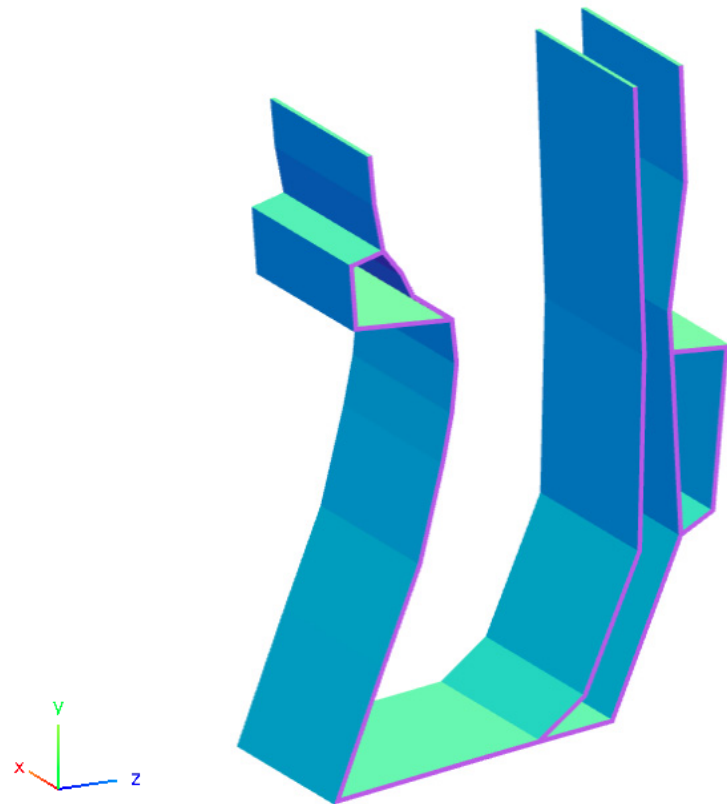


Workshop – Introduction to the PBMSECT Web App

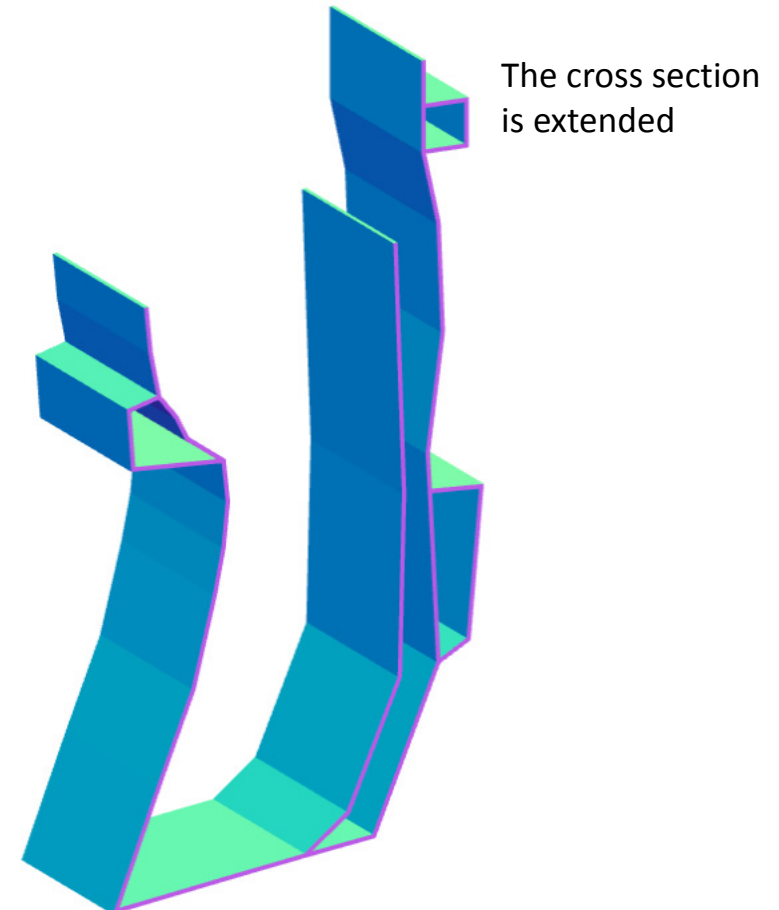
A PBMSECT/PBRSECT TUTORIAL

Goal: Modify an existing PBMSECT entry

Before



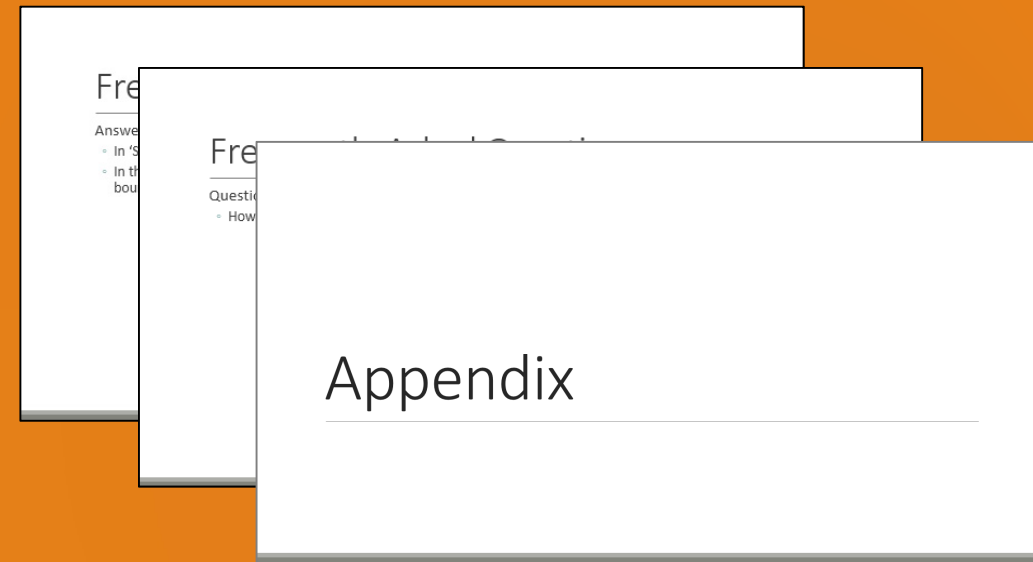
After



More Information Available in the Appendix

The Appendix includes information regarding the following:

- Procedure to Create PBMSECT/PBRSECT Entries
- Comment on Critical Points
- Supported PBMSECT/PBRSECT Keywords
- UFM 2012
- UFM 7201 - Cause 1
- UFM 7201 - Cause 2
- UFM 7733



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

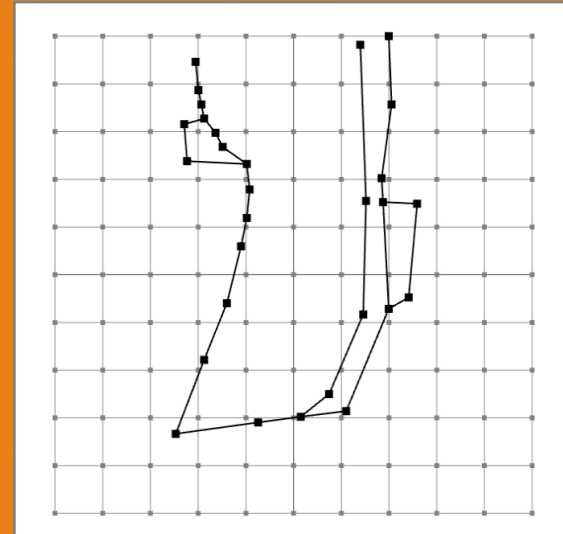
Tutorial

Tutorial Overview

1. Use the PBMSECT Web App to:
 - Edit an existing arbitrary beam cross section (ABCS) defined by a PBMSECT entry
 - Run MSC Nastran to confirm the ABCS is created properly

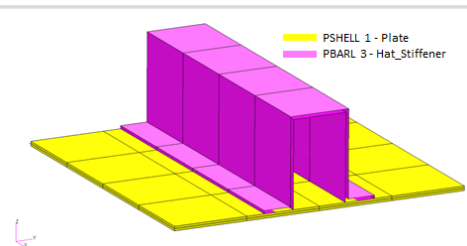
Special Topics Covered

Arbitrary Beam Cross Section - This tutorial introduces you to fundamental information regarding the use of the PBMSECT web app. After this tutorial, you will learn how to create arbitrary beam cross sections via the use of PBMSECT or PBRSECT entries.

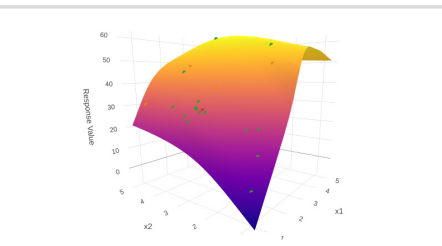


SOL 200 Web App Capabilities

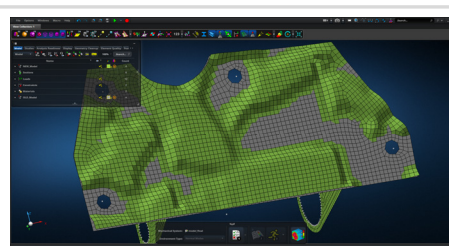
Capabilities



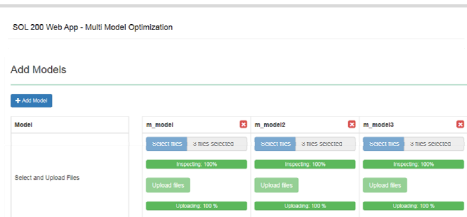
Web Apps for SOL 200
Pre/post for MSC Nastran SOL 200.
Support for size, topology,
topometry and topography.



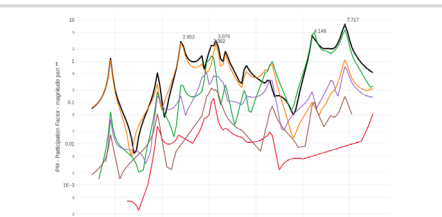
Machine Learning Web App
Bayesian Optimization for nonlinear
response optimization (SOL 400)



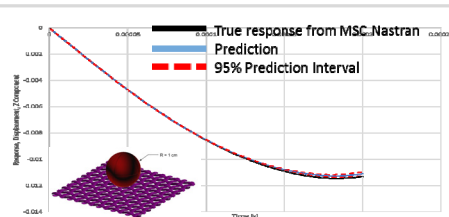
MSC Apex Post Processing Support
View the newly optimized model
after an optimization



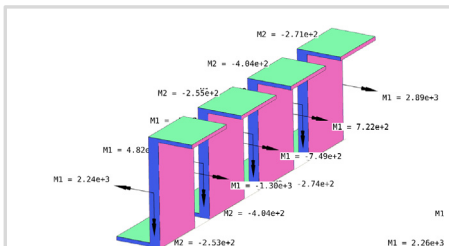
Multi-model Optimization Web App
Pre/post for multi model
optimization



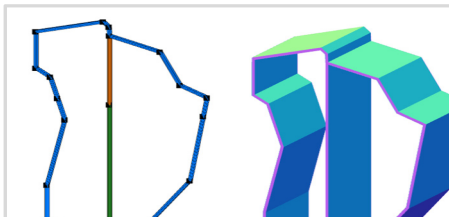
HDF5 Explorer Web App
Create XY plots using data from the
H5 file



Prediction Analysis Web App
Gaussian process regression to
predict output of MSC Nastran
without time consuming analyses



Beams Viewer Web App
Post process 1D element forces,
including shear forces, moments,
torque and axial forces



PBMSECT Web App
Generate PBMSECT and PBRSECT
entries graphically

Benefits

- 200+ error validations (real time)
- Web browser accessible
- Automated creation of entries (real time)
- Automatic post-processing
- 50+ tutorials

Tutorial

PART A – CREATING AND CONNECTING POINTS

PBMSECT Web App

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

The screenshot shows the SOL 200 Web App interface. At the top, the title "SOL 200 Web App" is displayed with a red circle containing the number "1" above it. Below the title is the instruction "Select a web app to begin". The interface features five main application tiles: "Optimization for SOL 200" (showing 'Before' and 'After' 3D models), "Multi Model Optimization" (showing a 3D model and a line graph), "Machine Learning | Parameter Study" (showing four mesh visualizations), "HDF5 Explorer" (showing a line graph), and "Remote Execution" (showing a diagram of data flow between a Remote System and a Local System). Below these tiles is a link for "Tutorials and User's Guide". At the bottom, a red box highlights the "Full list of web apps" link, with a red circle containing the number "2" next to it.

1

SOL 200 Web App

Select a web app to begin

Before
After

Optimization for SOL 200

Multi Model Optimization

Machine Learning | Parameter Study

HDF5 Explorer

Remote Execution

Remote System
Input Files
Results Files
Local System

Tutorials and User's Guide

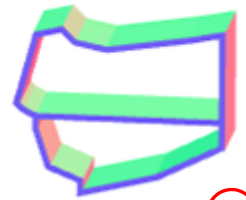
2

Full list of web apps

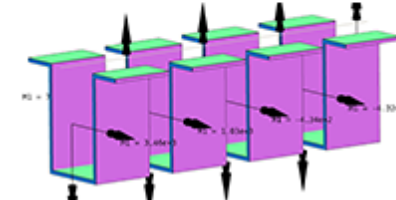
PBMSECT Web App

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

Beams

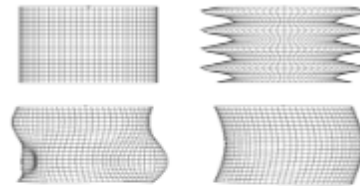


PBMSECT

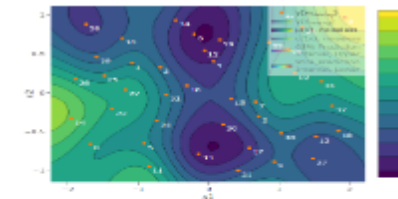


Beams Viewer

Machine Learning



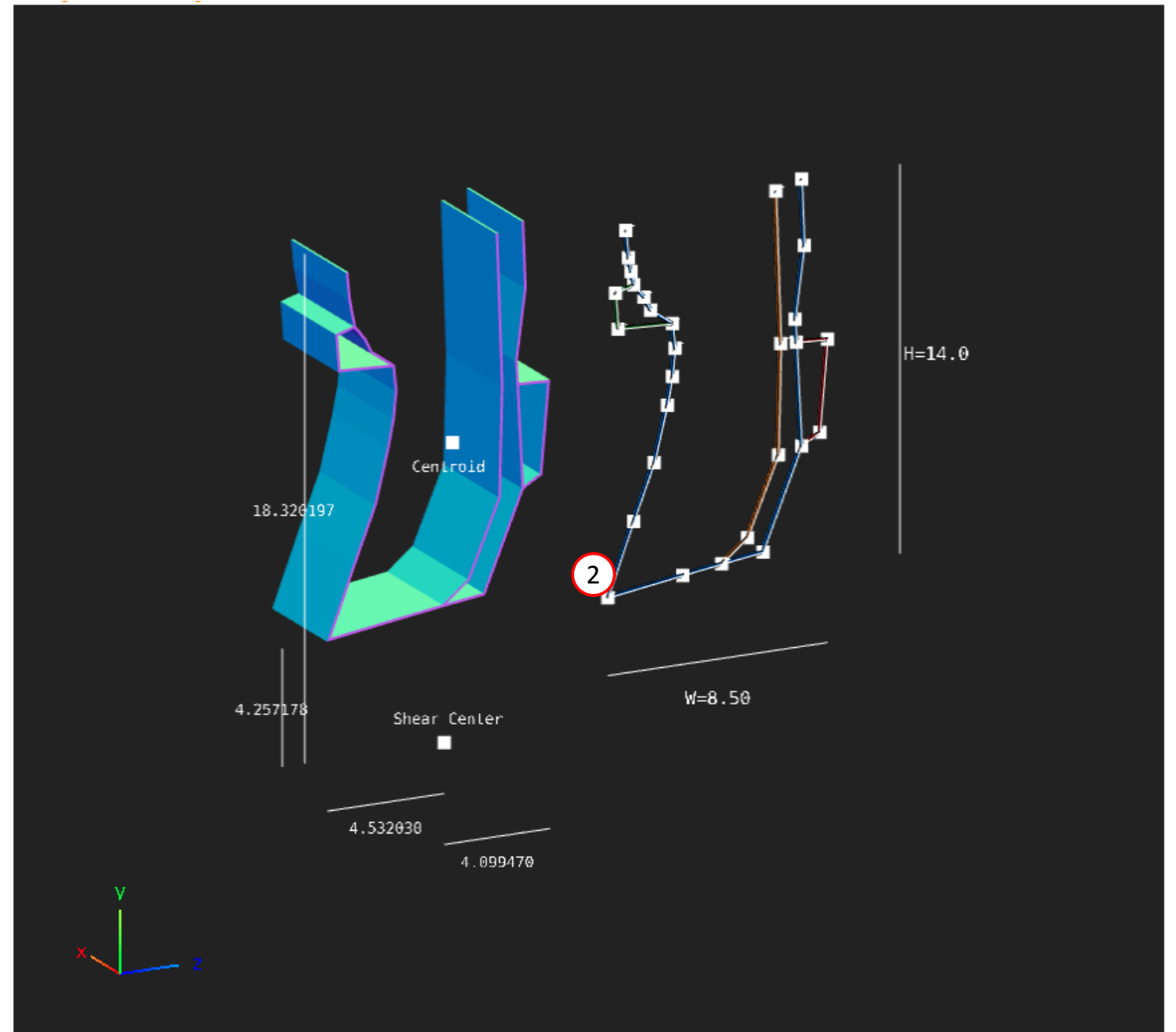
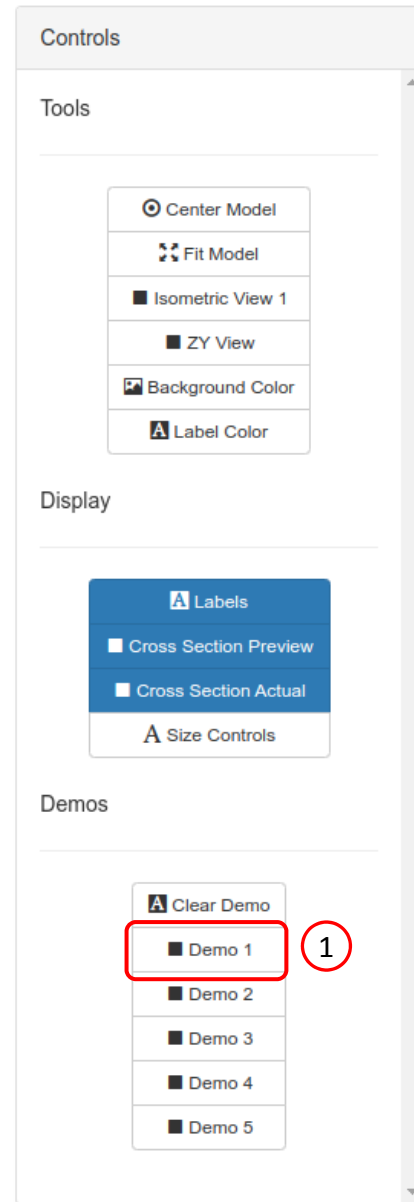
Machine Learning



Prediction Analysis

Load Demo

1. Click Demo 1 to load an existing beam cross section
2. The cross section is displayed



Developed by The Engineering Lab

Points

1. Click Create Points
2. Configure the Grid Helper as follows
 - Width and Height: 30
 - Number of Divisions: 30
3. Click on the Grid Helper to create 5 points

Points

Actions

1

Create Points

Create Points on Line

Remove Points

Settings - Grid Helper

Width and Height

30

Number of Divisions

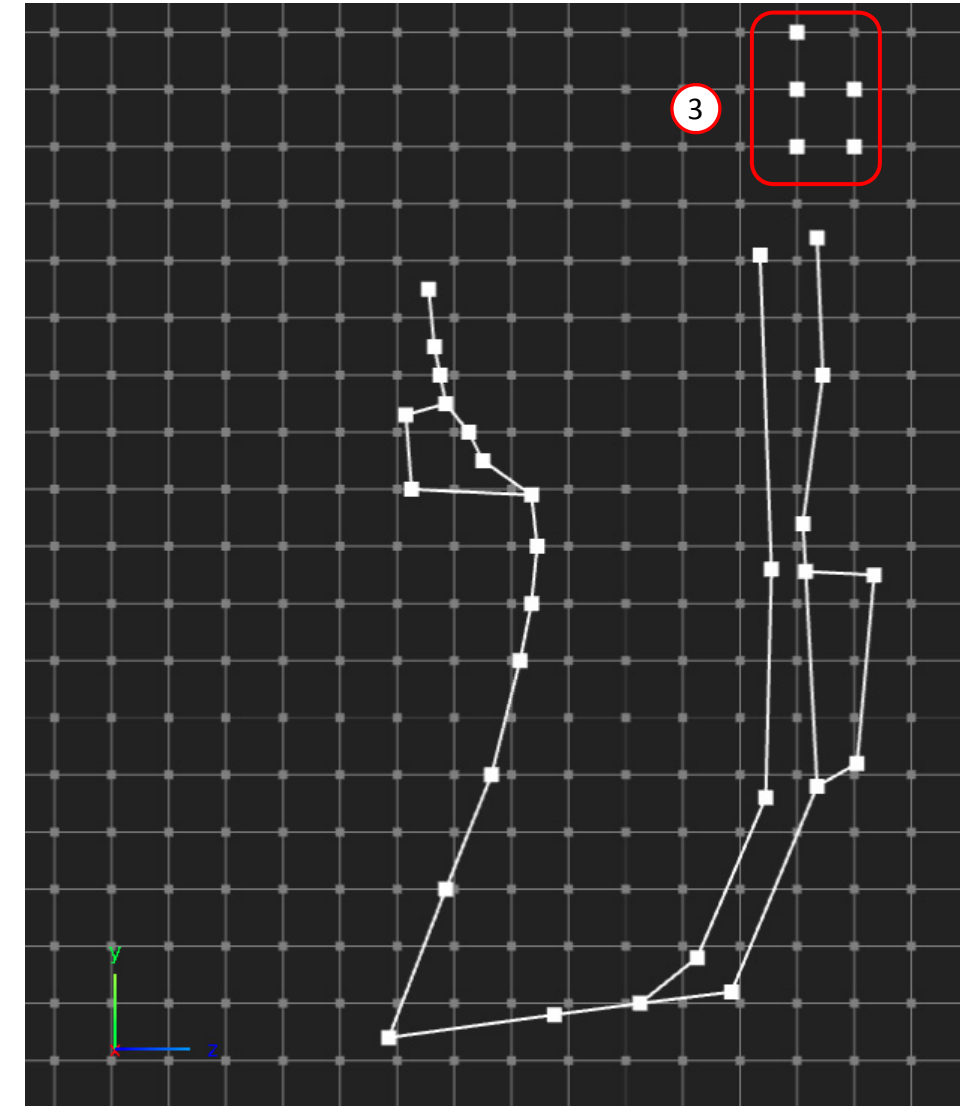
30

2

Max allowable divisions

Adjustments

Point ID	Z	Y
10000	-3.45	7.5
10001	-3.35	6.5
10002	-3.25	6.
10003	-3.15	5.5
10004	-2.75	5.
10005	-2.5	4.5
10006	-1.65	3.9
10007	-1.55	3.
10008	-1.65	2.
10009	-1.85	1.
10010	-2.35	-1.
10011	-3.15	-3.
10012	-4.15	-5.6
10013	-1.25	-5.2
10014	.25	-5.



Lines

1. Click Create Lines
2. Click on 2 points at a time to create 1 line
 - Repeat the process to create 6 lines as shown

Lines

Actions

1

Create Lines

✕ Remove Lines

Select Lines of Outer Perimeter

Deselect Lines of Outer Perimeter

Status:

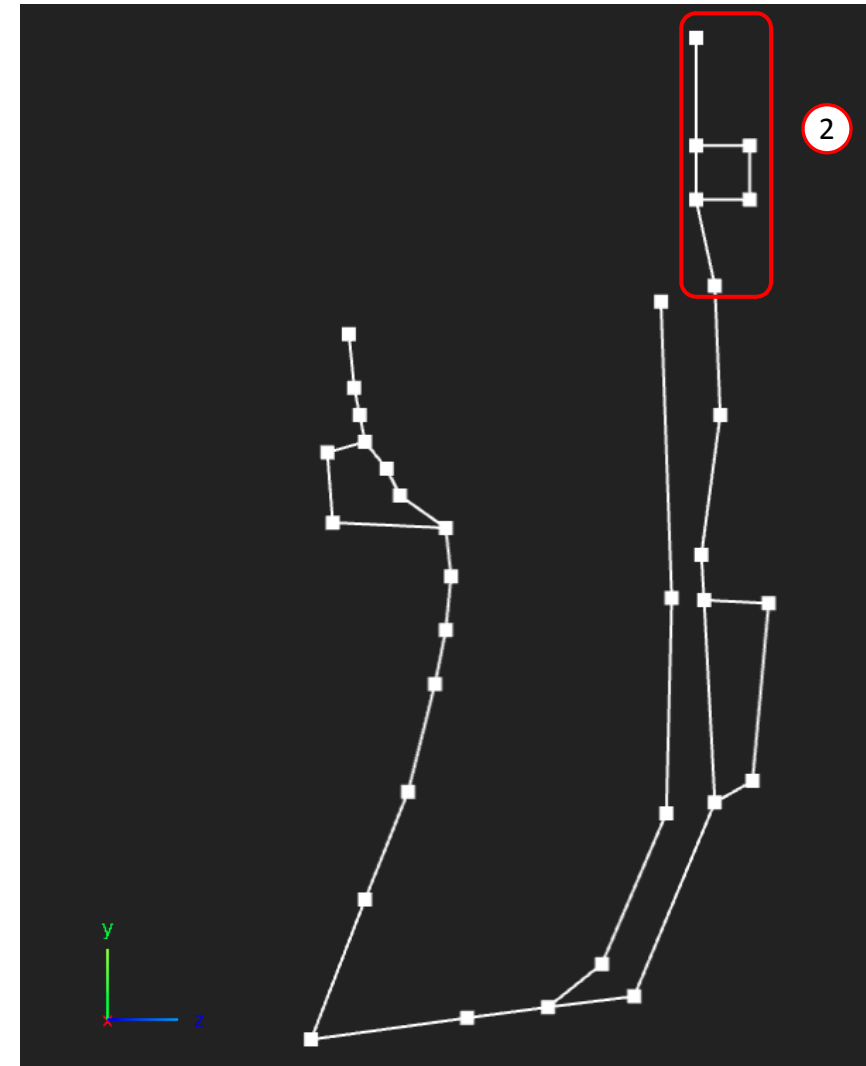
Adjustments

Default Thickness

0.1

Line Segments

Line ID	Type	Thickness
1	OUTP	
2	OUTP	
3	OUTP	
4	OUTP	
5	OUTP	
6	OUTP	
7	OUTP	
8	OUTP	
9	OUTP	
10	OUTP	
11	OUTP	
12	OUTP	
13	OUTP	



Outer Perimeter

- 1. Click Select Lines of Outer Perimeter
- 2. Click on the 3 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

Create Lines

Remove Lines

Select Lines of Outer Perimeter

Deselect Lines of Outer Perimeter

Status:

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

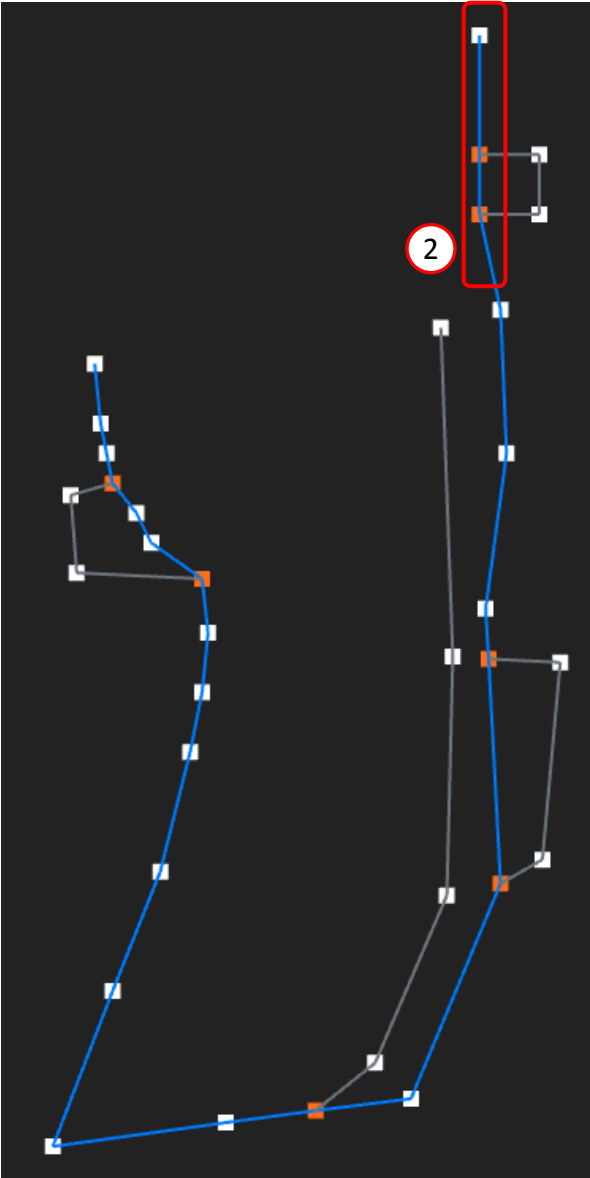
Adjustments

Default Thickness

0.1

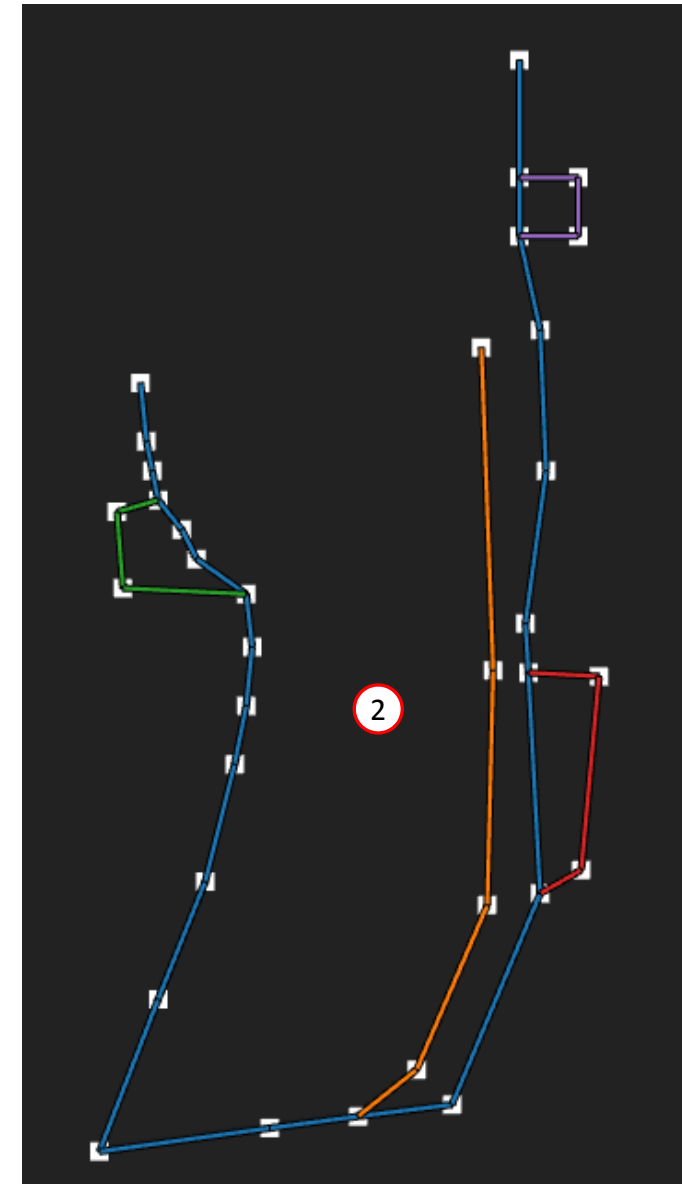
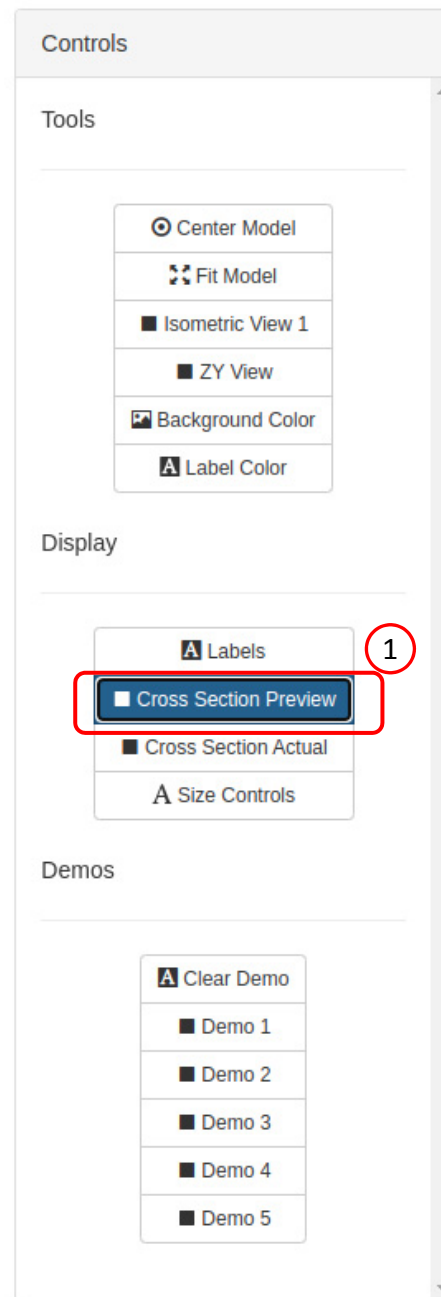
Line Segments

Line ID	Type	Thickness
1	OUTP	
2	OUTP	
3	OUTP	
4	OUTP	
5	OUTP	
6	OUTP	
7	OUTP	
8	OUTP	
9	OUTP	
10	OUTP	
11	OUTP	
12	OUTP	
13	OUTP	



Cross Section Preview

1. Click Cross Section Preview
2. The cross section's thickness is now displayed. Each different colored line represents a different outer perimeter or branch.



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

Bulk Data Entries

5

Download Test BDF File

2

Run MSC Nastran

Complete

Corresponding Bulk Data Entries

\$	1		2		3		4		5		6		7		8		9		10	
PBMSECT	10		0888		OP															
					OUTP=100, BRP=101, BRP=102, BRP=103, BRP=104, T=0.1															
POINT	10000				-3.45		7.5													
POINT	10001				-3.35		6.5													
POINT	10002				-3.25		6.													
POINT	10003				-3.15		5.5													
POINT	10004				-2.75		5.													
POINT	10005				-2.5		4.5													
POINT	10006				-1.65		3.9													
POINT	10007				-1.55		3.													

F06

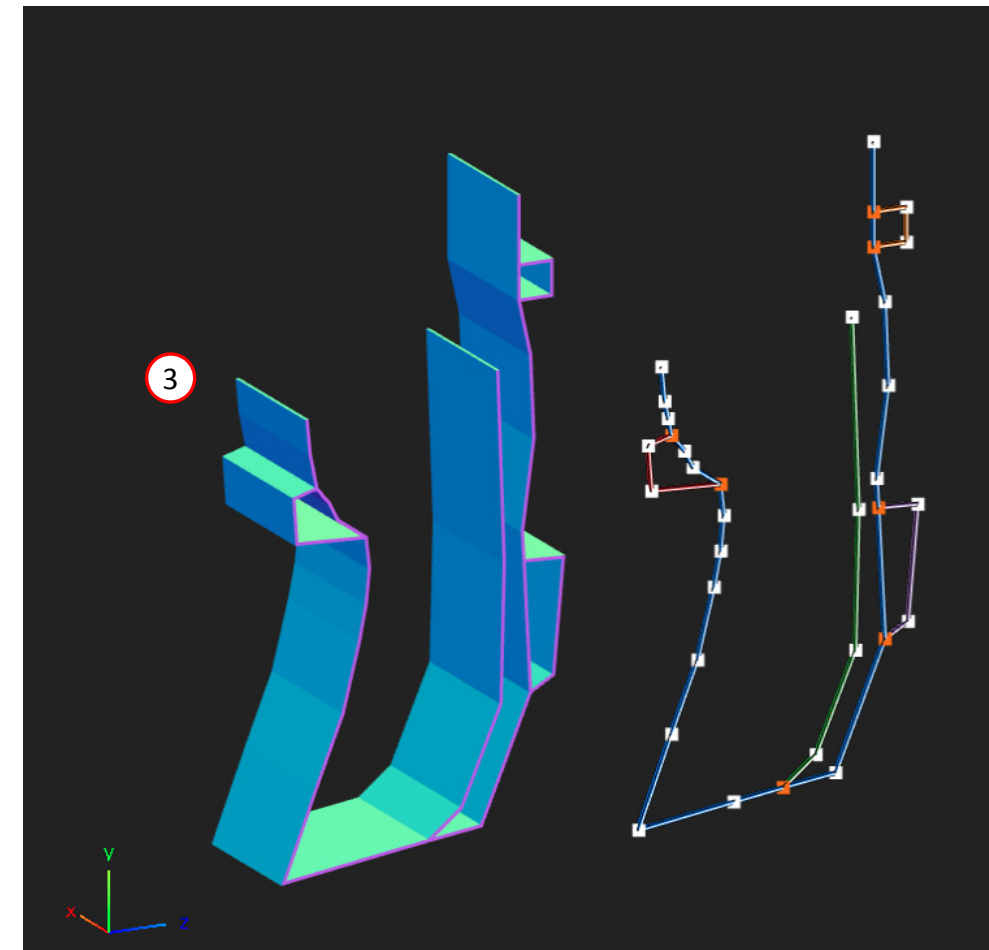
Command executed:

1

4

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

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** Hexagon AB **
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** M S C N a s t r a n **
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** Version 2022.1-CL872368 **
**
**
** MAR 15, 2022 **



Run MSC Nastran to Generate the Cross Section

1. If the MSC Nastran run was a success, an equivalent PBEAM entry is generated and listed in the F06 file. This PBEAM entry displays cross section information such as the cross sectional area and moments of inertia.
 - If a PBRSECT entry is created, a PBAR entry is generated.
 - If a PBMSECT is created with the CORE keyword, which is used for a composite section, a PBEAM3 entry is generated.
 - If a regular PBMSECT entry is created, a PBEAM entry is generated.

```

***
*** USER INFORMATION MESSAGE 4379 (IFP9A)
    THE USER SUPPLIED PBEAML/PBMSECT BULK DATA ENTRIES ARE REPLACED BY THE FOLLOWING
    CONVERSION METHOD FOR PBARL/PBEAML - FINITE ELEMENT METHOD.
PBEAM      10      888      6.4261E+00  1.5499E+02  4.8931E+01  2.6603E+01  8.
          2.3293E+01  1.5356E+00  2.3293E+01  1.4356E+00  2.1343E+01  2.5356E+00  2.
          4.7070E-01  4.6340E-02  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.
          0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.2262E+01 -5.7413E-01  1.
1  CONFIRMATION TEST OF PBMSECT/PBRSECT ENTRY                                     JUNE
  
```

PBEAM

Beam Property

Defines the properties of a beam element (CBEAM entry)

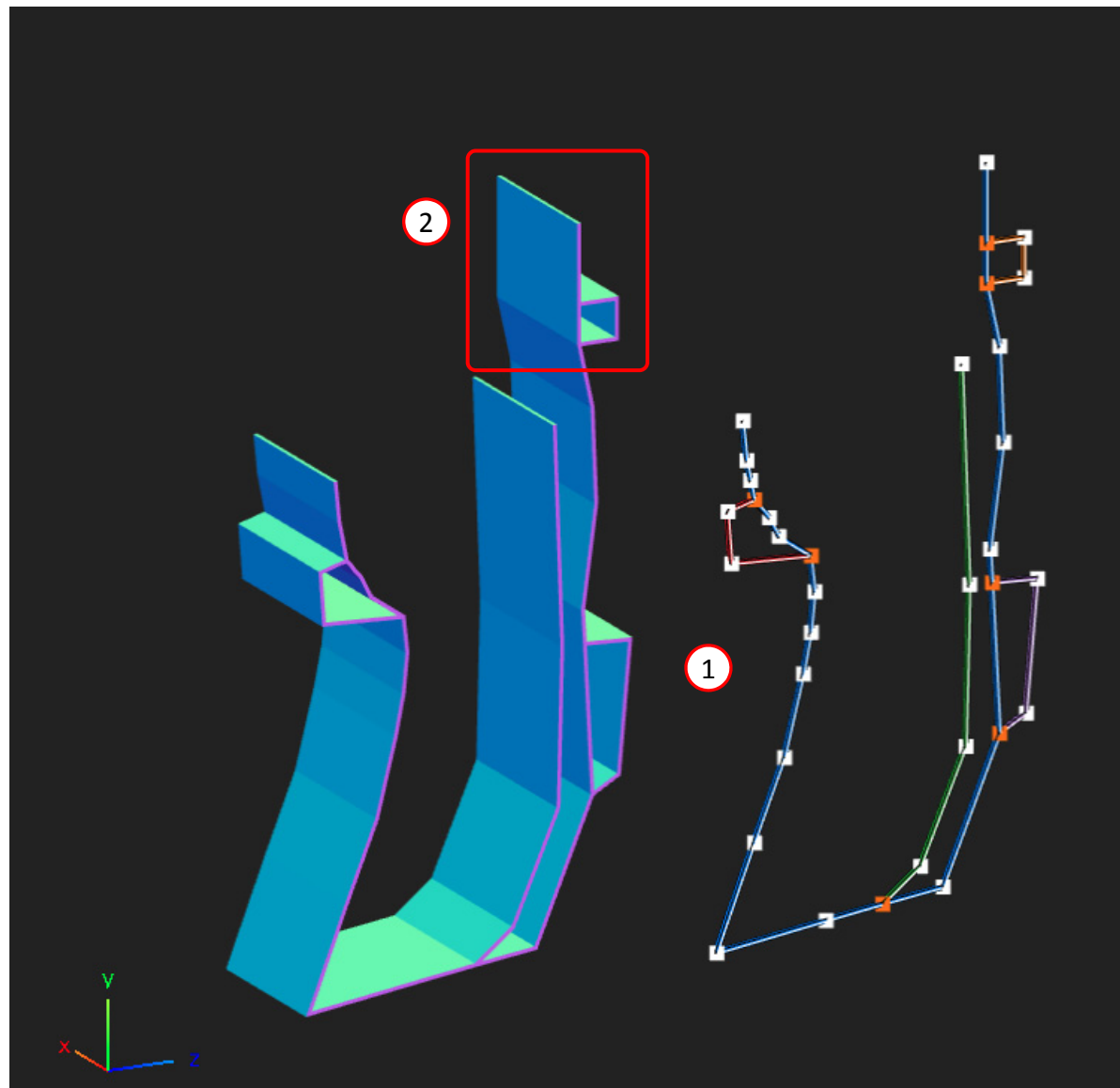
This element may be used to model tapered beams.

Format:

1	2	3	4	5	6	7	8	9	10
PBEAM	PID	MID	A(A)	I1(A)	I2(A)	I12(A)	J(A)	NSM(A)	
	C1 (A)	C2 (A)	D1 (A)	D2 (A)	E1 (A)	E2 (A)	F1 (A)	F2 (A)	

Review the MSC Nastran Generated Cross Section

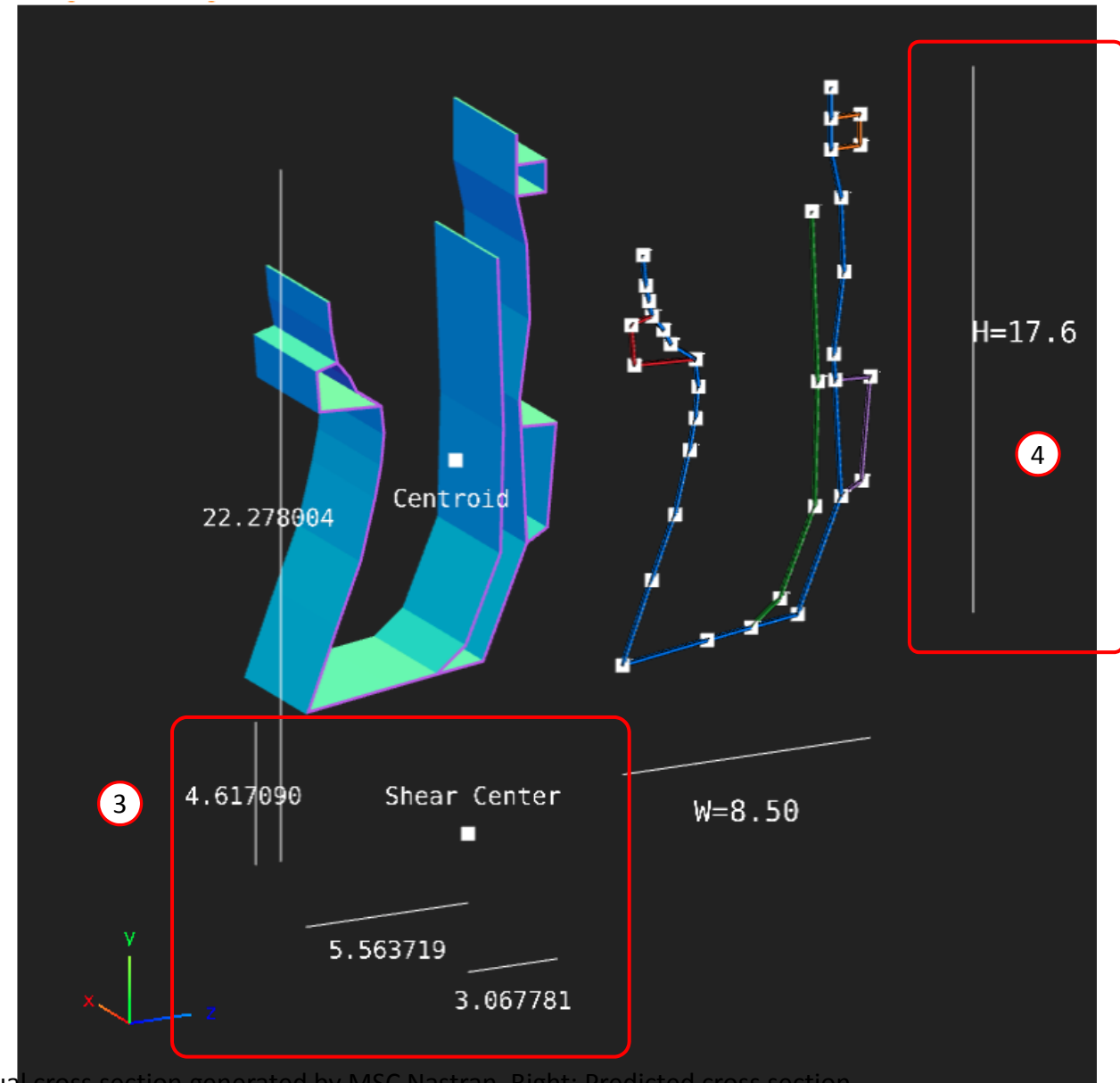
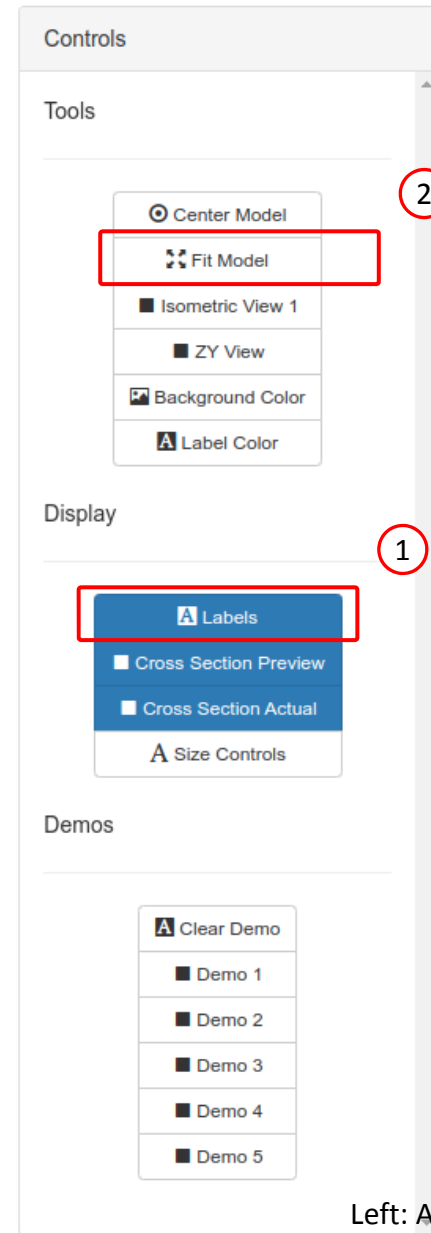
1. The cross sections are displayed side by side to confirm the intended cross section has been properly created
2. Note the edited portion of the cross section is now validated with MSC Nastran



Left: Actual cross section generated by MSC Nastran. Right: Predicted cross section.

Review the MSC Nastran Generated Cross Section

1. Click Labels
2. Click Fit Model
3. Lines measuring the point to point width and height are displayed
4. Lines measuring the distance between the shear center and top, bottom, left and right cross section fibers are displayed

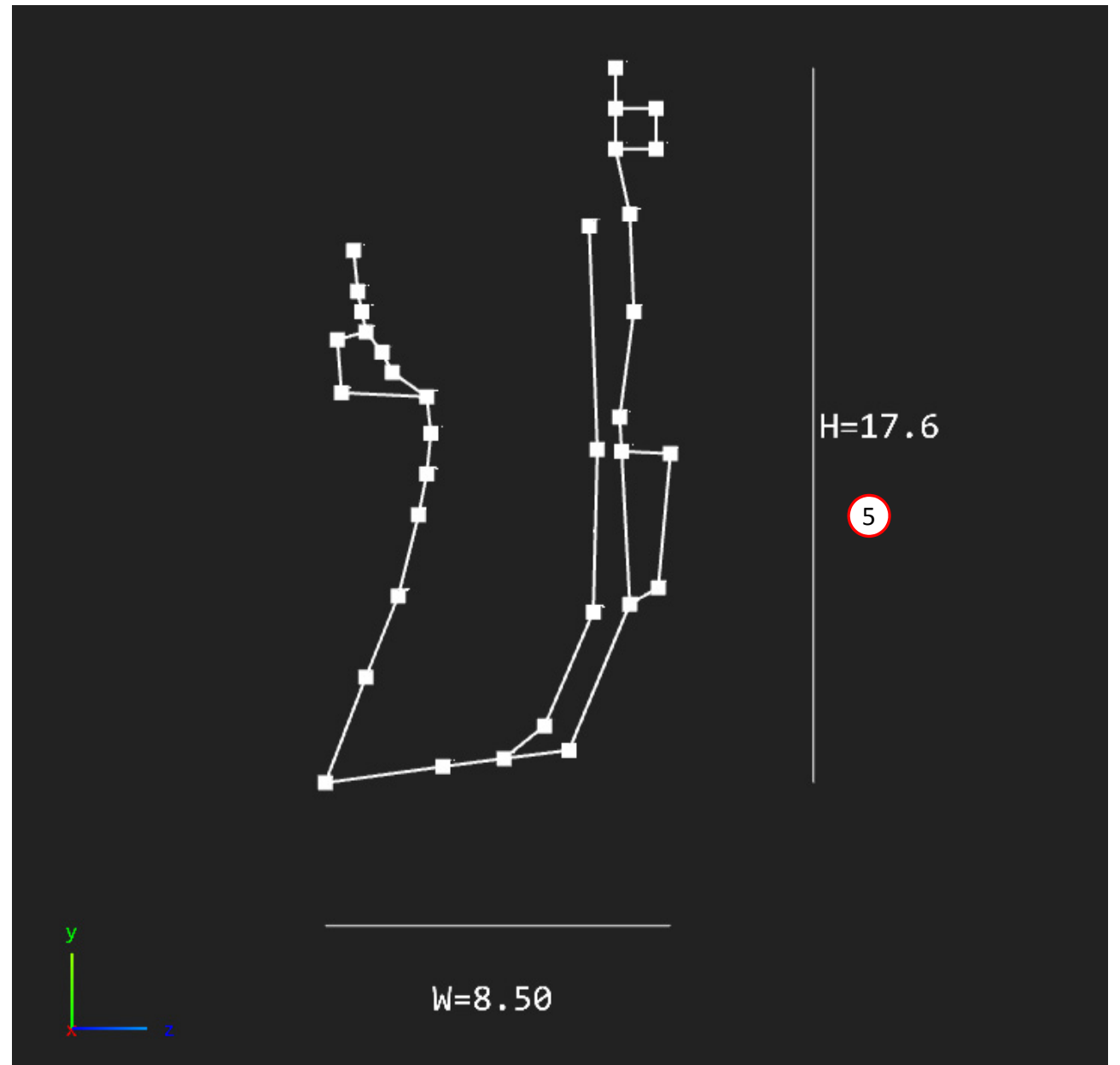
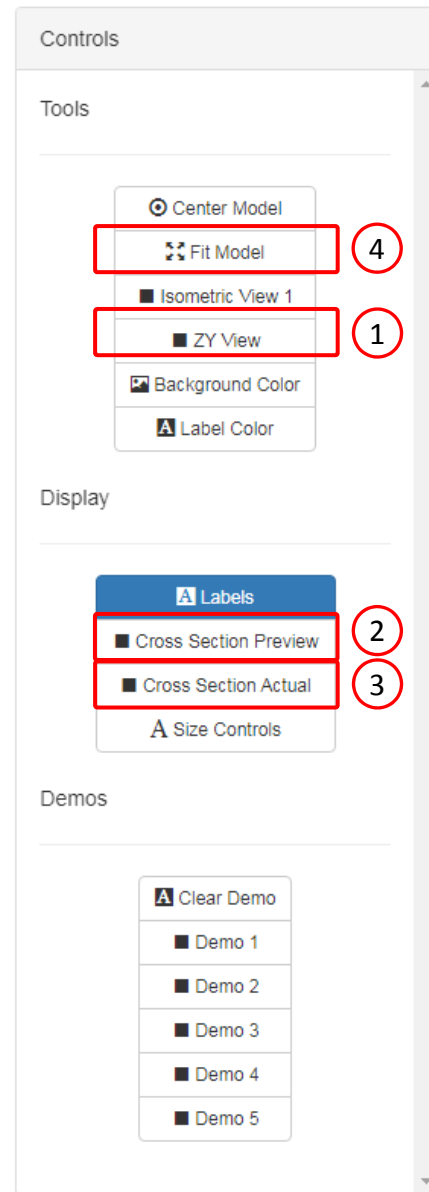


Left: Actual cross section generated by MSC Nastran. Right: Predicted cross section.

Developed by The Engineering Lab

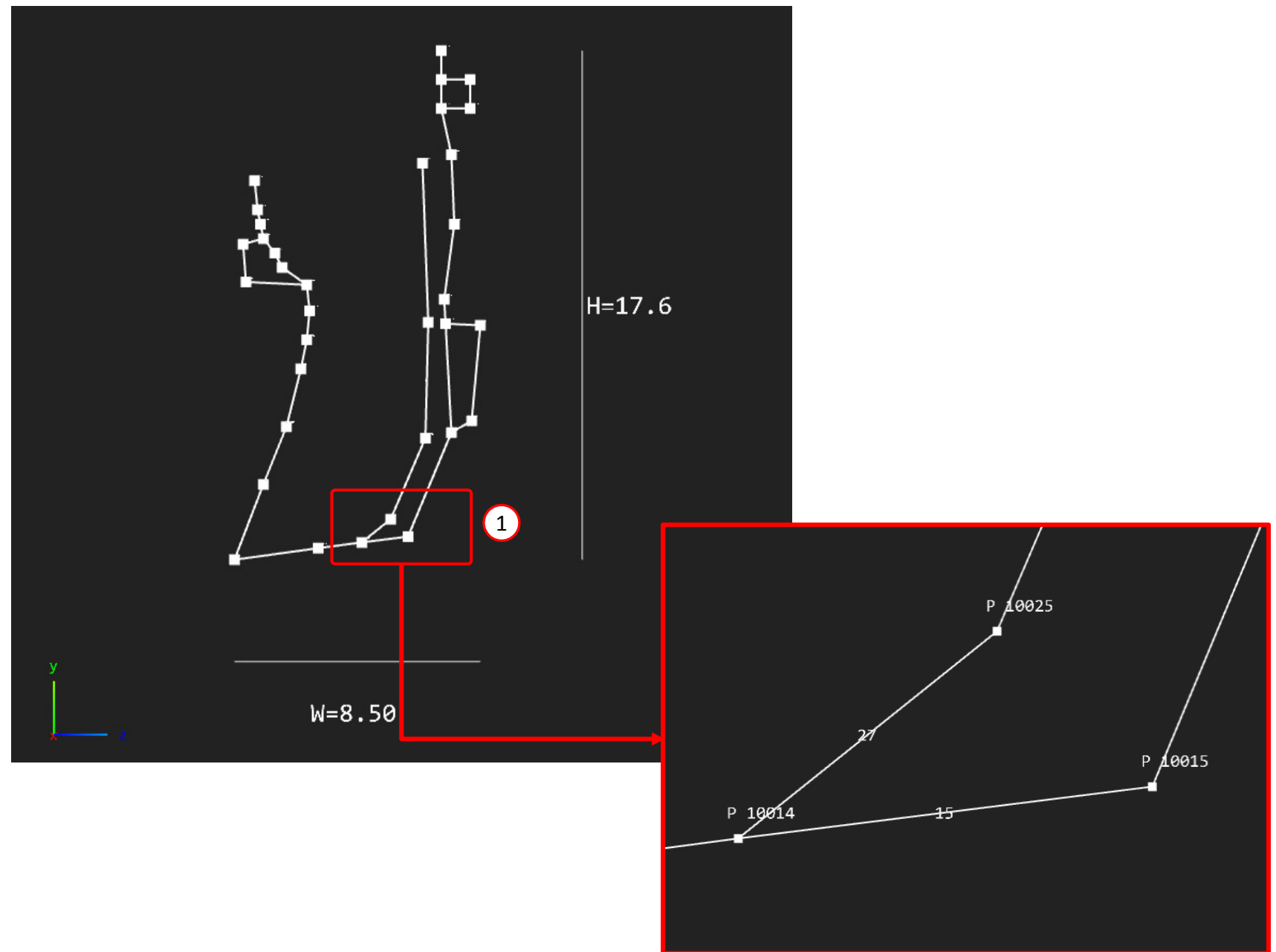
Labels

1. Click ZY View
2. Click Cross Section Preview
3. Click Cross Section Actual
4. Click Fit Model
5. The labels for the points, lines, width and height are displayed
 - Zoom in to see the labels for points and lines



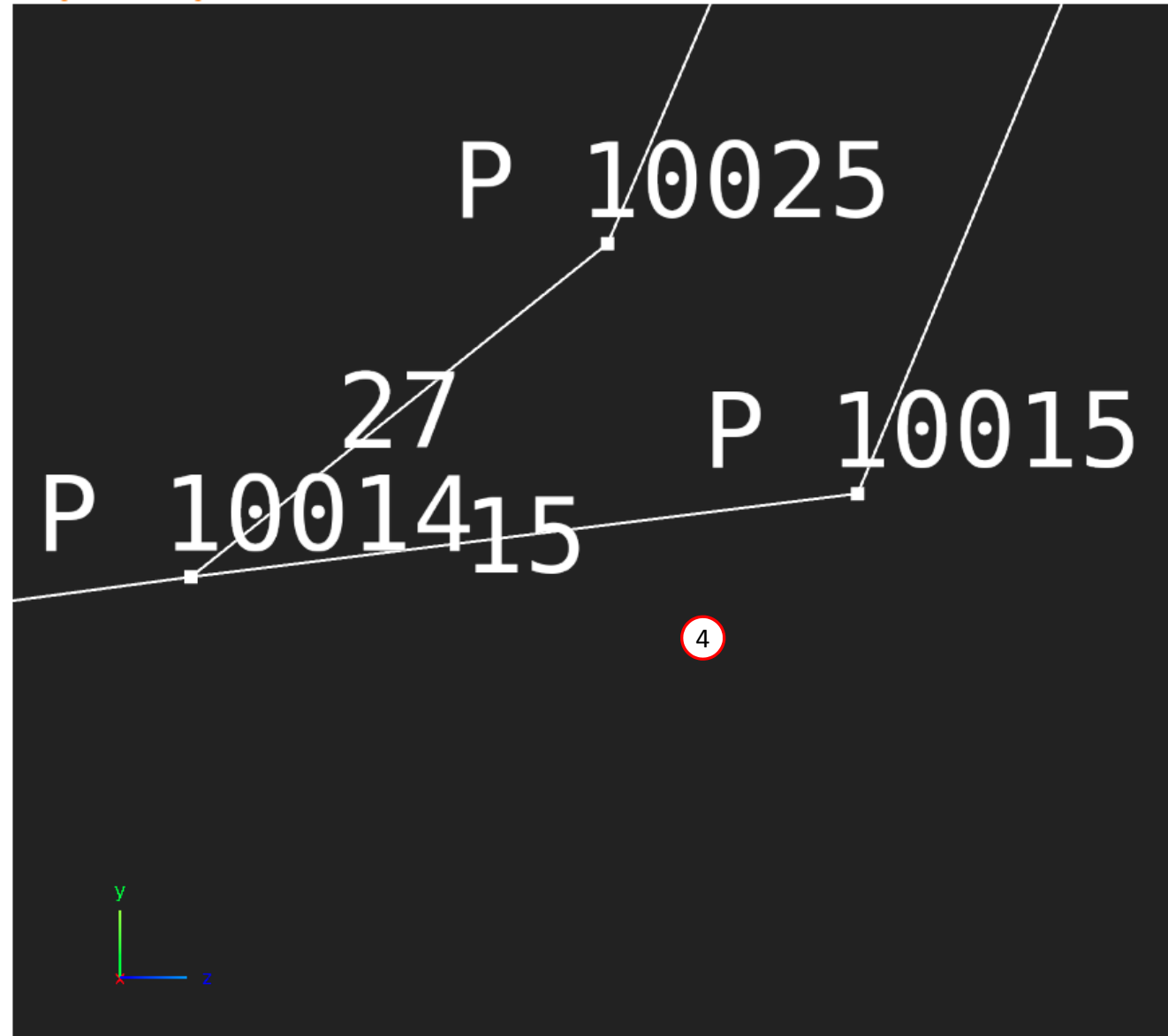
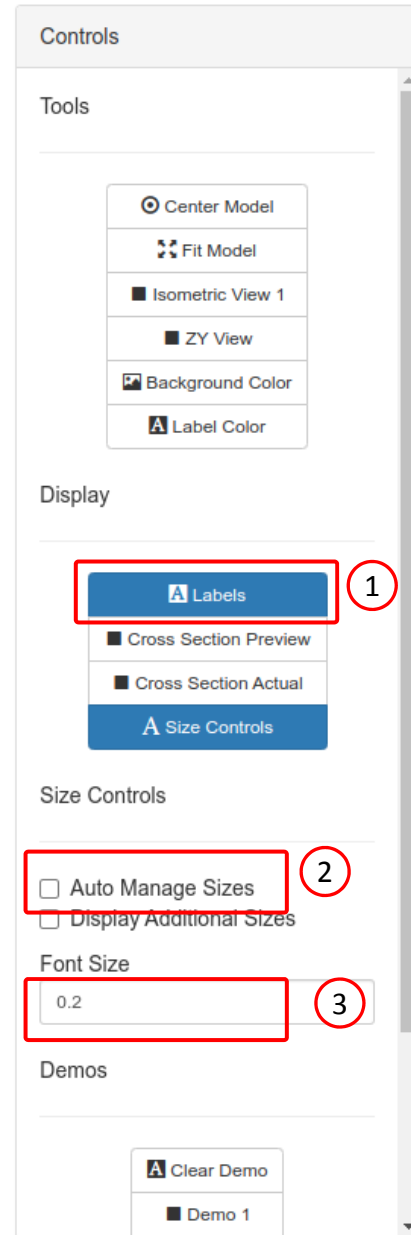
Labels

1. Zoom in to see the labels for points and lines
 - The size of the labels are purposely small to avoid interference with nearby labels



Labels

1. Click Size Controls
2. Unmark the checkbox for Auto Manage Sizes
3. Increase or decrease the font size
4. The labels are resized



Developed by The Engineering Lab

Guidelines

PART B - GUIDELINES

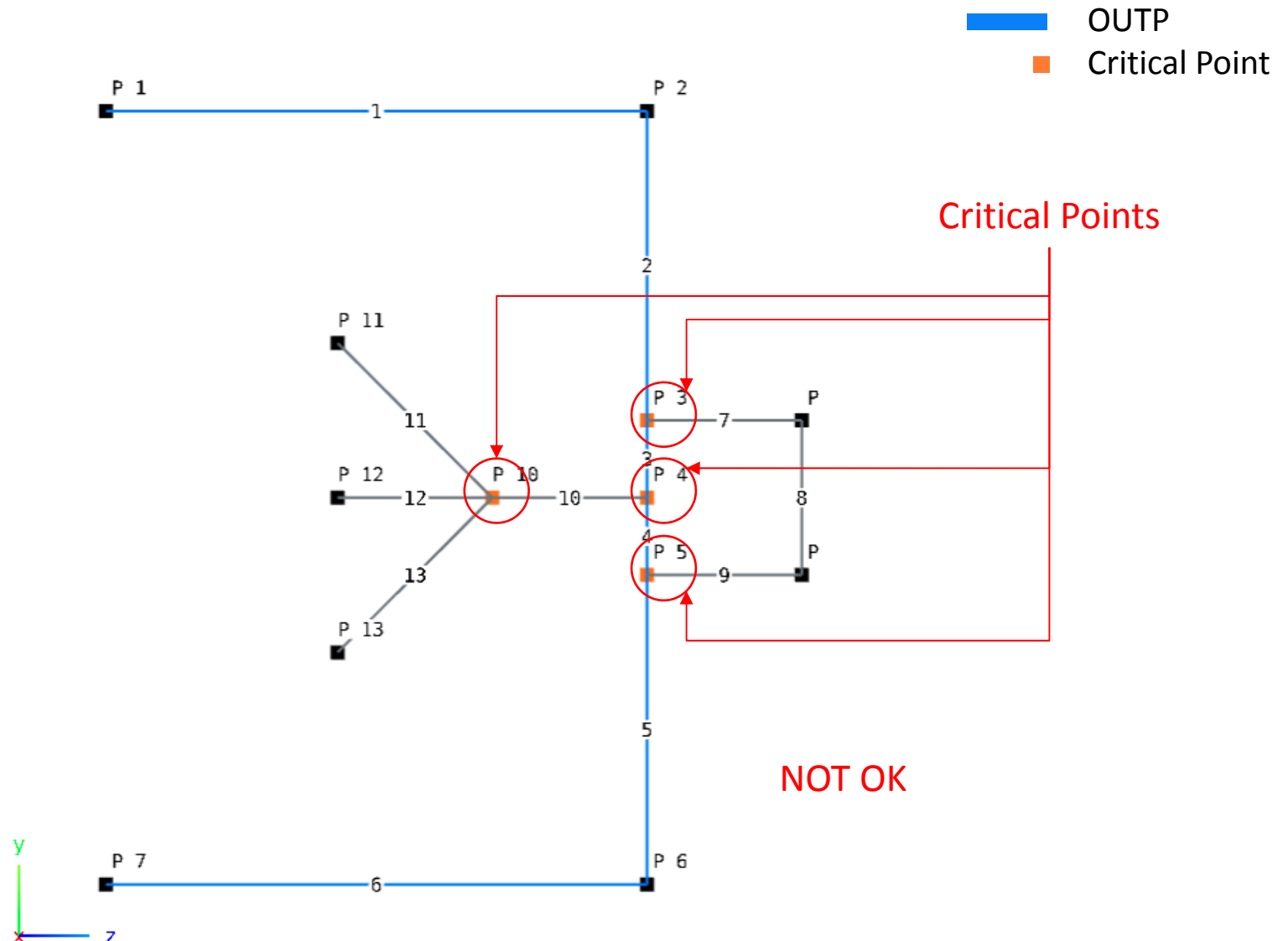
Guideline for Open Profile Sections

This guideline only applies if the arbitrary beam cross section is an open profile.

Guideline: The outer perimeter should connect all "critical points"

- A "critical point" is a point that has 3 or more connected lines
- There are exceptions to this guideline

The example on the right has 4 critical points: points 3, 4, 5, and 10. The outer perimeter (OUTP) are the blue lines. OUTP at best can cross 3 critical points. MSC Nastran cannot properly interpret this configuration.

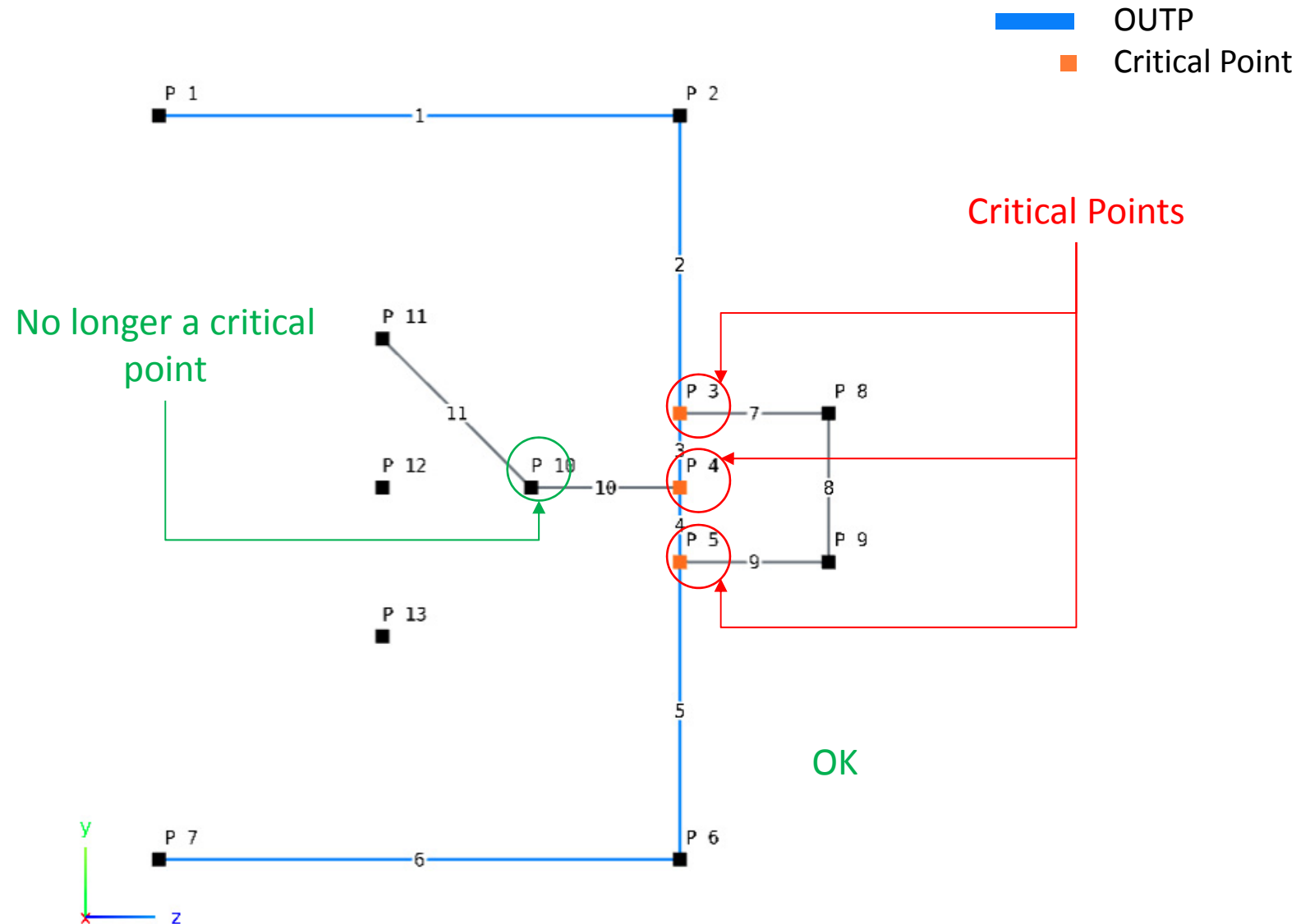


Guideline for Open Profile Sections

For this example, the solution is to remove the critical point that cannot be connected.

Lines 12 and 13 are removed so that point 10 is no longer critical.

This configuration of OUTP is valid.



End of Tutorial

Appendix

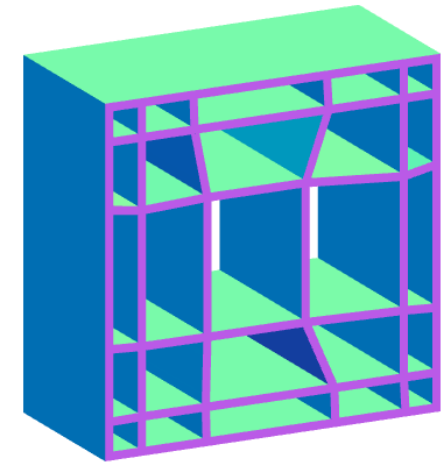
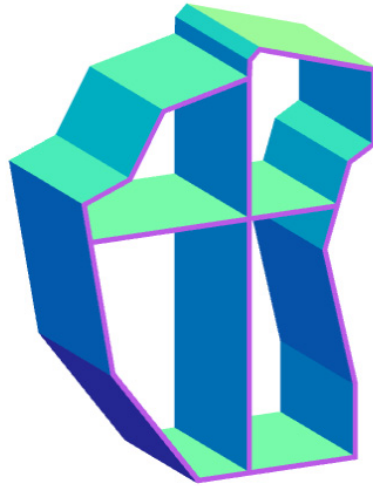
Appendix Contents

- Procedure to Create PBMSECT/PBRSECT Entries
- Comment on Critical Points
- Supported PBMSECT/PBRSECT Keywords
- UFM 2012
- UFM 7201 - Cause 1
- UFM 7201 - Cause 2
- UFM 7733

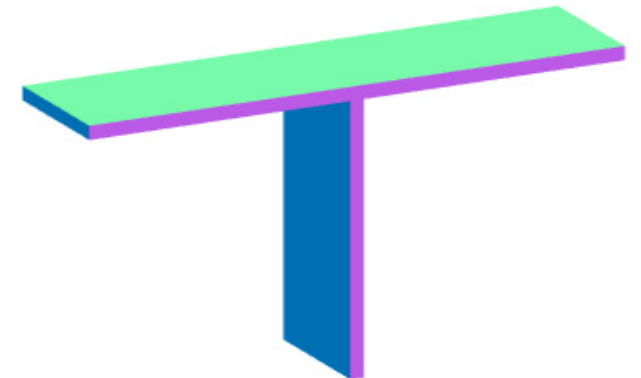
Procedure to Create PBMSECT/PBRSECT Entries

1. Create points
2. Connect points and create Lines
3. Identify lines on the outer perimeter (**Critical Step**)
 - Guideline: If creating an open profile, the outer perimeter should connect all "critical points"
4. Fine tune the configuration
 - Select between PBMSECT and PBRSECT
 - Select general section, open profile or closed profile
 - Adjust the point's z and y positions
 - Adjust the line segment thicknesses
 - Specify custom IDs for POINT and SET1 entries
5. Run MSC Nastran to validate the PBMSECT/PBRSECT entry
 - This only works if MSC Nastran is installed on the same machine as the SOL 200 Web App

Arbitrary Beam Cross Section Examples



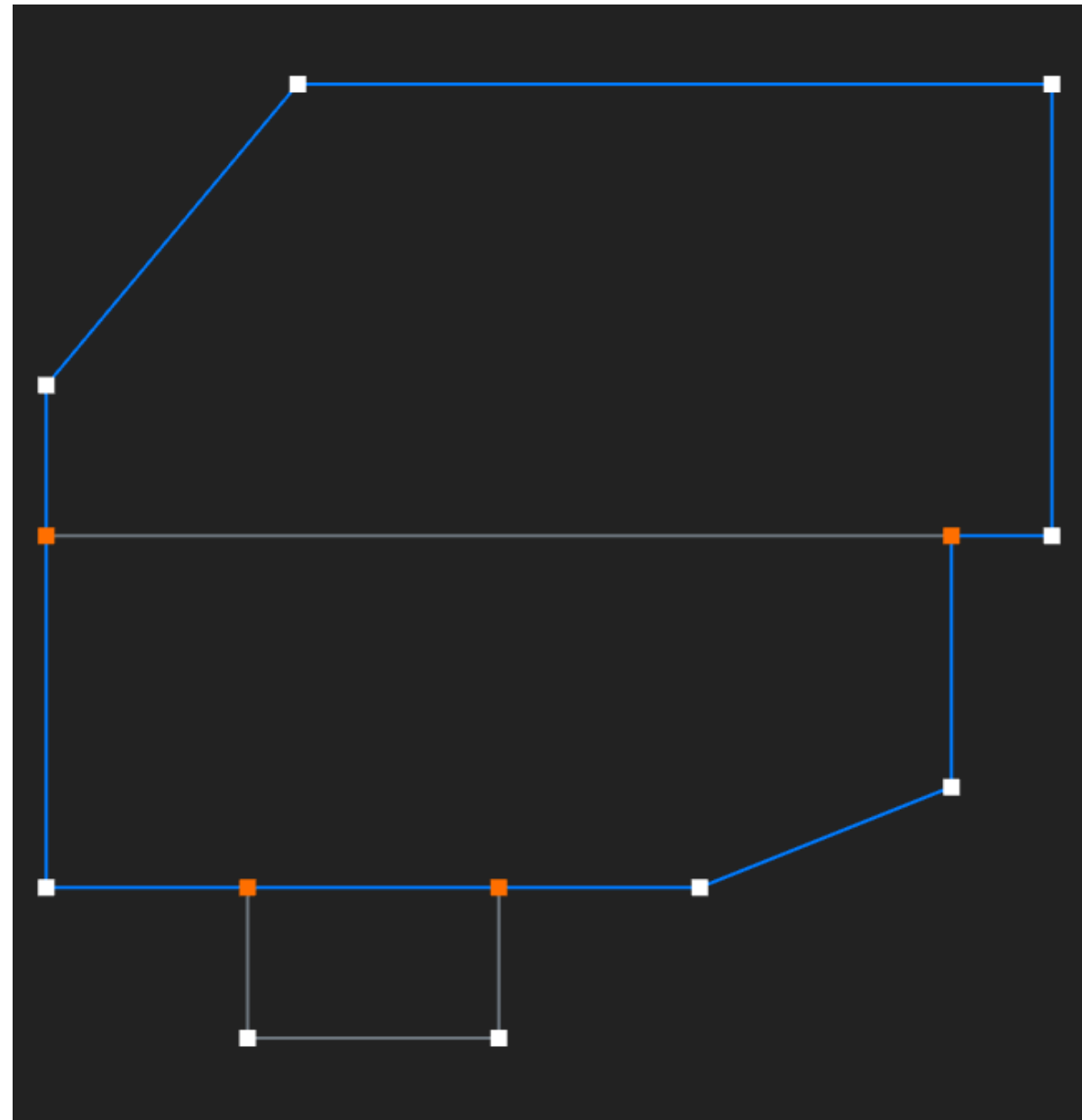
Composite Arbitrary Beam Cross Section Examples






Comment on Critical Points

A critical point is a point with 3 or more connecting lines.

1. For open profile (OP) cross sections, the outer perimeter should always cross the critical points.
2. For closed profile (CP) cross sections, it is recommended that the outer perimeter cross the critical points.

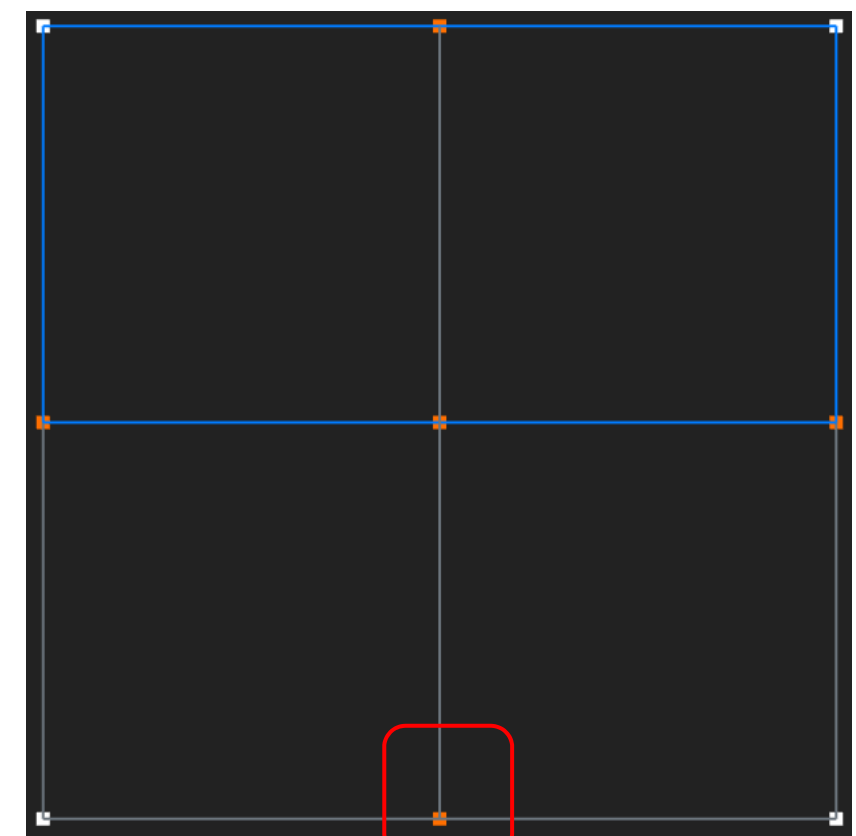
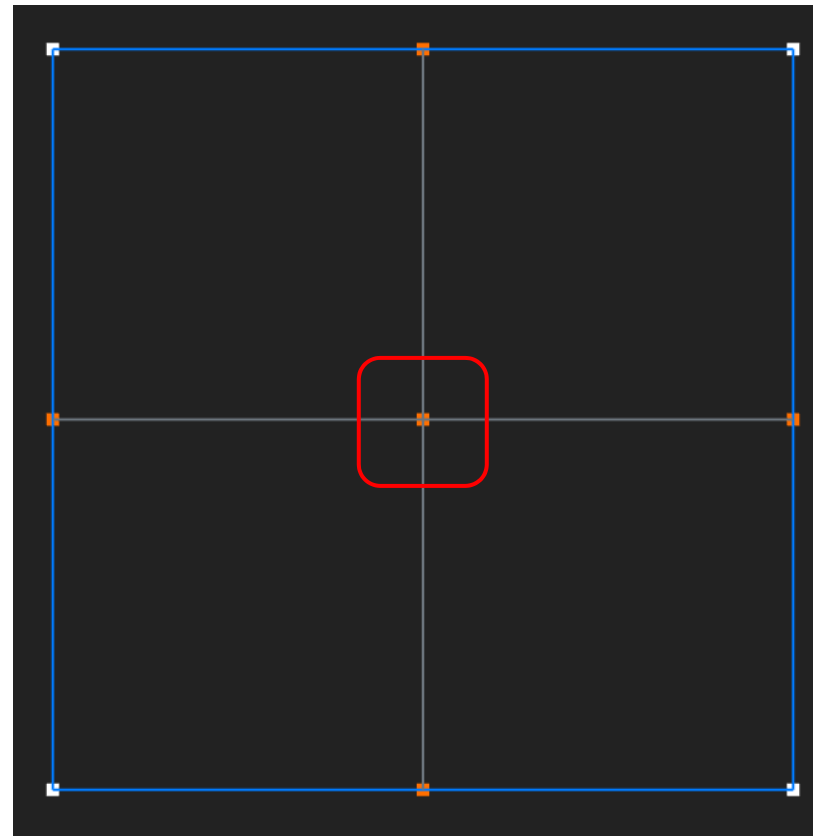


Legend




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

Comment on Critical Points

1. For closed profile cross sections, it is recommended that the outer perimeter cross the critical points.
 - This recommendation is NOT absolute. As shown in the examples to the right, certain cross sections provide flexibility where the outer perimeter does not need to cross all the critical points.



Legend

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

Supported Bulk Data Entries and Keywords

- The PBMSECT Web App supports the keywords listed in the table

Supported Bulk Data Entries

Entry	Import	Export
PBMSECT	YES	YES
PBRSECT	YES	YES
POINT	YES	YES
SET1	YES	YES
SET3	YES	NO

*When uploading BDF files to the SOL 200 Web App, including the PBMSECT web app and Beams Viewer, each entry listed in the table above must have a unique ID in all BDF files. The use of BEGIN MODULE allows for duplicate IDs for PBMSECT, POINT, SET1, etc. The following examples have duplicate IDs for POINT entries and are not supported by the SOL 200 Web App. All other DAT and BDF files are supported.

- /tpl/modules/mod_vabcor2a.dat
- /tpl/modules/mod_vabcore1.dat

Supported Keywords

Keyword	Supported?
OUTP	YES
OUTM**	NO
INP	YES
BRP	YES
T	YES
CORE or C	YES
LAYER or L	YES
NSM	YES

**OUTM and BEGIN BULK ARBMODEL are not supported.

Supported Forms

- GS General Section
- OP Open Profile
- CP Closed Profile

UFM 2012

1. The IDs for the POINT entries may be customized as shown and is done to avoid conflicts with existing GRID IDs

```
*** USER FATAL MESSAGE 2012 (GP1GSM)
      IDENTIFICATION 1 SAME BETWEEN GRID, SCALAR OR POINT OR
      AUTOMATICALLY GENERATED Q-SET SPOINT ID
*** USER FATAL MESSAGE 2012 (GP1GSM)
      IDENTIFICATION 2 SAME BETWEEN GRID, SCALAR OR POINT OR
      AUTOMATICALLY GENERATED Q-SET SPOINT ID
```

Custom IDs

☒ Renumber Lines and Points

Entry	Custom ID	Status	IDs Used by this PBMSECT/PBRSECT	IDs Used by other entries
PBMSECT/ PBRSECT	<input type="text" value="78020"/>	<input checked="" type="checkbox"/>	78020	
SET1	<input type="text" value="2000"/>	<input checked="" type="checkbox"/>		
POINT	<input type="text" value="2001"/>	! Check separately to ensure POINT IDs do not conflict with GRID IDs		

1

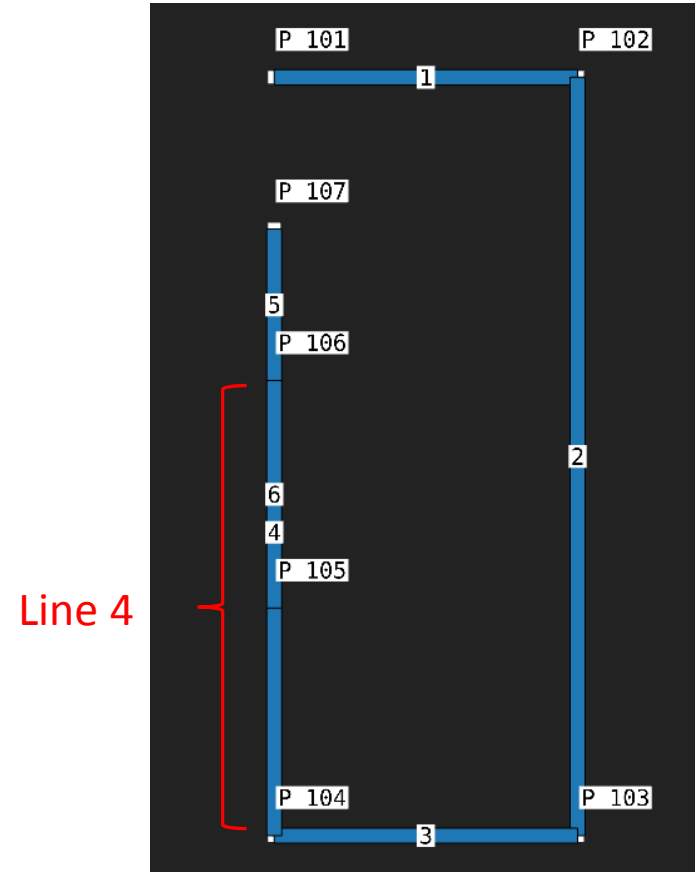
UFM 7201 Cause 1

1. This UFM sometimes occurs if line segments overlap

```
*** USER FATAL MESSAGE 7201 (ARNFCK)
PBRSECT/PBMSECT ENTRY ID=32, INTERSECTION OF SEGMENTS WITHIN A LOOP OR BETWEEN LOOPS FOUND.
USER ACTION : IF FORM=CP OR OP, USE LESSER NUMBER OF POINTS TO DESCRIBE THE PROFILE. ESPECIALLY IN MERGING AREA OF TWO LINES.
               IF FORM=GS, CHECK FOR OVERLAPPING POINTS AND/OR POINTS WITH SAME COORDINATES.

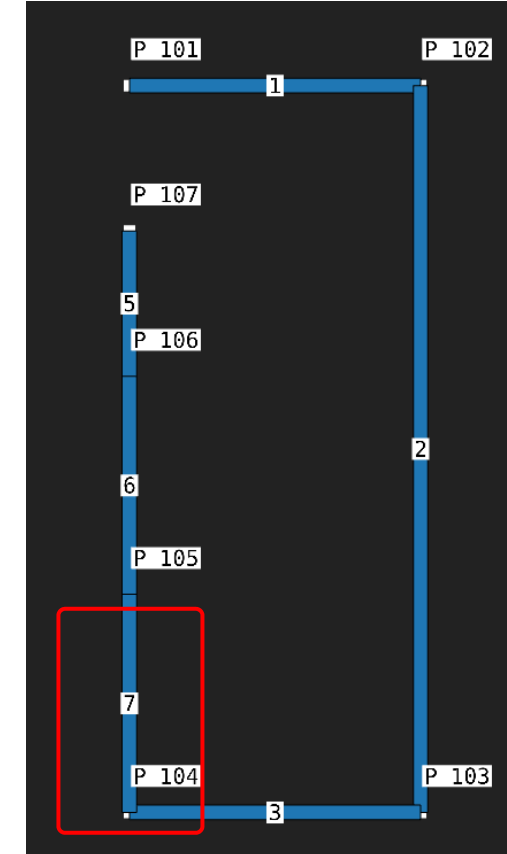
INTERSECTION
X-COOR      Y-COOR      PROXIMITY POINT ID
4.9407-324  0.0000E+00
USER ACTION: MAKE SURE POINTS IN CLOSE PROXIMITY OF ABOVE COORDINATES ARE SEPARATED BY
A DISTANCE LARGER THAN THE THICKNESS OF THE SEGMENT.
PLEASE NOTE THAT LIST OF PROXIMITY POINTS IS NOT EXHAUSTIVE. REVIEW OF ALL POINTS INVOLVED IS RECOMMENDED.
POST-SCRIPT OUTPUT FILE MAY BE UTILIZED AS A TOOL TO LOCATE THE PROBLEM SPOT.

*** USER FATAL MESSAGE 6624 (IFP9)
SEE INFORMATION MESSAGES ABOVE
```



Line 4

Not Correct: Line 4 overlaps line 6



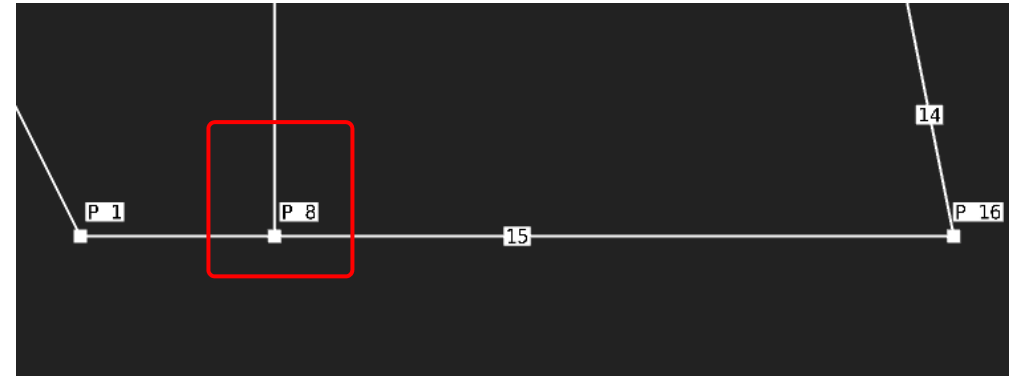
Correct: Line 4 is removed and line 7 is created.

UFM 7201 Cause 1, Another Example

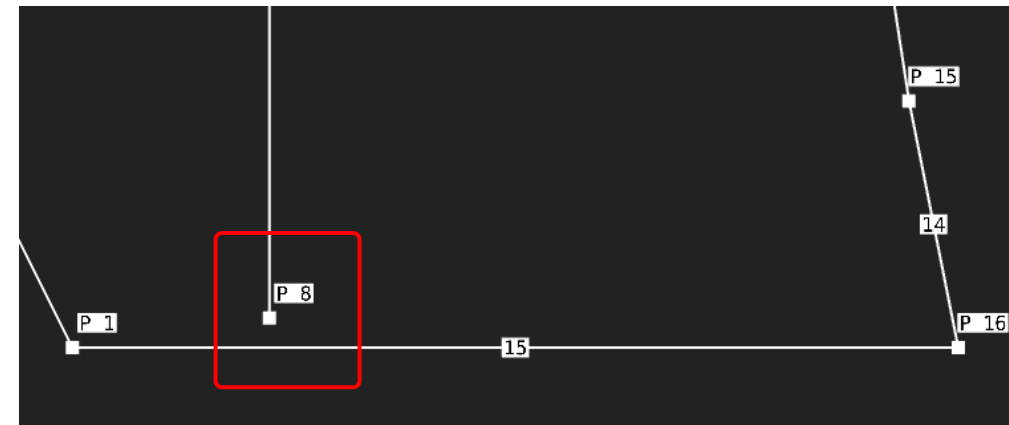
1. If a free end of a line is very close to another line, the overlapping sections will trigger this error

```
*** USER FATAL MESSAGE 7201 (ARNFCK)
PBRSECT/PBMSECT ENTRY ID=32, INTERSECTION OF SEGMENTS WITHIN A LOOP OR BETWEEN LOOPS FOUND.
USER ACTION : IF FORM=CP OR OP, USE LESSER NUMBER OF POINTS TO DESCRIBE THE PROFILE. ESPECIALLY IN MERGING AREA OF TWO LINES.
               IF FORM=GS, CHECK FOR OVERLAPPING POINTS AND/OR POINTS WITH SAME COORDINATES.
INTERSECTION
X-COOR      Y-COOR      PROXIMITY POINT ID
4.9407-324  0.0000E+00
USER ACTION: MAKE SURE POINTS IN CLOSE PROXIMITY OF ABOVE COORDINATES ARE SEPARATED BY
A DISTANCE LARGER THAN THE THICKNESS OF THE SEGMENT.
PLEASE NOTE THAT LIST OF PROXIMITY POINTS IS NOT EXHAUSTIVE. REVIEW OF ALL POINTS INVOLVED IS RECOMMENDED.
POST-SCRIPT OUTPUT FILE MAY BE UTILIZED AS A TOOL TO LOCATE THE PROBLEM SPOT.
*** USER FATAL MESSAGE 6624 (IFP9)
SEE INFORMATION MESSAGES ABOVE
```

Not Correct: Point 8 is too close to line 15



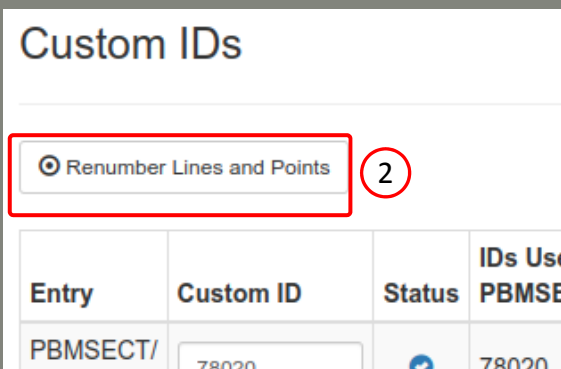
Correct: Point 8 is moved to avoid being too close to line 15



UFM 7201 Cause 2

This UFM sometimes occurs if the POINT IDs are not numbered sequentially.

- Click Renumber Lines and Points to automatically renumber the POINT IDs

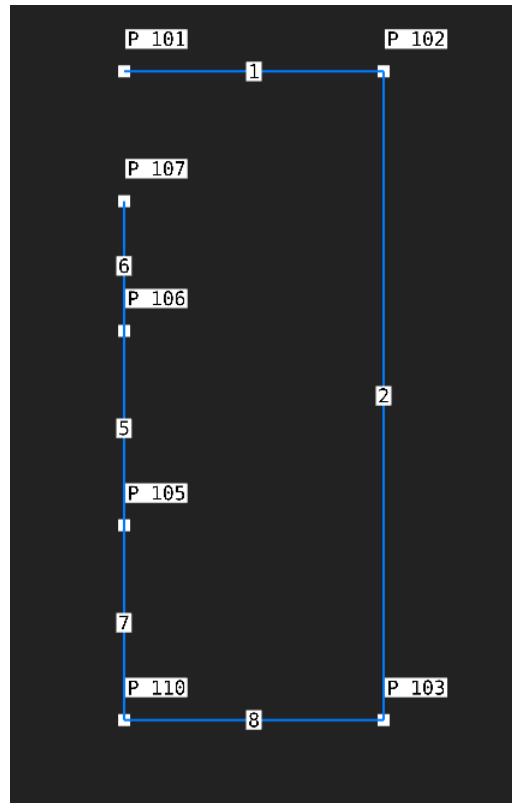


```

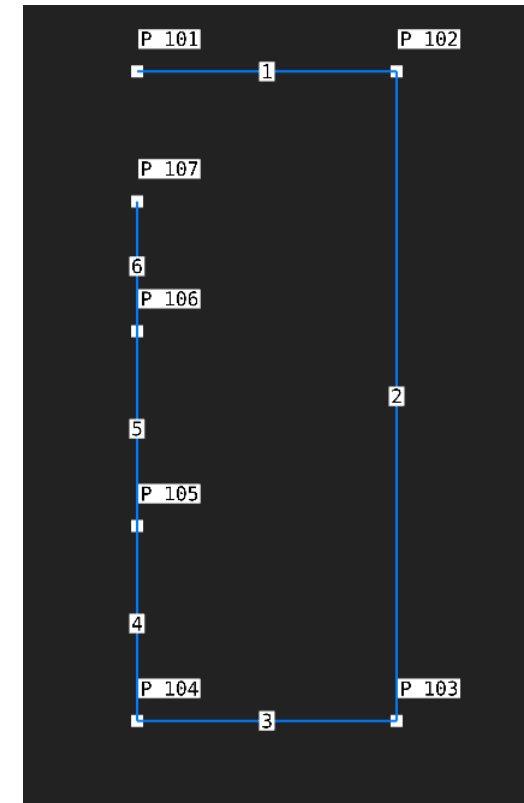
*** USER FATAL MESSAGE 7201 (ARNFCK)
PBRSECT/PBMSECT ENTRY ID=32, INTERSECTION OF SEGMENTS WITHIN A LOOP OR BETWEEN LOOPS FOUND.
USER ACTION : IF FORM=CP OR OP, USE LESSER NUMBER OF POINTS TO DESCRIBE THE PROFILE. ESPECIALLY IN MERGING AREA OF TWO LINES.
                IF FORM=GS, CHECK FOR OVERLAPPING POINTS AND/OR POINTS WITH SAME COORDINATES.

INTERSECTION
X-COOR      Y-COOR      PROXIMITY POINT ID
5.0000E+00  5.0395-322
USER ACTION: MAKE SURE POINTS IN CLOSE PROXIMITY OF ABOVE COORDINATES ARE SEPARATED BY
A DISTANCE LARGER THAN THE THICKNESS OF THE SEGMENT.
PLEASE NOTE THAT LIST OF PROXIMITY POINTS IS NOT EXHAUSTIVE. REVIEW OF ALL POINTS INVOLVED IS RECOMMENDED.
POST-SCRIPT OUTPUT FILE MAY BE UTILIZED AS A TOOL TO LOCATE THE PROBLEM SPOT.

*** USER FATAL MESSAGE 6624 (IFP9)
SEE INFORMATION MESSAGES ABOVE
  
```



Not Correct: The POINT IDs are not numbered in sequential order.

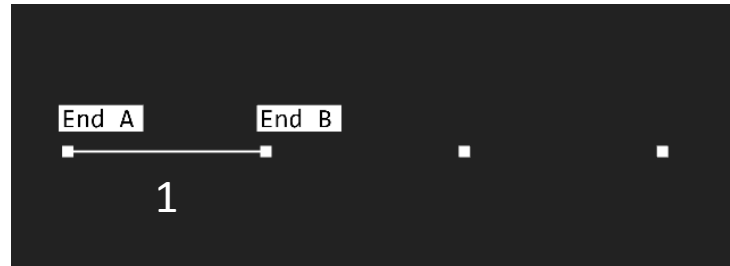


Correct: The POINT IDs are now numbered in sequential order.

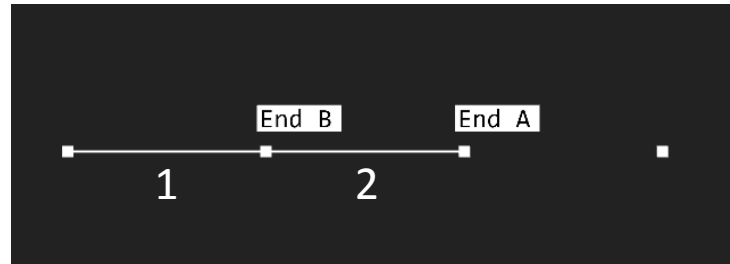
UFM 7201

If this error persists, recreate the lines and ensure the next line created starts the end of the last line created.

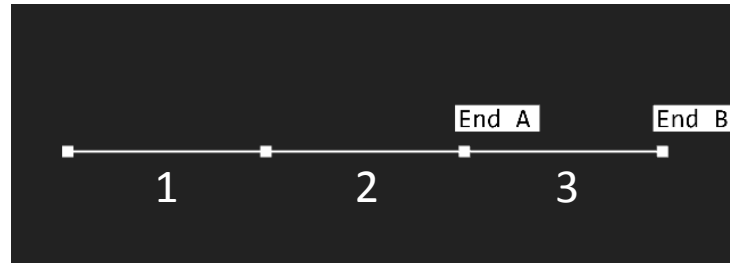
Step 1



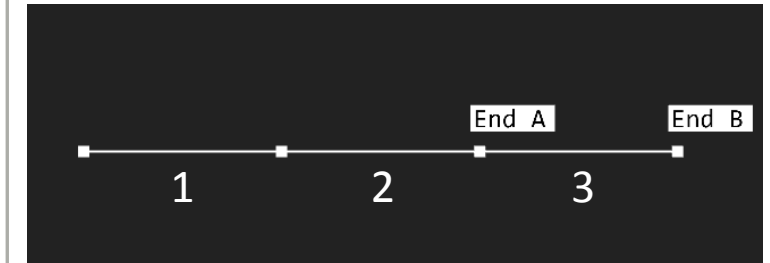
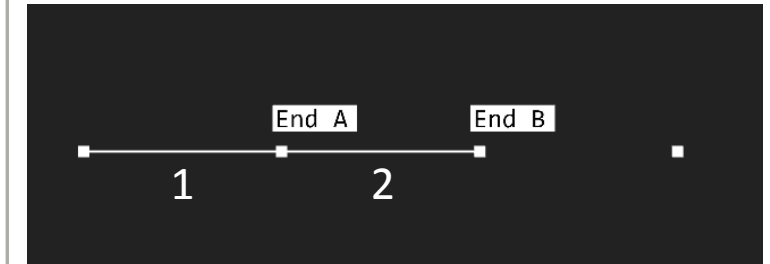
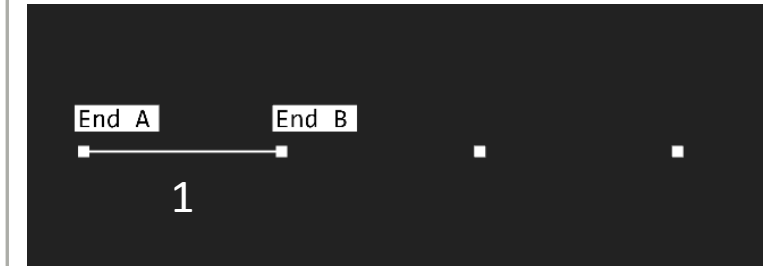
Step 2



Step 3



Not Ideal: End B of line 1 is connected to End B of line 2



Ideal: End B of line 1 is connected to End A of line 2