

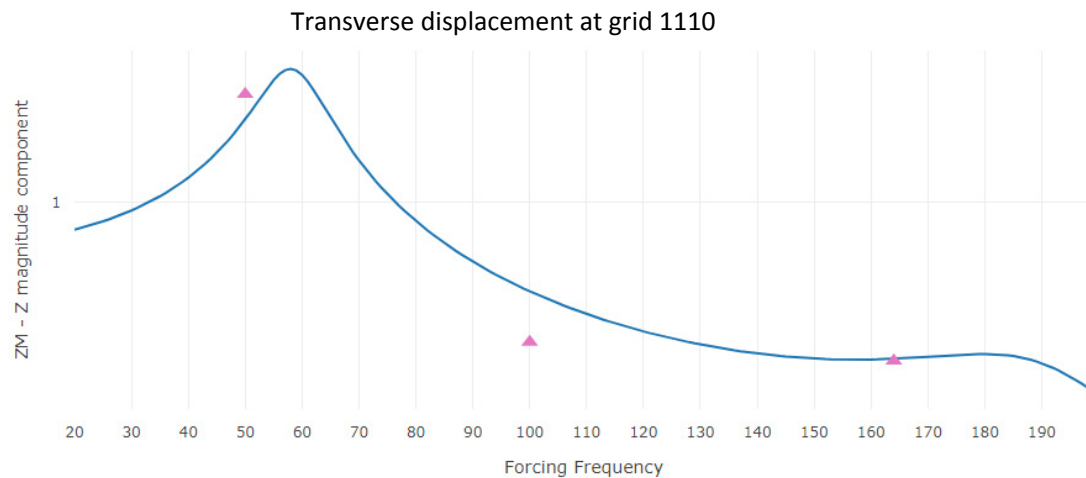
Workshop - Model Matching, Frequency Response

AN MSC NASTRAN SOL 200 TUTORIAL

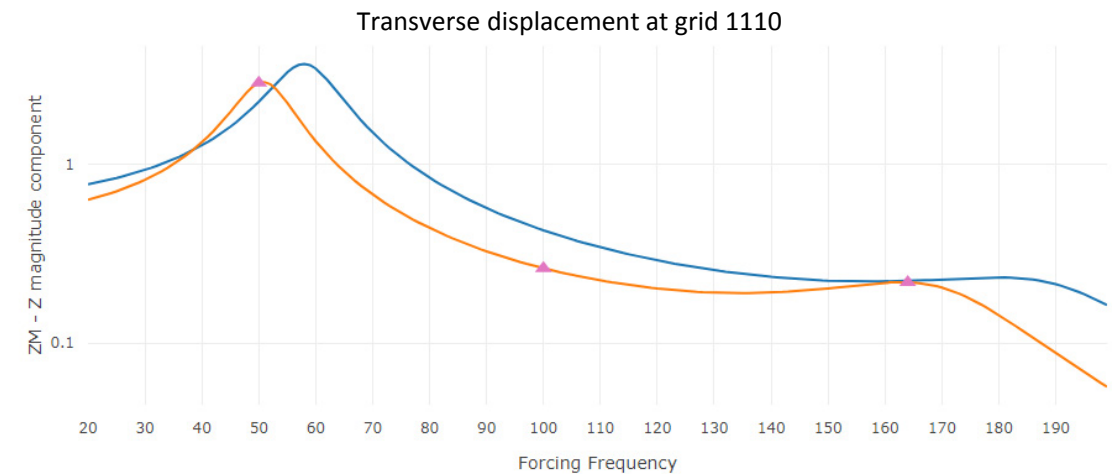
Goal: Use Nastran SOL 200 Optimization

Correlate Experiment and FEA Results

Before Optimization



After Optimization



— INITIAL FEA Results
— FINAL FEA Results
▲ Experiment/ Target Values

Details of the structural model

Dynamic Response Optimization

This example demonstrates structural optimization when the structural loads are frequency dependent. The system considered is a flat rectangular plate clamped on three edges and free along the fourth, as shown in Figure 8-21. The problem investigates minimization of the mean square response of the transverse displacement at the midpoint of the free edge, while constraining the volume of the structure (and hence, weight) to be equal to that of the initial design. A pressure loading with an amplitude of $1.0 \text{ lb}_f/\text{in}^2$ is applied across a frequency range of 20.0 to 200.0 Hz. A small amount of frequency-dependent modal damping has also been included.

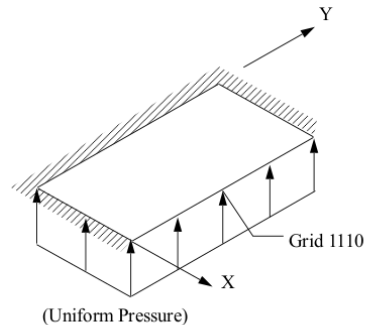
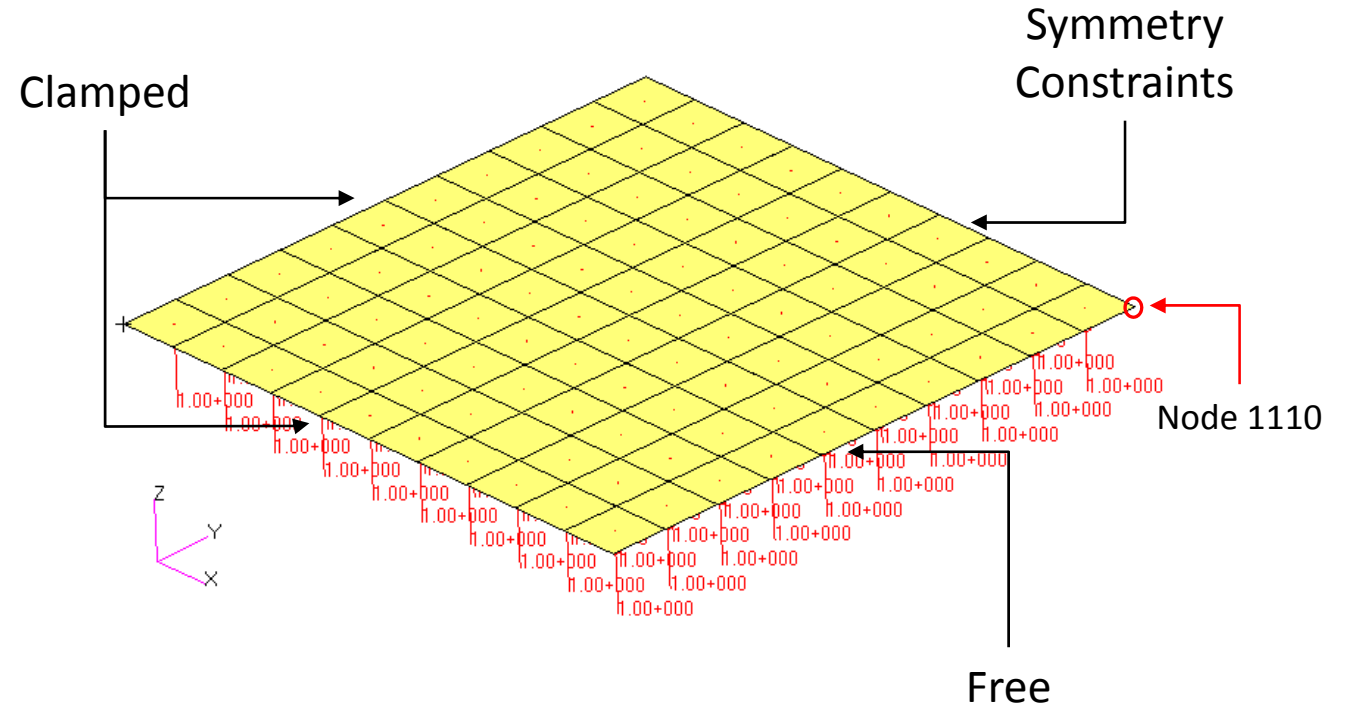


Figure 8-21 Pressure-Loaded Flat Plate

MSC Nastran Design Sensitivity and Optimization User's Guide
Chapter 8 - Example Problems - Dynamic Response
Optimization



Details of the structural model

Dynamic Response Optimization

This example demonstrates structural optimization when the structural loads are frequency dependent. The system considered is a flat rectangular plate clamped on three edges and free along the fourth, as shown in Figure 8-21. The problem investigates minimization of the mean square response of the transverse displacement at the midpoint of the free edge, while constraining the volume of the structure (and hence, weight) to be equal to that of the initial design. A pressure loading with an amplitude of 1.0 lb/in^2 is applied across a frequency range of 20.0 to 200.0 Hz. A small amount of frequency-dependent modal damping has also been included.

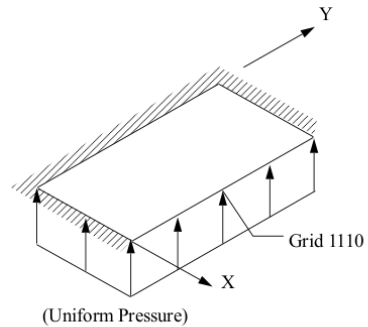
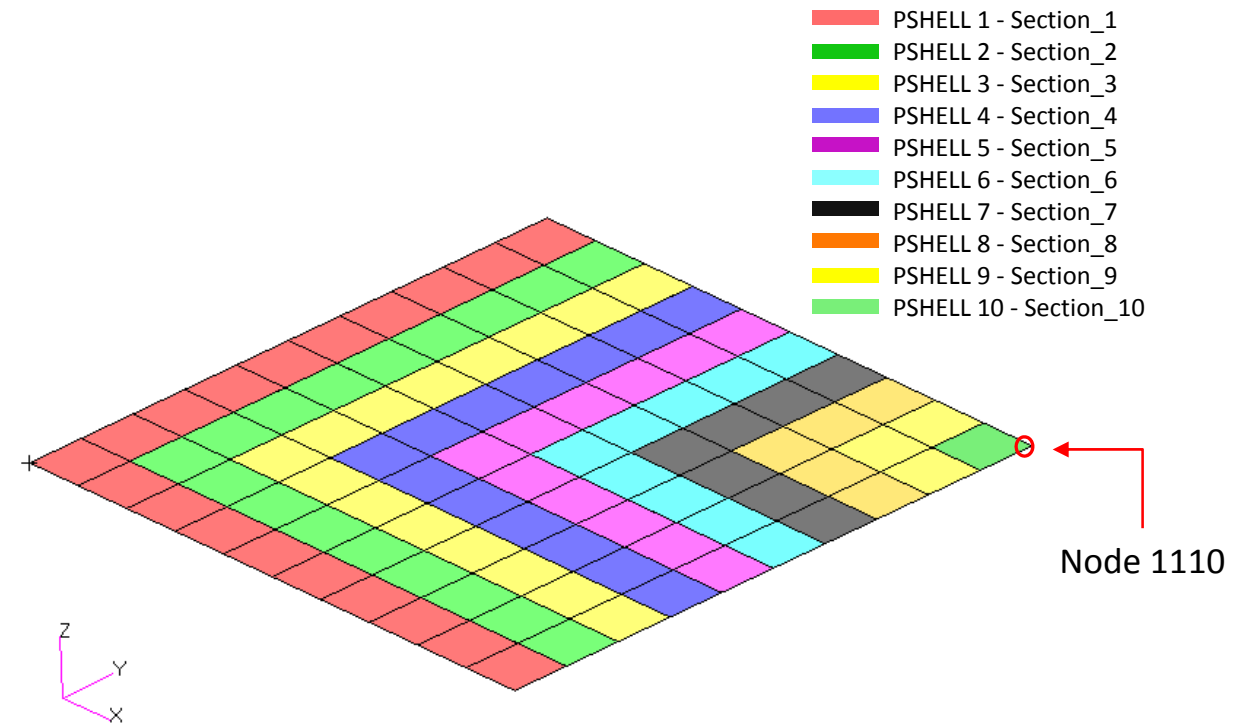


Figure 8-21 Pressure-Loaded Flat Plate



MSC Nastran Design Sensitivity and Optimization User's Guide
Chapter 8 - Example Problems - Dynamic Response
Optimization

Optimization Problem Statement

Design Variables

x1: T of PSHELL 1
 x2: T of PSHELL 2
 x3: T of PSHELL 3
 x4: T of PSHELL 4
 x5: T of PSHELL 5
 x6: T of PSHELL 6
 x7: T of PSHELL 7
 x8: T of PSHELL 8
 x9: T of PSHELL 9
 x10 : T of PSHELL 10

$$.01 < x_i < 1.0$$

Design Objective, Equation

R0: Minimize

$$\left(\frac{b1 - 2.8384}{2.8384}\right)^2 + \left(\frac{b2 - 0.2613}{0.2613}\right)^2 + \left(\frac{b3 - 0.2182}{0.2182}\right)^2$$

SUBCASE 1

- b1: RM - T3 component of displacement at grid 1110 at frequency 50. Hz
- b2: RM - T3 component of displacement at grid 1110 at frequency 100. Hz
- b3: RM - T3 component of displacement at grid 1110 at frequency 164. Hz

Design Constraints

r1: Volume $7.99 < r1 < 8.01$

Design Constraints, Equation

SUBCASE 1

$$R1 = \left(\frac{b4 - 0.488338}{0.488338}\right)^2 \quad R1 < .01$$

$$R2 = \left(\frac{b5 - .018219}{.018219}\right)^2 \quad R2 < .01$$

$$R3 = \left(\frac{b6 - 0.1845}{0.1845}\right)^2 \quad R3 < .01$$

$$R4 = \left(\frac{b7 - 0.022128}{0.022128}\right)^2 \quad R4 < .01$$

$$R5 = \left(\frac{b8 - 0.279055}{0.279055}\right)^2 \quad R5 < .01$$

- b4: RM - T3 component of displacement at grid 605 at frequency 50. Hz
- b5: RM - T3 component of displacement at grid 605 at frequency 84. Hz
- b6: RM - T3 component of displacement at grid 605 at frequency 171. Hz
- b7: RM - T3 component of displacement at grid 1105 at frequency 97. Hz
- b8: RM - T3 component of displacement at grid 1105 at frequency 173. Hz

SUBCASE 2

$$R6 = \left(\frac{b9 - 1.58019}{1.58019}\right)^2 \quad R6 < .01$$

$$R7 = \left(\frac{b10 - 0.140642}{0.140642}\right)^2 \quad R7 < .01$$

$$R8 = \left(\frac{b11 - 0.124761}{0.124761}\right)^2 \quad R8 < .01$$

- b9: RM - T3 component of displacement at grid 1110 at frequency 50. Hz
- b10: RM - T3 component of displacement at grid 1110 at frequency 100. Hz
- b11: RM - T3 component of displacement at grid 1110 at frequency 164. Hz

SUBCASE 3

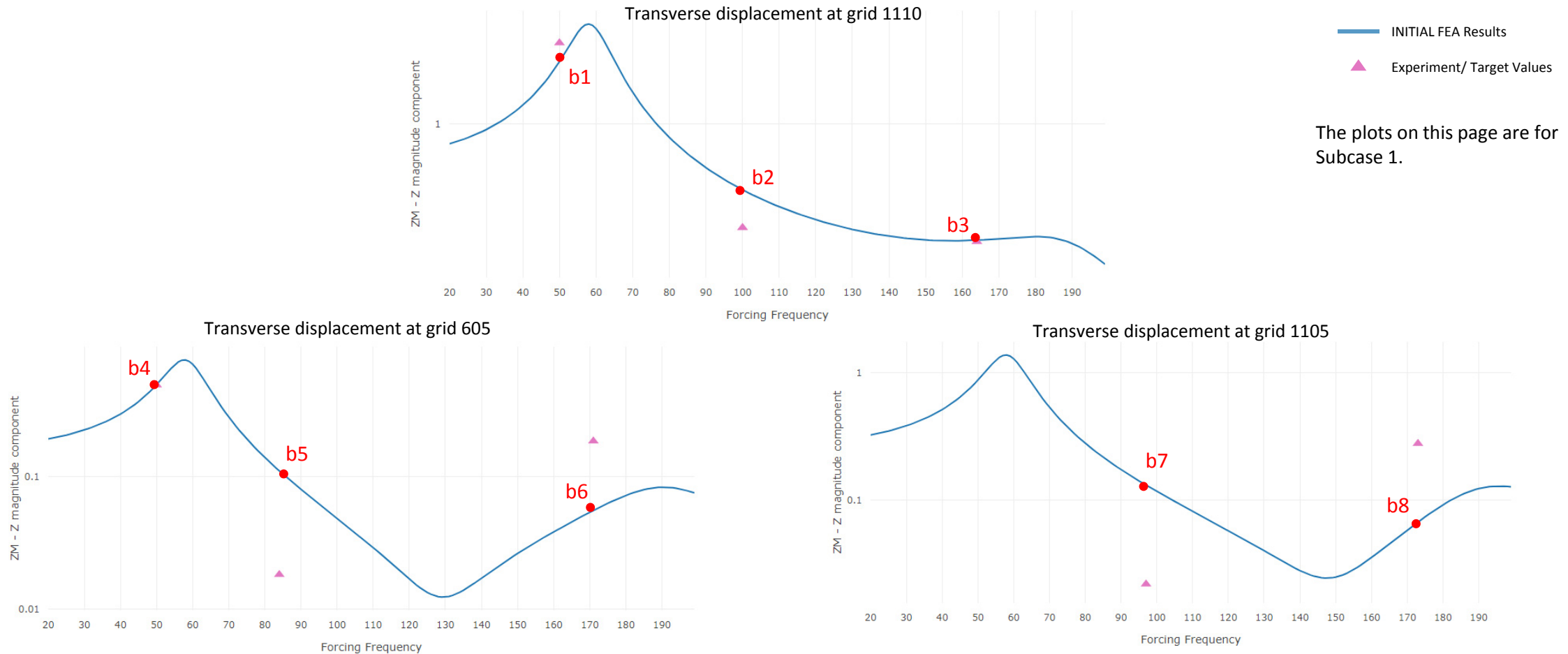
$$R9 = \left(\frac{b12 - 0.522618}{0.522618}\right)^2 \quad R9 < .01$$

$$R10 = \left(\frac{b13 - 0.048008}{0.048008}\right)^2 \quad R10 < .01$$

$$R11 = \left(\frac{b14 - 0.042346}{0.042346}\right)^2 \quad R11 < .01$$

- b12: RM - T3 component of displacement at grid 1110 at frequency 50. Hz
- b13: RM - T3 component of displacement at grid 1110 at frequency 100. Hz
- b14: RM - T3 component of displacement at grid 1110 at frequency 164. Hz

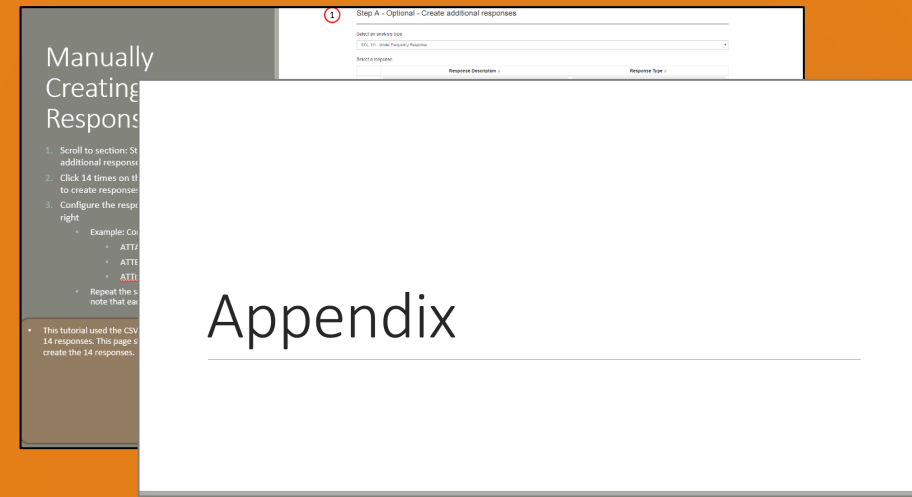
Optimization Problem Statement Continued



More Information Available in the Appendix

The Appendix includes information regarding the following:

- Manually Creating Responses
- How is error defined in this tutorial?



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

PART A

Tutorial Overview

1. Start with a .bdf or .dat file
2. 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
3. Plot the Optimization Results
4. Update the original model with optimized parameters

Special Topics Covered

Automatically Creating Hundreds of Design Variables - It may be the case that hundreds of design variables must be created. The Web App features a capability to automatically create and configure hundreds of design variables. Design variable lower and upper limits and discrete values can also be automatically set. This tutorial discusses the process of automatically creating multiple design variables.

Model Matching - The SOL 200 Web App features a single table where the model matching problem can be defined. In the background, the necessary objective and constraints are automatically generated. In addition, plots comparing the initial, final and target values are auto generated.

Multi Subcase - Model matching is to be performed across multiple subcases. The necessary steps and configuration is outlined in this tutorial to perform model matching across multiple subcases.

SOL 200 Web App Capabilities

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

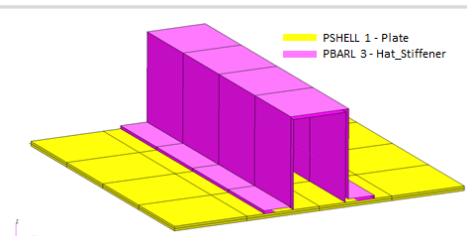
Compatibility

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

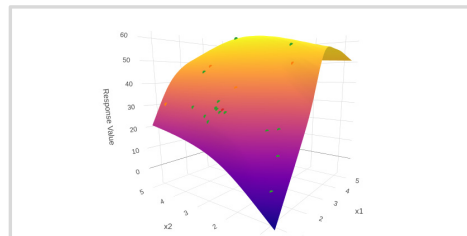
Benefits

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

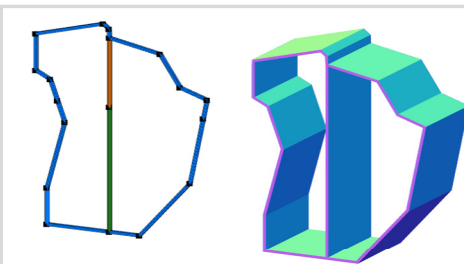
Web Apps



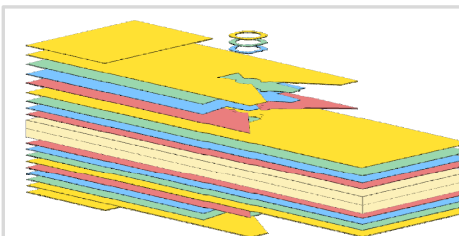
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200.
Support for size, topology, topometry, topography, multi-model optimization.



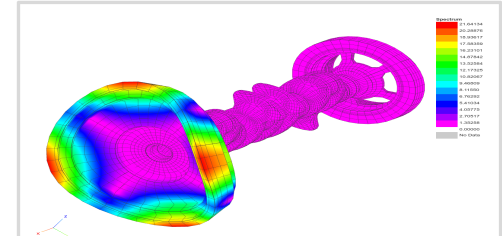
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



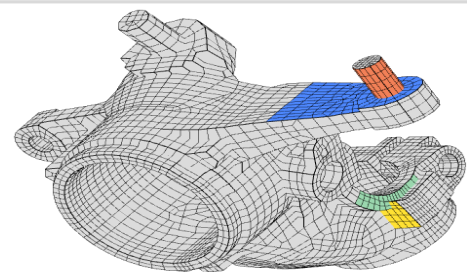
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



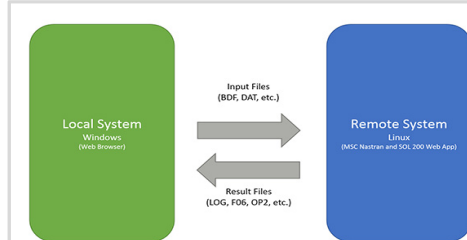
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



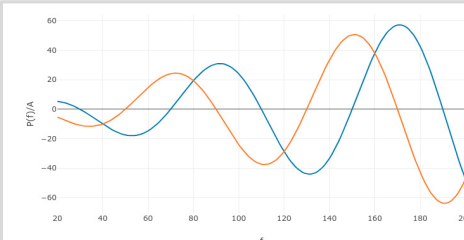
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



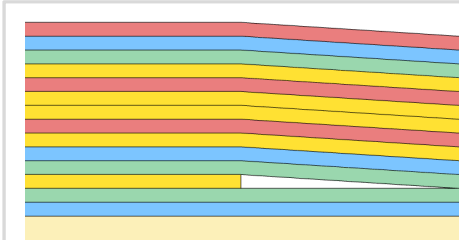
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



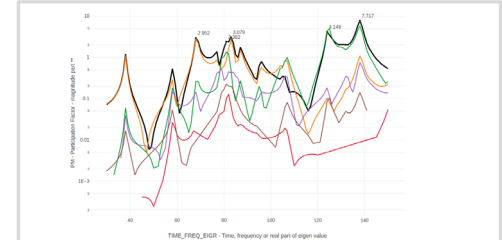
Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



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



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

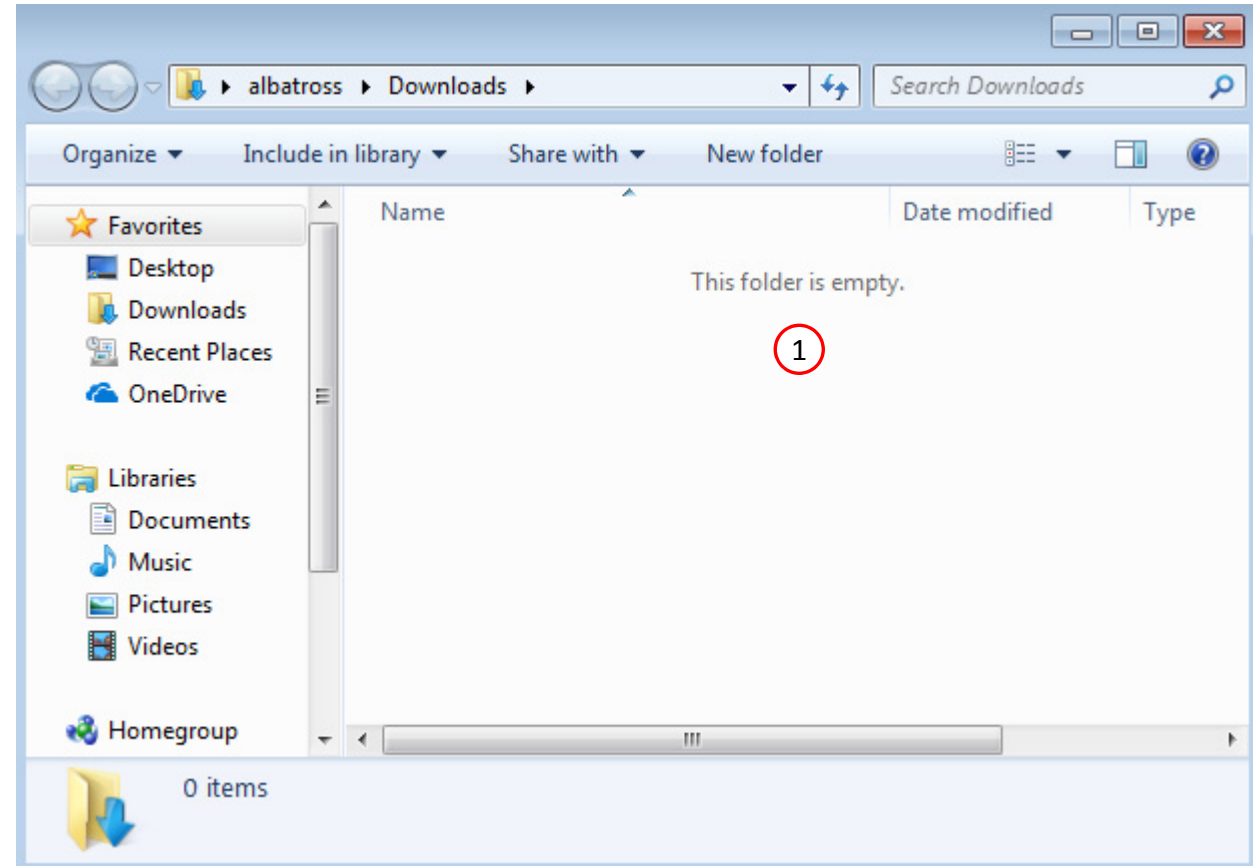


HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

Before Starting

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

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



Go to the User's Guide

1. Click on the indicated link

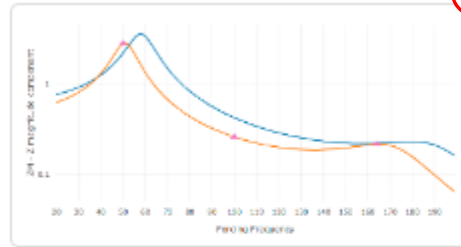
- The necessary BDF files for this tutorial are available in the Tutorials section of the User's Guide.



Obtain Starting Files

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

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



1

Model Matching, Frequency Response Analysis

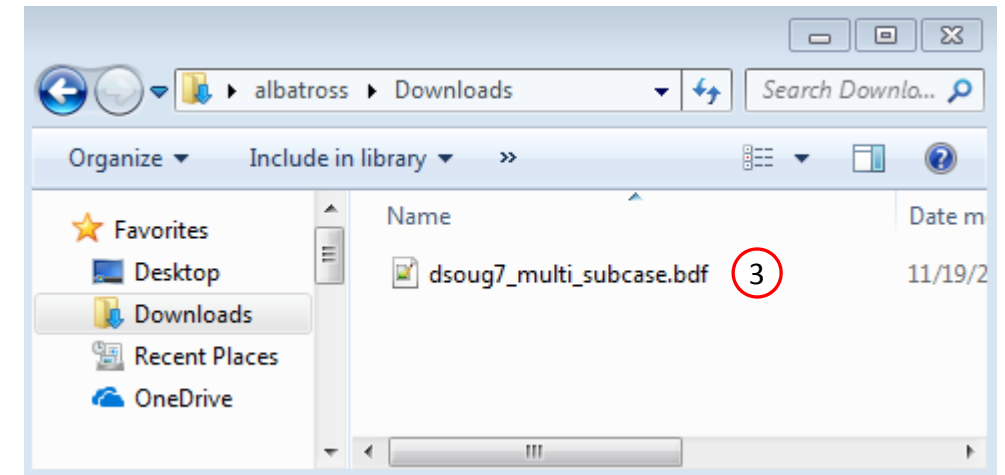
A frequency response analysis has been performed, but the results do not match experimental results.

This tutorial discusses the model matching procedure in order to correlate Finite Element Analysis and test results.

Starting BDF Files: [Link](#)

2

Solution BDF Files: [Link](#)



Open the Correct Page

1. 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 displays the SOL 200 Web App interface. At the top, the title "SOL 200 Web App" is centered, followed by the instruction "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 in two states, "Before" and "After" optimization. A red circle with the number "1" is placed over this category.
- Multi Model Optimization**: Shows a 3D model of a mechanical part and a line graph with multiple curves.
- Machine Learning | Parameter Study**: Shows four small images of mesh deformation or optimization results.
- HDF5 Explorer**: Shows a line graph with multiple curves, similar to the one in the Multi Model Optimization category.
- Viewer**: Shows a 3D cube with a color gradient from red to blue.

At the bottom of the interface, there are two additional links: "Tutorials and User's Guide" and "Full list of web apps".

Upload BDF Files

1. Click 1. Select Files and select dsoug7_multi_subcase.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

1. Select files dsoug7_multi_subcase.bdf

Inspecting: 100%

2. Upload files

Uploading: 100 %

☐ List of Selected Files




Create Design Variables

1. In the search box, type 't'
2. Click 10 on the pagination bar
3. Click on + Options
4. Set the Lower Bound to .01
5. Set the Upper Bound to 1.0
6. Click Create

- There are 2 methods to create the 10 design variables: Click each blue plus icon, which requires 10 mouse clicks, OR click the yellow Create icon, which requires 1 mouse click.
- Each step has hidden functionality for advanced users. The visibility is controlled by clicking **+ Options**.
- If the property entry, e.g. PSHELL, was given a name in Patran, e.g. Car Door, the name can be shown by marking the checkbox titled Entry Name.

Step 1 - Select design properties

3 + Options











Display Type	% Lower Bound	% Upper Bound	Lower Bound	Upper Bound	Allowed Discrete Values or Equation	Bulk Create
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
<input checked="" type="checkbox"/> DVXREL1	Lower	Upper	.01 4	1.0 5	Allowed discrete values, example: -2.0, 1.0, THRU, 10.0, BY, 1.0 6	
<input type="checkbox"/> DVXREL1 Unity	Lower	Upper	.01	1.0	Allowed discrete values, example: -2.0, 1.0, THRU, 10.0, BY, 1.0	
<input type="checkbox"/> DVXREL2	Lower	Upper	.01	1.0	Type equation here, example: y1**2 + x2 + k3	

Display Columns

☒ Create DVXREL1 ☐ Create Unity DVXREL1 ☐ Create DVXREL2 ☐ Entry Name

Settings for row filtering in tables

☒ Contains ☐ Starts with ☐ Ends with

Create DVXREL1	Property ⇅	Property Description ⇅	Entry ⇅	Entry ID ⇅	Current Value ⇅
	t 1	Search	Search	Search	Search
	T	Thickness	PSHELL	1	.08
	T	Thickness	PSHELL	2	.08
	T	Thickness	PSHELL	3	.08
	T	Thickness	PSHELL	4	.08
	T	Thickness	PSHELL	5	.08
	T	Thickness	PSHELL	6	.08
	T	Thickness	PSHELL	7	.08
	T	Thickness	PSHELL	8	.08
	T	Thickness	PSHELL	9	.08
	T	Thickness	PSHELL	10	.08

2

5 10 20 30 40 50

Create Design Variables

1. Click 10 on the pagination bar
2. 10 design variables (x1 - x10) have been created and correspond to the 10 different thicknesses

- In some instances, the optimizer will vary a positive design variable and make it negative, e.g. a thickness of .08 becomes - .01 in a weight minimization optimization. Certain properties, such as thickness or beam cross sections should never be negative. The lower bound in this example is set to .01 to avoid a negative variable during the optimization.

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"/>
✕	x1	✓	T	Thickness	PSHELL	1	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x2	✓	T	Thickness	PSHELL	2	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x3	✓	T	Thickness	PSHELL	3	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x4	✓	T	Thickness	PSHELL	4	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x5	✓	T	Thickness	PSHELL	5	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x6	✓	T	Thickness	PSHELL	6	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x7	✓	T	Thickness	PSHELL	7	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x8	✓	T	Thickness	PSHELL	8	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x9	✓	T	Thickness	PSHELL	9	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,
✕	x10	✓	T	Thickness	PSHELL	10	.08	<input type="text" value=".01"/>	<input type="text" value="1.0"/>	Examples: -2.0, 1.0, THRU, 10.0,

5 10 20 30 40 50

1

Create Design Constraints

1. Click Constraints
2. Click the plus (+) icon for Volume
3. Configure the following for constraint r1
 1. Lower Allowed Limit: 7.99
 2. Upper Allowed Limit: 8.01

- It may be desired to keep a certain response constant during the optimization. For example, the goal may be to preserve the volume of the original design. This is best addressed by creating a constraint where the lower and upper bound are slightly less and greater, than the original response. In this example, you may be tempted to use a lower bound of 8 and an upper bound of 8, but this is not advisable. The better option is to use 7.99 and 8.01 for the lower and upper bound, respectively.

Step 1 - Select constraints

Select an analysis type

SOL 111 - Modal Frequency Response

Select a response

	Response Description ▾	Response Type ▾
	<input type="text" value="Search"/>	<input type="text" value="Search"/>
	Weight	WEIGHT
	Volume	VOLUME
	Fatigue, random vibration fatigue analysis	FRFTG
	Displacement	FRDISP
	Acoustic Pressure	PRES

« 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="Se"/>	<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="3.1"/>	<input type="text" value="3.2"/>
	r1		VOLUME					7.99	8.01

Create Responses

1. Click Equation Constraints. This will make the Equation Constraints section visible and accessible

- The responses that are used for model matching must be defined. The response can be defined in the table titled “Step A – Optional – Create additional responses.” This table is accessible by first turning on the Equation Constraint section by marking the checkbox “Step 3”

SOL 200 Web App - Optimization Upload Variables Objective **Constraints** Subcases Exporter Results

Constraints **Equation Constraints** 1

Step 1 - Create equation constraints

[+ Add Equation Constraint](#)

+ Options

Label ⇅	Status ⇅	Equation ⇅	Lower Allowed Limit	Upper Allowed Limit
<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"/>

Create Responses

1. Scroll to section: Step A - Optional - Create additional responses
2. Click 1 time on the Displacement response to create responses: b1
3. Configure the responses as shown to the right
 - Example: Configure the following for b1
 - ATTA: 3 – RM –T3
 - ATTB: 50. (50 Hz)
 - ATTi: 1110 (grid/node 1110)

- In this example, there are 14 responses to match. One response, b1, is created here. On the next page, CSV and Excel is used to create the other 13 responses. Refer to the Appendix on how to create the 13 responses manually.

Step A - Optional - Create additional responses ①

Select an analysis type

SOL 111 - Modal Frequency Response

Select a response

	Response Description ▾	Response Type ▾
	<input type="text" value="Search"/>	<input type="text" value="Search"/>
	Weight	WEIGHT
	Volume	VOLUME
	Fatigue, random vibration fatigue analysis	FRFTG
②	Displacement	FRDISP
	Acoustic Pressure	PRES

« 1 2 3 4 5 »

5 10 20 30 40 50

Step B - Optional - Adjust responses

+ Options

	Label ▾	Status ▾	Response Type ▾	Property Type ▾	ATTA ▾	ATTB ▾	ATTi ▾
	<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"/>
	b1		FRDISP		3 - RM - T3 (Rectangular z, Cylindr ▾)	50.	1110

③

CSV Change of Responses

1. Click +Options
2. Click Export

- Once Export is clicked, a CSV file is downloaded.
- When using the CSV Export capability, it is best to first create and configure one response that serves as an example for other responses that will be created.

Step B - Optional - Adjust responses

+ Options **1**

☐ Overwrite PTYPE ☒ Property Type ☐ Element Type ☐ Overwrite ATTA ☒ ATTA

CSV Export

Export **2**

CSV Import

Select files

Select a CSV File

Import

	Label	Status	Response Type	Property Type	ATTA	ATTB	ATTi
	Se	Seal	Search	Search	Search	Search	Search
✖	b1	✔	FRDISP		3 - RM - T3 (Rectangular z, Cyindr	50.	1110

CSV Change of Responses

In the following steps, this will be done:

1. Open the downloaded file in Excel
2. Create 13 new rows and make the indicated changes
3. Save the file

Before

1

	A	B	C	D	E	F	G	H	I	J	K	L
1	Label	Response Type	Property Type	ATTA	ATTB	ATTi						
2	b1	FRDISP	-----	3	50	1110						
3												
4												
5												
6												
7												
8												
9												
10												

After

3

2

	A	B	C	D	E	F	G	H	I	J	K	L
1	Label	Response Type	Property Type	ATTA	ATTB	ATTi						
2	b1	FRDISP	-----	3	50	1110						
3	b2	FRDISP		3	100	1110						
4	b3	FRDISP		3	164	1110						
5	b4	FRDISP		3	50	605						
6	b5	FRDISP		3	84	605						
7	b6	FRDISP		3	171	605						
8	b7	FRDISP		3	97	1105						
9	b8	FRDISP		3	173	1105						
10	b9	FRDISP		3	50	1110						
11	b10	FRDISP		3	100	1110						
12	b11	FRDISP		3	164	1110						
13	b12	FRDISP		3	50	1110						
14	b13	FRDISP		3	100	1110						
15	b14	FRDISP		3	164	1110						

CSV Change of Responses

1. Select the .csv file that was modified on the previous slide.
2. Click Import.
3. A summary of changes are shown.

- The necessary 14 responses are now available in the web app.
- MSC Nastran has strict formatting requirements. For example, characters such as !, @, # are not valid for input fields on bulk data entries. Excel has no formatting rules for MSC Nastran, so care must be taken to ensure the formatting is MSC Nastran friendly. On CSV import, a summary is reported indicating all the changes or errors encountered.

Step B - Optional - Adjust responses

+ Options

☐ Overwrite PTYPE ☒ Property Type ☐ Element Type ☐ Overwrite ATTA ☒ ATTA

CSV Export

Export

CSV Import

1

Select files

b-responses-for-equation-constraints.csv

2

Import

CSV imported

3

Summary of successful updates. All other data untouched.

Label	Field	Previous Value	New Value
Created b2			
Created b3			
Created b4			
Created b5			
Created b6			
Created b7			
Created b8			
Created b9			
Created b10			

	Label	Status	Response Type	Property Type	ATTA	ATTB	ATTi
	Se	Seal	Search	Search	Search	Search	Search
✖	b1	✔	FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
✖	b2	✔	FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
✖	b3	✔	FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110
✖	b4	✔	FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	605
✖	b5	✔	FRDISP		3 - RM - T3 (Rectangular z, Cylindr	84.	605

CSV Change of Responses

1. Click +Options
2. Click 20 to list at most 20 rows.

- Since this example has only 14 responses, only 14 rows are displayed.

Step B - Optional - Adjust responses

+ Options **1**

	Label	Status	Response Type	Property Type	ATTA	ATTB	ATTI
	Search	Search	Search	Search	Search	Search	Search
	b1		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b2		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b3		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110
	b4		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	605
	b5		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	84.	605
	b6		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	171.	605
	b7		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	97.	1105
	b8		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	173.	1105
	b9		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b10		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b11		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110
	b12		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b13		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b14		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110

5 10 **20** 30 40 50

2

Configure Model Matching

1. Click Match
2. Click + Options
3. Click Export

A new CSV file is downloaded. Open the file in Excel.

- There are 2 methods to specify model matching data, e.g. target values, include in objective, allowed errors.
 - Method 1 – Supply the data directly in the web app
 - Method 2 – Use Excel and CSV to supply the data.
- This example will use Method 2.

1

Step 1 - Configure model matching

+ Options

2

☐ Show All Labels

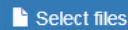
CSV Export



Export

3

CSV Import



Select files

Select a CSV File



Import

Status ▾	Label ▾	Single Scalar? ▾	Description ▾	Target Value ▾	Include in Objective ▾	Max Allowed Error ▾
Search	Search	Search	Search	Search	Search	Search
	b1	Yes	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b2	Yes	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b3	Yes	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b4	Yes	RM - T3 component of displacement at grid 605 at frequency 50. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b5	Yes	RM - T3 component of displacement at grid 605 at frequency 84. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b6	Yes	RM - T3 component of displacement at grid 605 at frequency 171. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b7	Yes	RM - T3 component of displacement at grid 1105 at frequency 97. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b8	Yes	RM - T3 component of displacement at grid 1105 at frequency 173. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b9	Yes	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1
	b10	Yes	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	Example: -100.1	<input type="checkbox"/>	Example: -100.1

« 1 2 »

5 10 20 30 40 50

Configure Model Matching

1. Add the indicated Target Values
2. Set the value to TRUE for the indicated cells
3. Click Save

- Excel is used to modify the CSV file and supply information for the target values, include in objective and allowed errors.
- If a label has TRUE for "Include in Objective," then the error will be minimized in the objective.
- If a label has a value for "Max Allowed Error," then the error will be constrained to be less than the max allowed error.
- If the Target Value is provided, but both the "Include in Objective" and "Max Allowed Error" cells are both blank, upon import to the web app, a default value of .01 will be used for "Max Allowed Error."
- A label can be set for both "Include in Objective" and "Max Allowed Error."

AutoSave Off | File Home Insert Page Layout | 3 | Data Review View Help | Tell me what you want to do | model-matching.csv - Excel

	A	B	C	D	E	F
1	Label	Single Scalar?	Description	Target Value	Include in Objective	Max Allowed Error
2	b1	TRUE	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	2.8384	TRUE	
3	b2	TRUE	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	0.2613	TRUE	
4	b3	TRUE	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	0.2182	TRUE	
5	b4	TRUE	RM - T3 component of displacement at grid 605 at frequency 50. Hz	0.488338		
6	b5	TRUE	RM - T3 component of displacement at grid 605 at frequency 84. Hz	0.018219		
7	b6	TRUE	RM - T3 component of displacement at grid 605 at frequency 171. Hz	0.1845		
8	b7	TRUE	RM - T3 component of displacement at grid 1105 at frequency 97. Hz	0.022128		
9	b8	TRUE	RM - T3 component of displacement at grid 1105 at frequency 173. Hz	0.279055		
10	b9	TRUE	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	1.58019		
11	b10	TRUE	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	0.140642		
12	b11	TRUE	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	0.124761		
13	b12	TRUE	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	0.522618		
14	b13	TRUE	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	0.048008		
15	b14	TRUE	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	0.042346		

Configure Model Matching

1. Select the CSV file that has been updated and saved
2. Click Import
3. A summary of changes is shown
4. The table has been updated to match the data in the CSV file

- If a target value is specified, then one of the following must be set: Include in Objective or Max Allowed Error. When a CSV is uploaded, if neither of these options are set, the Max Allowed Error is automatically set to .01. This value can be modified.
- Labels configured for Include in Objective are added to the Equation Objective. Labels configured with Max Allowed Error have corresponding Equation Constraints. Refer to the Equation Objective and Equation Constraint sections. A label can be set for both Include in Objective and Max Allowed Error.

Step 1 - Configure model matching

+ Options

☐ Show All Labels

CSV Export

Export

CSV Import

Select files

model-matching.csv

2

Import

CSV imported

Summary of successful updates. All other data untouched.

Label	Field	Previous Value	New Value
b1	Target Value		2.8384
b1	Include in Objectiv...		true
b2	Target Value		0.2613
b2	Include in Objectiv...		true
b3	Target Value		0.2182
b3	Include in Objectiv...		true
b4	Target Value		0.488338
b4	Max Allowed Error		.01 (Auto inserted)
b5	Target Value		0.018219
b5	Max Allowed Error		.01 (Auto inserted)

Status	Label	Single Scalar?	Description	Target Value	Include in Objective	Max Allowed Error
Search	Search	Search	Search	Search	Search	Search
<input checked="" type="checkbox"/>	b1	Yes	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	2.8384	<input checked="" type="checkbox"/>	Example: -100.1
<input checked="" type="checkbox"/>	b2	Yes	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	0.2613	<input checked="" type="checkbox"/>	Example: -100.1
<input checked="" type="checkbox"/>	b3	Yes	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	0.2182	<input checked="" type="checkbox"/>	Example: -100.1
<input checked="" type="checkbox"/>	b4	Yes	RM - T3 component of displacement at grid 605 at frequency 50. Hz	0.488338	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b5	Yes	RM - T3 component of displacement at grid 605 at frequency 84. Hz	0.018219	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b6	Yes	RM - T3 component of displacement at grid 605 at frequency 171. Hz	0.1845	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b7	Yes	RM - T3 component of displacement at grid 1105 at frequency 97. Hz	0.022128	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b8	Yes	RM - T3 component of displacement at grid 1105 at frequency 173. Hz	0.279055	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b9	Yes	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	1.58019	<input type="checkbox"/>	.01
<input checked="" type="checkbox"/>	b10	Yes	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	0.140642	<input type="checkbox"/>	.01

« 1 2 »

5 10 20 30 40 50

4

Assign Constraints to Load Cases (SUBCASES)

1. Click Subcases
2. Select all the Subcases to display the corresponding columns in the table

- This example involves multiple subcases. Model matching will be performed across different subcases.

1

Step 1 - Assign constraints to subcases

Display Columns

Global Constraints
SUBCASE 1
SUBCASE 2
SUBCASE 3

2

☐ Uncheck visible boxes

☒ Check visible boxes

Assign Constraints to Load Cases (SUBCASES)

1. Click 20 on the pagination bar
2. Assign r1 as a Global Constraint
3. This tutorial performs model matching for multiple subcases. The constraints must be assigned to the subcases accordingly.
3. Model matching for labels b4, b5, b6, b7 and b8 belong to SUBCASE 1. Mark the indicated checkboxes.
4. Model matching for labels b9, b10, b11 belong to SUBCASE 2. Mark the indicated checkboxes.
5. Model matching for labels b12, b13, b14 belong to SUBCASE 3. Mark the indicated checkboxes.

- Note that the labels R1, R2, ..., may not necessarily be identical to the image on this page. Refer to the labels b4, b5, b6, ..., in the Description column to assign the constraints.

+ Options

	Status	Label	Response Type	Description
		<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>
		r1	VOLUME	Volume of entire model
		R1	Equation	The least square difference between analysis result b4 and target value 0.486338.
		R2	Equation	The least square difference between analysis result b5 and target value 0.018219.
		R3	Equation	The least square difference between analysis result b6 and target value 0.1845.
		R4	Equation	The least square difference between analysis result b7 and target value 0.022128.
		R5	Equation	The least square difference between analysis result b8 and target value 0.279055.
		R6	Equation	The least square difference between analysis result b9 and target value 1.58019.
		R7	Equation	The least square difference between analysis result b10 and target value 0.140642.
		R8	Equation	The least square difference between analysis result b11 and target value 0.124761.
		R9	Equation	The least square difference between analysis result b12 and target value 0.522618.
		R10	Equation	The least square difference between analysis result b13 and target value 0.048008.
		R11	Equation	The least square difference between analysis result b14 and target value 0.042346.

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

5 10 20 30 40 50

1

Assign Constraints to Load Cases (SUBCASES)


1. Scroll to section: Step B - Optional - Configure DRSPAN for equation objective and constraints
2. Configure DRSPAN such that labels b1, b2, b3 are sourced from SUBCASE 1

- Each subcase will yield different displacement frequency responses. The equation objective R0 is dependent on labels b1, b2 and b3, any of which can come from subcase 1, 2 or 3. The DRSPAN option is used to specify the subcase in which each label is sourced from.
- In this example, the equation objective is dependent on b1 from subcase 1, b2 from subcase 1 and b3 from subcase 1.

1

☐ Step B - Optional - Configure DRSPAN for equation objective and constraints

+ Info

Label ⇅	Status ⇅	Configure SUBCASEs of Equation Inputs
Search	Search	
R0		R0 (b1 SUBCASE 1 , b2 SUBCASE 1 , b3 SUBCASE 1 ,)

2

R0		R0 (b1 SUBCASE 1 , b2 SUBCASE 1 , b3 SUBCASE 1 ,)
----	--	---

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

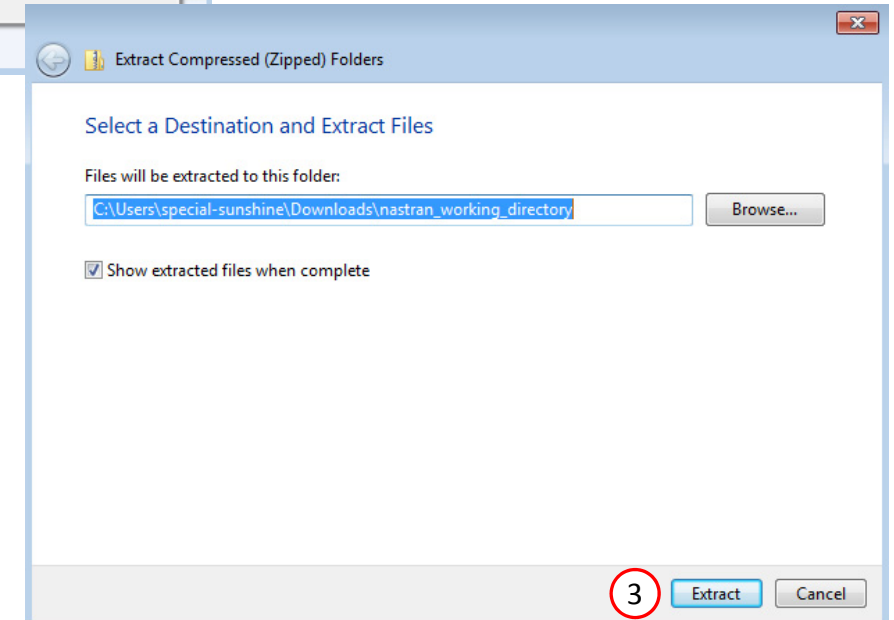
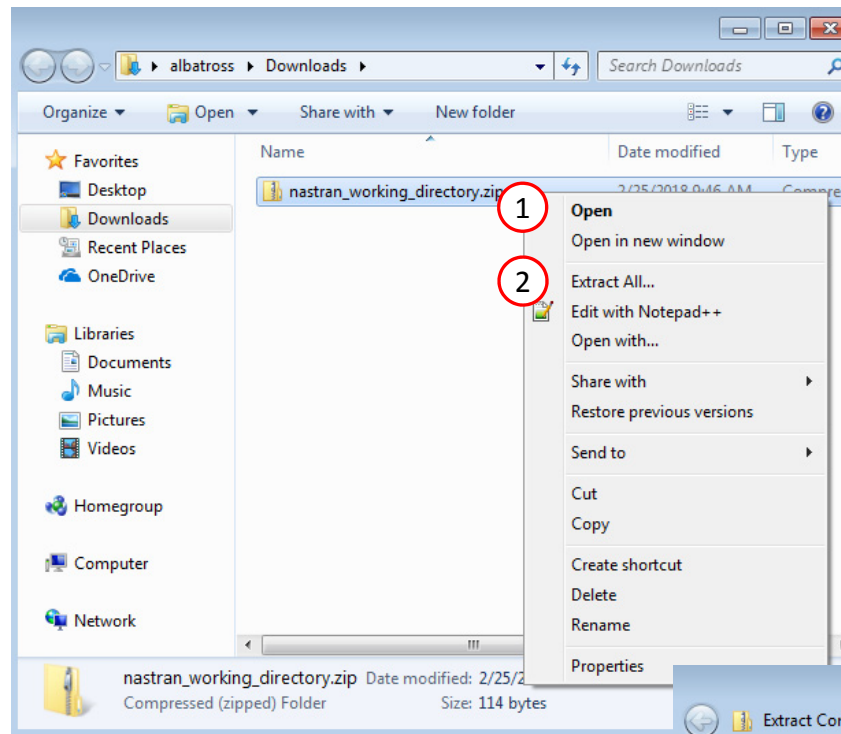
- When the download button is clicked a new file named "nastran_working_directory" is downloaded. If the file already exists in your local folder, the folder name is appended with a number, e.g. "nastran_working_directory (1).zip"

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

Perform the Optimization with Nastran SOL 200

1. A new .zip file 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.

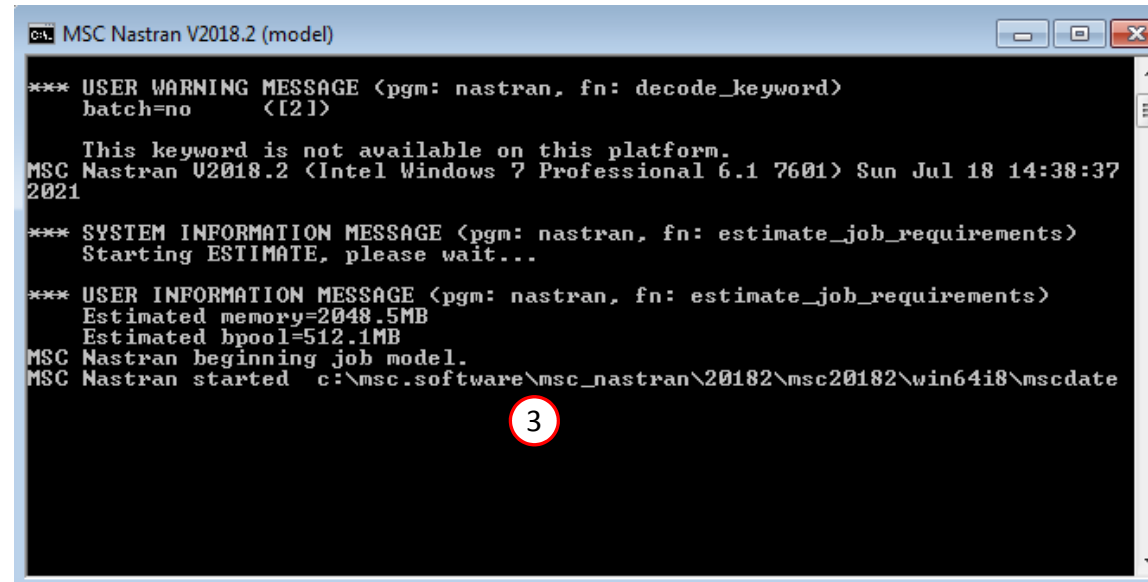
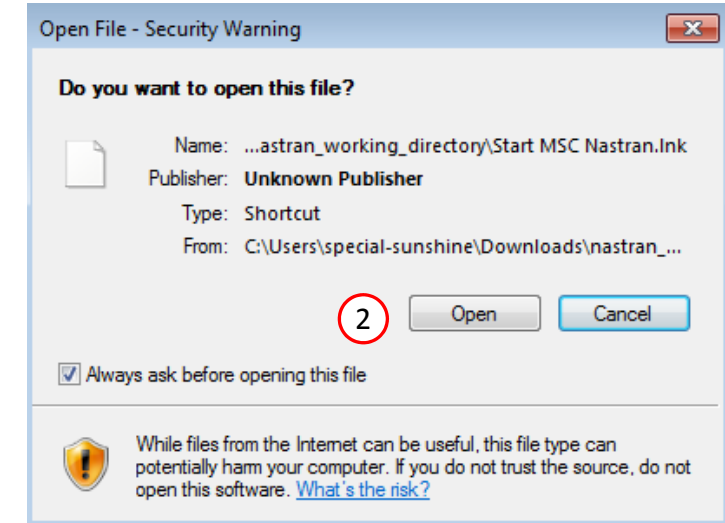
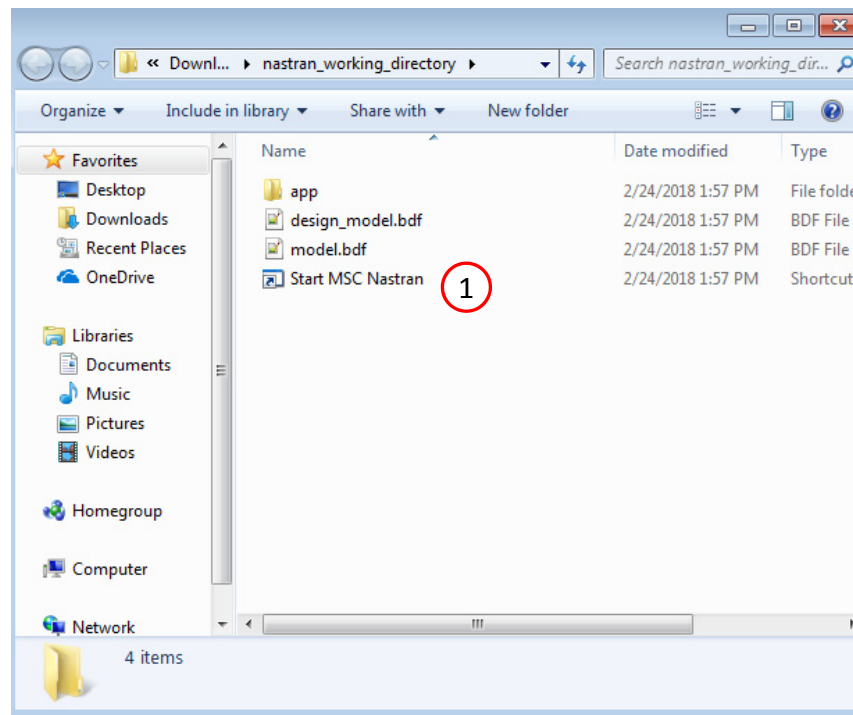
Using Linux?

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

After MSC Nastran is finished, the results will be automatically uploaded.

1. The final value of objective, normalized constraints and design variables (not shown) can be reviewed.

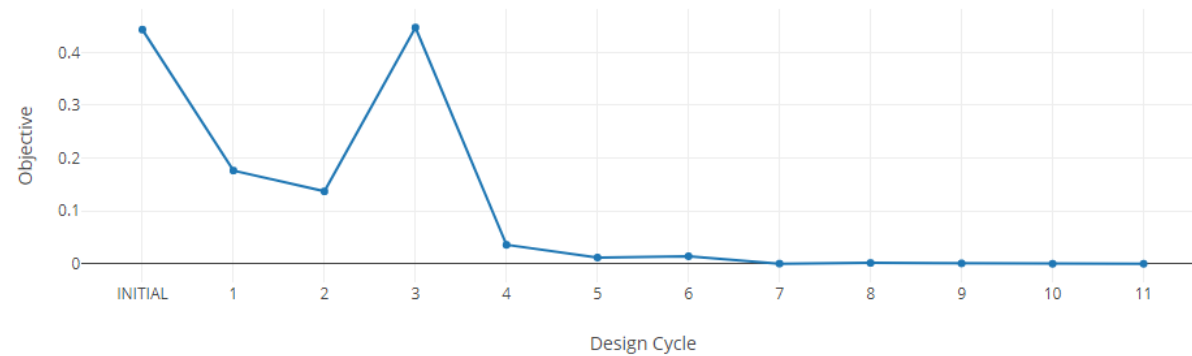
- When performing model matching, the final message in the F06 file may be one of the following messages:
 - RUN TERMINATED DUE TO HARD CONVERGENCE TO AN OPTIMUM
 - RUN TERMINATED DUE TO MAXIMUM NUMBER OF DESIGN CYCLES
 - RUN TERMINATED DUE TO HARD CONVERGENCE TO A BEST COMPROMISE INFEASIBLE DESIGN AT CYCLE NUMBER
- It is important to carefully interpret the final results to determine if the model matching was a success. For this example, the model matching was a success for the following reasons:
 - The objective, which is the error, is minimized as desired
 - The max normalized constraint is close to or less than 0.0
 - The Model Matching bar charts on the next page show good correlation
 - The Response vs. Frequency plots on later pages show good correlation
- If this optimization were repeated, setting the DESMAX, or maximum number of cycles, to a value of 10 will allow the optimizer to terminate sooner.

Final Message in .f06

1

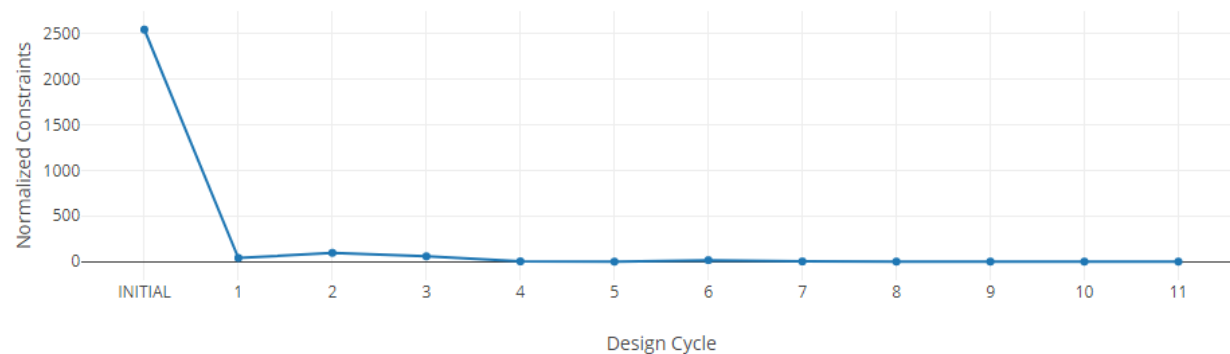
 RUN TERMINATED DUE TO HARD CONVERGENCE TO A BEST COMPROMISE INFEASIBLE DESIGN AT CYCLE NUMBER = 11.

Objective



Normalized Constraints

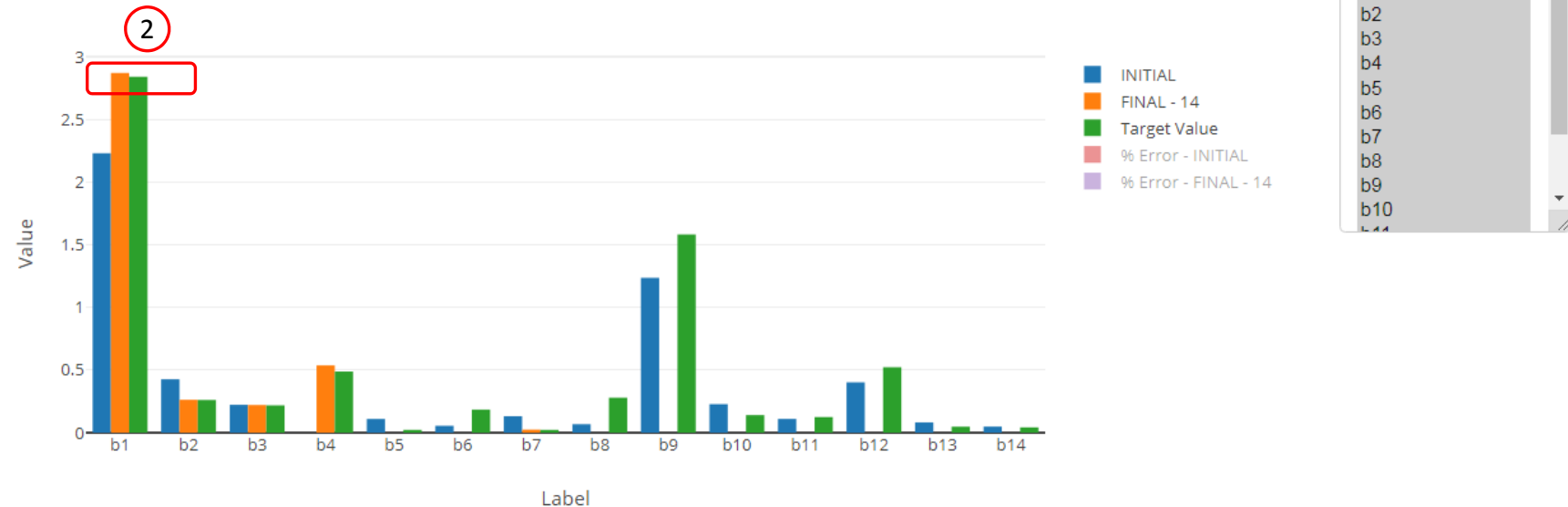
+ Info



Review Optimization Results

1. If “Option 1 – Auto Execute MSC Nastran” was used, bar charts will automatically be generated.
2. These charts can be used to compare the final values of the responses and the target values.

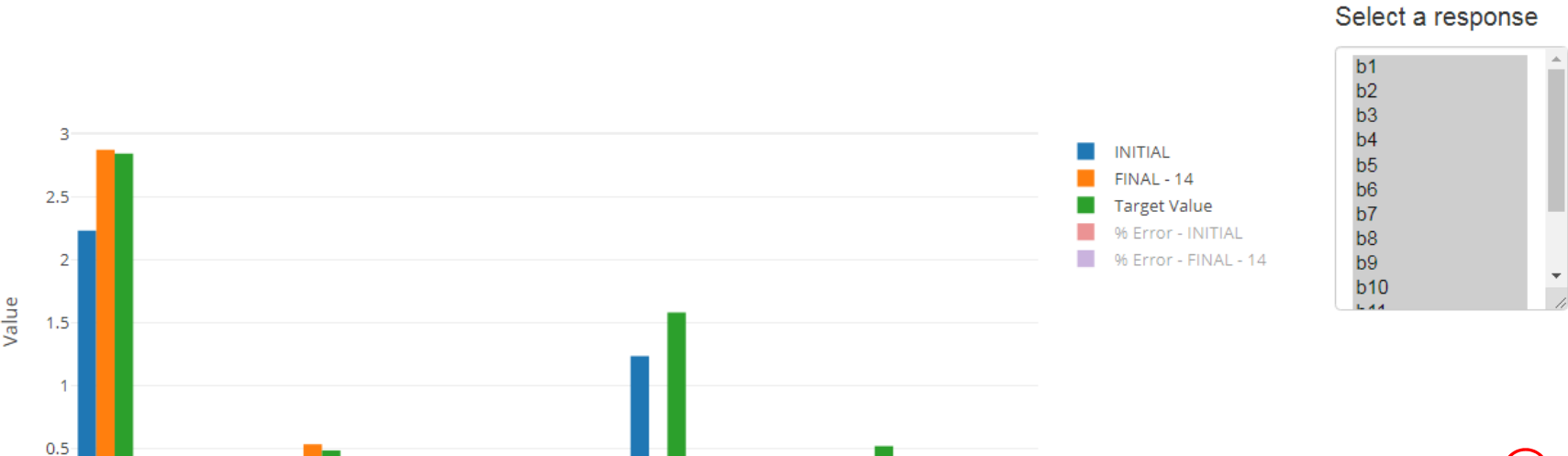
1 Model Matching Bar Charts



- A. The Bar Charts report the following values for each response/label: The original/initial value, the final value after optimization, the target value, and the percent errors of the initial and final design.
- B. If the bars for both final and target values are equally leveled, the indicates an exact correlation. Alternatively the percent errors are listed in the table and may be used to gauge the success of the model matching.

Design Cycle	b1	b2	b3	b4	b5
A	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	RM - T3 component of displacement at grid 605 at frequency 50. Hz	RM - T3 component of displacement at grid 605 at frequency 100. Hz
INITIAL	2.2289E+00	4.2585E-01	2.2228E-01	Not reported in F06**	1.100
FINAL - 14	2.8691E+00	2.6287E-01	2.2075E-01	5.3717E-01	Not reported in F06**
Target Value	2.8384E+00	2.6130E-01	2.1820E-01	4.8834E-01	1.821
% Error - INITIAL	-21.47	62.97	1.87		504.0
% Error - FINAL - 14	B 1.08	0.60	1.17	10.00	

Model Matching Bar Charts



3

**For the corresponding design cycle, this response was not reported in the F06 file, section: RESPONSES IN DESIGN MODEL.

This occurs when the design constraint is highly satisfied, i.e. the response is matching its targeted value, but due to constraint screening, highly satisfied constraints are not reported.

To keep and report the missing response values, use this bulk data entry and re-run the optimization: DSCREEN,EQUA,-1000,100

Design Cycle	b1	b2	b3	b4	b5
	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	RM - T3 component of displacement at grid 605 at frequency 50. Hz	RM - T3 component of displacement at grid 605 at frequency 100. Hz
INITIAL	2.2289E+00	4.2585E-01	2.2228E-01	Not reported in F06**	1.100
FINAL - 14	2.8691E+00	2.6287E-01	2.2075E-01	5.3717E-01	Not reported in F06**
Target Value	2.8384E+00	2.6130E-01	2.1820E-01	4.8834E-01	1.821
% Error - INITIAL	-21.47	62.97	1.87		504.0
% Error - FINAL - 14	1.08	0.60	1.17	10.00	

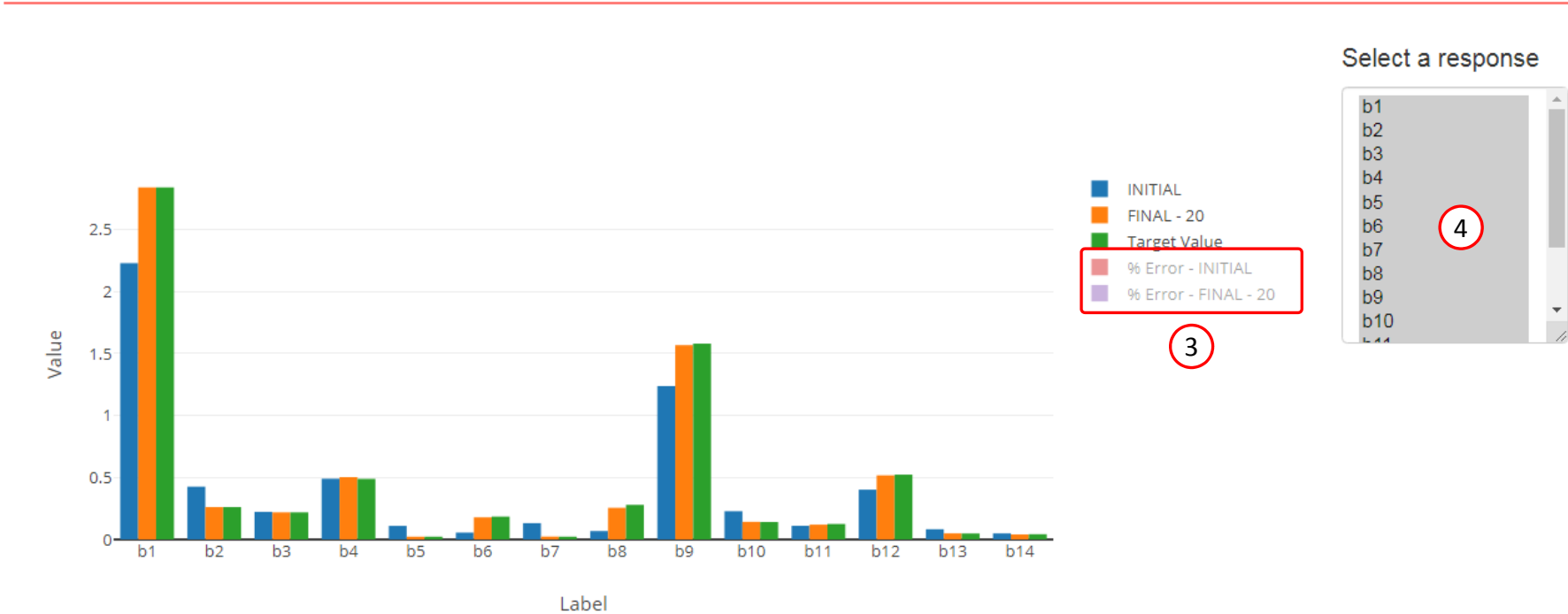
Review Optimization Results

1. Some error values are not reported.
2. The error value is dependent on the response values that are reported in the F06 file. Due to design constraint screening, some responses are not reported in the F06 file, so their errors cannot be determined.
3. Use the mouse cursor to hover over the message "Not reported in F06**." More details about the missing response values are displayed. The recommendation is to use the following bulk data entry to report more responses in the F06.

DSCREEN,EQUA,-1000,100

This is read as follows: "keep normalized constraints greater than a value of -1000. and keep up to 100 normalized constraints." This will force the optimization procedure to report additional response values to the F06 file.

Model Matching Bar Charts



Design Cycle	b1	b2	b3	b4	b5
	RM - T3 component of displacement at grid 1110 at frequency 50. Hz	RM - T3 component of displacement at grid 1110 at frequency 100. Hz	RM - T3 component of displacement at grid 1110 at frequency 164. Hz	RM - T3 component of displacement at grid 605 at frequency 50. Hz	RM - T3 component of displacement at grid 605 at frequency 100. Hz
INITIAL	2.2289E+00	4.2585E-01	2.2228E-01	4.8972E-01	1.100
FINAL - 20	2.8385E+00	2.6130E-01	2.1820E-01	5.0333E-01	1.830
Target Value	2.8384E+00	2.6130E-01	2.1820E-01	4.8834E-01	1.821
% Error - INITIAL	-21.47	62.97	1.87	0.28	504.0
% Error - FINAL - 20	0.00	0.00	0.00	3.07	0.49

Review Optimization Results

The optimization is repeated, but with this entry.

- DSCREEN,EQUA,-1000.,100
- After the optimization is complete and the results are displayed, note that additional responses are reported and their respective errors are now calculated.
 - The change of response b1 is inspected. The initial error was -21.47%, but was reduced to 0.00% during the optimization. Note the actual percent error is 3.5E-5, but was rounded to two decimal places. Similar results are observed for the other errors. This was a successful model matching.
 - Bars for the error values may be displayed by clicking on the indicated entries in the legend.
 - Bars for specific responses may be displayed with the indicated select box.

Review Dynamic Results

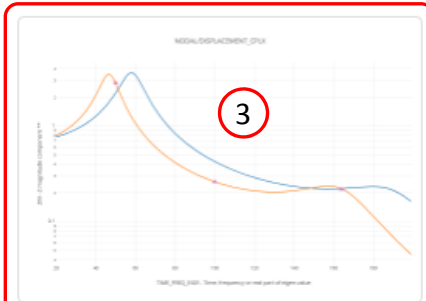
1. If “Start MSC Nastran” is used and MSC Nastran 2016 or newer is used, the HDF5 Explorer will be opened and a plot will automatically be created.
2. The Plots Browser contains a list of the plots that have been created
3. Click the indicated image

- Use the navigation bar at the top of the web app to navigate between the following sections
 - Acquire Dataset
 - Plots Browser
 - Combine Plots
 - Last Plot Added

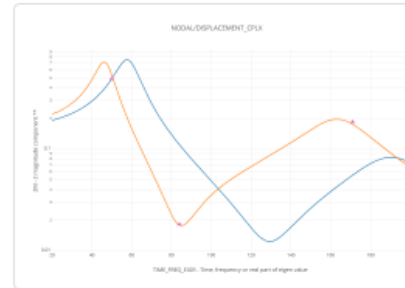
Plots Browser 2

NODAL/DISPLACEMENT_CPLX

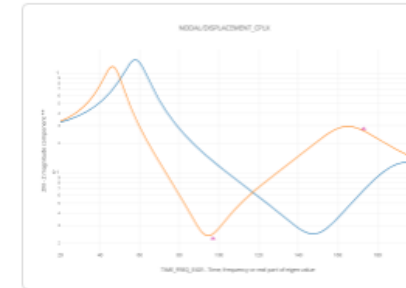
Download CSV



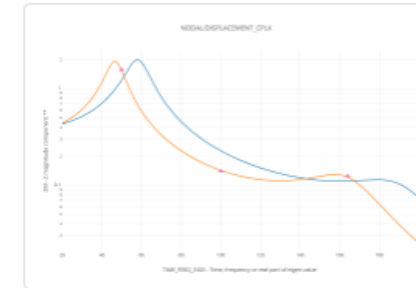
Plot #: 1 - ID: 1110 | SAMPLE: model | SUBCASE: 1 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR



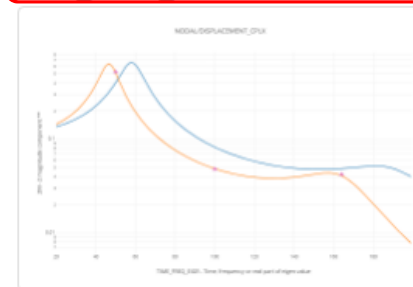
Plot #: 2 - ID: 605 | SAMPLE: model | SUBCASE: 1 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR



Plot #: 3 - ID: 1105 | SAMPLE: model | SUBCASE: 1 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR



Plot #: 4 - ID: 1110 | SAMPLE: model | SUBCASE: 2 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR



Plot #: 5 - ID: 1110 | SAMPLE: model | SUBCASE: 3 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR

Review Dynamic Results

1. The plot contains the INITIAL and FINAL values of the dynamic response.
2. The target values are shown by triangle markers. It is shown that the final displacement curve correlates to the target values.

- The HDF5 Explorer is useful for creating plots of frequency response analysis results and can be used in non-optimization scenarios.

Plot - NODAL/DISPLACEMENT_CPLX - Plot #: 1 - ID: 1110 | SAMPLE: model | SUBCASE: 1 | DESIGN_CYCLE: 0, 11 | ZM vs. TIME_FREQ_EIGR

Vertical Axis

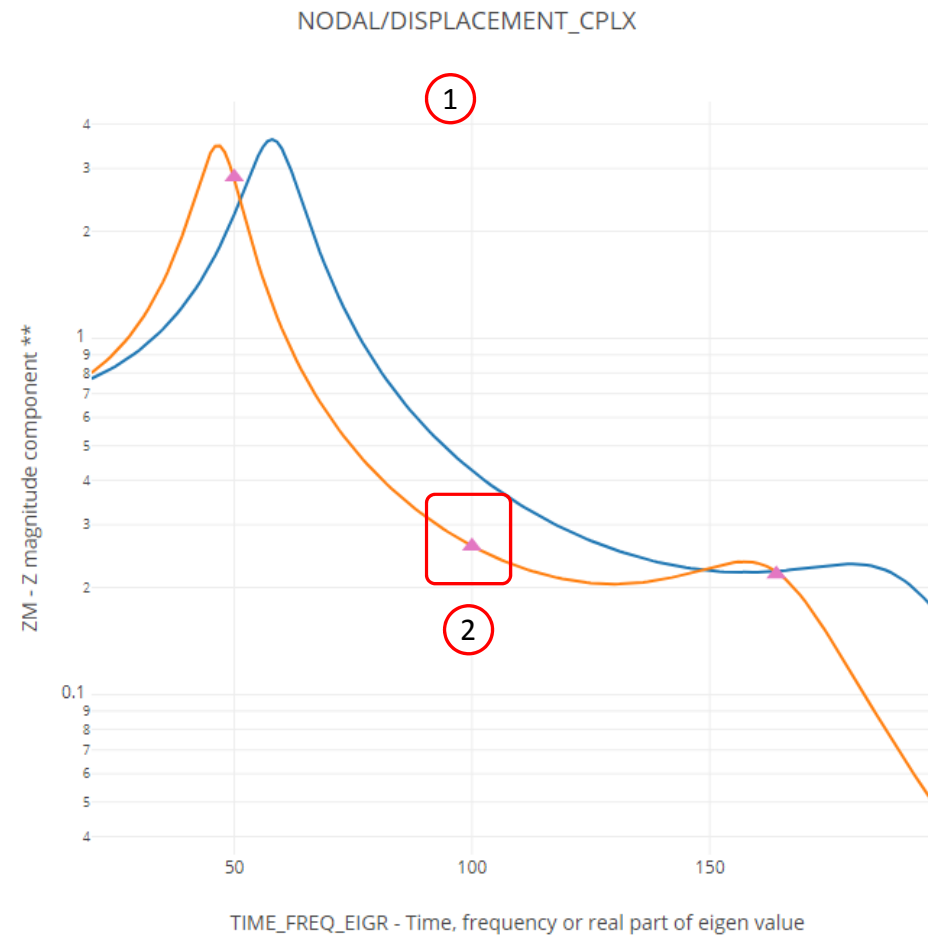


ZM - Z magnitude comp

Horizontal Axis

TIME_FREQ_EIGR - Tir

+ Options



☐ Display None ☒ Display All

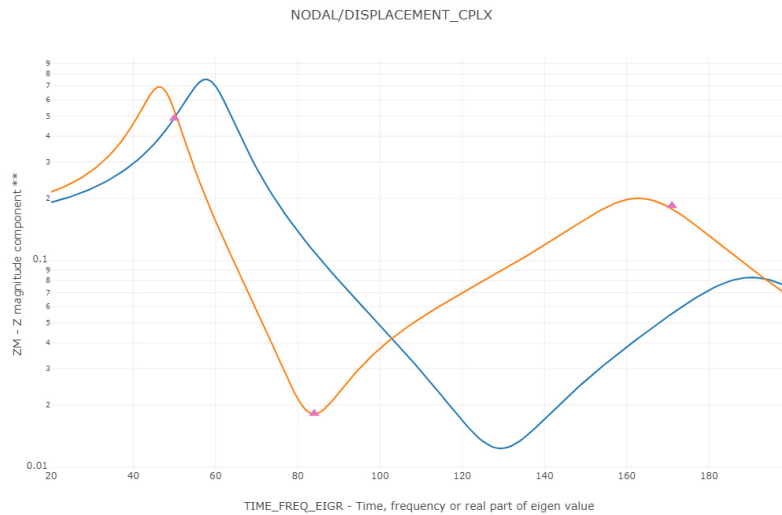
Display	Color	Name
<input checked="" type="checkbox"/>	Blue	0 - ID: 1110 SAMPLE: model SUBCASE: 1 DESIGN_CYCLE: 0
<input checked="" type="checkbox"/>	Orange	1 - ID: 1110 SAMPLE: model SUBCASE: 1 DESIGN_CYCLE: 11
<input checked="" type="checkbox"/>	Pink Triangle	ID: 1110 SUBCASE: 1 Target Values

Results

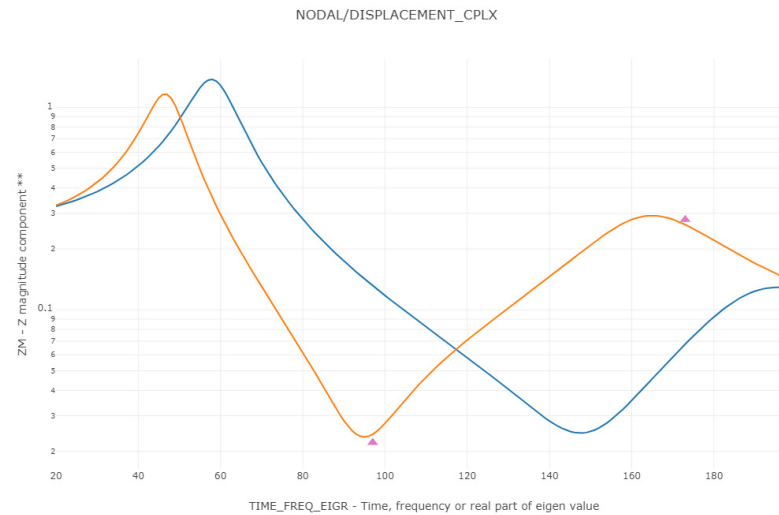
Subcase 1

— INITIAL FEA Results
— FINAL FEA Results
▲ Experiment/ Target Values

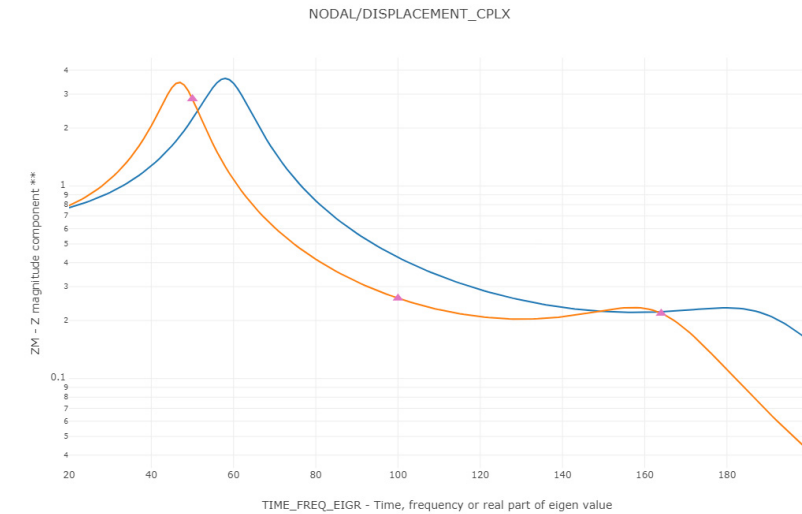
Transverse displacement at grid 605



Transverse displacement at grid 1105



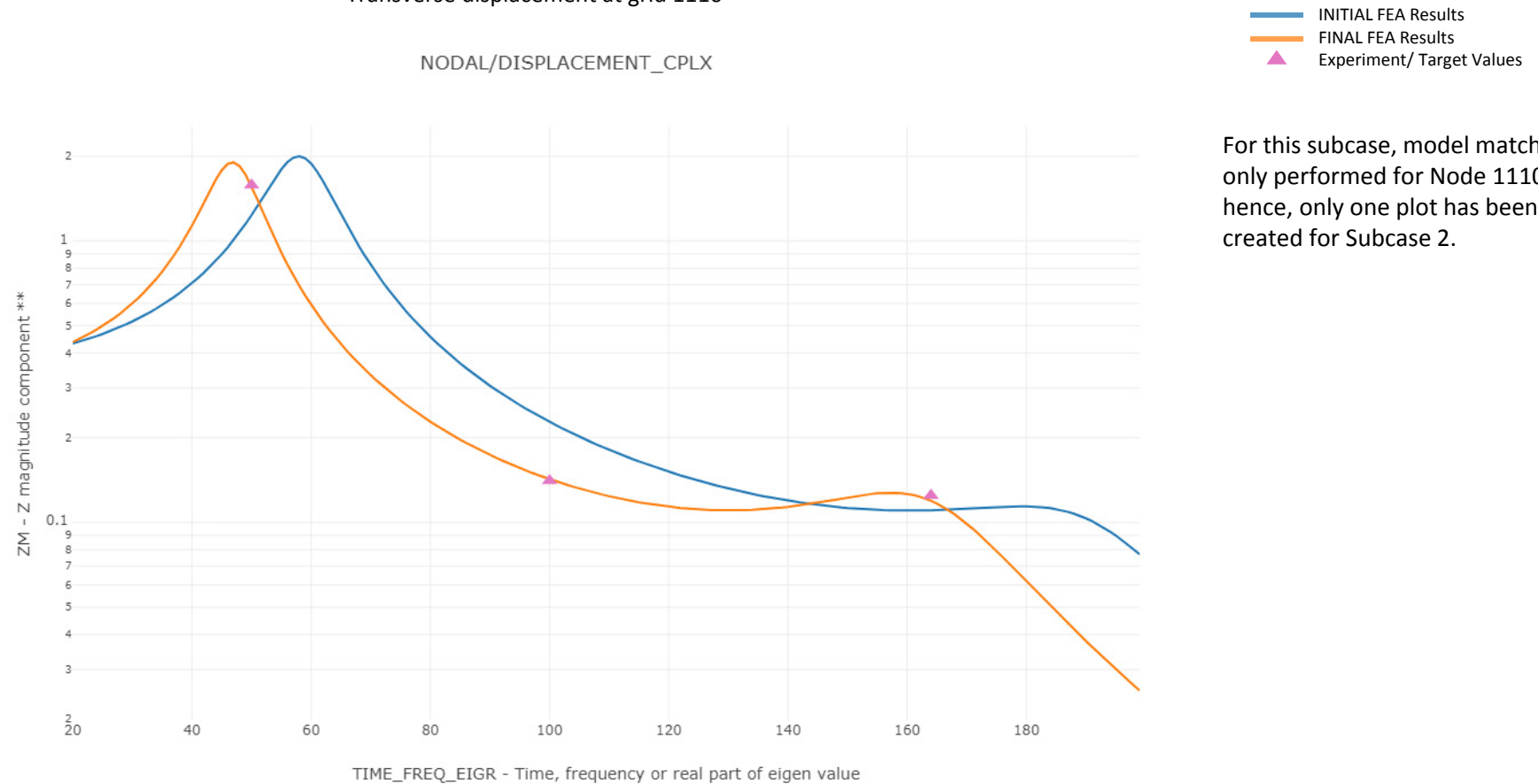
Transverse displacement at grid 1110



Results

Subcase 2

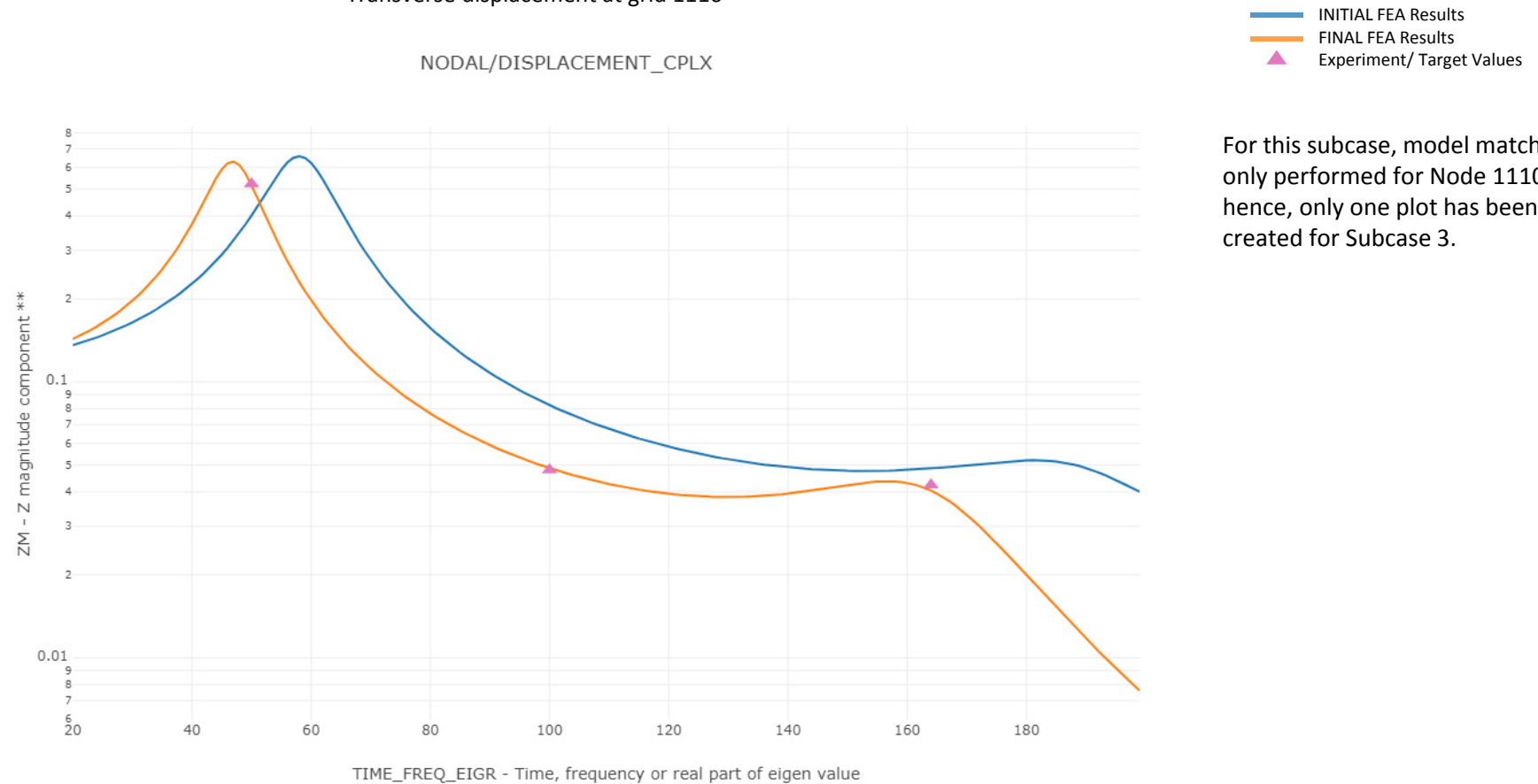
Transverse displacement at grid 1110



Results

Subcase 3

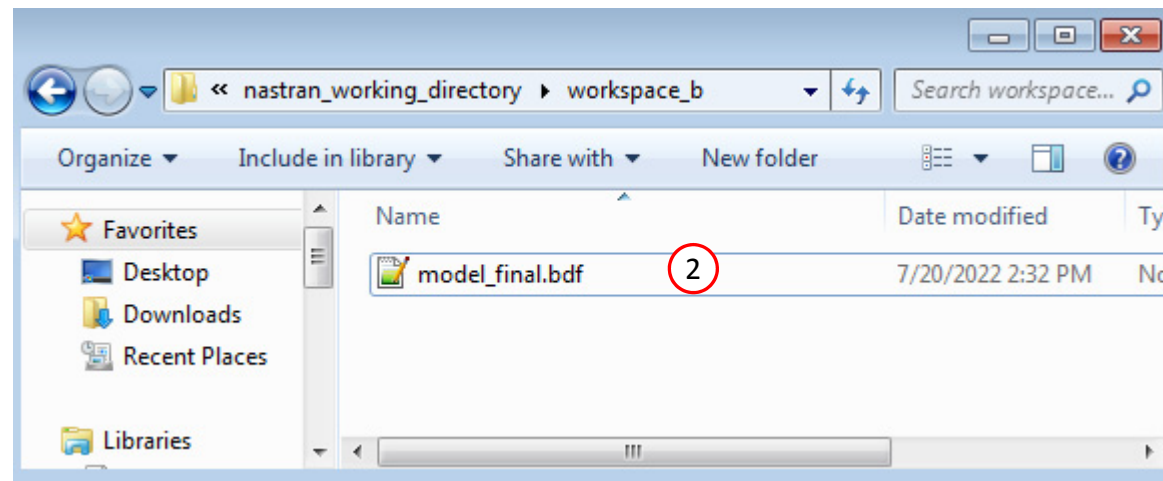
Transverse displacement at grid 1110



Update the Original Model

1. The original input files, e.g. DAT, BDF, etc., contains the original values for the designed properties. These original values must be updated to use the new and optimized values.
2. A new BDF file has been created in nastran_working_directory/workspace_b/ model_final.bdf.
3. The file model_final.bdf is a copy of the original input files but the original values for the designed properties have been updated to use the optimized values.

- If you were using multiple INCLUDE files, model_final.bdf is a combination of all INCLUDE files. The next few slides discuss an alternative method of using the PCH to BDF web app to update the values for the designed properties while preserving separate INCLUDE files.



Original Input Files

```

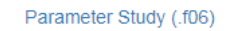
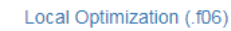
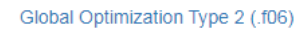
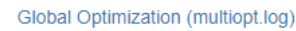
$ Elements and Element Properties for region : Section_1
PSHELL 1 150 .08 150
$ Elements and Element Properties for region : Section_2
PSHELL 2 150 .08 150
$ Elements and Element Properties for region : Section_3
PSHELL 3 150 .08 150
$ Elements and Element Properties for region : Section_4
PSHELL 4 150 .08 150
$ Elements and Element Properties for region : Section_5
PSHELL 5 150 .08 150
$ Elements and Element Properties for region : Section_6
PSHELL 6 150 .08 150
$ Elements and Element Properties for region : Section_7
PSHELL 7 150 .08 150
$ Elements and Element Properties for region : Section_8
PSHELL 8 150 .08 150
$ Elements and Element Properties for region : Section_9
PSHELL 9 150 .08 150
$ Elements and Element Properties for region : Section_10
PSHELL 10 150 .08 150
RLOAD1 700 730 800
RLOAD1 701 740 801
RLOAD1 702 750 802
SPC1 100 246 1101 1102 1103 1104 1105 1106
SPC1 1107 1108 1109
SPC1 100 246 1110
SPC1 100 123456 100 101 102 103 104 105
SPC1 106 107 108 109 110 200 300 400
SPC1 500 600 700 800 900 1000 1100
TABDMP1 2000
    
```

Updated BDF File (model_final.bdf)

```

$ Elements and Element Properties for region : Section_1
PSHELL 1 150 .118409 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_2
PSHELL 2 150 .07019 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_3
PSHELL 3 150 .040908 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_4
PSHELL 4 150 .058417 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_5
PSHELL 5 150 .047482 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_6
PSHELL 6 150 .077489 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_7
PSHELL 7 150 .098516 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_8
PSHELL 8 150 .120287 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_9
PSHELL 9 150 .167569 150 1.0 0 .833333 0.
$ Elements and Element Properties for region : Section_10
PSHELL 10 150 .234747 150 1.0 0 .833333 0.
    
```

1. Click Results
2. Click PCH to BDF



Converter

PCH to BDF

Update the Original Model

The original .bdf/.dat file has old information about the properties. The properties will be updated.

1. Select the model.pch file
2. Select the original file: dsoug7_multi_subcase.bdf
3. A summary of updates that will be performed are shown
4. Click Download and a new updated BDF file is downloaded

Step 1 - Select PCH File

1

Select files

model.pch

Inspecting: 100%

☐ List of Selected Files

PCH Entries

PSHELL	1	150	.118409 0	150	1.0	0	.833333	0.0
PSHELL	2	150	.07019 0	150	1.0	0	.833333	0.0
PSHELL	3	150	.040908 0	150	1.0	0	.833333	0.0
PSHELL	4	150	.058417 0	150	1.0	0	.833333	0.0
PSHELL	5	150	.047482 0	150	1.0	0	.833333	0.0
PSHELL	6	150	.077489 0	150	1.0	0	.833333	0.0
PSHELL	7	150	.098516 0	150	1.0	0	.833333	0.0
PSHELL	8	150	.120287 0	150	1.0	0	.833333	0.0
PSHELL	9	150	.167569 0	150	1.0	0	.833333	0.0
PSHELL	10	150	.234747 0	150	1.0	0	.833333	0.0

Step 2 - Select BDF Files

2

Select files

dsoug7_multi_subcase.bdf

Inspecting: 100%

☐ List of Selected Files

BDF Entries

PSHELL	1	150	.08	150
PSHELL	2	150	.08	150
PSHELL	3	150	.08	150
PSHELL	4	150	.08	150
PSHELL	5	150	.08	150
PSHELL	6	150	.08	150
PSHELL	7	150	.08	150
PSHELL	8	150	.08	150
PSHELL	9	150	.08	150
PSHELL	10	150	.08	150

Step 3 - Download New BDF Files

On download, the PCH entries will replace older BDF entries.

Download

4

Update the Original Model

1. Note the entries have been updated with the optimized properties

dsouq7 multi_subcase.bdf	dsouq7 multi_subcase.bdf
298 \$ Elements and Element Properties for region : Section_1	298 \$ Elements and Element Properties for region : Section_1
299 PSHELL 1 150 .08 150	299 PSHELL 1 150 .118409 150 1.0 0 .833333 0.
300 \$ Elements and Element Properties for region : Section_2	300 \$ Elements and Element Properties for region : Section_2
301 PSHELL 2 150 .08 150	301 PSHELL 2 150 .07019 150 1.0 0 .833333 0.
302 \$ Elements and Element Properties for region : Section_3	302 \$ Elements and Element Properties for region : Section_3
303 PSHELL 3 150 .08 150	303 PSHELL 3 150 .040908 150 1.0 0 .833333 0.
304 \$ Elements and Element Properties for region : Section_4	304 \$ Elements and Element Properties for region : Section_4
305 PSHELL 4 150 .08 150	305 PSHELL 4 150 .058417 150 1.0 0 .833333 0.
306 \$ Elements and Element Properties for region : Section_5	306 \$ Elements and Element Properties for region : Section_5
307 PSHELL 5 150 .08 150	307 PSHELL 5 150 .047482 150 1.0 0 .833333 0.
308 \$ Elements and Element Properties for region : Section_6	308 \$ Elements and Element Properties for region : Section_6
309 PSHELL 6 150 .08 150	309 PSHELL 6 150 .077489 150 1.0 0 .833333 0.
310 \$ Elements and Element Properties for region : Section_7	310 \$ Elements and Element Properties for region : Section_7
311 PSHELL 7 150 .08 150	311 PSHELL 7 150 .098516 150 1.0 0 .833333 0.
312 \$ Elements and Element Properties for region : Section_8	312 \$ Elements and Element Properties for region : Section_8
313 PSHELL 8 150 .08 150	313 PSHELL 8 150 .120287 150 1.0 0 .833333 0.
314 \$ Elements and Element Properties for region : Section_9	314 \$ Elements and Element Properties for region : Section_9
315 PSHELL 9 150 .08 150	315 PSHELL 9 150 .167569 150 1.0 0 .833333 0.
316 \$ Elements and Element Properties for region : Section_10	316 \$ Elements and Element Properties for region : Section_10
317 PSHELL 10 150 .08 150	317 PSHELL 10 150 .234747 150 1.0 0 .833333 0.
318 RLOAD1 700 730 800	318 RLOAD1 700 730 800
319 RLOAD1 701 740 801	319 RLOAD1 701 740 801
320 RLOAD1 702 750 802	320 RLOAD1 702 750 802
321 SPC1 100 246 1101 1102 1103 1104 1105 1106	321 SPC1 100 246 1101 1102 1103 1104 1105 1106
322 SPC1 1107 1108 1109	322 SPC1 1107 1108 1109
323 SPC1 100 246 1110	323 SPC1 100 246 1110
324 SPC1 100 123456 100 101 102 103 104 105	324 SPC1 100 123456 100 101 102 103 104 105
325 SPC1 106 107 108 109 110 200 300 400	325 SPC1 106 107 108 109 110 200 300 400
326 SPC1 500 600 700 800 900 1000 1100	326 SPC1 500 600 700 800 900 1000 1100
327 TABDMP1 2000	327 TABDMP1 2000

Original BDF/DAT File

Downloaded BDF/DAT File

End of Tutorial

Appendix

Appendix Contents

- Manually Creating Responses
- How is error defined in this tutorial?

Manually Creating Responses

1. Scroll to section: Step A - Optional - Create additional responses
2. Click 14 times on the Displacement response to create responses: b1, b2, ..., b14
3. Configure the responses as shown to the right
 - Example: Configure the following for b1
 - ATTA: 3 – RM – T3
 - ATTB: 50.
(50 Hz)
 - ATTi: 1110
(grid/node 1110)
 - Repeat the same for b2 through b14 but note that each row will be different

• This tutorial used the CSV and Excel method to create all 14 responses. This page shows the process to manually create the 14 responses.

1 Step A - Optional - Create additional responses

Select an analysis type

SOL 111 - Modal Frequency Response

Select a response

	Response Description	Response Type
	<input type="text" value="Search"/>	<input type="text" value="Search"/>
	Weight	WEIGHT
	Volume	VOLUME
	Fatigue, random vibration fatigue analysis	FRFTG
	Displacement	FRDISP
	Acoustic Pressure	PRES

2

Step B - Optional - Adjust responses

+ Options

	Label	Status	Response Type	Property Type	ATTA	ATTB	ATTi
	<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"/>
	b1		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b2		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b3		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110
	b4		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	605
	b5		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	84.	605
	b6		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	171.	605
	b7		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	97.	1105
	b8		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	173.	1105
	b9		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b10		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b11		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110
	b12		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	50.	1110
	b13		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	100.	1110
	b14		FRDISP		3 - RM - T3 (Rectangular z, Cylindr	164.	1110

3

5 10 20 30 40 50

How is error defined in this tutorial?

There are 2 methods to define the error.

- Method A requires the use of both the lower and upper bound.
- Method B requires only the use of the upper bound.

Method A and Method B are equivalent. Method A requires both the upper and lower bound to specified, but Method B requires only the specification of an upper bound. Method B is used in this tutorial.

Let

$$\text{Error} = \frac{b1 - \text{Target}}{\text{Target}}$$

Method A

$$\text{Lower Bound} < \frac{b1 - \text{Target}}{\text{Target}} < \text{Upper Bound}$$

- $b1$: Response from FEA
- Target : Value from experiment
- Lower Bound: -.1 or -10%
- Upper Bound: +.1 or +10%
 - The error is allowed to be between -.1 and +.1 (Equivalently between -10% and +10%)

Method B

$$\left(\frac{b1 - \text{Target}}{\text{Target}}\right)^2 < \text{Upper Bound}$$

- $b1$: Response from FEA
- Target : Value from experiment
- Upper Bound: $.1^2 = .01$
 - In this method, the expression is now the error squared. The max allowed error is +/- .1 but can be expressed with one bound, i.e. $\text{error}^2 < .1^2 = .01$.