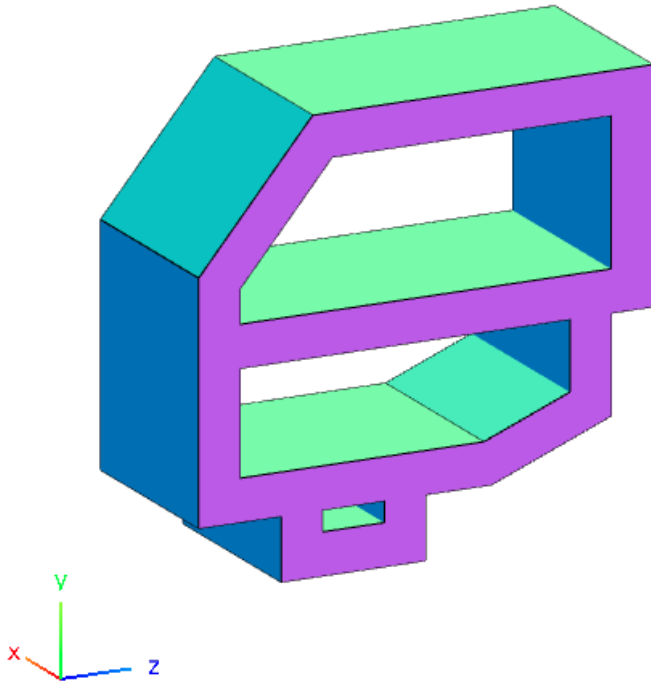


Workshop - Arbitrary Beam Cross Section Optimization

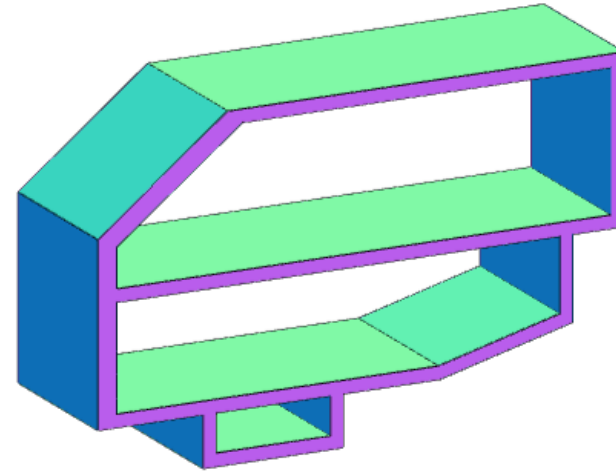
A PBMSECT/PBRSECT AND SOL 200 WEB APP TUTORIAL

Goal: Create a PBMSECT entry and optimize the arbitrary beam cross section with MSC Nastran SOL 200

Before



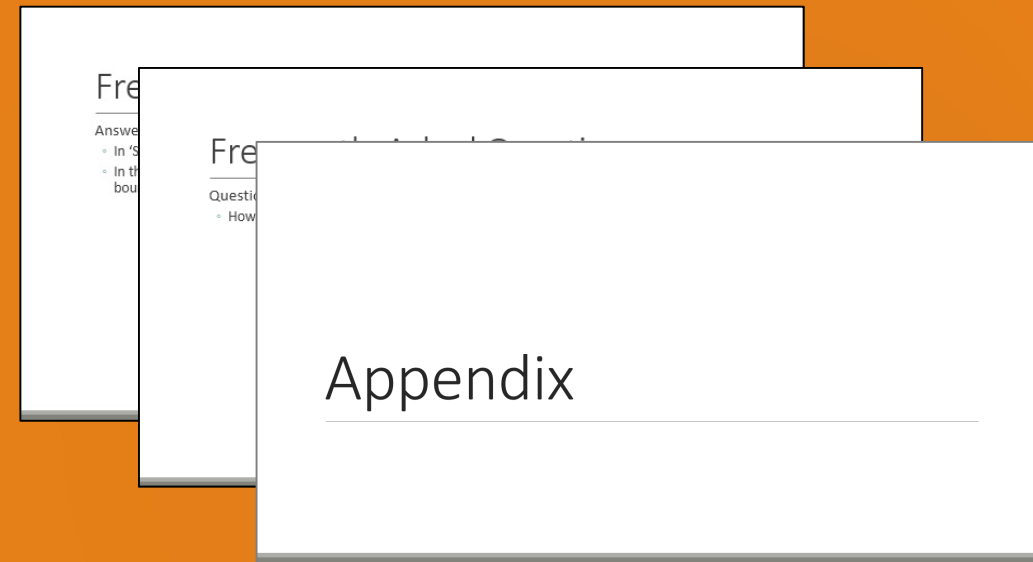
After



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

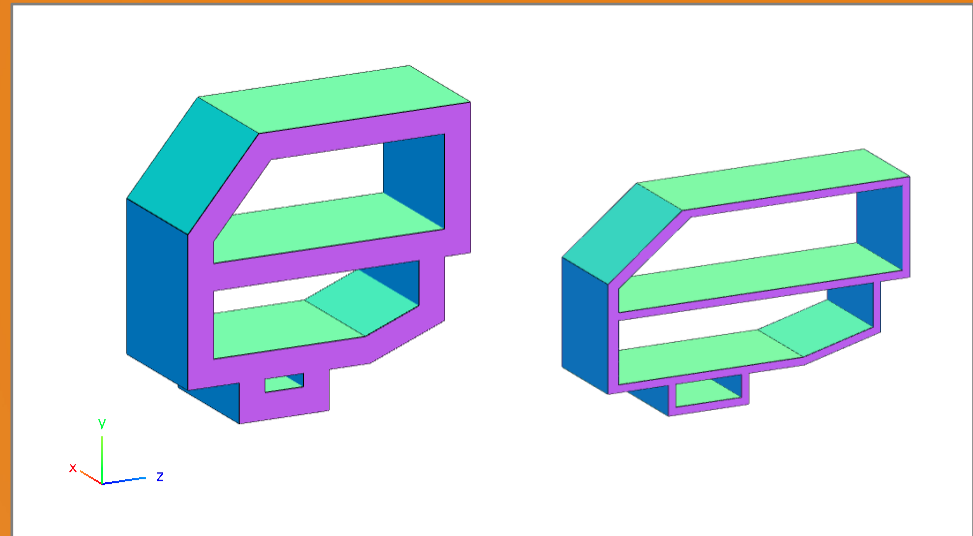
Tutorial

Tutorial Overview

1. Start with a .bdf or .dat file
2. Use the PBMSECT Web App to:
 - Create a new arbitrary beam cross sections (ABCS)
 - Run MSC Nastran to confirm the ABCS is created properly
 - Download an updated BDF file
3. Use the SOL 200 Web App to:
 - Convert the .bdf file to SOL 200
 - Design Variables
 - Design Objective
 - Design Constraints
 - Perform optimization with Nastran SOL 200
4. Plot the Optimization Results
5. Update the original model with optimized parameters
6. Use the Beams Viewer to view the updated beam elements with the newest ABCSs

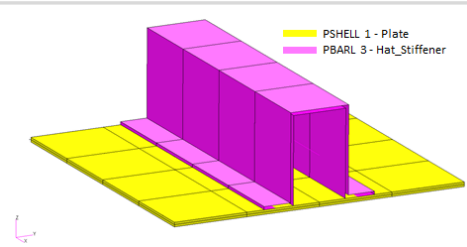
Special Topics Covered

Arbitrary Beam Cross Section Optimization - The width, height and 2 wall thicknesses of the ABCS are set as design variables and MSC Nastran SOL 200 is used to perform the optimization. After the optimization, the Beams Viewer is used to post process the beam's forces.



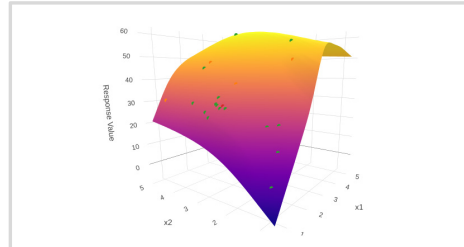
SOL 200 Web App Capabilities

Capabilities



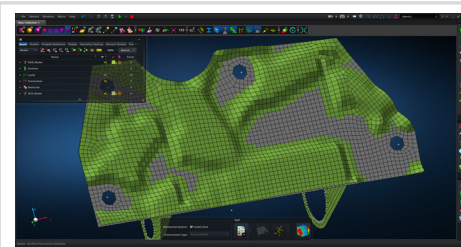
Web Apps for SOL 200

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



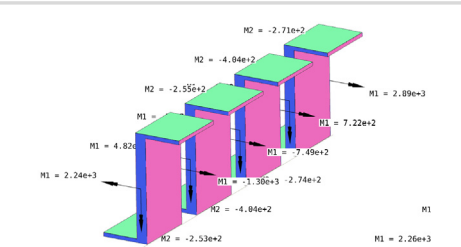
Machine Learning Web App

Bayesian Optimization for nonlinear
response optimization (SOL 400)



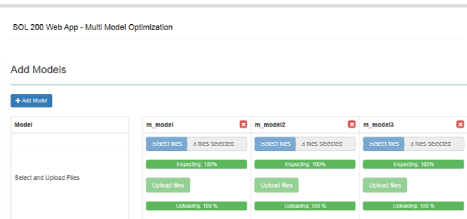
MSC Apex Post Processing Support

View the newly optimized model
after an optimization



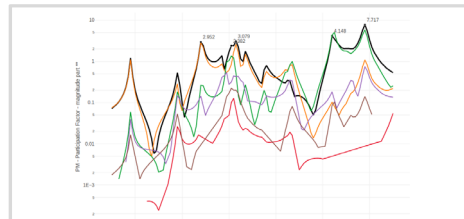
Beams Viewer Web App

Post process 1D element forces,
including shear forces, moments,
torque and axial forces



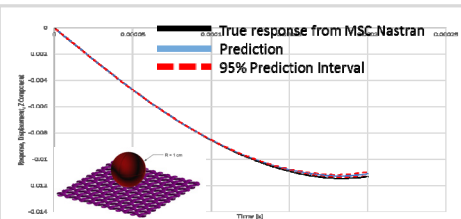
Multi-model Optimization Web App

Pre/post for multi model
optimization



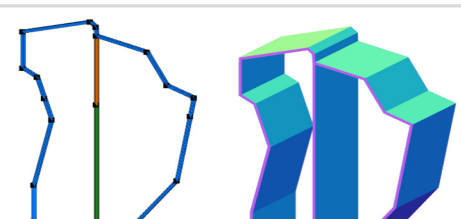
HDF5 Explorer Web App

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



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

Part A - Locating the Web Apps

Locating the Web Apps

Throughout this tutorial the following web apps will be used

- Size web app
- Beams Viewer
- PBMSECT web app

The following slides detail where to locate these web apps

Beams Viewer and PBMSECT Web App

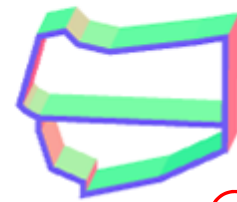
1. Navigate to the homepage
2. Click on the indicated link

The screenshot shows the SOL 200 Web App interface. At the top, the text "SOL 200 Web App" is displayed with a red circle containing the number "1" above it. Below this, the instruction "Select a web app to begin" is shown. Five web app tiles are presented: "Optimization for SOL 200" (showing 'Before' and 'After' beam cross-sections), "Multi Model Optimization" (showing a 3D model and a line graph), "Machine Learning | Parameter Study" (showing four mesh plots), "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, the text "Tutorials and User's Guide" is visible. At the bottom, a red box highlights the link "Full list of web apps", with a red circle containing the number "2" next to it.

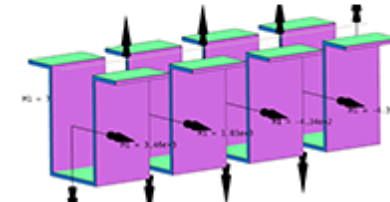
Beams Viewer and PBMSECT Web App

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

Beams

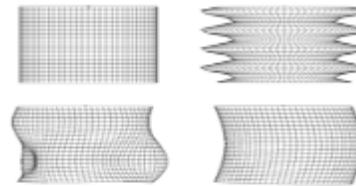


PBMSECT

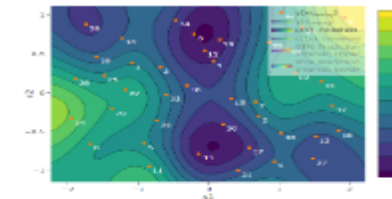


Beams Viewer

Machine Learning



Machine Learning

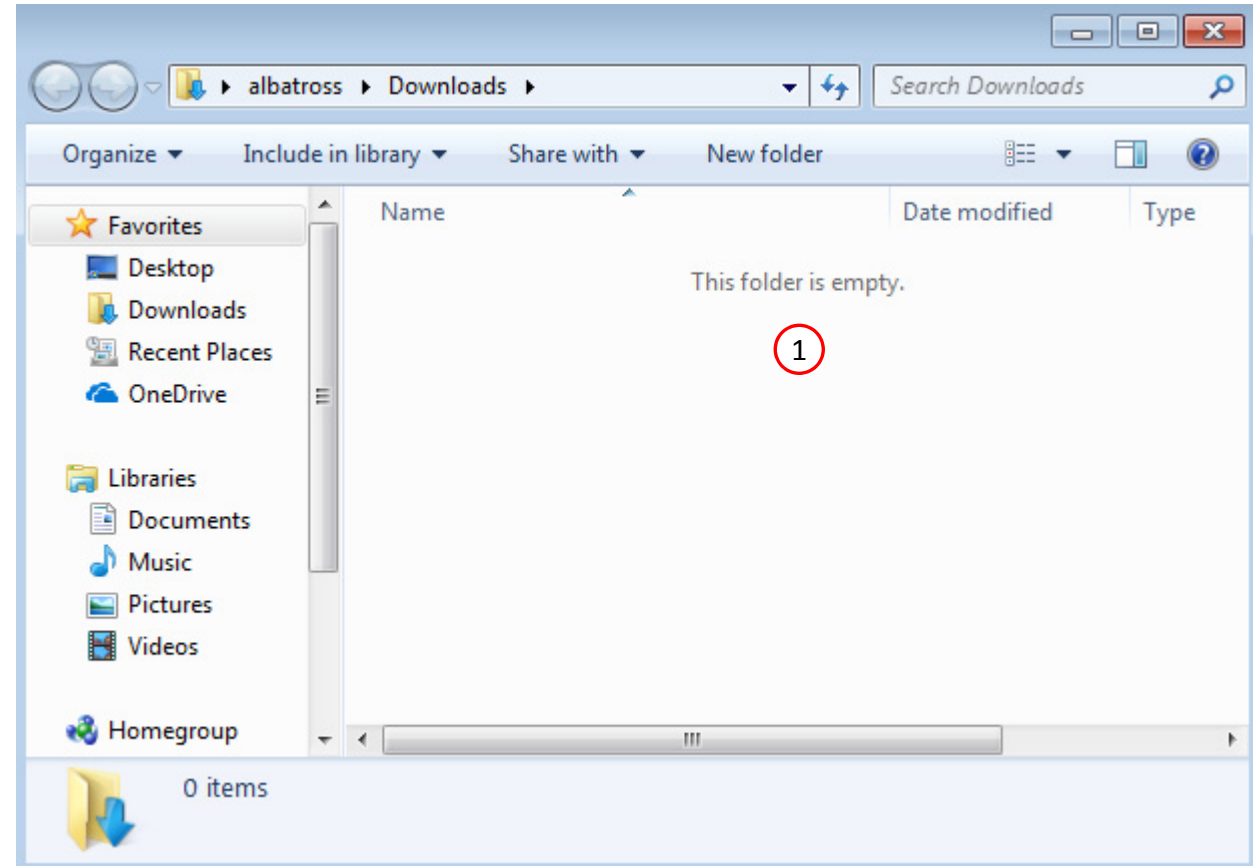


Prediction Analysis

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.

The screenshot displays the SOL 200 Web App interface. At the top, it says "SOL 200 Web App" and "Select a web app to begin". Below this, there are five main categories of web apps, each with a representative image and a label:

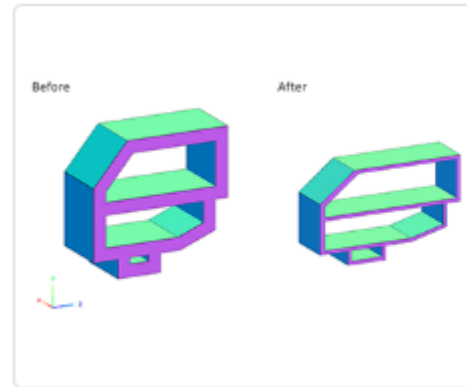
- Optimization for SOL 200**: Shows a 3D model of a mechanical part with "Before" and "After" states.
- Multi Model Optimization**: Shows a 3D model of a mechanical part with a graph of optimization results.
- Machine Learning | Parameter Study**: Shows four small plots representing different machine learning or parameter study results.
- HDF5 Explorer**: Shows a line graph with multiple data series.
- Remote Execution**: Shows a diagram of data flow between a "Remote System" and a "Local System", with "Input Files" and "Results Files" labels.

At the bottom center, there is a red-bordered button labeled "Tutorials and User's Guide" with a circled "1" next to it. Below this button, the text "Full list of web apps" is visible.

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

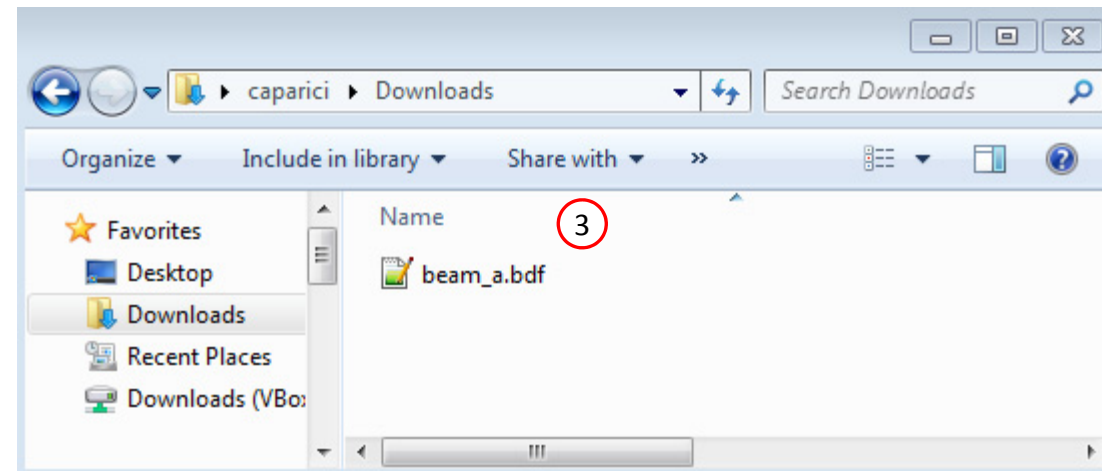
Arbitrary Beam Cross Section Optimization

MSC Nastran SOL 200 supports varying the width, height and wall thickness of arbitrary beam cross sections (ABCS) defined by the PBRSECT or PBMSECT entries. This tutorial walks you through the process of generating an ABCS via the PBMSECT entry, configuring an optimization for MSC Nastran SOL 200, and reviewing the optimization results.

Starting BDF Files: [Link](#)

2

Solution BDF Files: [Link](#)



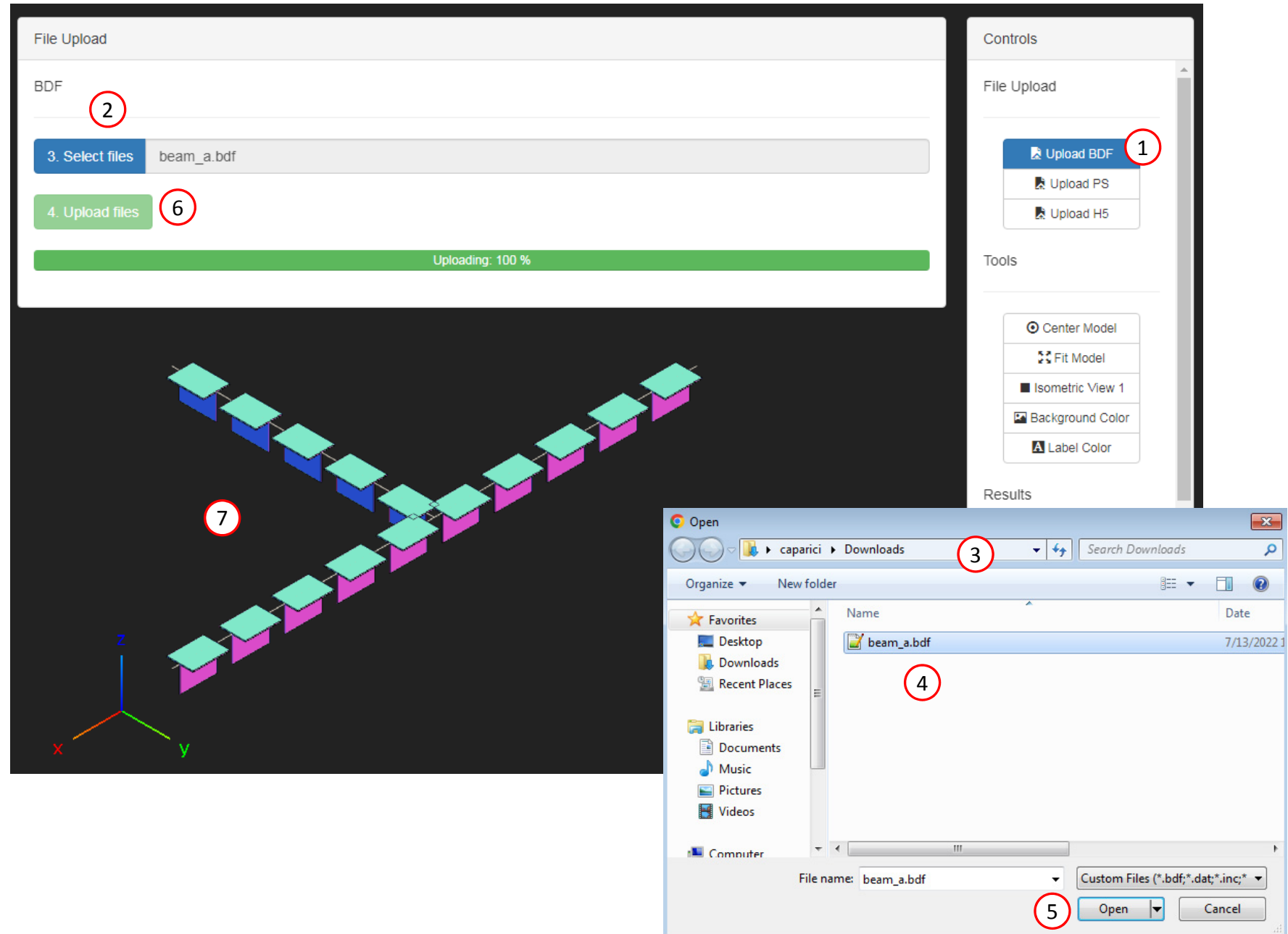
Part B – Creating an Arbitrary Beam Cross Section (ABCS) with the PBMSECT Web App

Beams Viewer

Open the Beams Viewer

1. Click Upload BDF
2. Click Select files
3. Navigate to the directory Downloads
4. Select beam_a.bdf
5. Click Open
6. Click Upload files
7. The MSC Nastran model has been uploaded to the Beams Viewer
 1. This model consists of 15 CBEAM elements and their cross section is defined by a PBEAML entry, which defines a T cross section

- The selected BDF file was created by a separate pre processor. The Beams Viewer does NOT generate any bulk data entries.



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 beam_a.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.

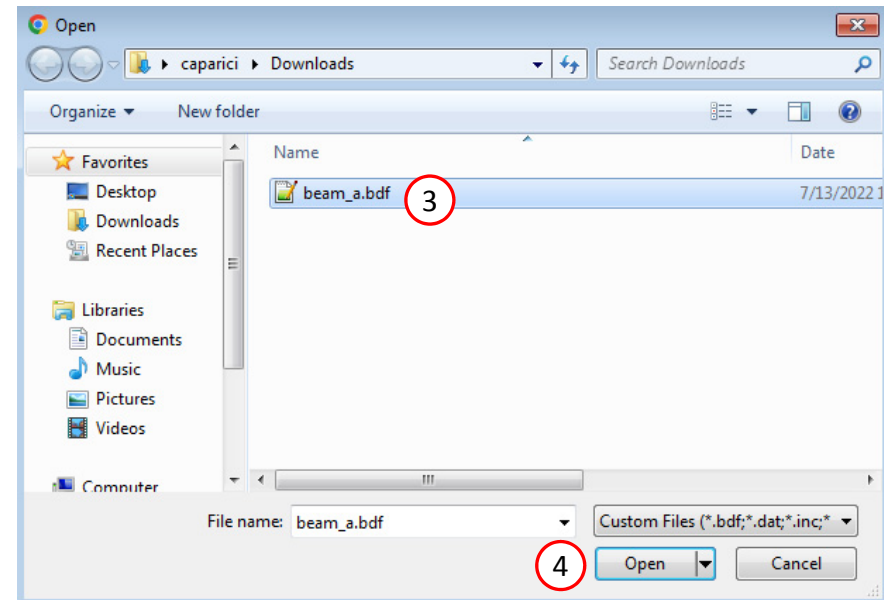
Select BDF Files

- 2 1. Select files beam_a.bdf

Inspecting: 100%

- 5 2. Upload files

Uploading: 100 %



Create a New PBMSECT Entry

1. Click Create New Entry
2. Configure the Cross Section Options follows:
 1. Entry: PBMSECT
 2. PID: 1
 3. MID: 1, MAT1
 4. FORM: CP Closed Profile
 5. CORE: No
 6. NSM: Leave blank
3. If you have multiple PBMSECT or PBRSECT entries, you may use the select box to switch between entries
4. Refer to the section Custom IDs
5. The Status icon is red and indicates an ID conflict between the PBMSECT ID and another entry
6. Inspect the beam_a.bdf file. There is an existing PBEAML entry with ID=1 and will conflict with the newly created PBMSECT ID=1 entry. Later in this tutorial, the PBEAML entry will be renumbered to ID=99 to avoid the conflict.

Existing PBMSECT/PBRSECT Entries

Select a PBMSECT/PBRSECT ID to edit

1 3

+ Create New Entry

✖ Delete Selected Entry

1

Cross Section Options

Entry PBMSECT

PID 1

MID 1, MAT1

FORM CP Closed Profile

CORE No - Do not use CORE

NSM

2

Custom IDs 4

⊙ Renumber Lines and Points

Entry	Custom ID	Status	IDs Used by this PBMSECT/PBRSECT	IDs Used by other entries
PBMSECT/PBRSECT	1	5	1	1
SET1	201			
POINT	2000001		Check separately to ensure POINT IDs do not conflict with GRID IDs	

6

```

40 LOAD = 2
41 BEGIN BULK
42 $ Direct Text Input for Bulk Data
43 MDLPRM HDF5 0
44 PARAM PRTMAXIM YES
45 $ Elements and Element Properties for region
46 PBEAML 1 1 T2
47 .1 .1 .003 .003
48 $ Pset: "Beam_Assignment_A" will be imported
49 CBEAM 1 1 1 2 0
  
```

Points

1. Click Create Points (The button should be blue)
2. Adjust the Grid Helper as follows
 1. Width and Height: 0.1
 2. Number of Divisions: 20
3. Click Fit Model
4. Click on the points on the Grid Helper to create 13 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

Width and Height

0.1

Number of Divisions

20

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

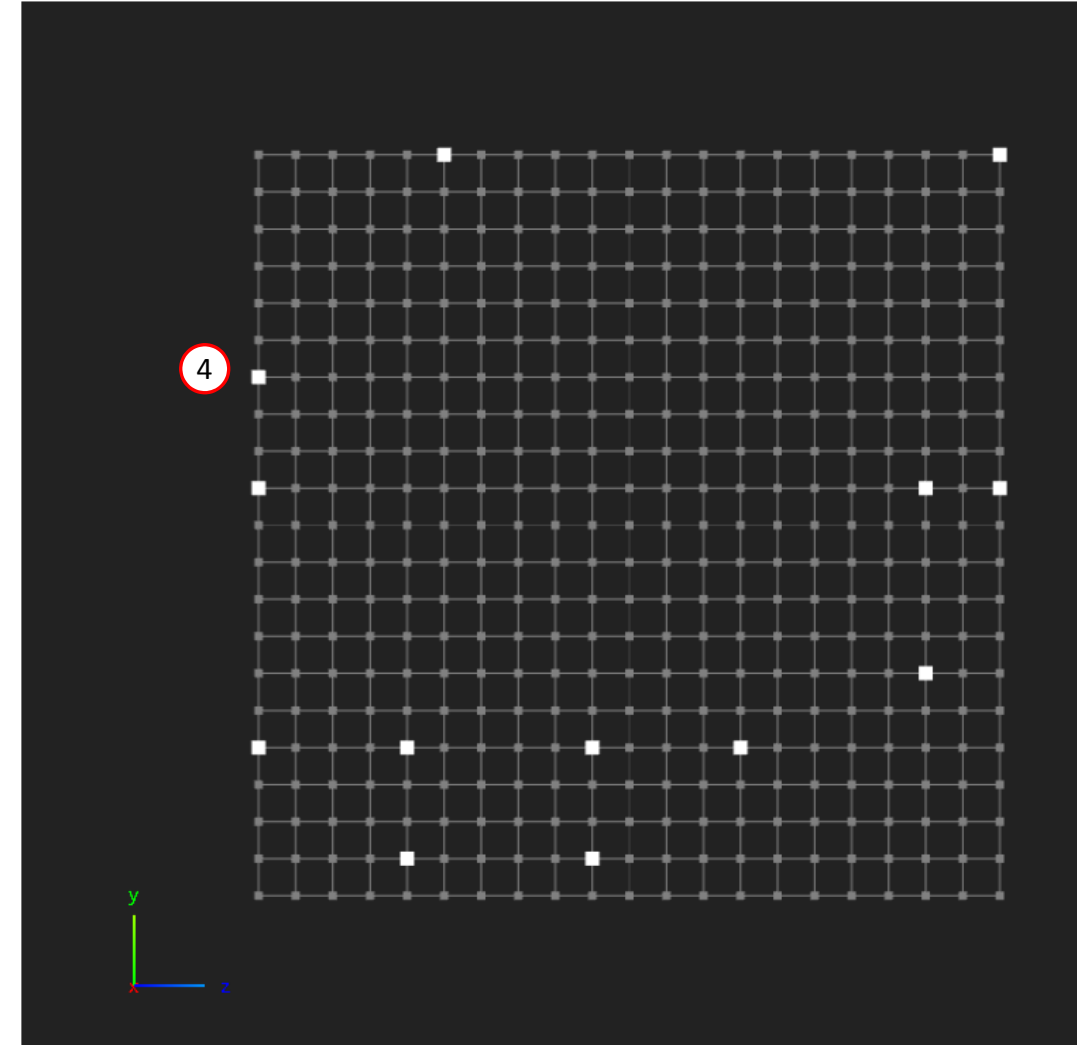
☐ Demo 2

☐ Demo 3

☐ Demo 4

☐ Demo 5

Editing PBMSECT 1



Lines

1. Click Create Lines
2. Click on 2 points at a time to create the 3 indicated lines
3. Repeat the process to create 15 lines in total

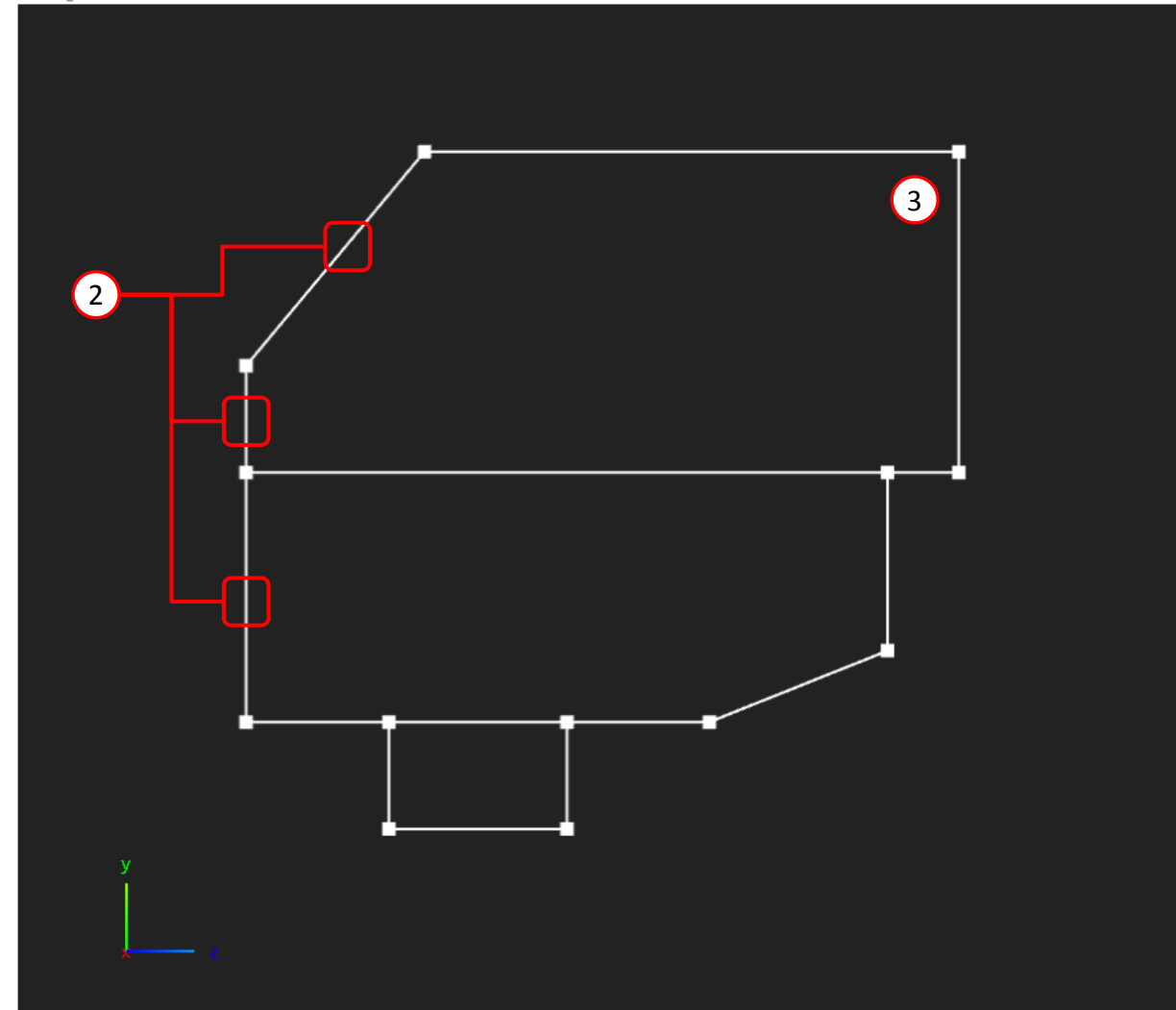
Lines

Actions

1

— Create Lines
✕ Remove Lines
☞ Select Lines of Outer Perimeter
☞ Deselect Lines of Outer Perimeter

Editing PBMSECT 1



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 3 indicated lines to select the lines as part of the Outer Perimeter. Successful selection is indicated by a blue color.
3. Repeat the process by selecting the other 8 lines as indicated.
4. In most cases, the outer perimeter should connect all critical points (orange points)

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

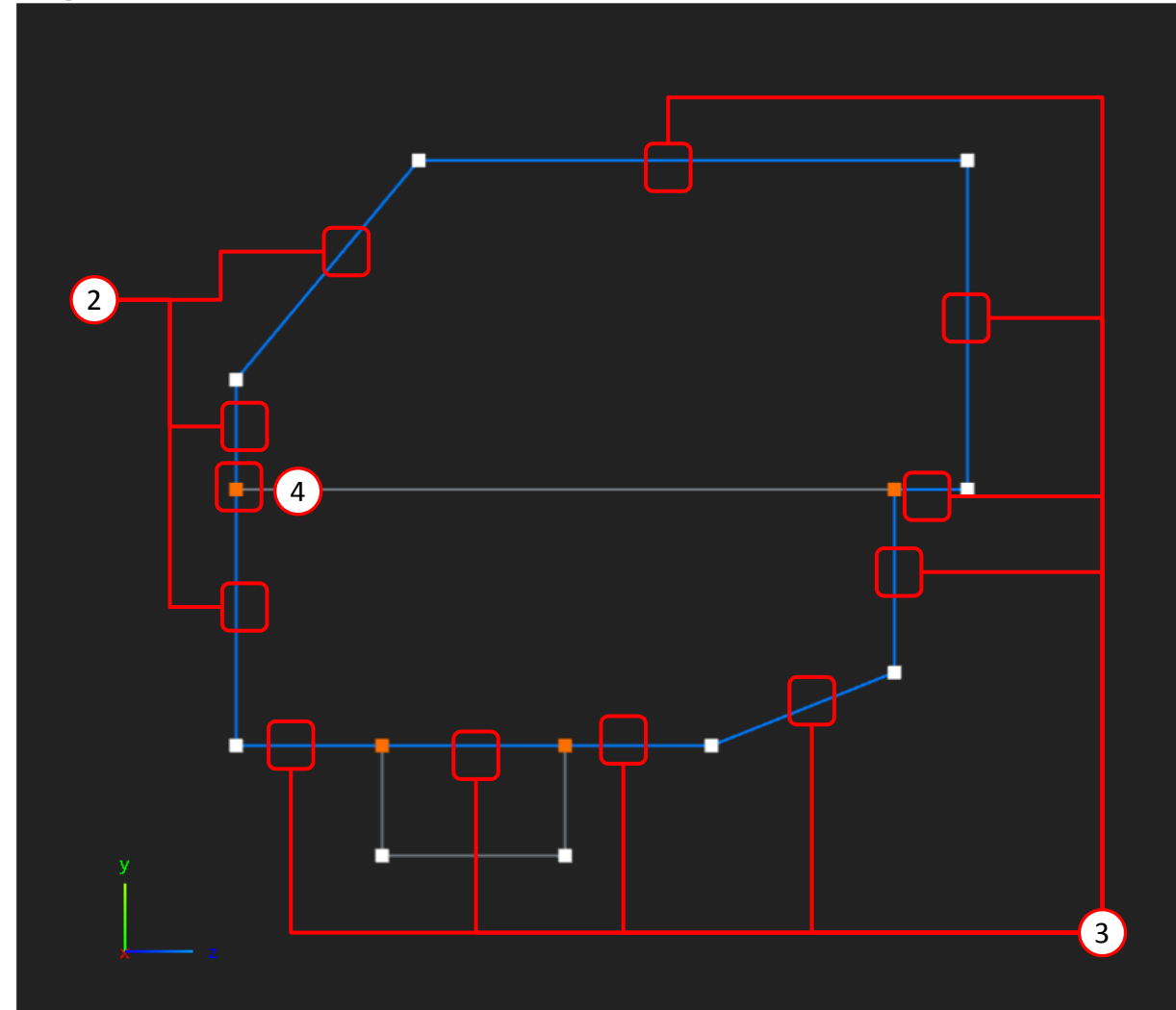
Select Lines of Outer Perimeter

⌵ Deselect Lines of Outer Perimeter

Legend

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

Editing PBMSECT 1



Cross Section Preview

1. Click Cross Section Preview
2. A preview of the arbitrary beam cross section is displayed
3. Set the Default Thickness to .010
4. Set the Thickness of lines 1, 2 and 3 to .0101
5. Refer to the section Corresponding Bulk Data Entries
6. In the PBMSECT entry, a new T keyword has been created which corresponds to the 3 line segments. Later in this tutorial, the Default Thickness (keyword T=) and the thickness of the 3 line segments (T(1)=) will be set as design variables for the optimization.

Lines

Actions

- Create Lines
- ✕ Remove Lines
- Select Lines of Outer Perimeter
- Deselect Lines of Outer Perimeter

Status:

Legend

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

Adjustments

Default Thickness

.010 3

Line Segments

Line ID	Type	Thick
1	OUTP	.0101 4
2	OUTP	.0101
3	OUTP	.0101
4	OUTP	
5	OUTP	
6	OUTP	
7	OUTP	
8	OUTP	
9	OUTP	
10	OUTP	

Controls

Tools

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

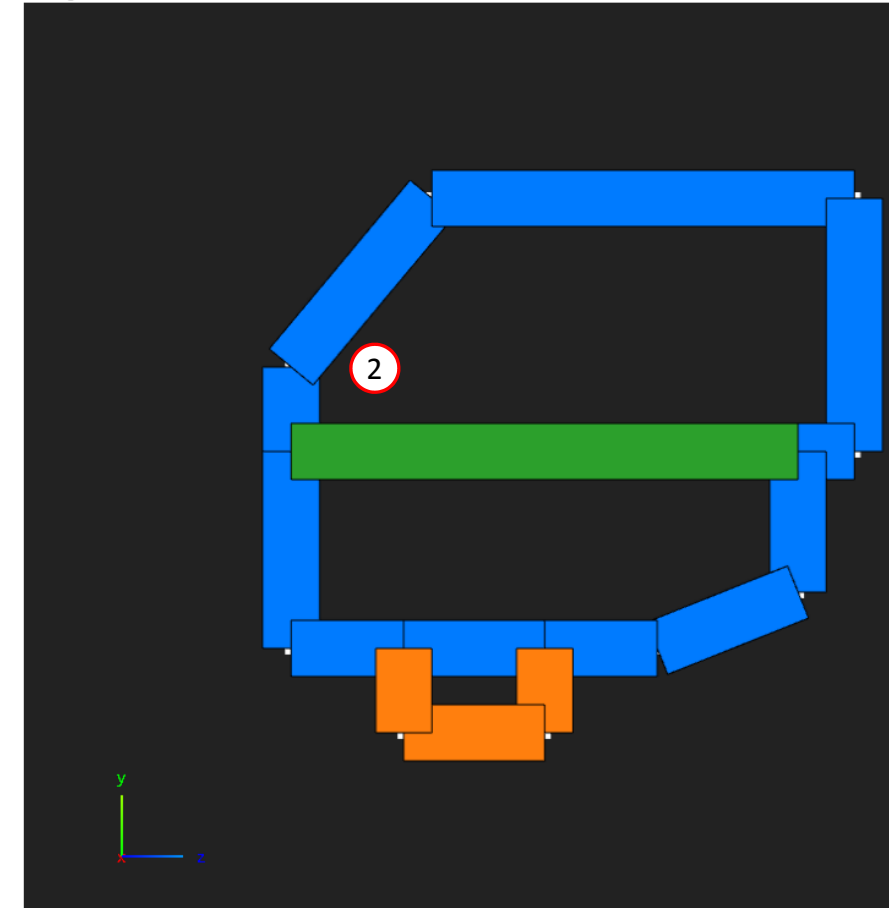
Display

- Labels
- Cross Section Preview 1
- Cross Section Actual
- Size Controls

Demos

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

Editing PBMSECT 1



Corresponding Bulk Data Entries 5

```

$ 1 || 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10 |
PBMSECT 1      1      CP
          OUTP=201, BRP=202, BRP=203, T=.010, T(1)= [ .0101, PT=(2000012, 2000007)
          ]
  
```

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

Run MSC Nastran

2

Complete

Corresponding Bulk Data Entries

```
$ 1 || 2 || 3 || 4 || 5 || 6 || 7 || 8 || 9 || 10 |
```

```
PBMSECT 1      1      CP
      OUTP=201,BRP=202,BRP=203,T=.010,T(1)=[.0101,PT=(2000012,2000007)
      ]
POINT  2000007      -0.025000.050000
POINT  2000008      0.050000.050000
POINT  2000012      -0.050000-0.029999
POINT  2000013      -0.029999-0.029999
POINT  2000014      -0.004999-0.029999
POINT  2000015      0.014999-0.029999
POINT  2000016      -0.029999-0.045000
POINT  2000017      -0.004999-0.045000
POINT  2000018      -0.050000.019999
POINT  2000019      -0.050000.004999
POINT  2000020      0.039999.004999
POINT  2000021      0.050000.004999
POINT  2000022      0.039999-0.019999
SET1    201      2000012 2000019 2000018 2000007 2000008 2000021 2000020
2000022 2000015 2000014 2000013
SET1    202      2000013 2000016 2000017 2000014
SET1    203      2000020 2000019
```

1

F06

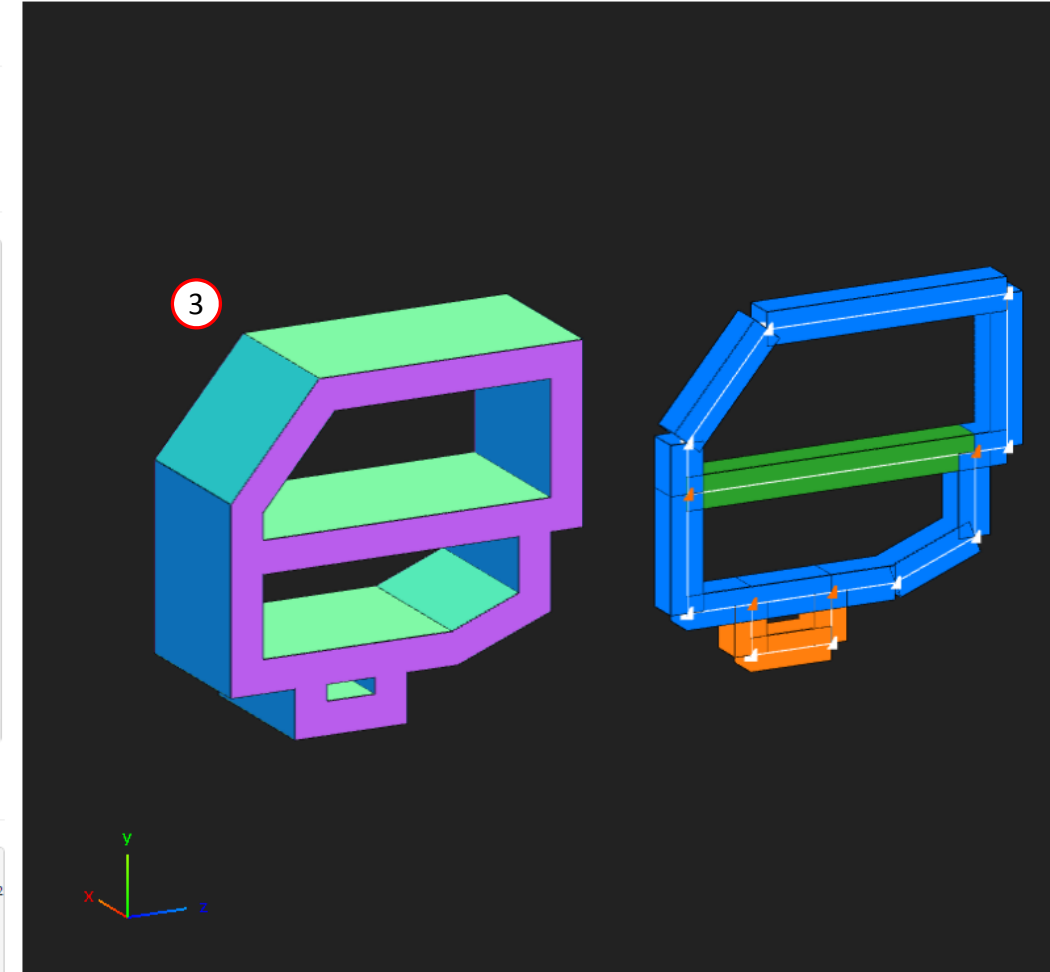
```
Command executed: /msc/MSC_Nastran/2022.1/bin/msc20221 nastran ./tmp/854e82ee40045005a441ff1e2

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 1



Inspect F06 Output

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 PBEAM EN
      CONVERSION METHOD FOR PBARL/PBEAML FINITE ELEMENT METHOD.
PBEAM      1      1  4.6182E-03  4.5635E-06  5.3515E-06  1.1963E-06  7.2492E-06
      4.9952E-02  6.0074E-02 -5.5048E-02 -2.9916E-02 -5.0487E-03  6.0074E-02 -2.8423E-02
      3.1567E-01  6.2217E-01  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.1989E-10
      0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00 -1.1396E-03  3.0214E-03 -1.1396E-03
1  CONFIRMATION TEST OF PBMSECT/PBRSECT ENTRY                                     JUNE  6, 2022

```

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)	

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 [41] in file beam_a.bdf.

Entry	PID
PBMSECT	1

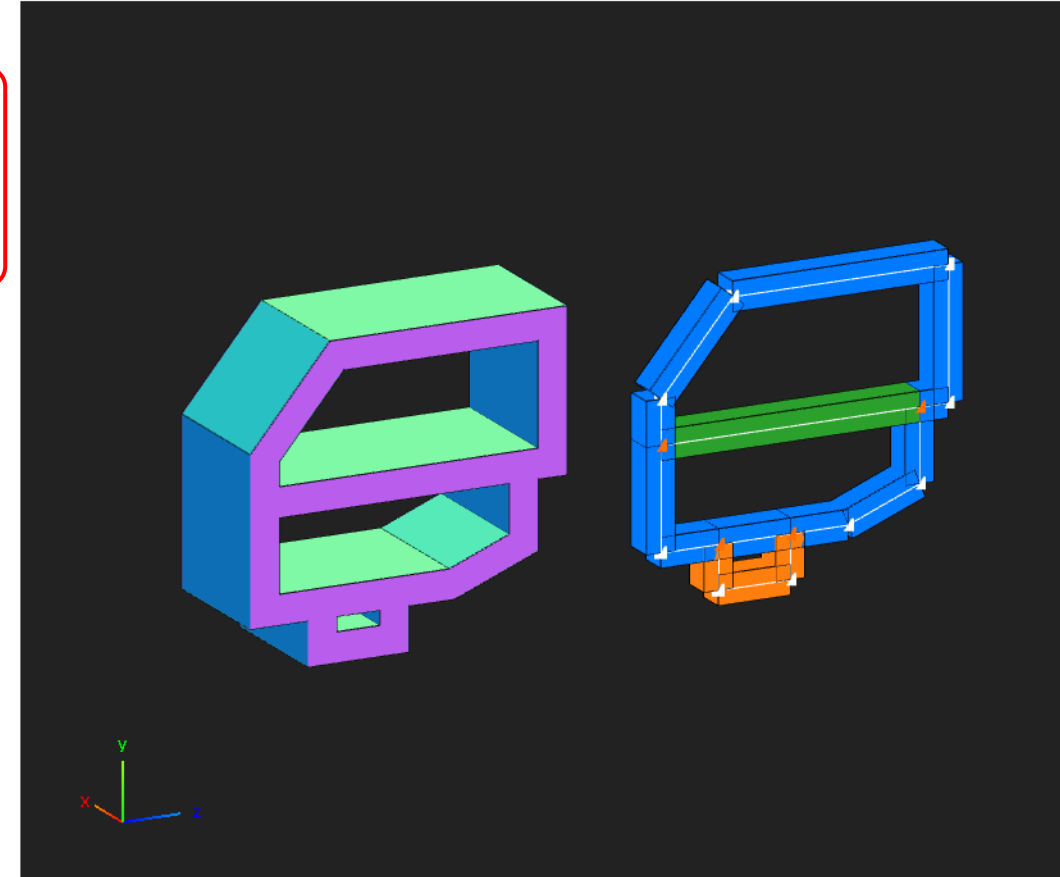
Download

1

Download BDF Files

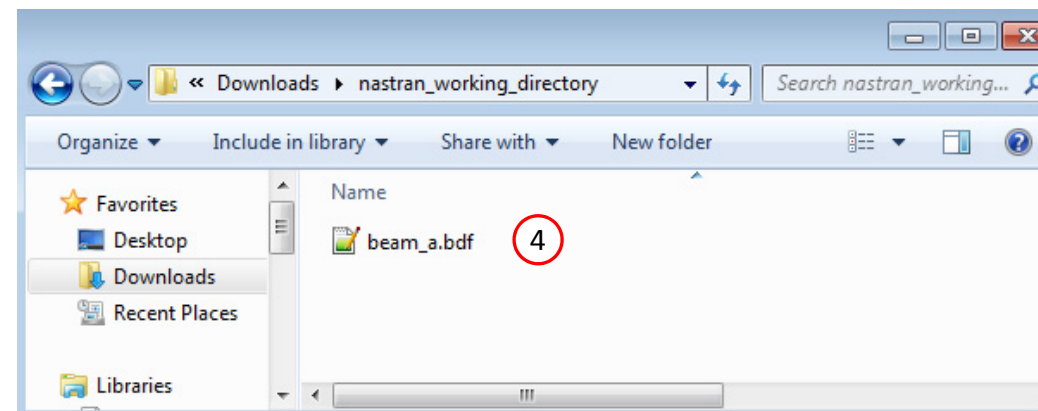
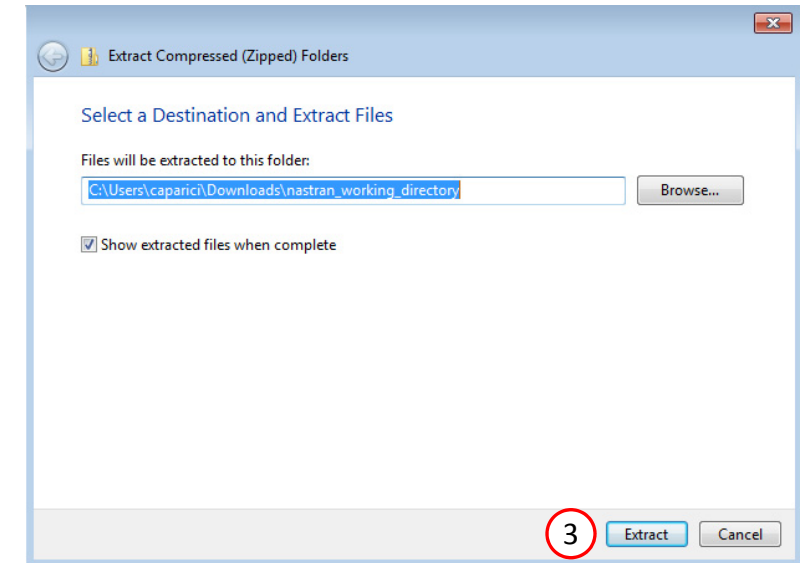
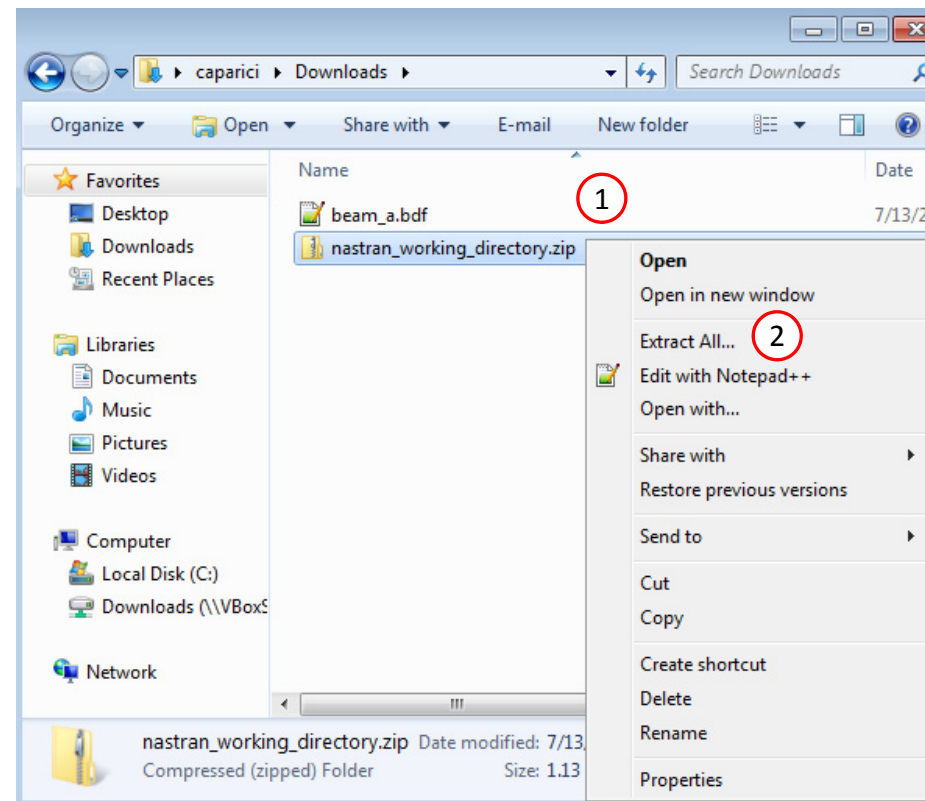
3

Editing PBMSECT 5



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 `beam_a.bdf` file



Compare the Original and New BDF Files

1. Open file Downloads/beam_a.bdf and nastran_working_directory/beam_a.bdf in a text editor
2. The entries PBMSECT, POINT and SET1 that define the ABCS have been inserted into the BDF file
3. Renumber PBEAML 1 to PBEAM 99 so that the PBEAML entry does not conflict with PBMSECT 1
4. Click save to save the edits to the BDF file

The image shows two Notepad++ windows side-by-side, comparing two BDF files. The left window is titled 'C:\Users\aparcic\Downloads\nastran_working_directory\model.bdf - Notepad++' and the right window is titled 'C:\Users\aparcic\Downloads\nastran_working_directory\model.bdf - Notepad++'. Both windows show the same text content, but the right window has a red box around the new entries (PBMSECT, POINT, SET1) and a red circle around the renumbered PBEAML entry (99). The text in the windows is as follows:

```

41 BEGIN BULK
42 $ Direct Text Input for Bulk Data
43 MDLPRM HDF5 0
44 PARAM PRTMAXIM YES
45 $ Elements and Element Properties for region : Beam_Assignment_A
46 PBEAML 1 1 .1 .003 .003 T2
47
48 $ Pset: "Beam_Assignment_A" will be imported as:
49 CBEAM 1 1 2 0.
50 CBEAM 2 1 3 0.
51 CBEAM 3 1 4 0.
52 CBEAM 4 1 5 0.
53 CBEAM 5 1 6 0.
54 CBEAM 6 1 8 0.
55 CBEAM 7 1 9 0.
56 CBEAM 8 1 10 0.
57 CBEAM 9 1 11 0.
58 CBEAM 10 1 12 0.
59 CBEAM 11 1 14 0.
60 CBEAM 12 1 15 0.
61 CBEAM 13 1 16 0.
62 CBEAM 14 1 17 0.
63 CBEAM 15 1 18 0.
64 $ Referenced Material Records
65 $ Material Record : aluminum
66 $ Description of Material : Length: m

```

The right window shows the same text, but with additional entries highlighted by a red box:

```

41 BEGIN BULK
42 PBMSECT 1 1 CP
43 OUTP=201, BRP=202, BRP=203, T=.010, T(1)=[.0101, PT=(2000012, 2000007)]
44 ]
45 POINT 2000007 -0.025000 .050000
46 POINT 2000008 0.050000 .050000
47 POINT 2000012 -0.050000 -0.029999
48 POINT 2000013 -0.029999 -0.029999
49 POINT 2000014 -0.004999 -0.029999
50 POINT 2000015 0.014999 -0.029999
51 POINT 2000016 -0.029999 -0.045000
52 POINT 2000017 -0.004999 -0.045000
53 POINT 2000018 -0.050000 .019999
54 POINT 2000019 -0.050000 .004999
55 POINT 2000020 0.039999 .004999
56 POINT 2000021 0.050000 .004999
57 POINT 2000022 0.039999 -0.019999
58 SET1 201 2000012 2000019 2000018 2000007 2000008 2000021 2000020
59 2000022 2000015 2000014 2000013
60 SET1 202 2000013 2000016 2000017 2000014
61 SET1 203 2000020 2000019
62 $ Direct Text Input for Bulk Data
63 MDLPRM HDF5 0
64 PARAM PRTMAXIM YES
65 $ Elements and Element Properties for region : Beam_Assignment_A
66 PBEAML 99 .1 .1 .003 .003 T2
67
68 $ Pset: "Beam_Assignment_A" will be imported as:
69 CBEAM 1 1 2 0.
70 CBEAM 2 1 3 0.
71 CBEAM 3 1 4 0.
72 CBEAM 4 1 5 0.
73 CBEAM 5 1 6 0.
74 CBEAM 6 1 8 0.
75 CBEAM 7 1 9 0.
76 CBEAM 8 1 10 0.
77 CBEAM 9 1 11 0.
78 CBEAM 10 1 12 0.
79 CBEAM 11 1 14 0.
80 CBEAM 12 1 15 0.
81 CBEAM 13 1 16 0.
82 CBEAM 14 1 17 0.
83 CBEAM 15 1 18 0.
84 $ Referenced Material Records
85 $ Material Record : aluminum
86 $ Description of Material : Length: m

```

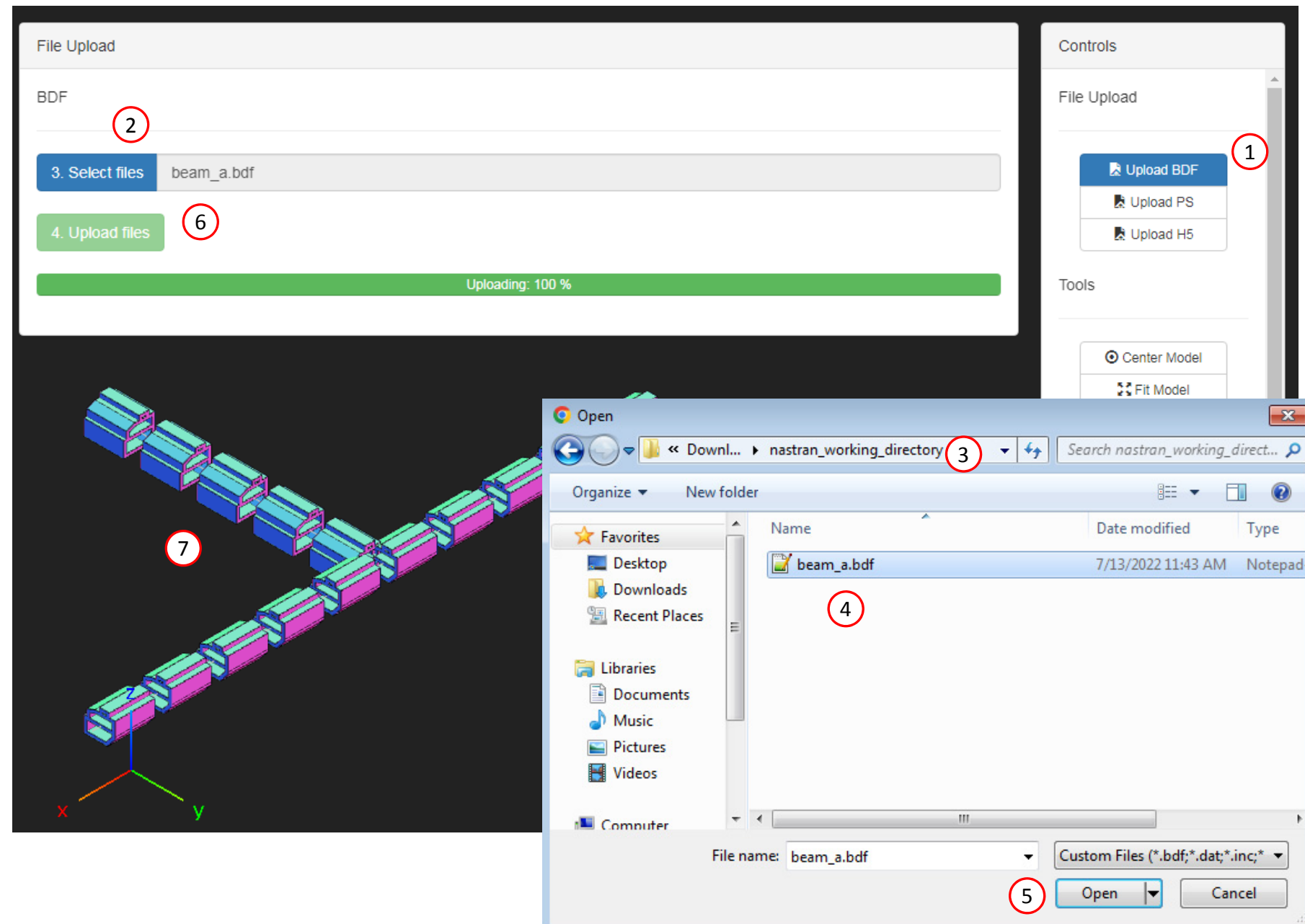
Downloads/beam_a.bdf

nastran_working_directory/beam_a.bdf

View the Model in the Beams Viewer

Open the Beams 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 beam_a.bdf
5. Click Open
6. Click Upload files
7. The MSC Nastran model has been uploaded to the Beams Viewer
 1. Notice the cross section is now the ABCS that was defined in the PBMSECT web app



Part C – Using MSC Nastran SOL 200 To Optimize the ABCS

Optimization Problem Statement

Design Variables

x1: Width of arbitrary cross section (ABCS)

x2: Height of ABCS

x3: Thickness of segments 4-15

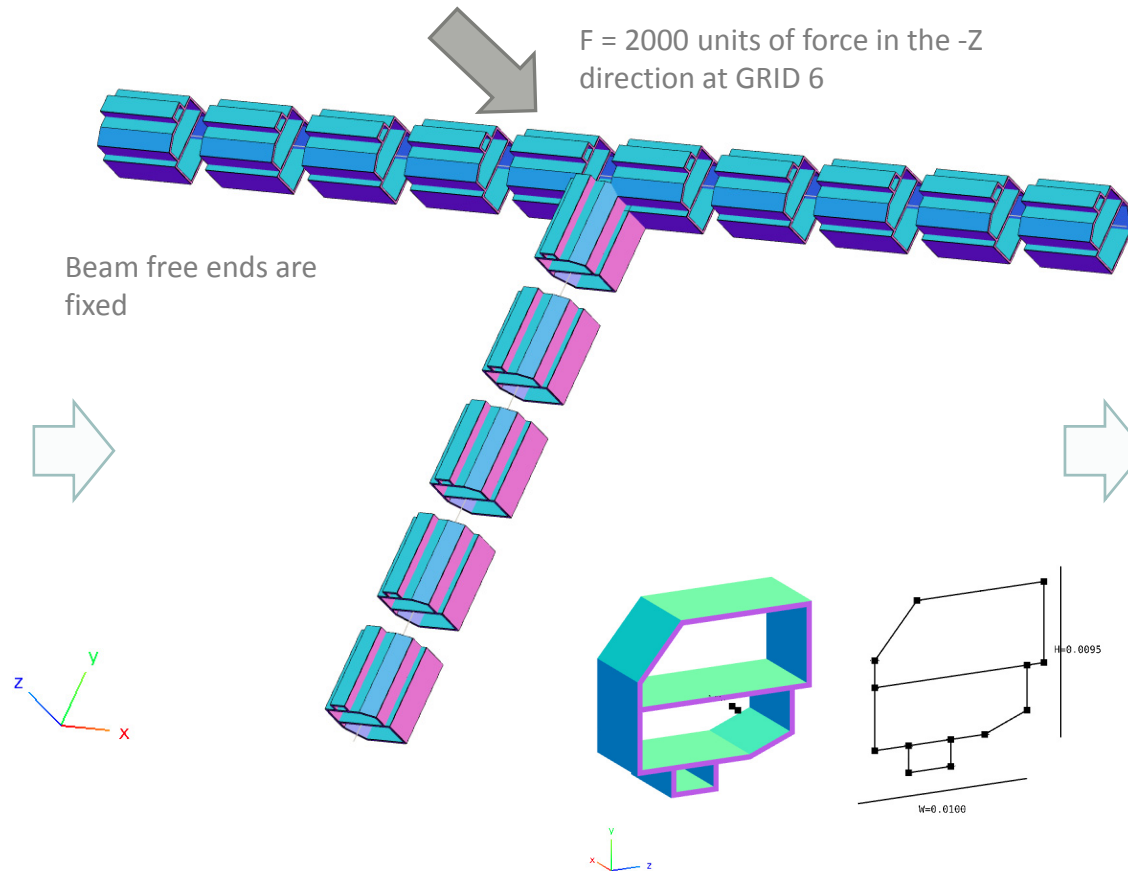
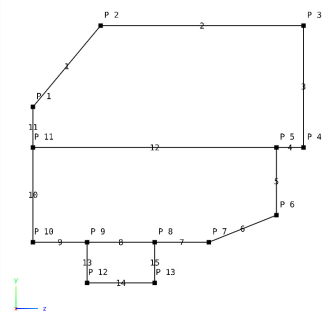
x4: Thickness of segments 1, 2 and 3

$$.08 < x1 < .2$$

$$.05 < x2 < .2$$

$$.002 < x3 < .02$$

$$.003 < x4 < .02$$



Design Objective

r0: Minimize weight

Design Constraints

r1: The displacement, z component, at GRID 6

$$-.01 < r1 < .01$$

Open the Correct Page

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

- MSC Nastran can perform many optimization types. The SOL 200 Web App includes dedicated web apps for the following:
 - Optimization for SOL 200 (Size, Topology, Topometry, Topography, Local Optimization, Sensitivity Analysis and Global Optimization)
 - Multi Model Optimization
 - Machine Learning
- The web app also features the HDF5 Explorer, a web application to extract results from the H5 file type.

The screenshot shows the SOL 200 Web App interface. At the top, a red circle with the number '1' points to the title 'SOL 200 Web App'. 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' structural models), 'Multi Model Optimization' (showing a model and a graph), 'Machine Learning | Parameter Study' (showing four mesh deformation images), 'HDF5 Explorer' (showing a line graph), and 'Remote Execution' (showing a flow between 'Remote System' and 'Local System' with 'Input Files' and 'Results Files'). Below these tiles are links for 'Tutorials and User's Guide' and 'Full list of web apps'. A red circle with the number '2' points to the 'Optimization for SOL 200' tile.

Upload BDF Files

1. Click 1. Select Files and select nastran_working_directory/beam_a.bdf
2. Click Upload Files

- The process starts by uploading all the necessary BDF files. The BDF files can be files of your own or files found in the Tutorials section of the User's Guide.

Step 1 - Upload .BDF Files

The screenshot shows a web interface for uploading BDF files. It consists of two main steps, each with a progress bar.

Step 1: Select files (indicated by a red circle with the number 1). The progress bar is labeled "1. Select files" and "beam_a.bdf". Below it, a green progress bar shows "Inspecting: 100%".

Step 2: Upload files (indicated by a red circle with the number 2). The progress bar is labeled "2. Upload files". Below it, a green progress bar shows "Uploading: 100 %".

At the bottom, there is a checkbox labeled "List of Selected Files" which is currently unchecked.

Create Design Variables

1. Click the 4 plus icons to create 4 design variables for the width, height, overall thickness and thickness of line segment 1 of the ABCS
2. Configure the bounds for the variables as using the values in the table below

Variable	Lower Bound	Upper Bound
x1	.08	.2
x2	.05	.2
x3	.002	.02
x4	.003	.02

Step 1 - Select design properties

+ Options

Create DVXREL1	Property	Property Description	Entry	Entry ID	Current Value
	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>
<div>1</div> <div>+</div>	W	Overall width	PBMSECT	1	.1
<div>+</div>	H	Overall height	PBMSECT	1	.095
<div>+</div>	T	Overall thickness	PBMSECT	1	.010
<div>+</div>	T(1)	Thickness of segment	PBMSECT	1	.0101
<div>+</div>	DIM1(A)	T2 - Width of flange	PBEAML	99	.1

« 1 2 3 4 5 6 7 ... 12 »

5 10 20 30 40 50

Number of Visible Rows 5

Step 2 - Adjust design variables

✕ Delete Visible Rows

+ Options

	Label	Status	Property	Property Description	Entry	Entry ID	Initial Value	Lower Bound	Upper Bound	Allowed Discrete Values
	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>
<div>✕</div>	x1	<div>✓</div>	W	Overall width	PBMSECT	1	1.000E-1	<input type="text" value=".08"/>	<input type="text" value=".2"/>	Examples: -2.0, 1.0, THRU, 10.0,
<div>✕</div>	x2	<div>✓</div>	H	Overall height	PBMSECT	1	9.500E-2	<input type="text" value=".05"/>	<input type="text" value=".2"/>	Examples: -2.0, 1.0, THRU, 10.0,
<div>✕</div>	x3	<div>✓</div>	T	Overall thickness	PBMSECT	1	.010	<input type="text" value=".002"/>	<input type="text" value=".02"/>	Examples: -2.0, 1.0, THRU, 10.0,
<div>✕</div>	x4	<div>✓</div>	T(1)	Thickness of segment	PBMSECT	1	.0101	<input type="text" value=".003"/>	<input type="text" value=".02"/>	Examples: -2.0, 1.0, THRU, 10.0,

Create Design Objective

1. Click Objective
2. Select the plus (+) icon for weight
3. The objective has been set to minimize the weight, no further modification is necessary

- The objective must always be a single and global response. A response such as weight and volume are single responses, are independent of load case, and can be used as an objective. Other responses require special care when set as an objective. For example, if the objective is stress, only the stress of a single component, e.g. von Mises, of a single element, of a single load case may be used.

Step 1 - Select an objective

Select an analysis type

SOL 101 - Statics

Select a response

	Response Description ▾	Response Type ▾
	<input type="text" value="Search"/>	<input type="text" value="Search"/>
2 +	Weight	WEIGHT
+	Volume	VOLUME
+	Displacement	DISP
+	Strain	STRAIN
+	Element Strain Energy	ESE

« 1 2 3 4 5 »

5 10 20 30 40 50

Step 2 - Adjust objective

+ Options

	Label	Status	Response Type	Maximize or Minimize	Property Type	ATTA	ATTB	ATTI
✖	r0	⬇	WEIGHT	MIN ▾	3	3 ▾	3 ▾	

Create Design Constraints

1. Click Constraints
2. Click the plus(+) icon for Displacement to create 1 displacement constraint
3. Configure the constraints as shown to the right
 - Configure the following for r1
 - ATTA: 3 – T3
 - ATTi: 6 (GRID 6)
 - Lower Allowed Limit: -.01
 - Upper Allowed Limit: .01

1

Step 1 - Select constraints

Select an analysis type

SOL 101 - Statics

Select a response

	Response Description ▾	Response Type ▾
	<input type="text" value="Search"/>	<input type="text" value="Search"/>
	Weight	WEIGHT
	Volume	VOLUME
	Displacement	DISP
	Strain	STRAIN
	Element Strain Energy	ESE

« 1 2 3 4 5 »

5 10 20 30 40 50

Step 2 - Adjust constraints

+ Options

	Label ▾	Status ▾	Response Type ▾	Property Type ▾	ATTA ▾	ATTB ▾	ATTi ▾	Lower Allowed Limit	Upper Allowed Limit
	<input type="text" value="St"/>	<input type="text" value="Seal"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>
	r1		DISP		3 - T3 (Rectangular z, Cylindrical z ▾)		6	-.01	.01

3

Assign Constraints to Load Cases (SUBCASES)

1. Click Subcases
2. Click Check visible boxes
3. Unmark the indicated checkboxes

- The following constraints have been applied to SUBCASE 1, 3 and 5: r1
- When hundreds of SUBCASEs must be configured, the following options expedite the process:

Uncheck visible boxes

Check visible boxes

1

Step 1 - Assign constraints to subcases

Display Columns

Global Constraints
SUBCASE 1
SUBCASE 2
SUBCASE 3
SUBCASE 4
SUBCASE 5

2

☐ Uncheck visible boxes

☒ Check visible boxes

+ Options

	Status	Label	Response Type	Description
		<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>
		r1	DISP	T3 component(s) of displacement at grid 6

Global Constraints	SUBCASE 1	SUBCASE 2	SUBCASE 3	SUBCASE 4	SUBCASE 5
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

3

1. Click on Exporter
2. Click on Download BDF Files

- When the download button is clicked a new file named “nastran_working_directory” is downloaded. If the file already exists in your local folder, the folder name is appended with a number, e.g. “nastran_working_directory (1).zip”

SOL 200 Web App - Optimization

BDF Output - Model

```
assign userfile = 'optimization_results.csv', status = unknown,
form = formatted, unit = 52
$ MSC.Nastran input file created on June      02, 2022 at 08:03:30 by
$ Patran 2020
$ Direct Text Input for Nastran System Cell Section
$ Direct Text Input for File Management Section
$ Direct Text Input for Executive Control
$ Linear Static Analysis, Database
SOL 200
CEND

$ Direct Text Input for Global Case Control Data
TITLE = MSC.Nastran Job created on 02-Jun-22 at 07:31:29
ECHO = NONE
DISPLACEMENT(SORT1,REAL)=ALL
SPCFORCES(SORT1,REAL)=ALL
STRESS(SORT1,REAL,VONMISES,BILIN)=ALL
FORCE=ALL
DESOR3(INV) = 8000000
$ DESGL Slot
$ DSAOPT(FORMATTED, EXPORT, END=5ENS) = ALL
SUBCASE 1
ANALYSIS = STATICS
DESSUB = 40000001
$ DRSPAN Slot
$ Subcase name : Load Case 1
SUBTITLE=Load Case 1
SPC = 2
LOAD = 2
```

Download BDF Files

 Download BDF Files

2

BDF Output - Design Model

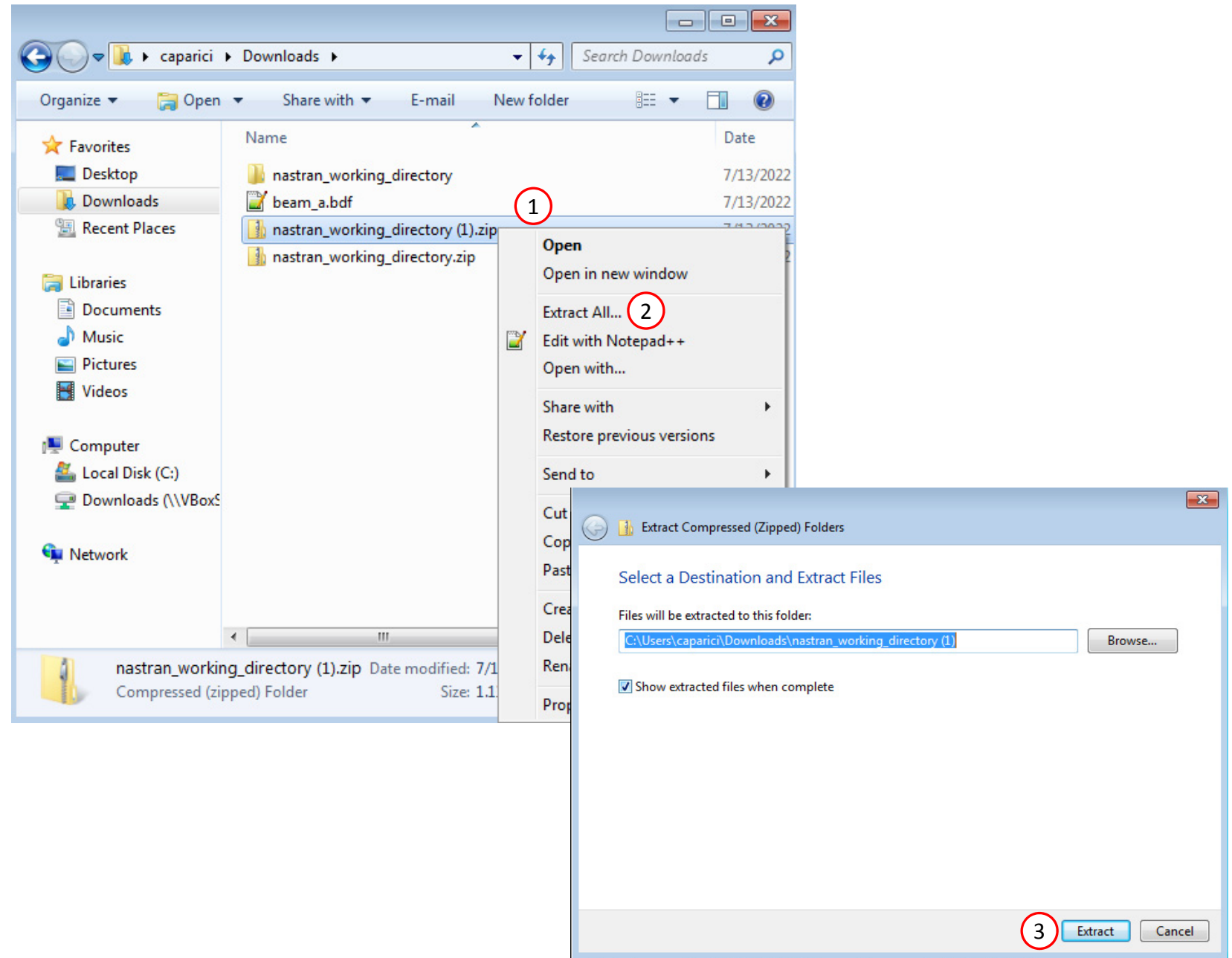
```
$*****  
$*                                     *  
$*                               Design Model                                *  
$*                                     *  
$*****  
$  
$                               Design Variables - Type 1                         
$-----  
$  
$  
$  
DVPREL1 1000001 PBHSECT 1           W  
      100001 1.0  
DVPREL1 1000002 PBHSECT 1           H  
      100002 1.0  
DVPREL1 1000003 PBHSECT 1           T  
      100003 1.0  
DVPREL1 1000004 PBHSECT 1           T(1)  
      100004 1.0  
  
$  
DESVAR 100001 X1          1.000E-1.00 .2  
DESVAR 100002 X2          9.500E-2.05 .2  
DESVAR 100003 X3          .010 .002 .02  
DESVAR 100004 X4          .0101 .003 .02  
  
$  
$  
  
$  
$  
  
$                               Design Variables - Type 2                         
$-----  
$  
$  
  
$  
$  
  
$  
$  
  
$                               Design Objective                               
$-----  
$
```

Developed by The Engineering Lab

Perform the Optimization with Nastran SOL 200

1. A new file nastran_working_directory (1).zip has been downloaded
2. Right click on the file
3. Click Extract All
4. Click Extract on the following window

- Always extract the contents of the ZIP file to a new, empty folder.



Perform the Optimization with Nastran SOL 200

1. Inside of the new folder, double click on Start MSC Nastran
2. Click Open, Run or Allow Access on any subsequent windows
3. MSC Nastran will now start

- After a successful optimization, the results will be automatically displayed as long as the following files are present: BDF, F06 and LOG.
- One can run the Nastran job on a remote machine as follows:
 - 1) Copy the BDF files and the INCLUDE files to a remote machine.
 - 2) Run the MSC Nastran job on the remote machine.
 - 3) After completion, copy the BDF, F06, LOG, H5 files to the local machine.
 - 4) Click "Start MSC Nastran" to display the results.

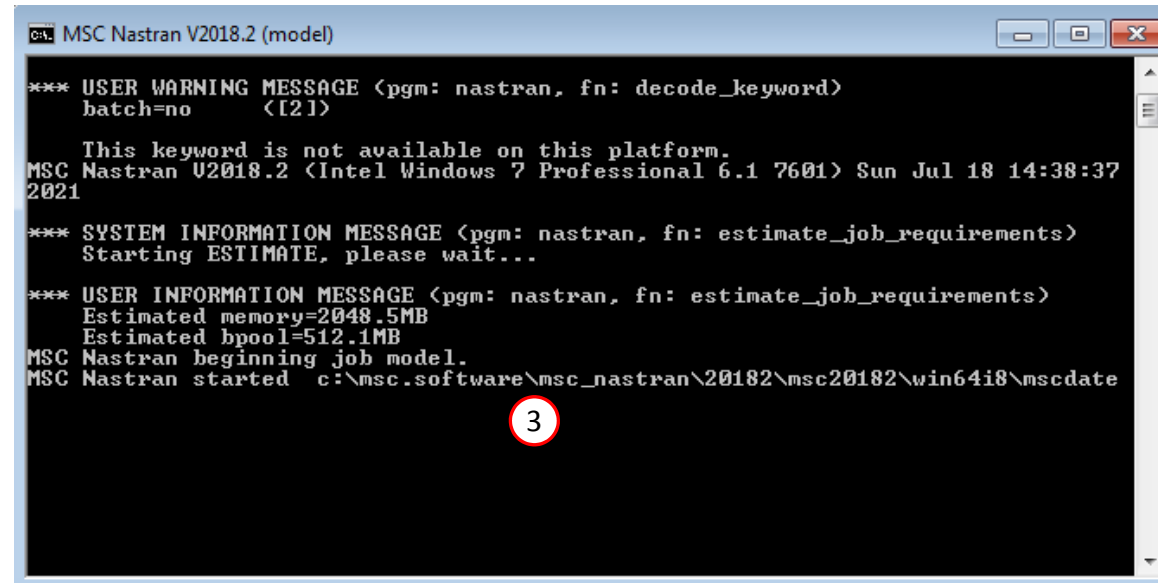
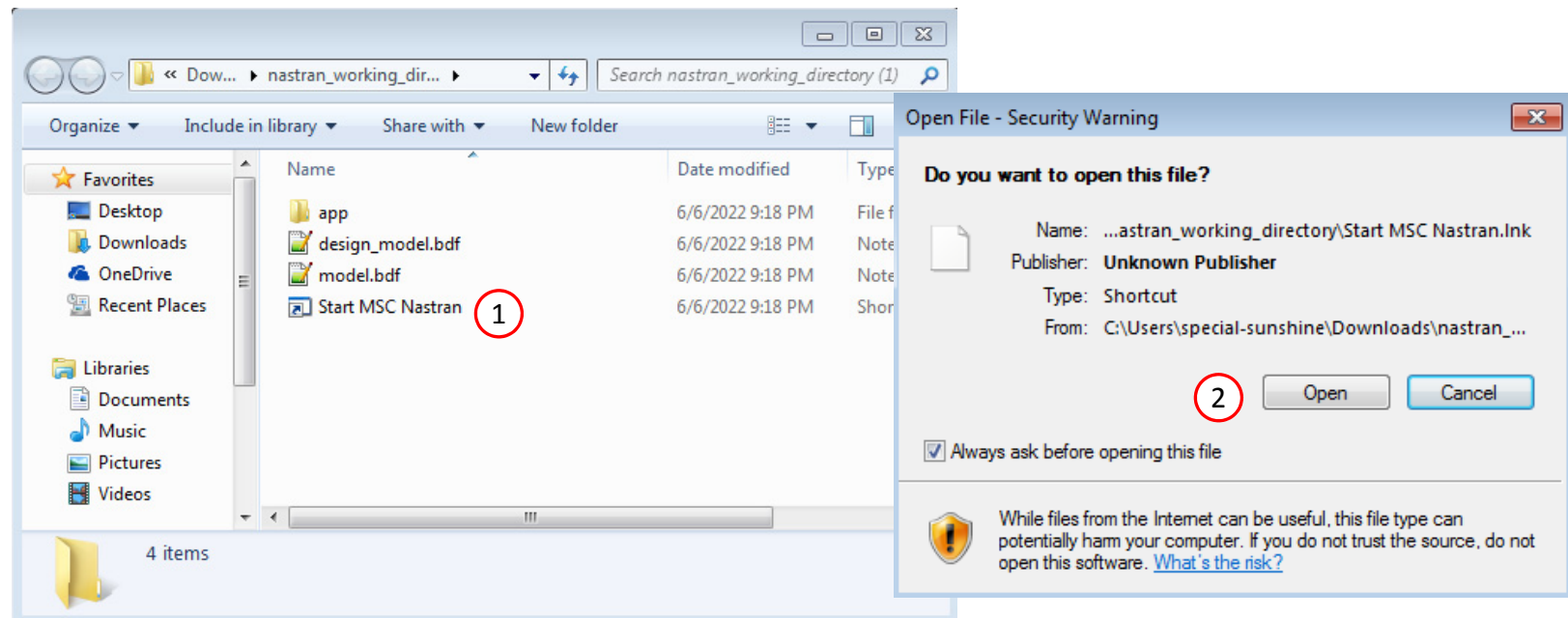
Using Linux?

Follow these instructions:

- 1) Open Terminal
- 2) Navigate to the nastran_working_directory
`cd ./nastran_working_directory`
- 3) Use this command to start the process
`./Start_MSC_Nastran.sh`

In some instances, execute permission must be granted to the directory. Use this command. This command assumes you are one folder level up.

```
sudo chmod -R u+x ./nastran_working_directory
```



Status

1. While MSC Nastran is running, a status page will show the current state of MSC Nastran

- The status of the MSC Nastran job is reported on the Status page. Note that Windows 7 users will experience a delay in the status updates. All other users of Windows 10 and Red Hat Linux will see immediate status updates.

SOL 200 Web App - Status

 Python  MSC Nastran

Status

Name	Status of Job	Design Cycle	RUN TERMINATED DUE TO
model.bdf	Running	None	


Review Optimization Results

1. After MSC Nastran is finished, the results will be automatically uploaded.
2. Ensure the messages shown have green checkmarks. This is indication of success. Any red icons indicate challenges.
3. The final value of objective, normalized constraints (not shown) and design variables can be reviewed.

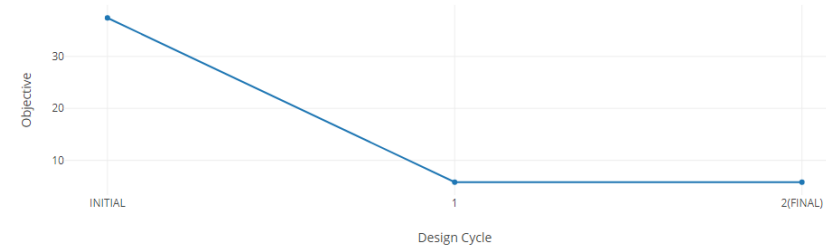
- After an optimization, the results will be automatically displayed as long as the following files are present: BDF, F06 and LOG.
- For this optimization, each variable has been reduced. On close inspection, each variable has been reduced to its lower bound.

Final Message in .f06

1

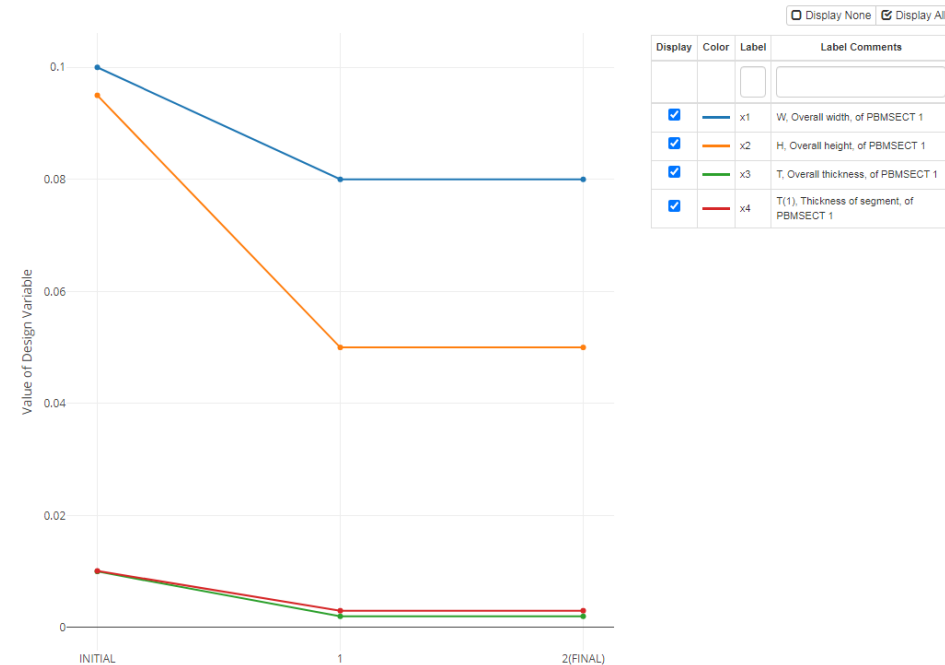
 RUN TERMINATED DUE TO HARD CONVERGENCE TO AN OPTIMUM AT CYCLE NUMBER = 2.

Objective



Design Variables

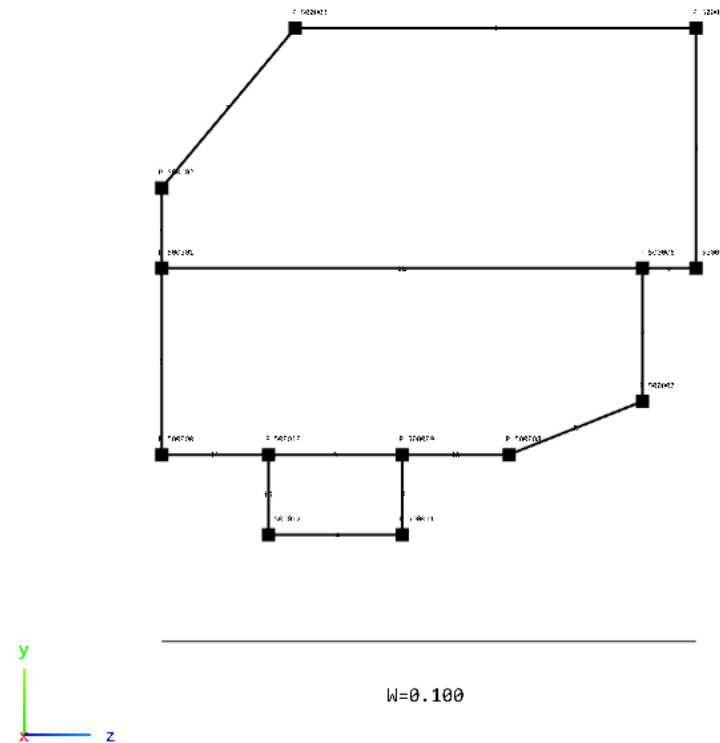
2



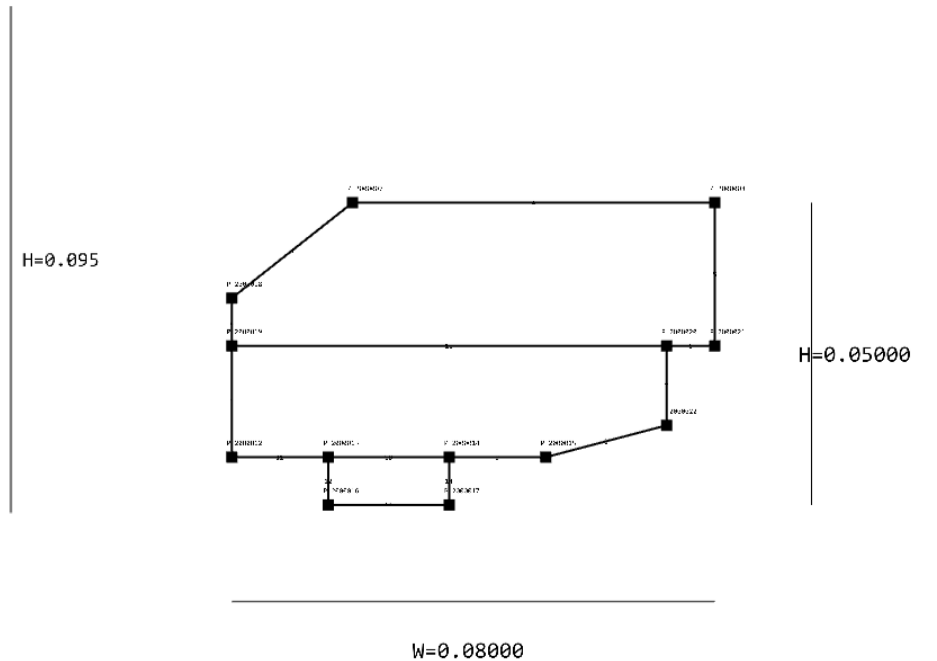
Comparison of Original and New Arbitrary Beam Cross Section

This slide show a comparison of the original and new cross section after optimization

Before Optimization

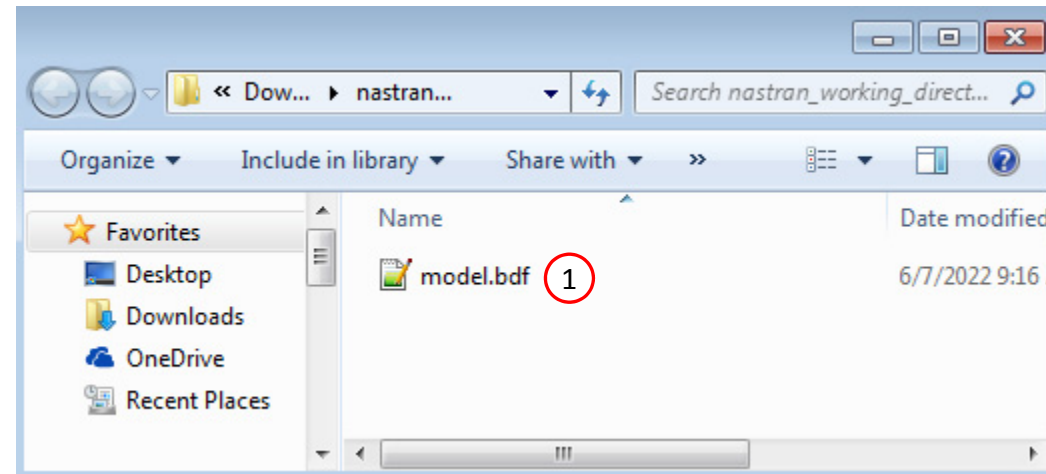
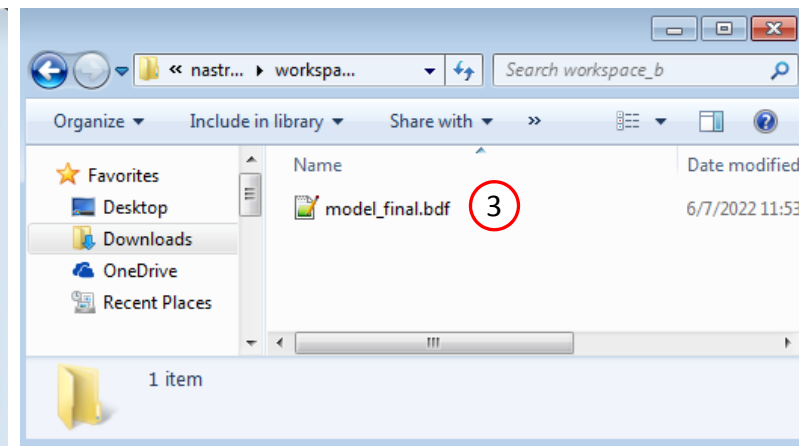
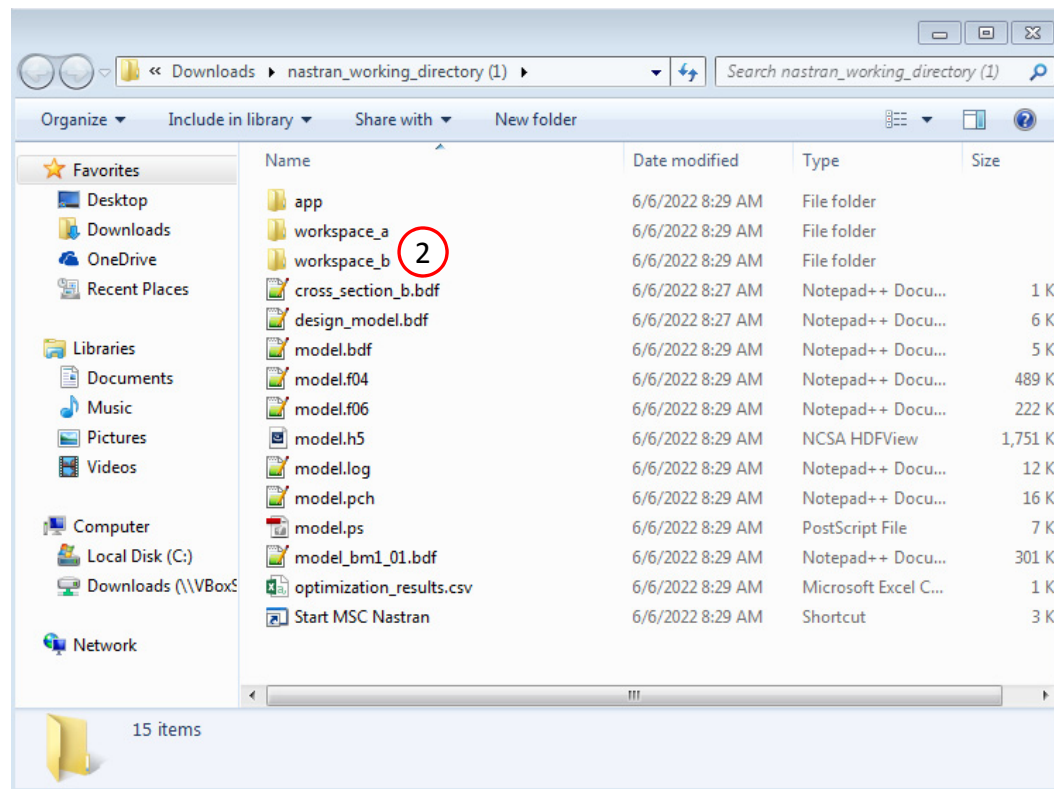


After Optimization



Comparison of the Original and New PBMSECT Entries

1. Open the following file in a text editor:
nastran_working_directory/beam_a.bdf
2. Open the directory named
workspace_b
3. Open the following file in a text editor:
nastran_working_directory
(1)/workspace_b/model_final.bdf



Comparison of the Original and New PBMSECT Entries

1. model_final.bdf contains updated POINT entries that describe the new ABCS

The image shows two side-by-side Notepad++ windows comparing the original 'model.bdf' file (left) with the updated 'model_final.bdf' file (right). Both files contain PBMSECT entries for a CP (Cylindrical Part) with a radius of 1.0. The original file (left) shows a set of POINT entries for a cylinder with a radius of 1.0, defined by a series of points (2000007 to 2000022) and a set of points (2000012 to 2000019). The updated file (right) shows the same set of POINT entries, but with updated coordinates for the points. A red box highlights the updated POINT entries in the right window, and a circled '1' is placed next to the first point (2000007) in the updated set.

Line	Original POINT	Updated POINT
45	POINT 2000007 -0.025000 0.050000	POINT 2000007 -0.03 0.005
46	POINT 2000008 0.050000 0.050000	POINT 2000008 0.03 0.005
47	POINT 2000012 -0.050000 -0.029999	POINT 2000012 -0.05 -0.0371
48	POINT 2000013 -0.029999 -0.029999	POINT 2000013 -0.033992 -0.0371
49	POINT 2000014 -0.004999 -0.029999	POINT 2000014 -0.013992 -0.0371
50	POINT 2000015 0.014999 -0.029999	POINT 2000015 0.001999 -0.0371
51	POINT 2000016 -0.029999 -0.045000	POINT 2000016 -0.033992 -0.045
52	POINT 2000017 -0.004999 -0.045000	POINT 2000017 -0.013992 -0.045
53	POINT 2000018 -0.050000 0.019999	POINT 2000018 -0.05 -0.01079
54	POINT 2000019 -0.050000 0.049999	POINT 2000019 -0.05 -0.018685
55	POINT 2000020 0.039999 0.049999	POINT 2000020 0.021999 -0.018685
56	POINT 2000021 0.050000 0.049999	POINT 2000021 0.03 -0.018685
57	POINT 2000022 0.039999 -0.019999	POINT 2000022 0.021999 -0.031837

Original BDF/DAT File

Updated BDF/DAT File

Part D – Inspecting the new ABCS in the PBMSECT Web App and Beams Viewer

PBMSECT Web App

1. Open the PBMSECT web app
2. Click Select files
3. Select nastran_working_directory (1)/workspace_b/model_final.bdf
4. Click Open
5. Click Upload files
6. Select PBMSECT 1 from the list of available entries

1 SOL 200 Web App - PBMSECT

Existing PBMSECT/PBRSECT Entries

Cross Sec

Select BDF Files

2 1. Select files

model_final.bdf

Inspecting: 100%

3 2. Upload files

Uploading: 100 %

☐ List of Selected Files

Existing PBMSECT/PBRSECT Entries

Select a PBMSECT/PBRSECT ID to edit

1 6

+ Create New Entry

✕ Delete Selected Entry

Open

nastran_working_dir... workspace_b

Search workspace_b

Organize New folder

Favorites

Desktop

Downloads

OneDrive

Recent Places

Libraries

Documents

Music

Pictures

Videos

Name

Date modified

Type

model_final.bdf 4 6/7/2022 11:53 AM Notepad+

File name: model_final.bdf

Custom Files (*.bdf;*.dat;*.inc;*)

5 Open

Cancel

View the New Cross Section

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

1. Click Run MSC Nastran
 1. The web app will run MSC Nastran in the background and will 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.
2. If the run is successful, the MSC Nastran generated cross section is displayed.
3. Click Labels
4. Click Fit Model

SOL 200 Web App - PBMSECT Existing PBMSECT/PBRSECT Entries Cross Section Options Points Lines Custom IDs Run MSC Nastran and Bulk Data Entries Download Home

Run MSC Nastran and Bulk Data Entries

Download Test BDF File Run MSC Nastran **1** Complete

Corresponding Bulk Data Entries

```
PBMSECT 1 1 CP
OUTP=201,BRP=202,BRP=203,T=.002,T(1)=[.003,PT=(2000012,2000007)]
POINT 2000007 -.03 .005
POINT 2000008 .03 .005
POINT 2000012 -.05 -.0371
POINT 2000013 -.033992-.0371
POINT 2000014 -.033992-.0371
POINT 2000015 .001999 -.0371
POINT 2000016 -.033992-.045
POINT 2000017 -.033992-.045
POINT 2000018 -.05 -.01079
POINT 2000019 -.05 -.010685
POINT 2000020 .021999 -.010685
POINT 2000021 .03 -.010685
POINT 2000022 .021999 -.031037
SET1 201 2000012 2000019 2000018 2000007 2000008 2000021 2000020
2000022 2000015 2000014 2000013
SET1 202 2000013 2000016 2000017 2000014
SET1 203 2000020 2000019
```

F06

```
Command executed: /msc/MSC_Nastran/2022.1/bin/msc20221 nastran ./tmp/92628fab09b109fae6a0b7b2
1

Warning: This computer program is protected by copyright law and interna
Unauthorized use, reproduction or distribution of this computer program, or
```

Controls

Tools

- Center Model
- Fit Model** **4**
- Isometric View 1
- ZY View
- Background Color
- Label Color

Display

- Labels** **3**
- Cross Section Preview
- Cross Section Actual
- Size Controls

Demos

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

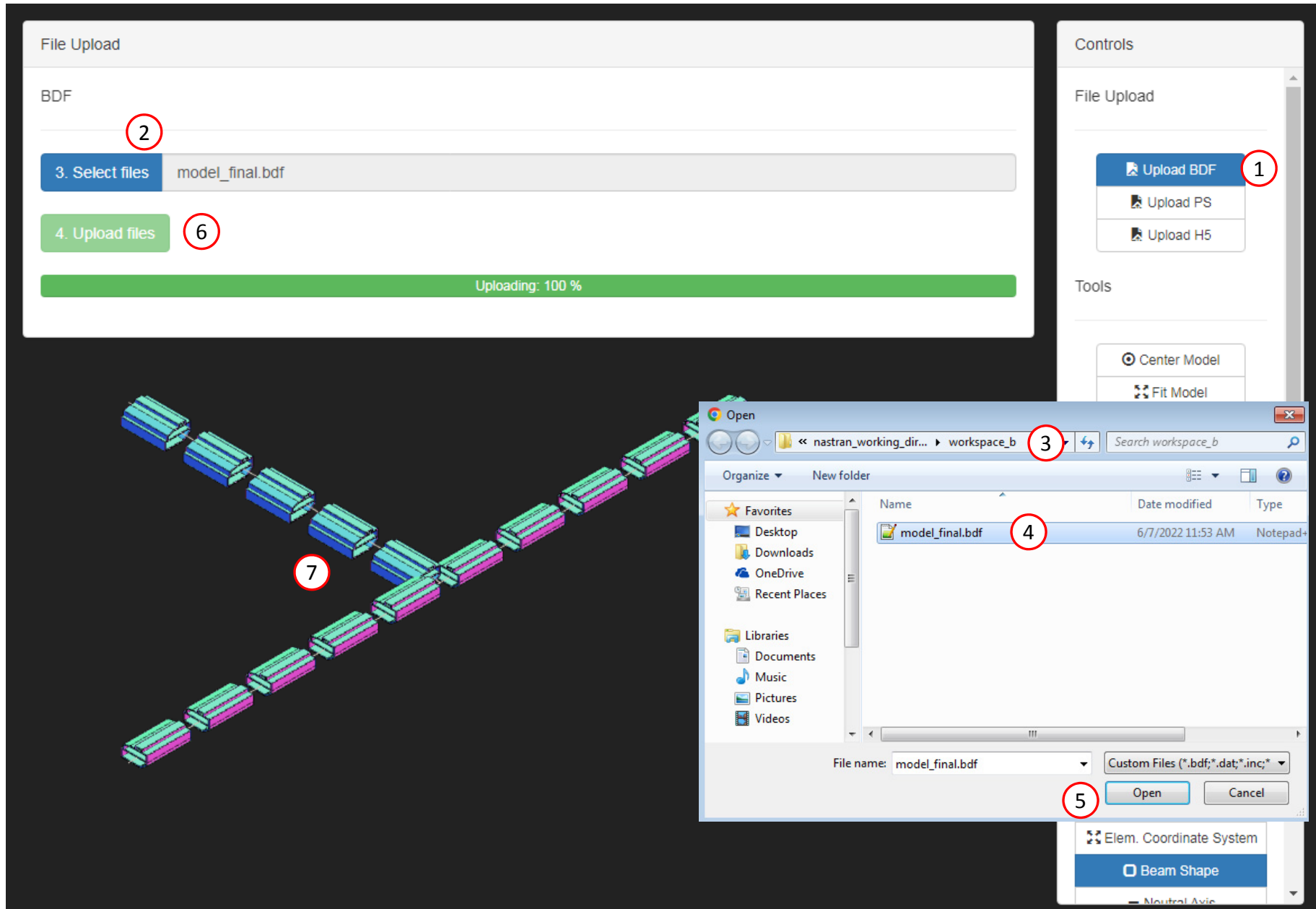
Editing PBMSECT 1

Developed by The Engineering Lab

Beams Viewer

Open the Beams Viewer

1. Click Upload BDF
2. Click Select files
3. Navigate to the directory workspace_b
4. Select model_final.bdf
5. Click Open
6. Click Upload files
7. The MSC Nastran model has been uploaded to the Beams Viewer



Upload the H5 File

1. Click Upload H5
2. Click Select files
3. Select file nastran_working_directory (1)/model.h5
4. Click Open
5. Click Upload files

File Upload

H5

Session ID: 7352

Upload .h5 File

1. Select files **2** model.h5

2. Upload files **5**

Acquired Datasets

Dataset	Acquire	Parse
---------	---------	-------

Open

File name: model.h5 NCSA HDFView (*.h5) **4**

Open Cancel

Controls

File Upload

Upload BDF

Upload PS

Upload H5 **1**

Tools

Center Model

Fit Model

Isometric View 1

Background Color

Label Color

Results

Forces and Stresses

Display

GRID IDs

Element IDs

Orientation Vector

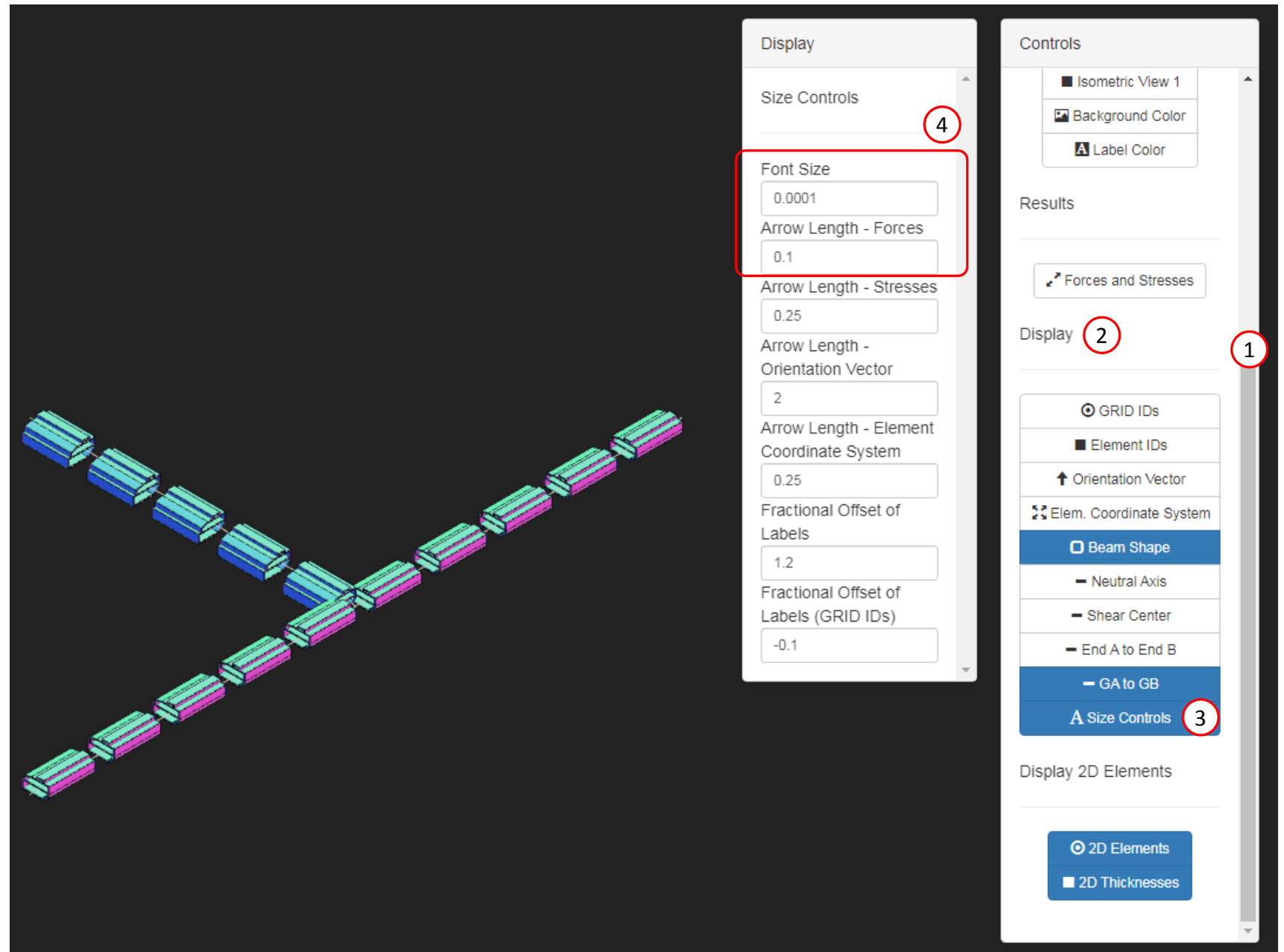
Elem. Coordinate System

Beam Shape

Neutral Axis

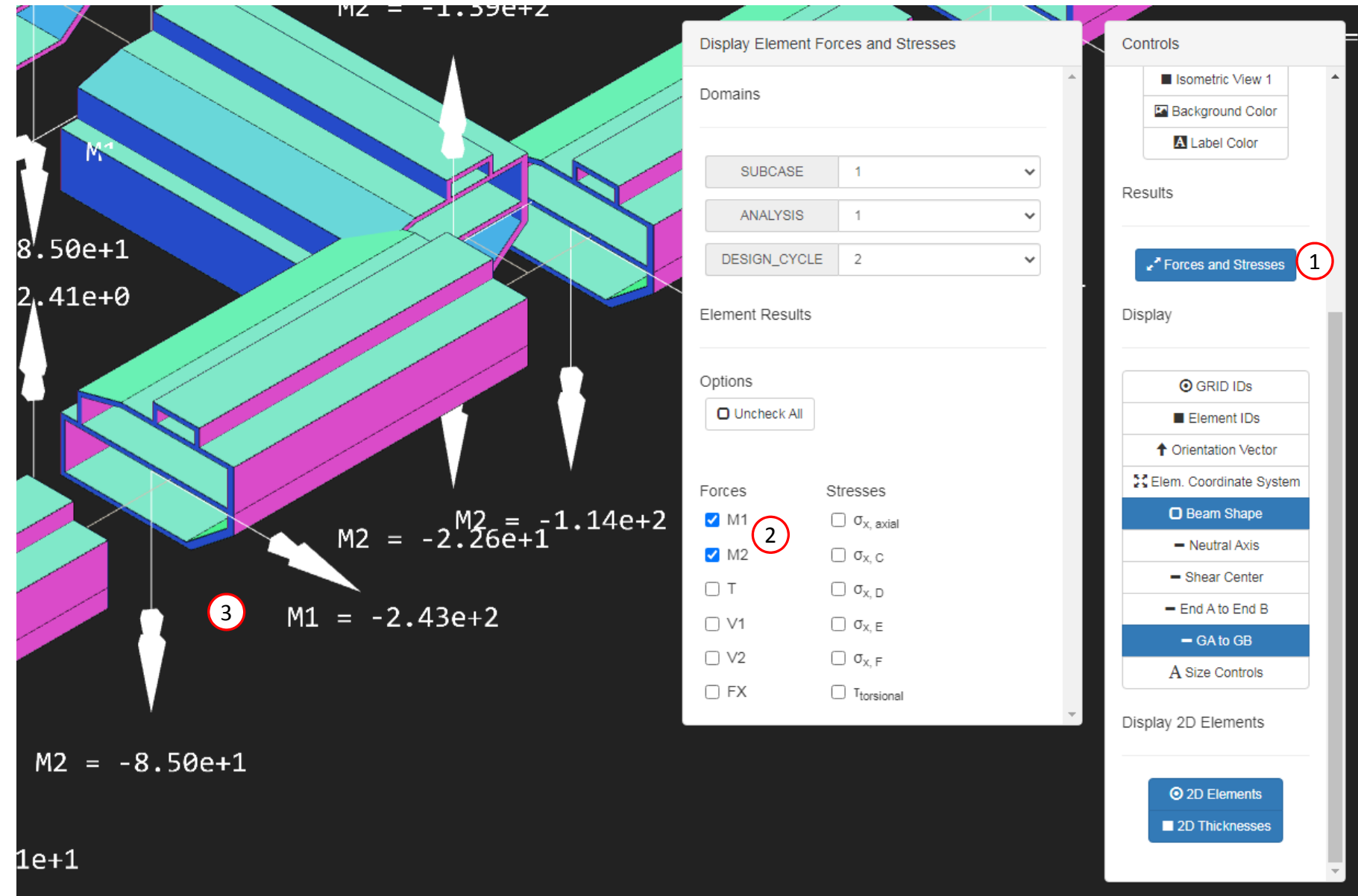
Adjust the Size of Labels

1. Use the vertical scroll bar
2. Locate the Display section
3. Click Size Controls
4. In the new panel, configure the following values:
 1. Font Size: .0001
 2. Arrow Length – Forces: 0.1



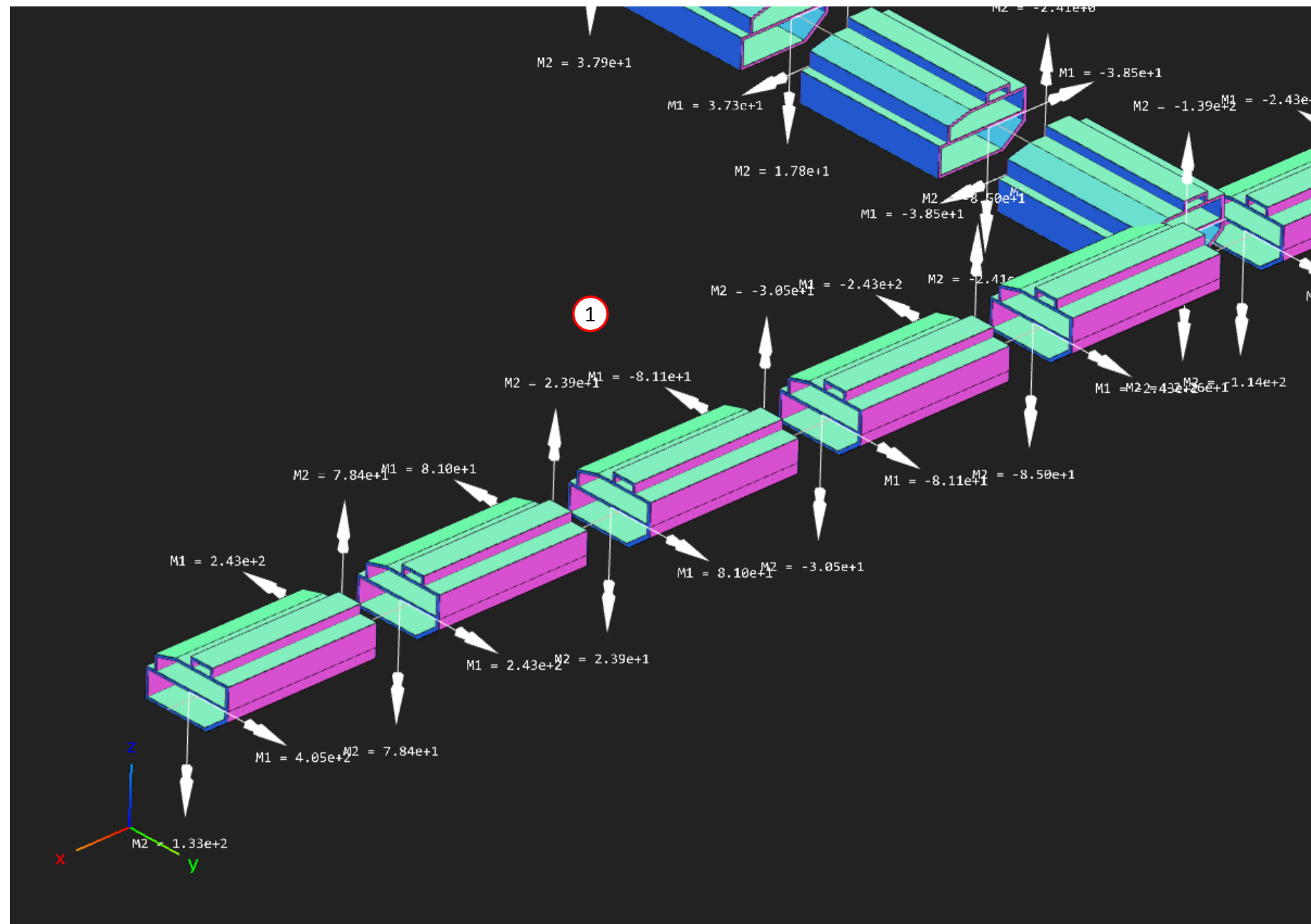
Display Internal Element Moments

1. Click Forces and Stresses
2. Mark the check boxes for M1 and M2, which correspond to the moments
3. The moments are now displayed on the beam elements



Display Internal Element Moments

1. Rotate the model to view additional elements



Part E – Manually Upload PS and BDF Files to Display the ABCS in the Beams Viewer

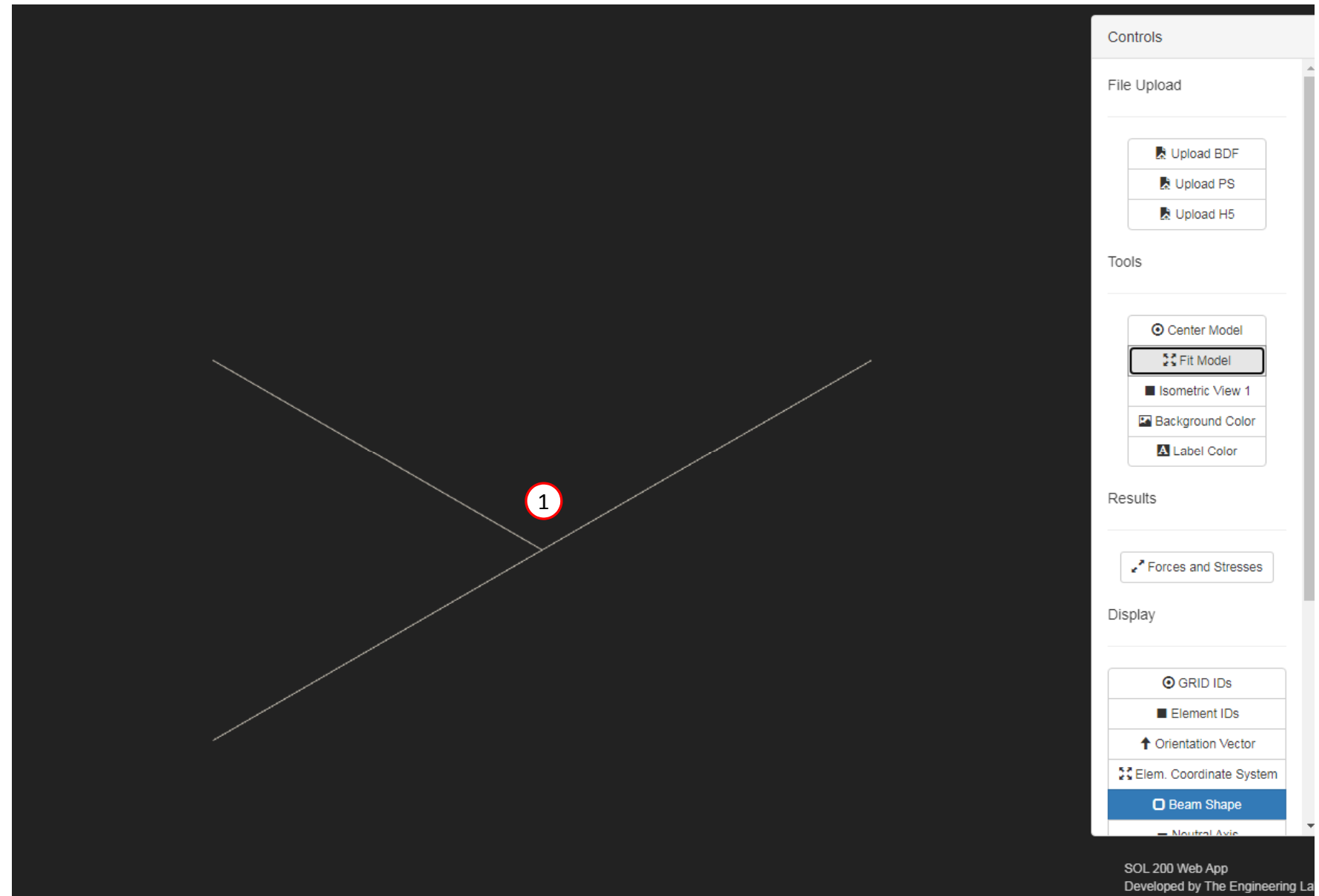
Beams Viewer

The Beams Viewer needs information about the ABCS in order to display the cross section. This ABCS information is obtained from the PostScript and BDF files.

When the BDF files are uploaded to the Beams Viewer, in the background MSC Nastran is executed to generate the PS and BDF files.

1. If the MSC Nastran run is unsuccessful, the PS and BDF files will be unavailable, and the ABCS will not be displayed. This is evident if only the lines appear after BDF upload.

The following slides discuss how to manually upload the PS and BDF files to the Beams Viewer so the ABCS is displayed.



Verify the Status

1. Click Upload PS
2. If an error occurred during the MSC Nastran run, this is indicated in the status column of the first row of the table.

File Upload

Information

This section only applies if the PBMSECT or PBRSECT entries are in the BDF files.

To display the arbitrary beam cross sections defined by PBMSECT or PBRSECT, the following files are necessary: the PostScript (.ps) and Bulk Data Files for each cross section, which have a naming convention similar to model_name_bm_pbmsectid_01.bdf.

This section provides 2 methods to obtain the PS and BDF files.

Method	Status	Display	Comments
Auto ABCS Display	<div><div></div><div>2</div></div>	<input type="checkbox"/>	After the BDF files are uploaded and in the background, MSC Nastran will automatically be executed and the necessary PS and BDF files will be acquired. The cross section will then be displayed. This requires MSC Nastran to be installed and configured on the same machine as the SOL 200 Web App, i.e. the machine that is running <code>node app.min.js</code> .
Manual ABCS Display		<input checked="" type="checkbox"/>	MSC Nastran must be manually executed separately to produce the PS and BDF files. Then, the PS and BDF files are manually uploaded to this section. Remember to click Parse to display the cross sections.

Manual ABCS Display

A) Upload PS File

1. Select files

2. Upload files

Uploading

B) Upload BDF Files

3. Select files

4. Upload files

Uploading

Controls

File Upload

Upload BDF

1

Upload PS

Upload H5

Tools

Center Model

Fit Model

Isometric View 1

Background Color

Label Color

Results

Forces and Stresses

Display

GRID IDs

Element IDs

Orientation Vector

Elem. Coordinate System

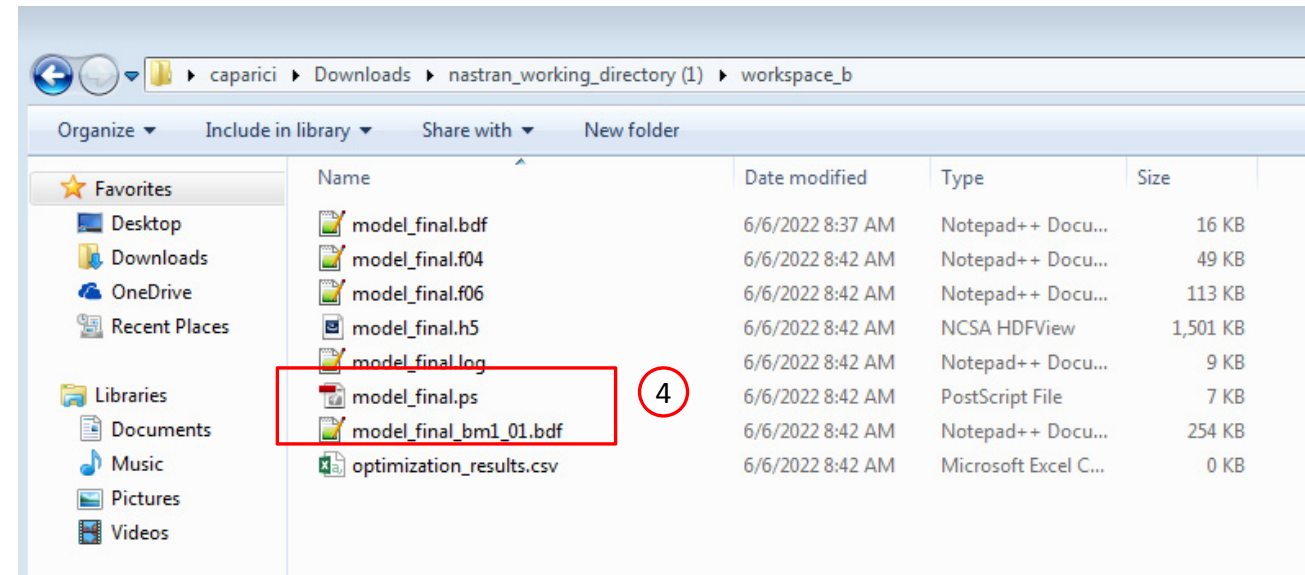
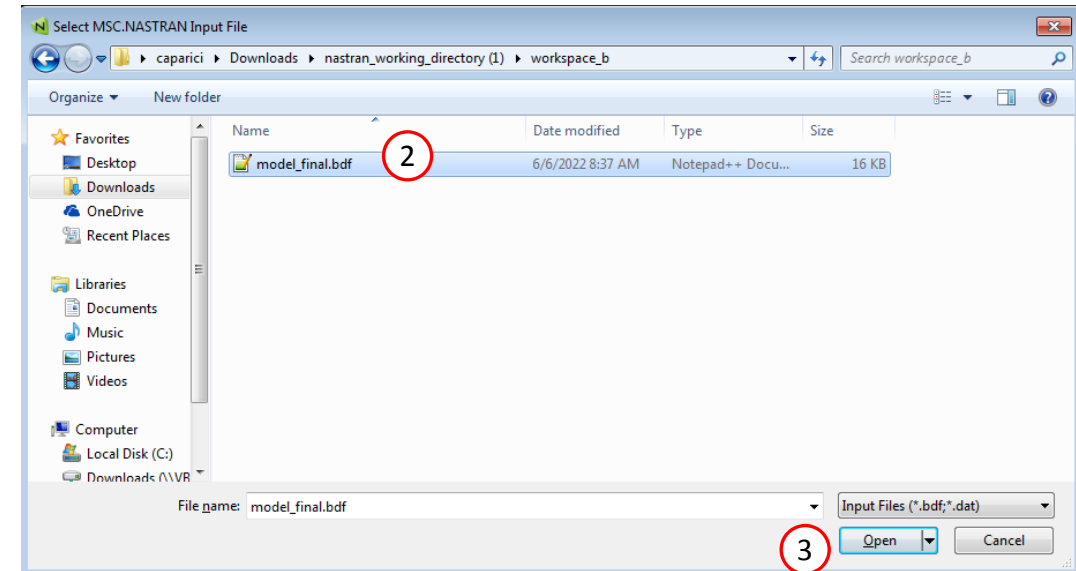
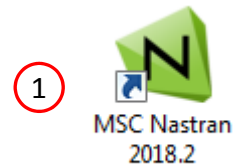
Beam Shape

Neutral Axis

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Manually Generating the PS and BDF Files

1. Double click the MSC Nastran desktop shortcut
2. Select this file
nastran_working_directory
(1)/workspace_b/model_final.bdf
3. Click Open
4. The PS and BDF files have been
generated by MSC Nastran

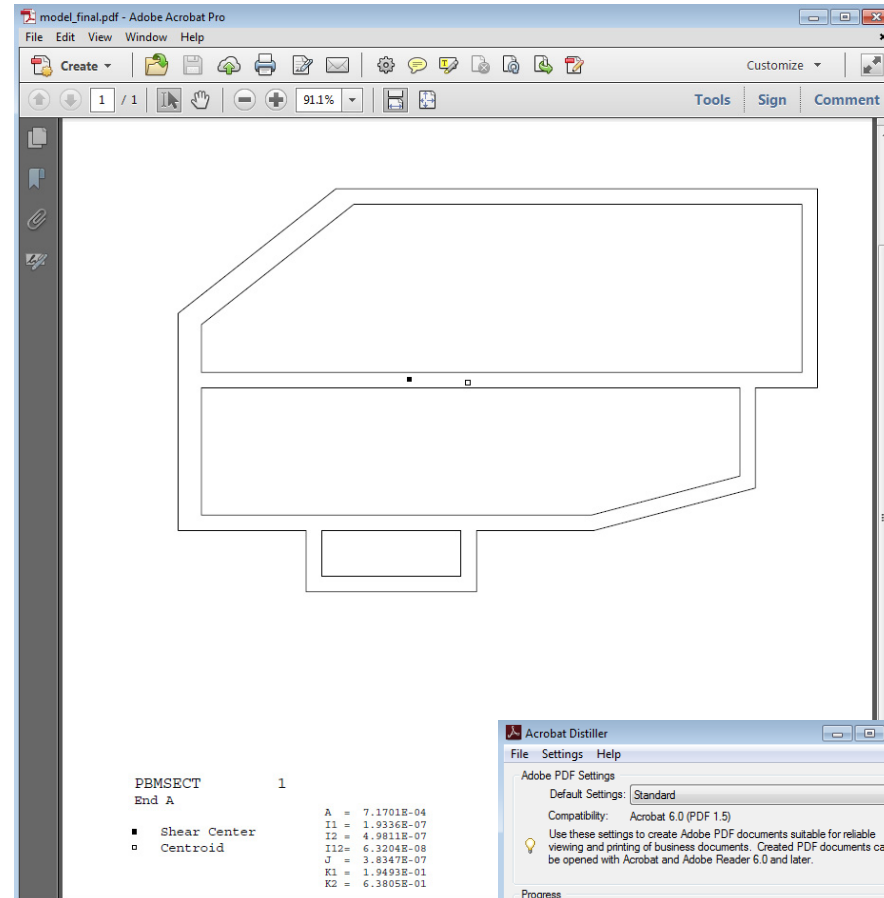


Viewing the PS and BDF Files

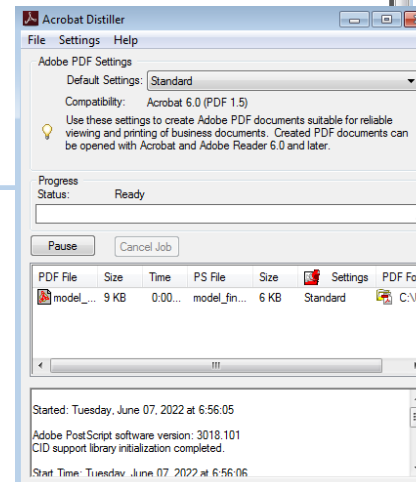
These steps are optional

1. An application is used to convert the PostScript (PS) file into a PDF file
2. A pre-processor, in this case Patran, is used to view the file model_final_bm1_01.bdf

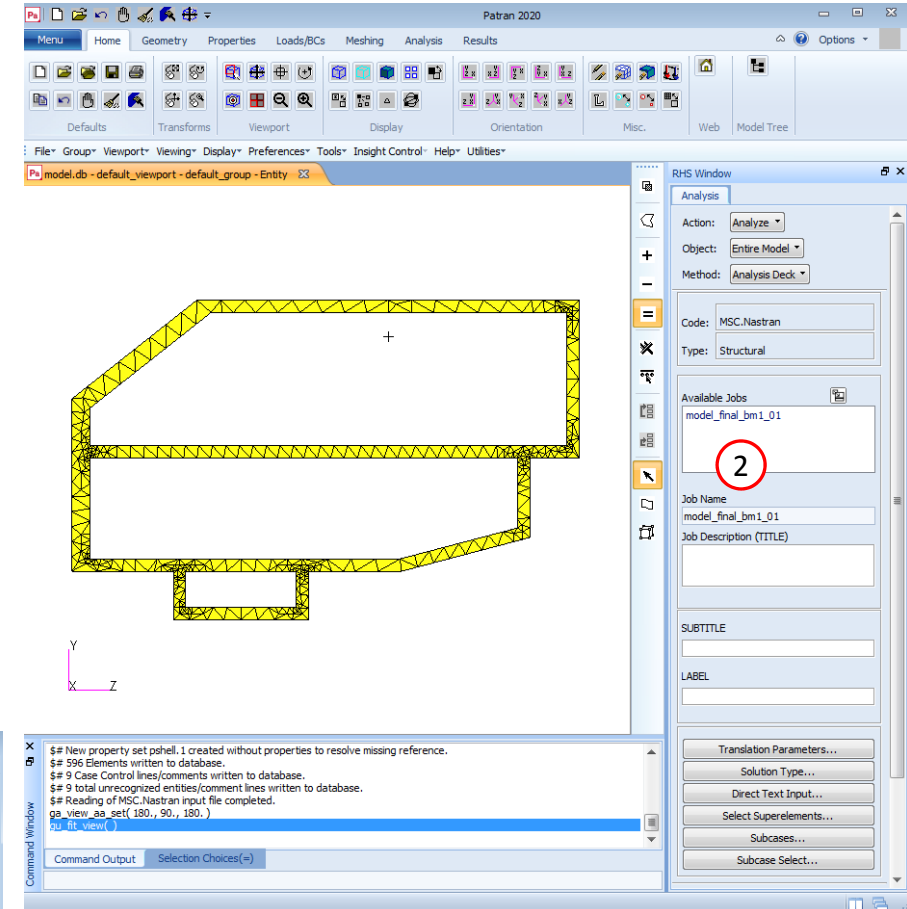
model_final.ps



1



model_final_bm1_01.bdf



Upload the PS and BDF Files to the Beams Viewer

1. Return to the Beams Viewer
2. Click Select files
3. Select model_final.ps
4. Click Open
5. Click Upload files
6. Click Select files
7. Select model_final_bm1_01.bdf
8. Click Open
9. Click Upload files
10. Click Parse
11. The information in the PS and BDF files are used to construct the ABCS. If successful, the table should display green checkboxes.

The image illustrates the process of uploading PS and BDF files to the Beams Viewer. It consists of two file explorer screenshots at the top and a central screenshot of the Beams Viewer interface with numbered callouts (2-11) indicating the workflow.

File Explorer Screenshots:

- Left Screenshot:** Shows the selection of `model_final.ps` (Step 3) and the `Open` button (Step 4).
- Right Screenshot:** Shows the selection of `model_final_bm1_01.bdf` (Step 7) and the `Open` button (Step 8).

Beams Viewer Interface:

A) Upload PS File

- 2. Select files: `model_final.ps`
- 5. Upload files
- Uploading: 100 %

B) Upload BDF Files

- 6. Select files: `model_final_bm1_01.bdf`
- 9. Upload files
- Uploading: 100 %

C) Parse Files

- 10. Parse
- Complete

Summary of detected PBMSECT and PBRSECT entries

Entry Name	ID	File Name PS	File Name BDF
PBMSECT	✓	model_final.ps	model_final_bm1_01.bdf

Results and Display:

- Isometric View 1
- Background Color
- Label Color
- Forces and Stresses
- Display: GRID IDs, Element IDs, Orientation Vector, Elem. Coordinate System, Beam Shape, Neutral Axis

SOL 200 Web App
Developed by The Engineering Lab

Inspect the ABCSs

1. Click Upload PS to close the Upload PS panel
2. The ABCS is now displayed for the elements



End of Tutorial

Appendix

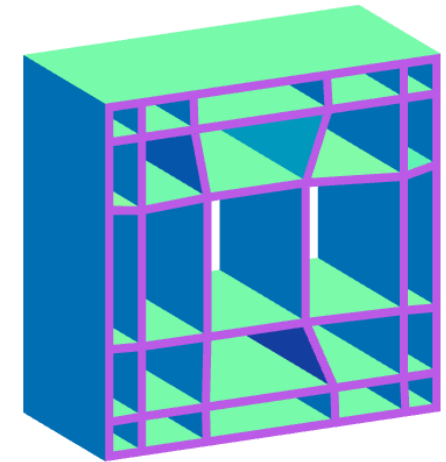
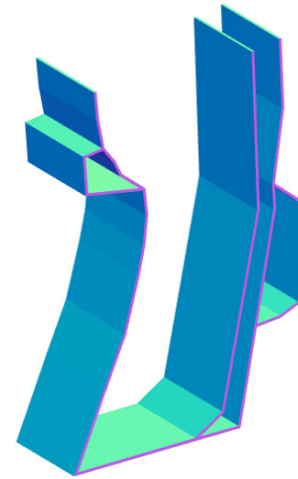
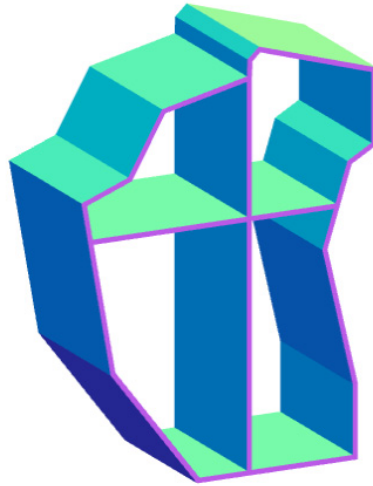
Appendix Contents

- 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

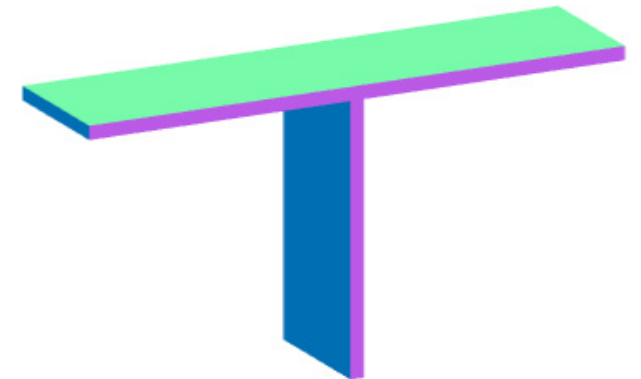
Procedure to Create PBMSECT/PBRSECT Entries

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



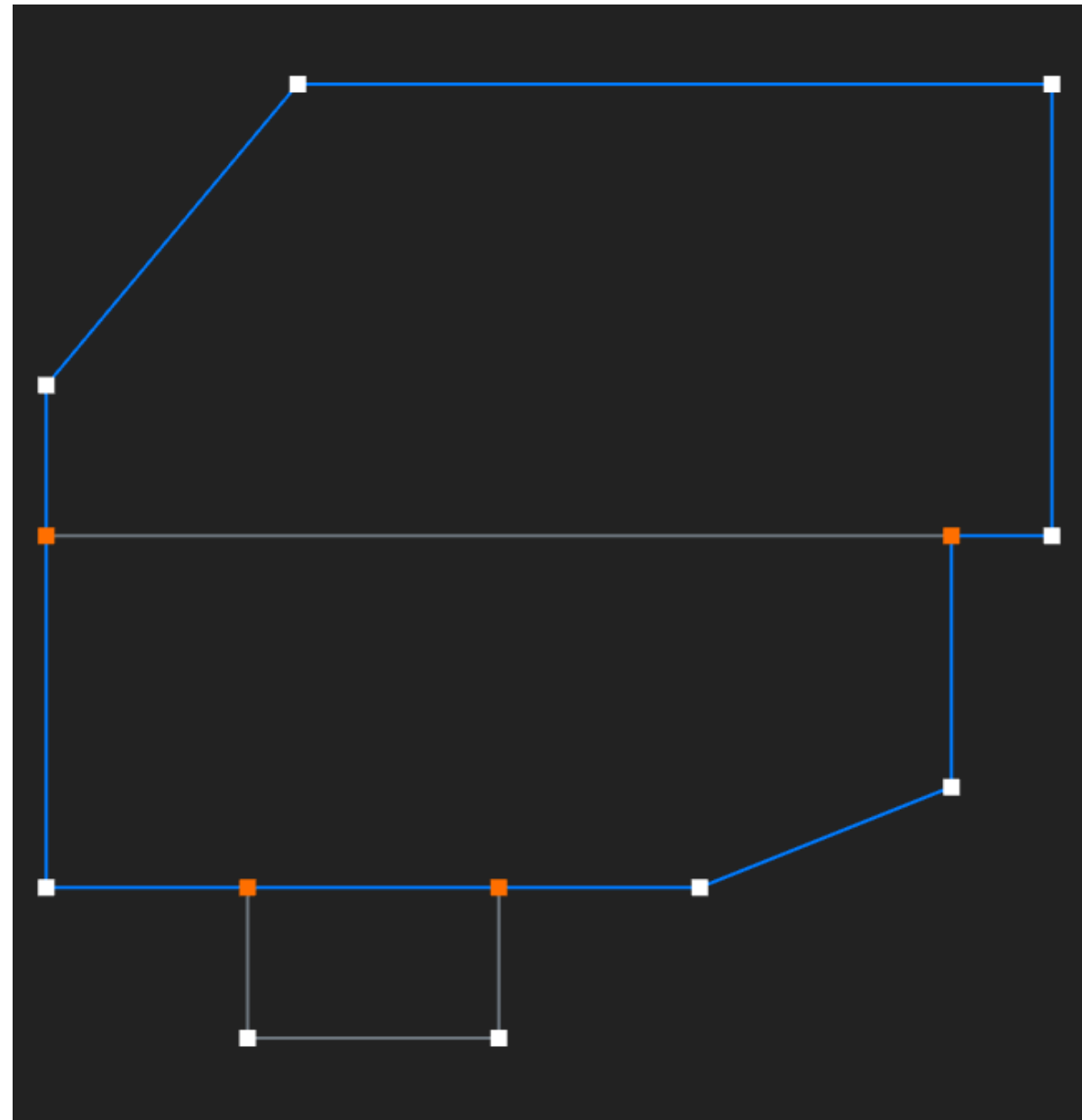
Composite Arbitrary Beam Cross Section Examples






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.

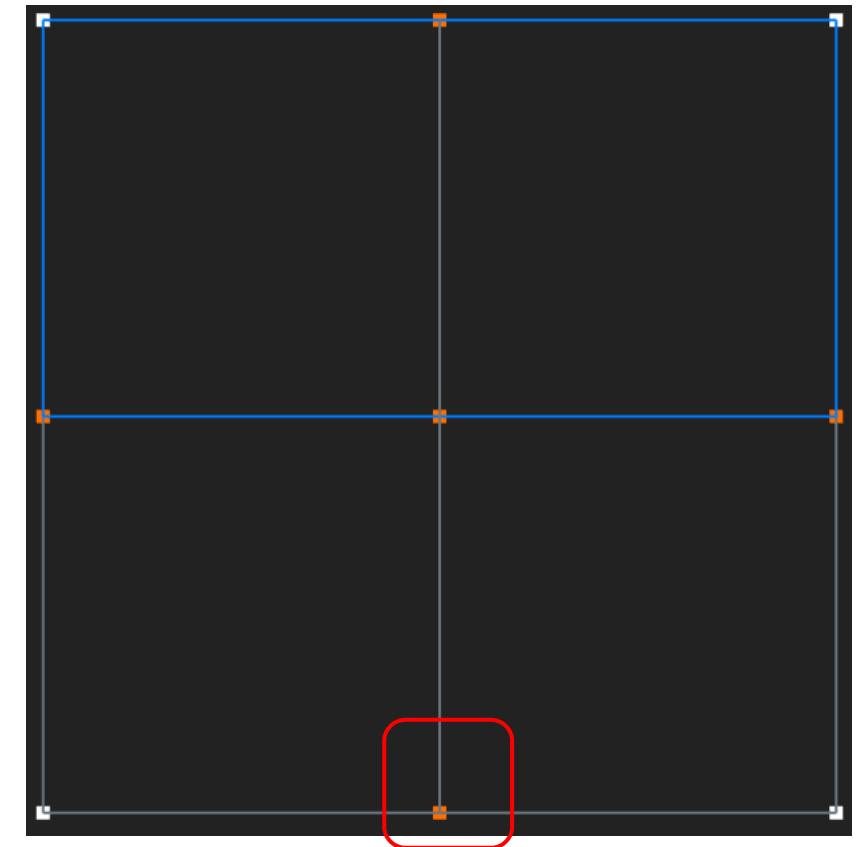
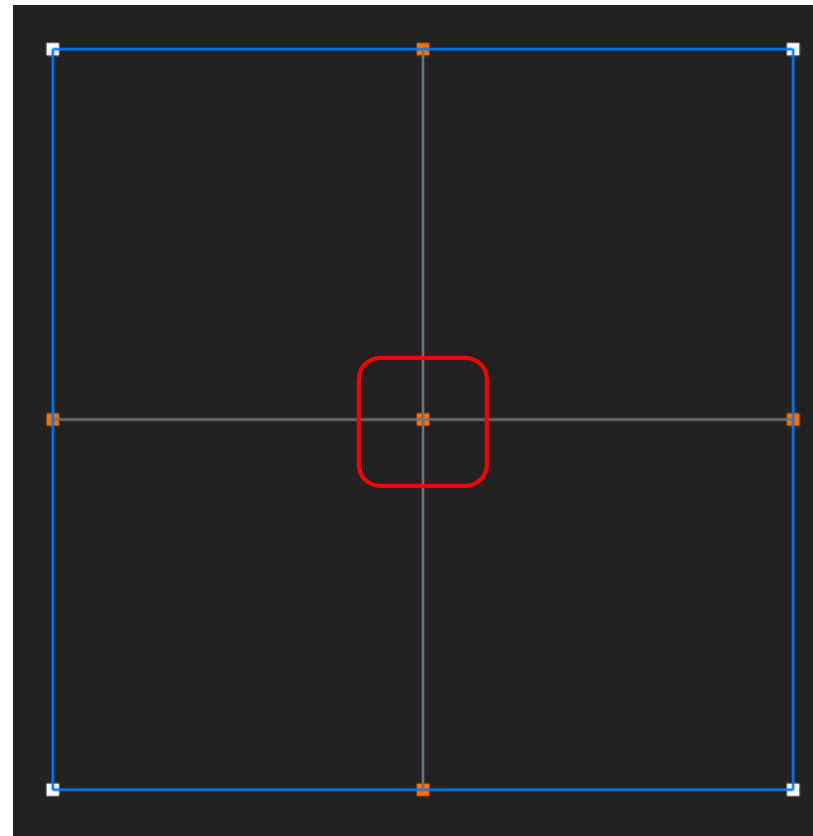


Legend




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

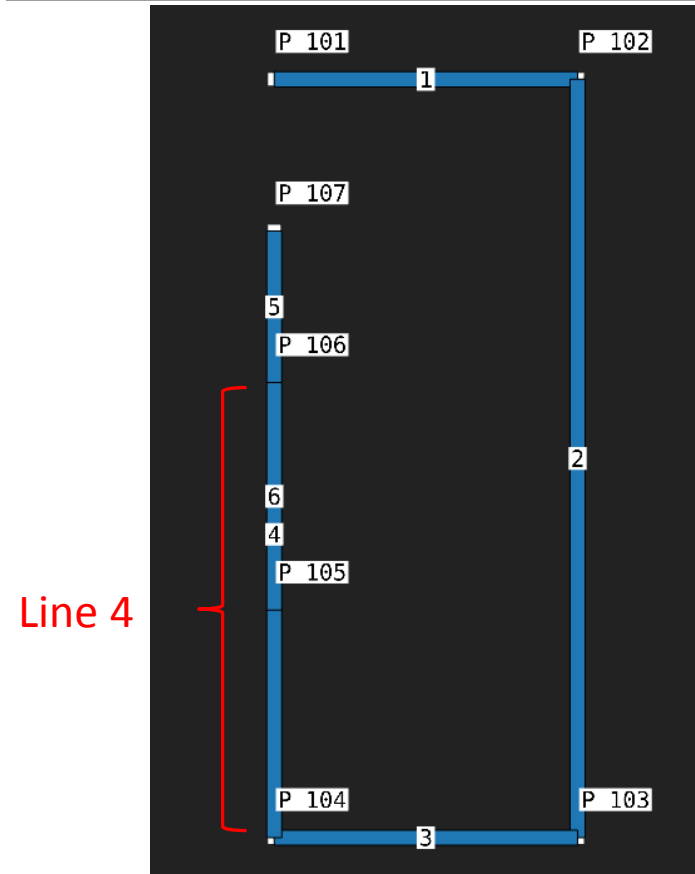
UFM 7201 Cause 1

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.

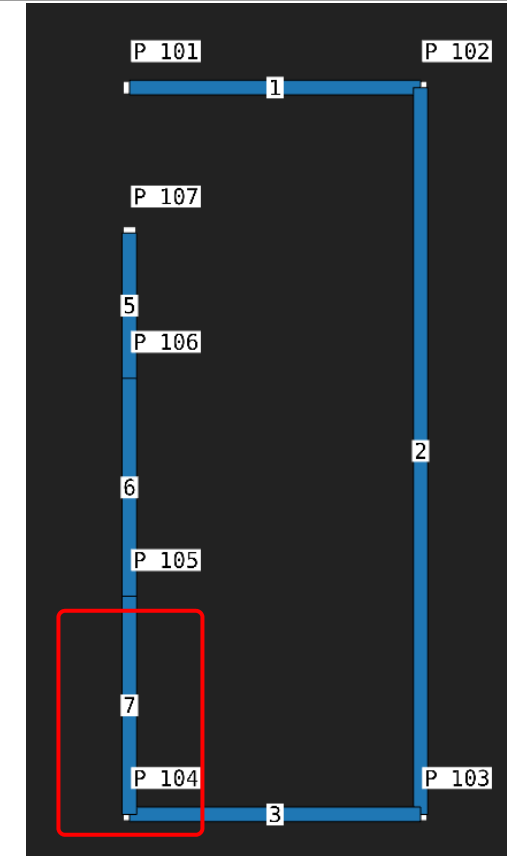
    INTERSECTION
    X-COOR      Y-COOR      PROXIMITY POINT ID
4.9407-324    0.0000E+00
    USER ACTION: MAKE SURE POINTS IN CLOSE PROXIMITY OF ABOVE COORDINATES ARE SEPARATED BY
                  A DISTANCE LARGER THAN THE THICKNESS OF THE SEGMENT.
    PLEASE NOTE THAT LIST OF PROXIMITY POINTS IS NOT EXHAUSTIVE. 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



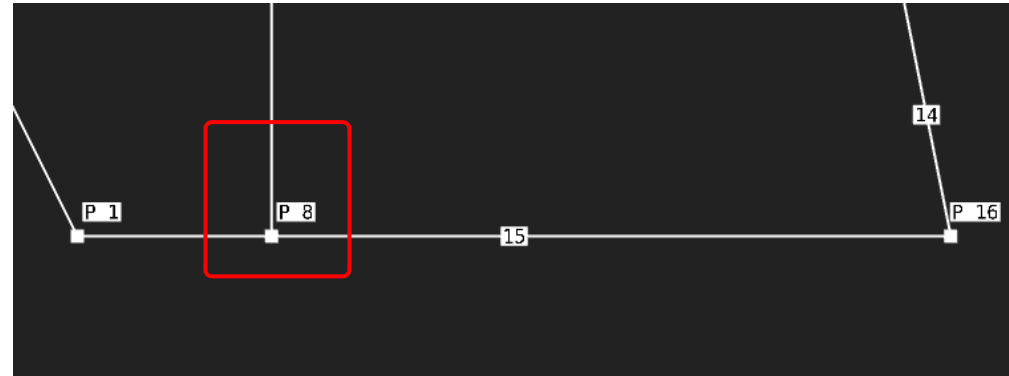
Correct: Line 4 is removed and line 7 is created.

UFM 7201 Cause 1, Another Example

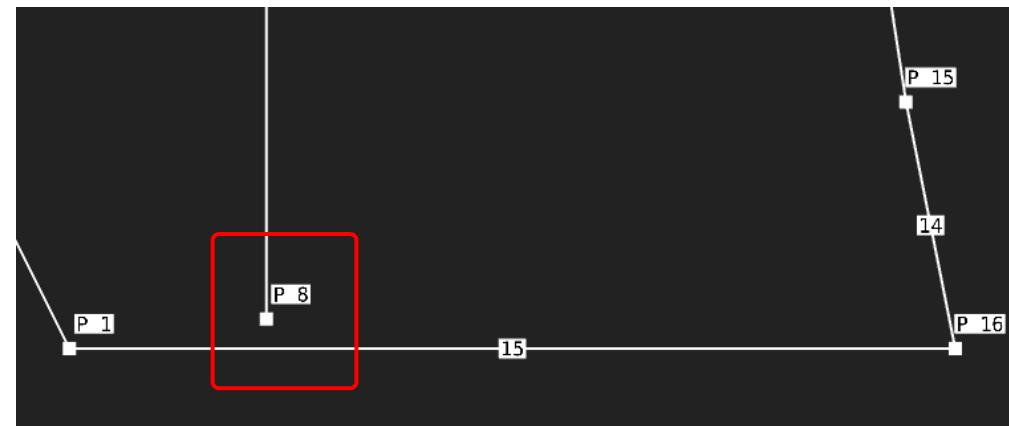
1. If a free end of a line is very close to another line, the overlapping sections will trigger this error

```
*** 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



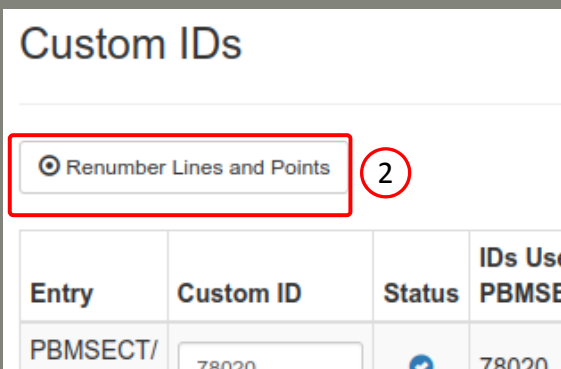
Correct: Point 8 is moved to avoid being too close to line 15



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

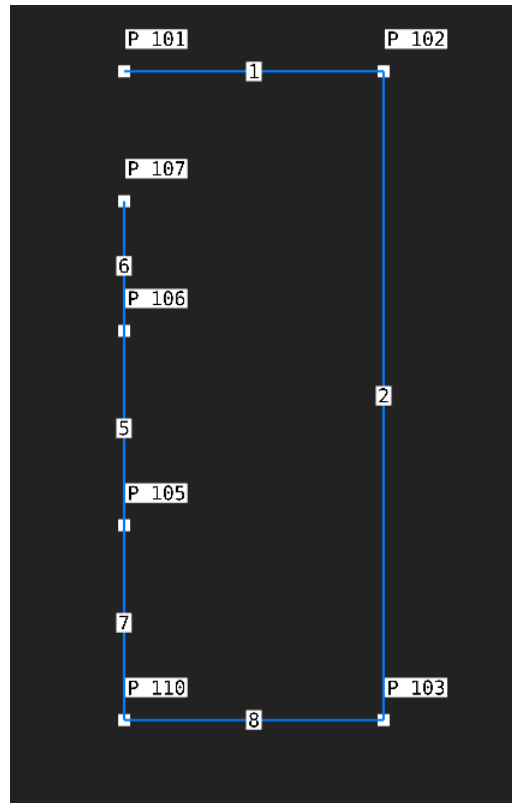


```

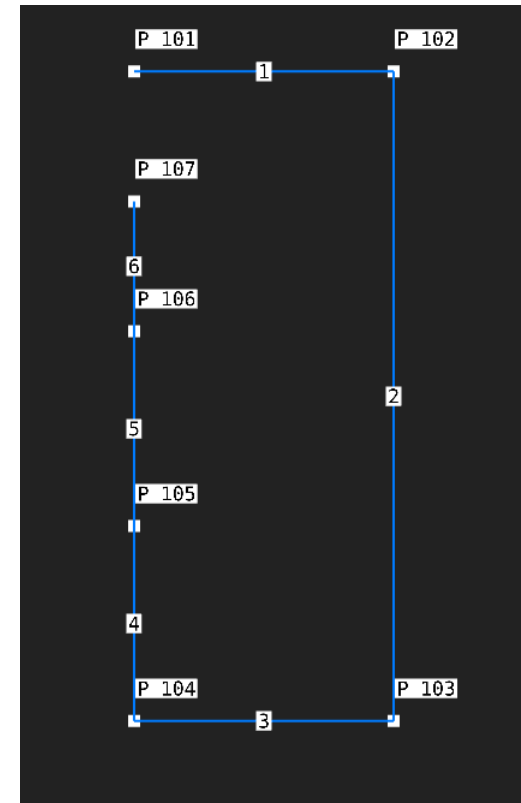
*** USER FATAL MESSAGE 7201 (ARNFCK)
PBRSECT/PBMSECT ENTRY ID=32, INTERSECTION OF SEGMENTS WITHIN A LOOP OR BETWEEN LOOPS FOUND.
USER ACTION : IF FORM=CP OR OP, USE LESSER NUMBER OF POINTS TO DESCRIBE THE PROFILE. ESPECIALLY IN MERGING AREA OF TWO LINES.
                IF FORM=GS, CHECK FOR OVERLAPPING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

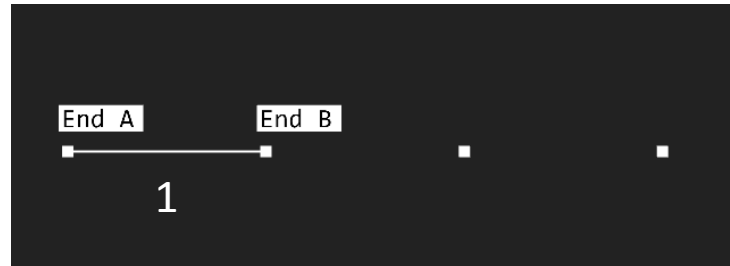


Correct: The POINT IDs are now numbered in sequential order.

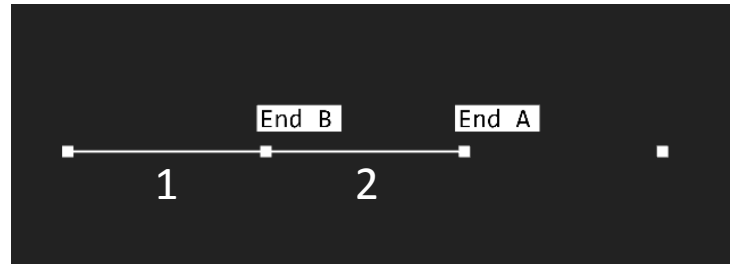
UFM 7201

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

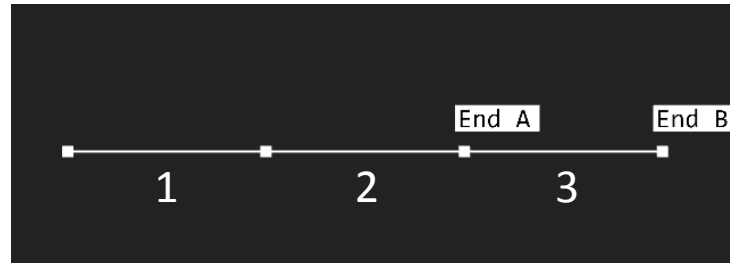
Step 1



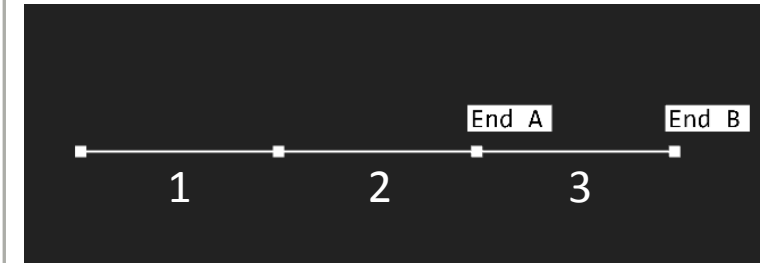
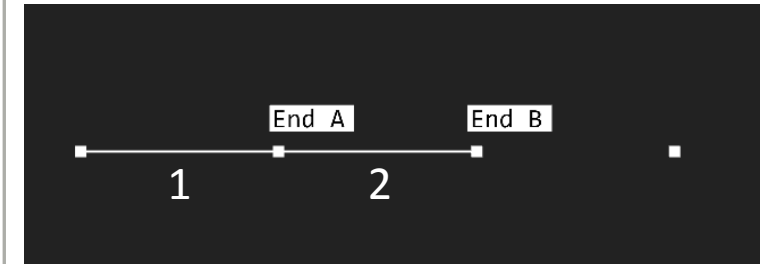
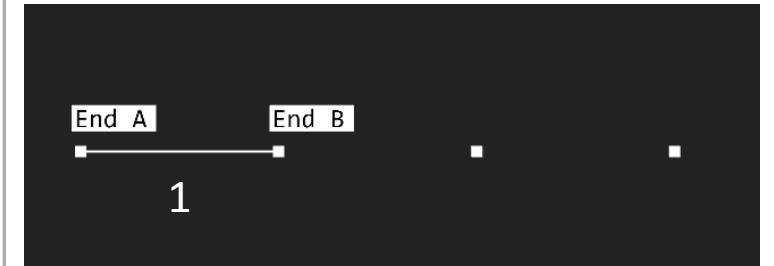
Step 2



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