies when transitioning from OUTP to BRP lines will sometimes cause UFM 7733

NOT OK



OK

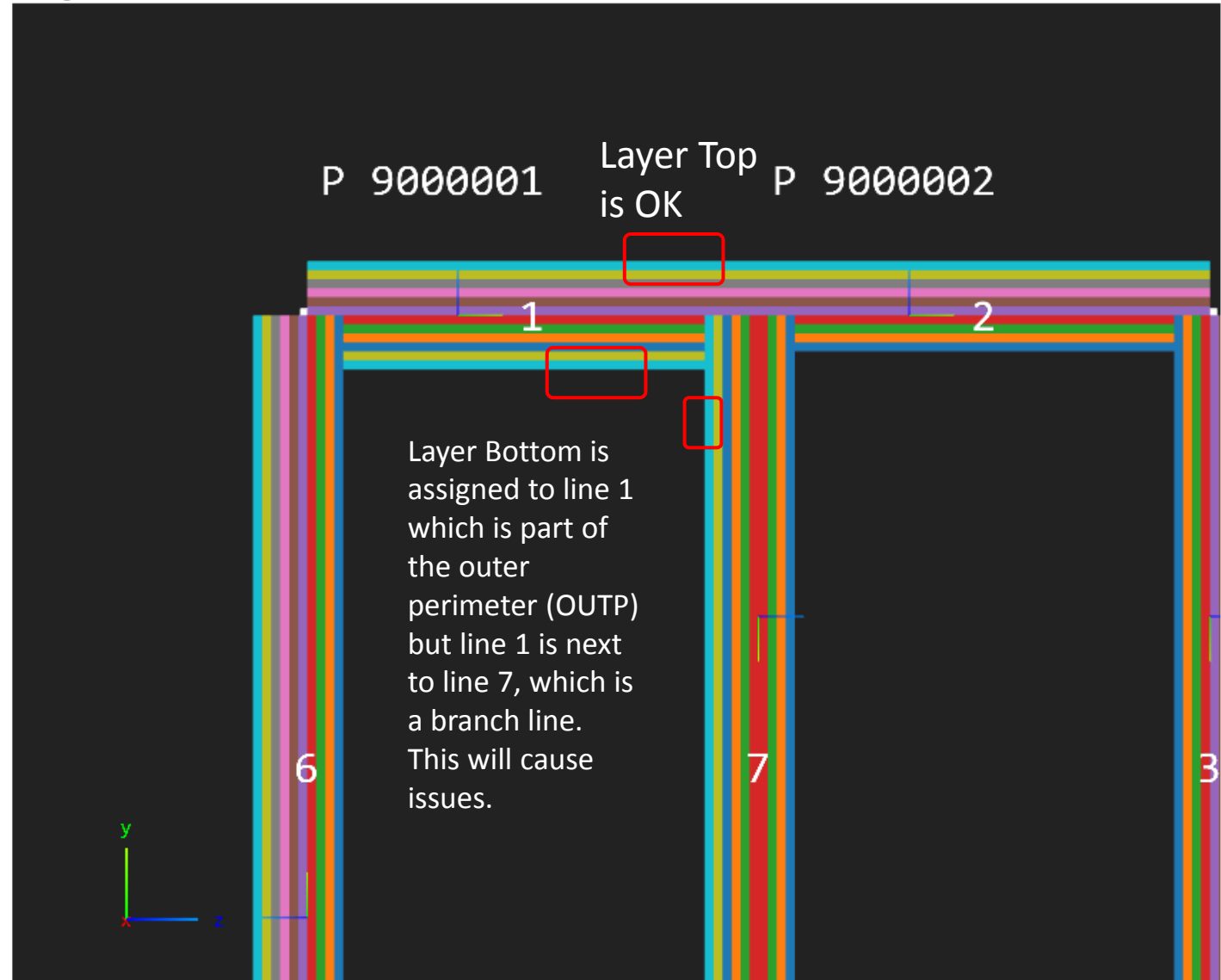


```
*** USER FATAL MESSAGE 7733 (VABPOS)
      CORE/LAYER ID 501 REFERENCED ON PBRSECT/PBMSECT ENTRY ID=9 IS NOT
DEFINED.
*** USER FATAL MESSAGE 6624 (IFP9)
      SEE INFORMATION MESSAGES ABOVE
^^^
*** USER FATAL MESSAGE 9002 (SUBDMAP IFPS)
      ERROR(S) ENCOUNTERED IN THE MAIN BULK DATA SECTION
      SEE MESSAGES ABOVE. ERROR ENCOUNTERED IN MODULE IFP9,
^^^
```


The use of the LAYER keyword creates algorithm conflicts

1. Avoid using the LAYER keyword (Layer Top or Bottom) next to BRP lines
2. The top and bottom layers are determined by the orientation of the line's ply coordinate system
3. If continuous persists, avoid using the LAYER keyword entirely, i.e. do not set layer top or bottom

Editing PBMSECT 9



Offset Z0 Considerations

Offset Z0 Considerations

1. Do not use Z0 for PCOMP or PCOMPG entries used by PBMSECT entries or you will get UFM 7735.
2. It is recommended that the Z0 field is left blank or the default value is used. The default value is -0.5 times the composite thickness.

NOT OK

PCOMP	10	-1.5	1		13000.	HILL			
	5	1.0	0.	YES	5	1.0	0.	YES	

*** USER FATAL MESSAGE 7735 (IFP9)
Z0 FOR PCOMP ID 10 IS NOT LOCATED ON THE MID-SURFACE IN-BETWEEN LAYERS FOR ARBITRARY BEAM APPLICATION.

OK

PCOMP	10		2		13000.	HILL			
	5	1.0	0.	YES	5	1.0	0.	YES	

OK

PCOMP	10	-1.0			13000.	HILL			
	5	1.0	0.	YES	5	1.0	0.	YES	