

Workshop - Dynamic Response Optimization with Nastran Optimization

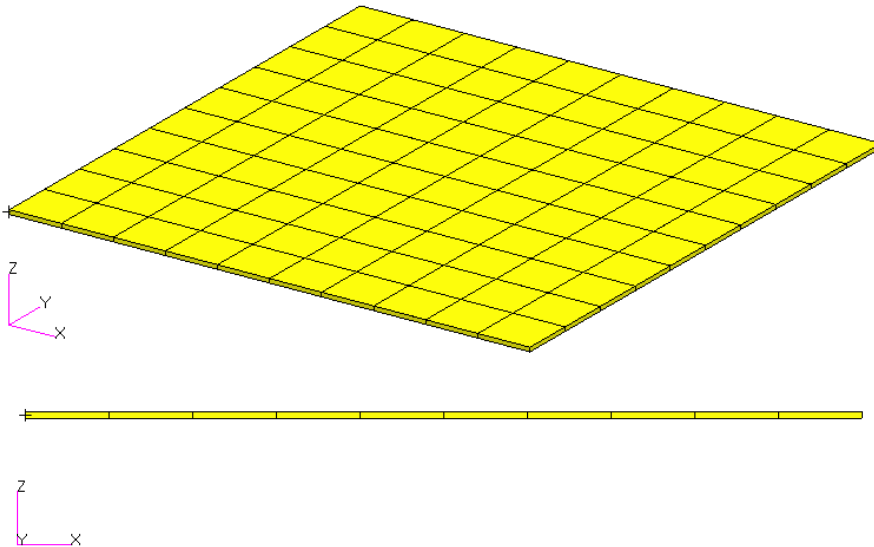
AN MSC NASTRAN SOL 200 TUTORIAL

Goal: Use Nastran SOL 200 Optimization

Minimize the RSS displacement while maintaining a constant volume

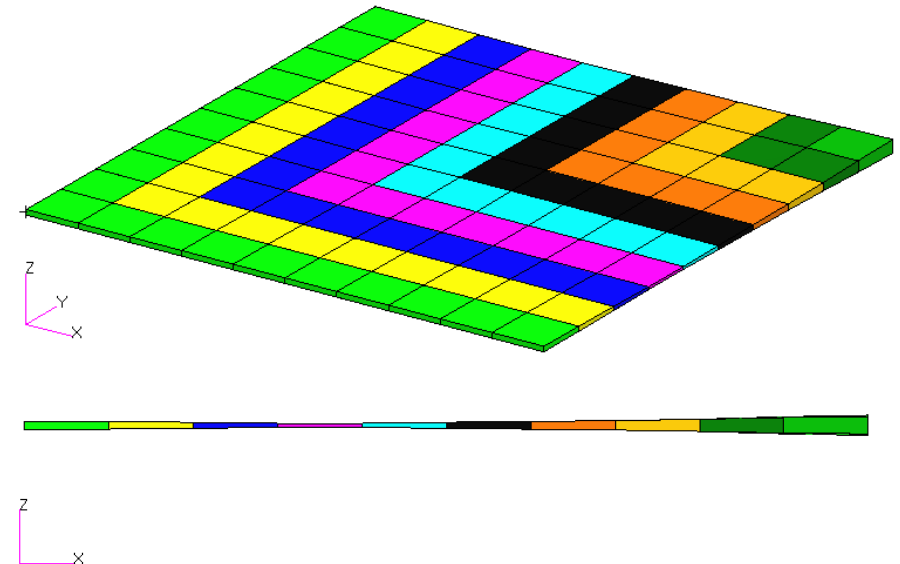
Before Optimization

- RSS displacement at node 1110: 15.2 in.
- Volume: 8.00 in³



After Optimization

- RSS displacement at node 1110: 11.3 in.
- Volume: 7.99 in³



*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 $1.0 \text{ lb}_f/\text{in}^2$ 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.

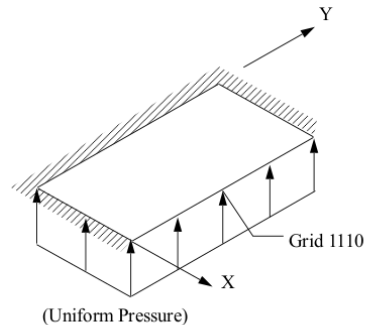
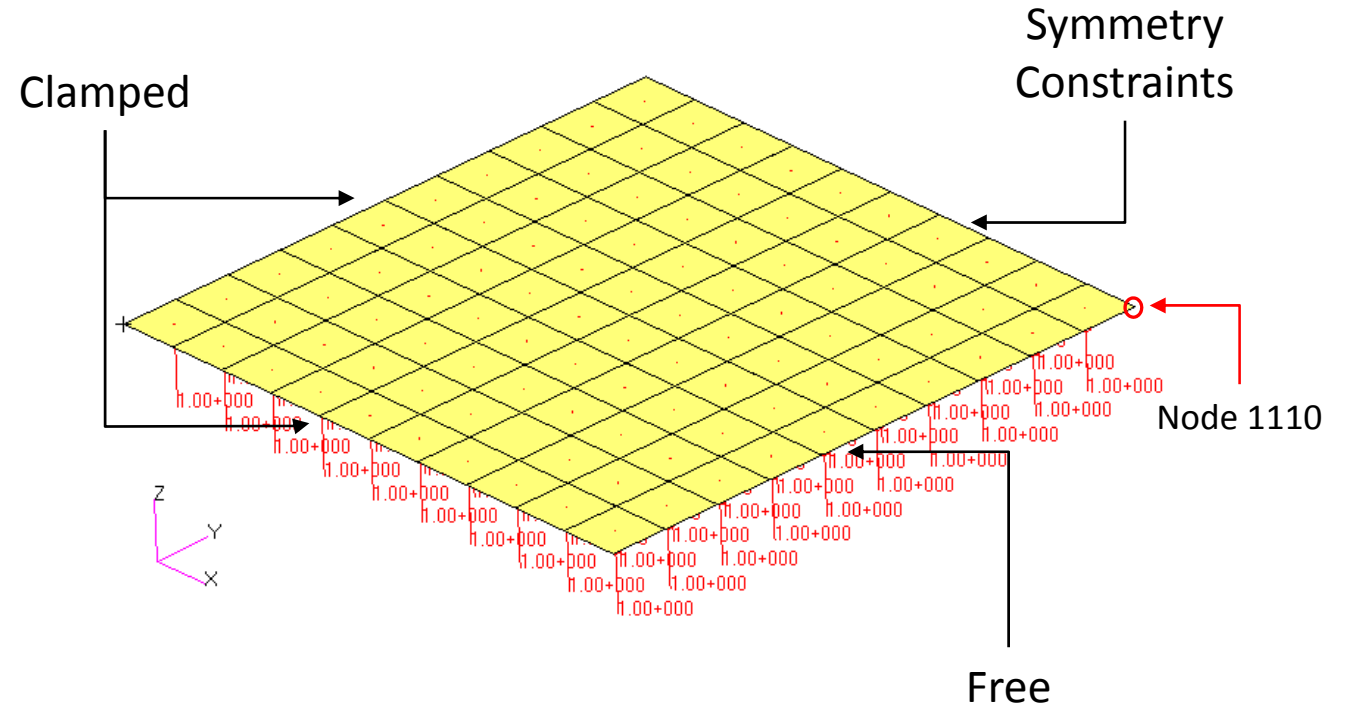


Figure 8-21 Pressure-Loaded Flat Plate

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

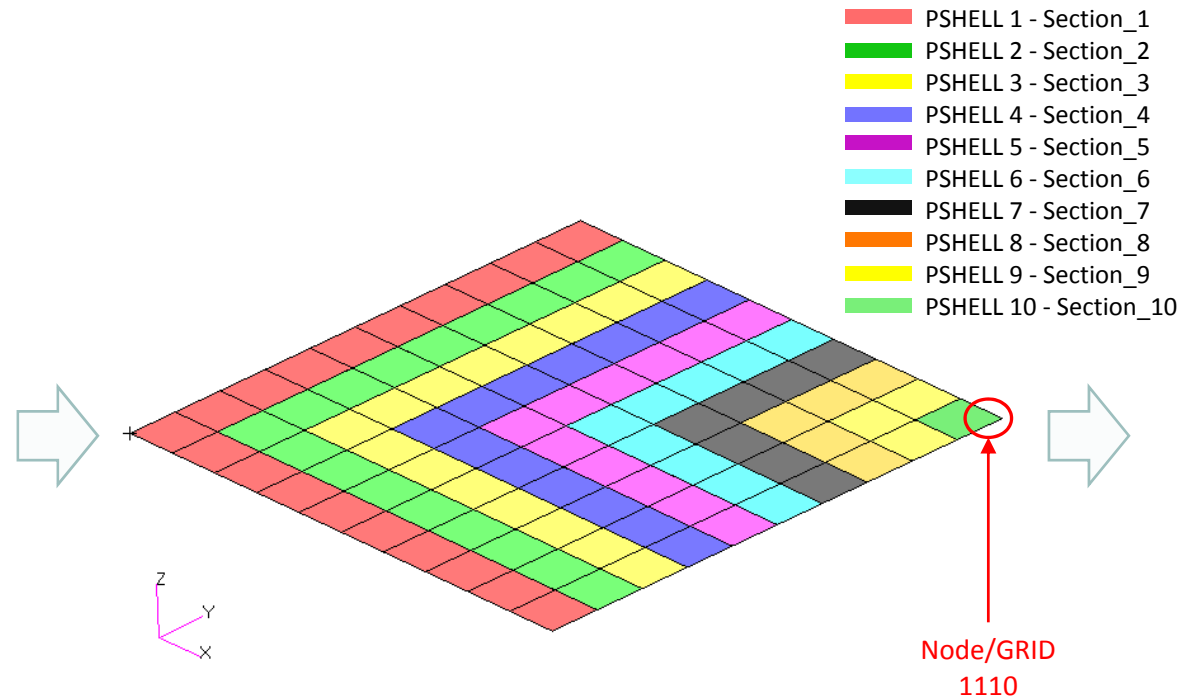


Optimization Problem Statement

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

S0: Minimize the root sum of squares for displacement magnitudes at node 1110 for forcing frequencies 20Hz - 200 Hz

$$\min \phi = \sqrt{\sum_{i=20}^{200} (u_{z, 1110}^i)^2}$$

Design Constraints

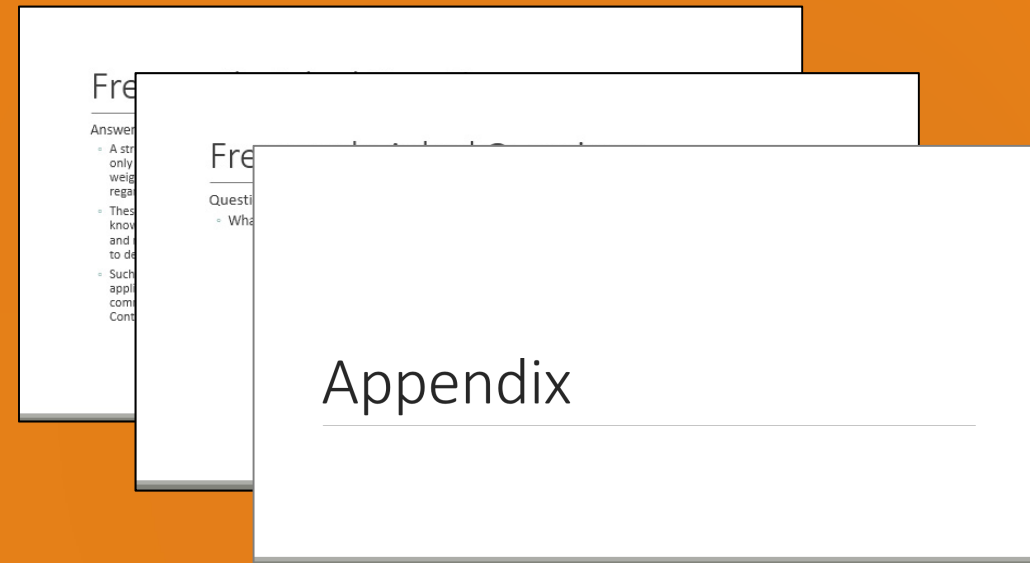
r1: Volume

$$7.99 < r_1 < 8.01$$

More Information Available in the Appendix

The Appendix includes information regarding the following:

- Frequently Asked Questions
 - What are global constraints?



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

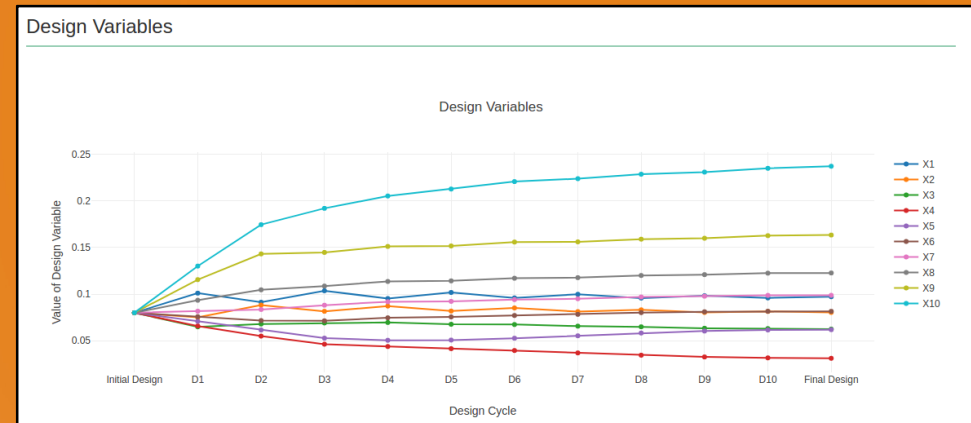
Tutorial

Tutorial Overview

1. Start with a .bdf or .dat file
2. Use the 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.



SOL 200 Web App Capabilities

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

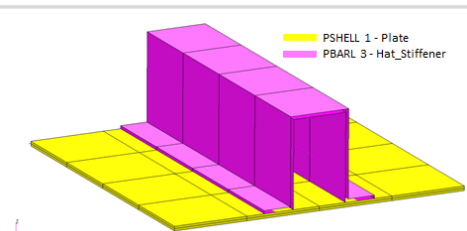
Compatibility

- 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.

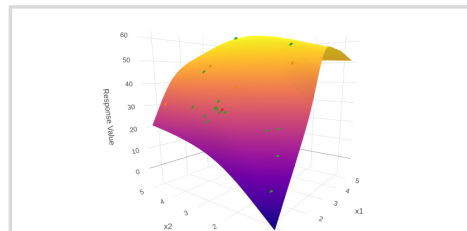
Web Apps

Benefits

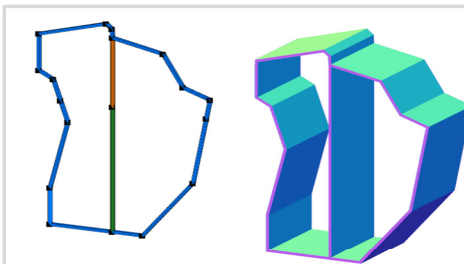
- REAL TIME error detection. 200+ error validations.
- REAL TIME creation of bulk data entries.
- Web browser accessible
- Free Post-processor web apps
- +80 tutorials



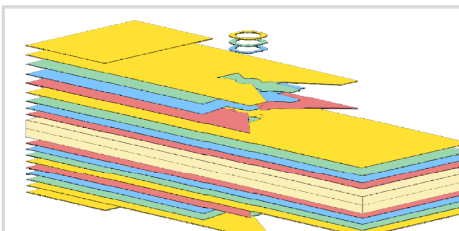
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200.
Support for size, topology, topometry, topography, multi-model optimization.



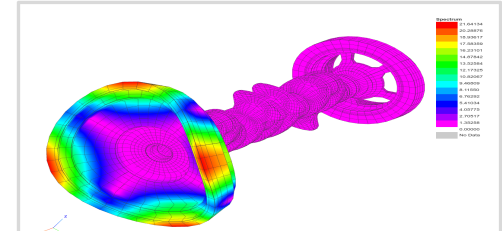
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



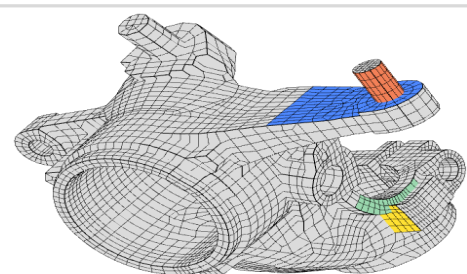
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



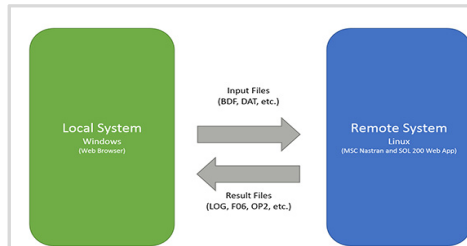
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



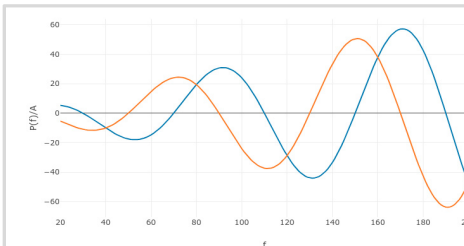
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



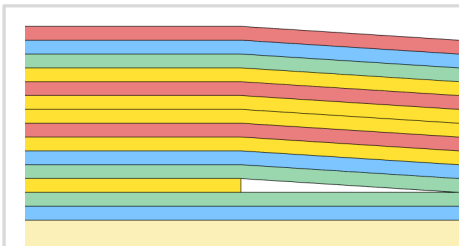
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



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

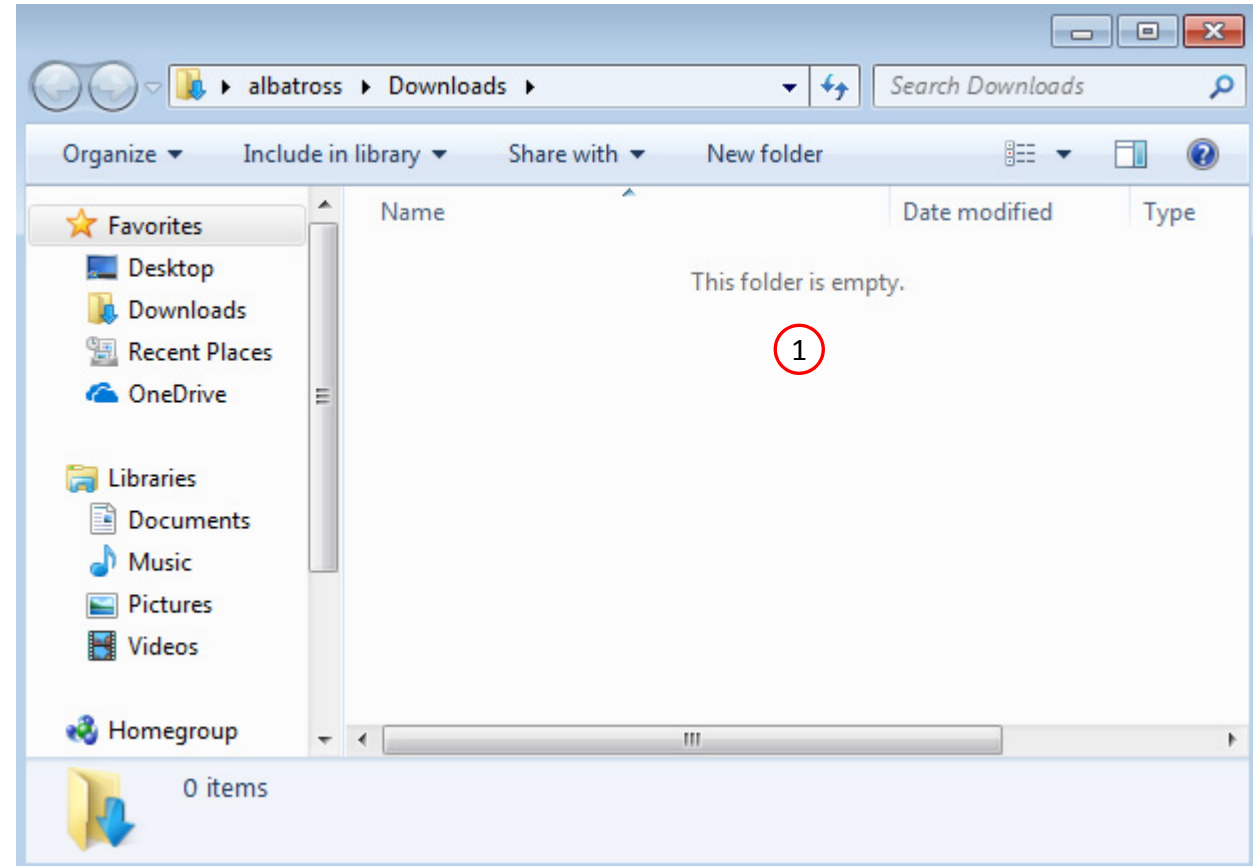


HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

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

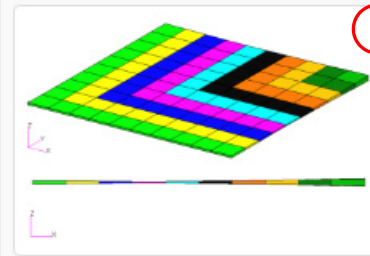
- The necessary BDF files for this tutorial are available in the Tutorials section of the User's Guide.



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 Dynamic Response Optimization with MSC Nastran Optimization

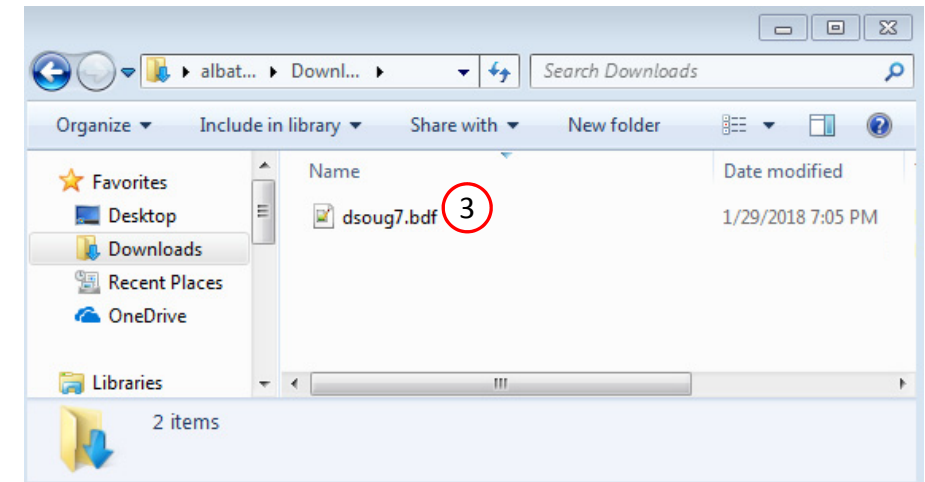
[Link](#)

This example is from the MSC Nastran Design Sensitivity and Optimization User's Guide.

"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 lbf/in² 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."

— MSC Nastran 2016 Design Sensitivity and Optimization User's Guide. Chapter 8: Example Problems. Dynamic Response Optimization.

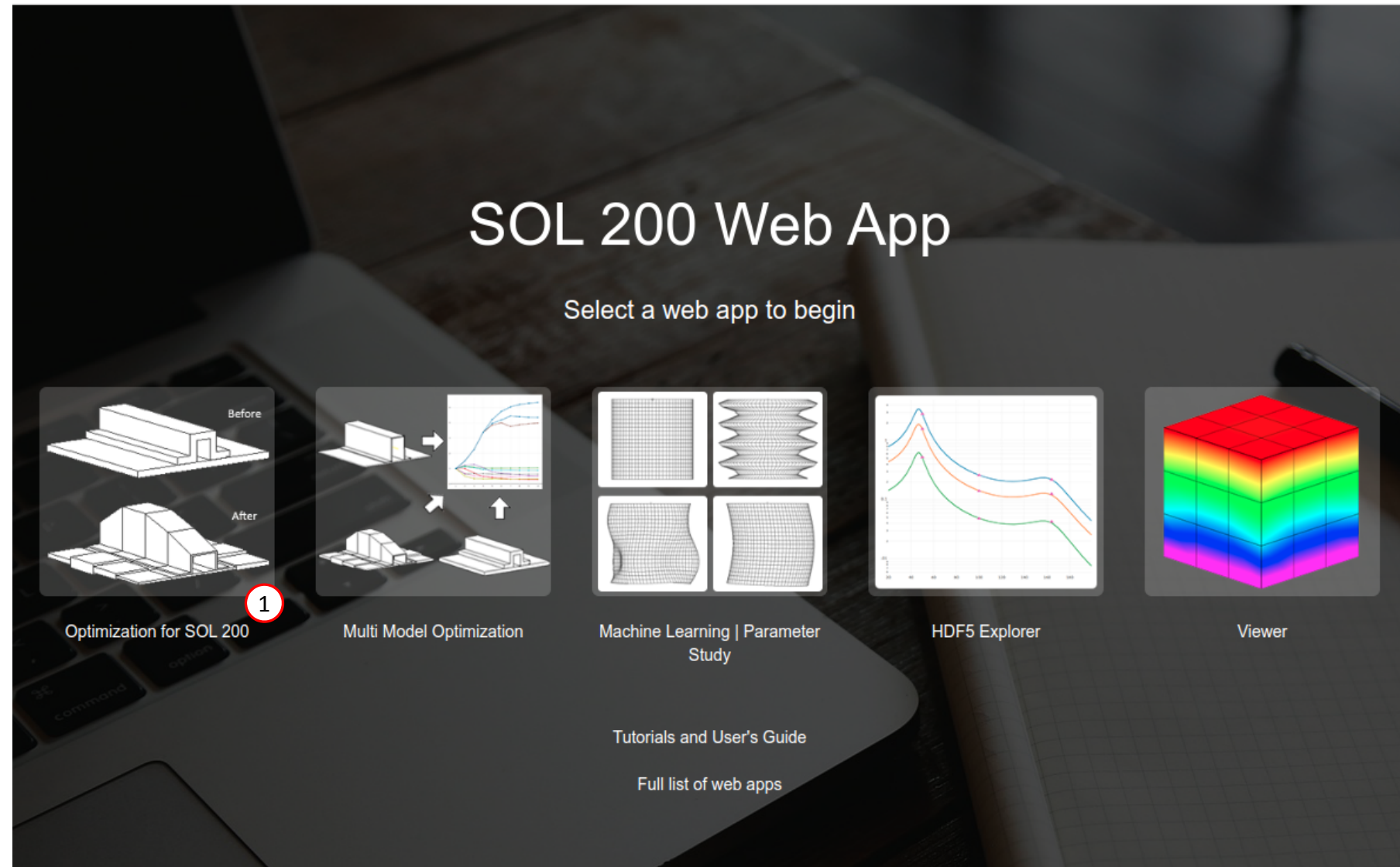
Starting BDF Files: [Link](#)
Solution BDF Files: [Link](#)



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.



Upload BDF Files

1. Click 1. Select Files and select dsoug7.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 two-step process for uploading BDF files. Step 1, '1. Select files', is highlighted with a red circle and shows a file named 'dsoug7.bdf' selected. Below this, a green progress bar indicates 'Inspecting: 100%'. Step 2, '2. Upload files', is also highlighted with a red circle and shows a green progress bar indicating 'Uploading: 100 %'. At the bottom, there is a checkbox labeled 'List of Selected Files' which is currently unchecked.

1. Select files dsoug7.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 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	Create
<input type="checkbox"/> DVXREL1 Unity	Lower	Upper	.01	1.0	Allowed discrete values, example: -2.0, 1.0, THRU, 10.0, BY, 1.0	Create
<input type="checkbox"/> DVXREL2	Lower	Upper	.01	1.0	Type equation here, example: y1**2 + x2 + k3	Create

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

Create Design Objective

1. Click Objective
2. Select the plus (+) icon for displacement
3. Configure the following for S0
 1. ATTA: 3 - RM - T3
 2. ATTB: RSS - Root Sum of Squares
 3. ATTi: 1110 (node 1110)

- Suppose the frequency response displacement is given as follows.
 - Freq: 10Hz, Displacement: .3
 - Freq: 50Hz, Displacement: 1.
 - Freq: 100Hz, Displacement: .7
- If ATTB="All Frequencies," then the 3 displacement values above are referenced, yielding 3 responses for r0.
- If ATTB=RSS, then the Root Sum of Squares of the 3 values is referenced, yielding 1 response for S0. For this example,

$$S0 = RSS = \sqrt{.3^2 + 1^2 + .7^2} = 1.26$$

Step 1 - Select an objective

↔ Switch to Equation Objective

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 2 - Adjust objective

+ Options

	Label	Status	Response Type	Maximize or Minimize	Property Type	ATTA	ATTB	ATTi
	S0		FRDISP	MIN		3 - RM - T3 (Rectangular, Cylindr 3.1	RSS - Root Sum 3.2	1110 3.3

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="S1"/>	<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"/>		
	r1		VOLUME					7.99	8.01

Assign Constraints to Load Cases (SUBCASES)

1. Click Subcases

2. Mark the checkbox

r1 or the Volume is applied as a Global Constraint

- There are 2 types of responses: Global and Subcase Dependent responses. Global responses are the same regardless of subcase and examples include volume, weight, etc. Subcase Dependent responses vary across subcases. For example, stress or strain will vary from subcase to subcase.
- In this example, Volume is a global response, therefore, the volume constraint is assigned as a Global Constraint.

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




Step 1 - Assign constraints to subcases

Display Columns

Global Constraints
SUBCASE 1

☐ Uncheck visible boxes ☒ Check visible boxes

+ Options

	Status ⌵	Label ⌵	Response Type ⌵	Description	Global Constraints ⌵	SUBCASE 1 ⌵
		<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>		
		r1	VOLUME	Volume of entire model	2 	

Configure Settings

1. Click Settings
2. Scroll to section Result Files
3. Select one of the following H5 output options
 - Create the H5 file with MDLPRM
 - Create the H5 file with HDF5OUT

- The H5 file is used by the Post-processor web app to display MSC Nastran results.
- The H5 file is used by the HDF5 Explorer to create graphs (XY Plots) of MSC Nastran results.

The screenshot shows the 'SOL 200 Web App - Optimization' interface. The 'Settings' tab is selected, indicated by a red circle with the number '1'. Below the navigation bar, the 'Result Files' section is highlighted with a red circle and the number '2'. Within this section, the 'H5 Output Option' dropdown menu is open, showing three options: 'Create the H5 file with HDF5OUT (supported in MSC Nastran 2022.2 or newer)', 'Create the H5 file with MDLPRM (supported in MSC Nastran 2016.1 or newer)', and 'Create the H5 file with HDF5OUT (supported in MSC Nastran 2022.2 or newer)'. The third option is selected and highlighted in blue, with a red circle and the number '3' next to it. On the right side of the interface, there is a 'BDF Output' section with a list of parameters including '\$', '\$', '\$', '\$', '\$', 'DOPTPRM', 'DESM', '\$ Parameter t', and 'HDF5OUT INPUT'.

Export New BDF Files

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

UploadVariablesObjectiveConstraintsSubcases**Exporter**Results

SettingsMatchOtherUser's GuideHome

BDF Output - Model

```
assign userfile = 'optimization_results.csv', status = unknown,
form = formatted, unit = 52
ID MSC DSOUG7 $ v2004 ehj 25-Jun-2003
TIME 200
SOL 200
CEND

TITLE = Synthesis of Responses across Different Frequencies: DSOUG7
ECHO = NONE
SET 10 = 1110
$ ANALYSIS AS WELL AS SENSITIVITY ANALYSIS
$ DESOBJ(MIN) = 8000000
DESLB = 40000000
$ DSAPRT(FORMATTED, EXPORT, END=SENS) = ALL
subcase 1
ANALYSIS = HFREQ
$ DESUR slot
$ DRSPAN slot
SPC = 100
DLOAD = 700
FREQ = 740
METHOD = 500
sdamping = 2000
output
disp(plot,phase) = ALL
output(xyout)
cscale 2.0
ymax=4.0
plotter = nastran
```

Download BDF Files

BDF Output - Design Model

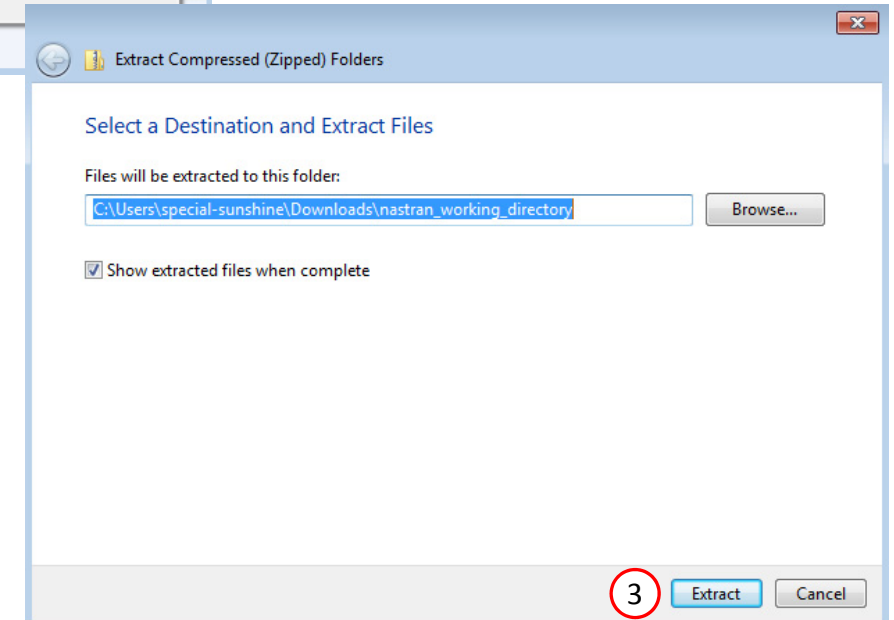
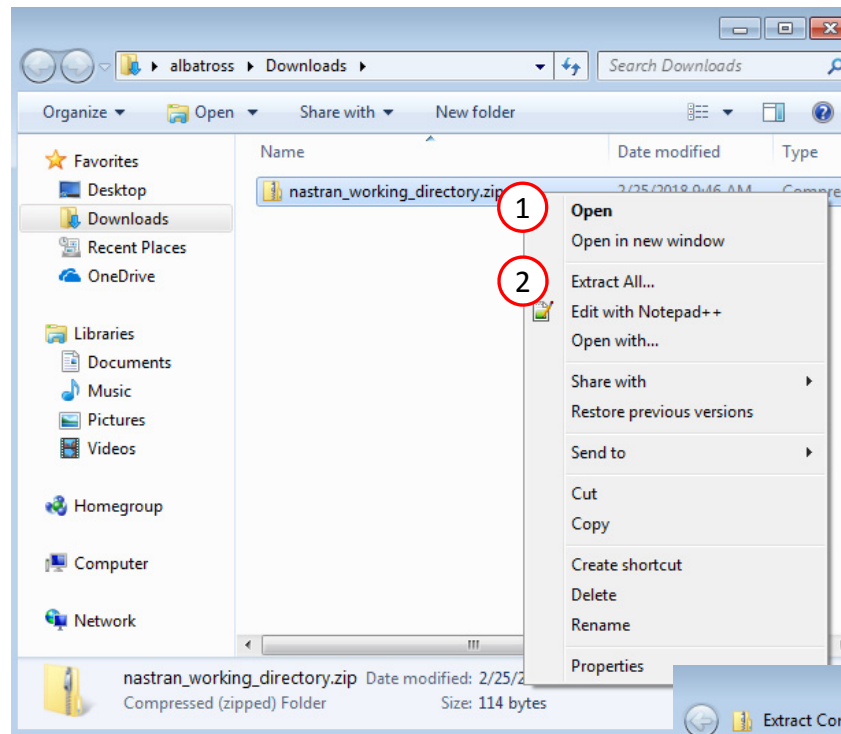
```
$*****
$*                                     *
$*                               Design Model *
$*                                     *
$*****
$
$                               Design Variables - Type 1
$-----
$
$
$
DVPREL1 1000001 PSHELL 1 T
100001 1.0
DVPREL1 1000002 PSHELL 2 T
100002 1.0
DVPREL1 1000003 PSHELL 3 T
100003 1.0
DVPREL1 1000004 PSHELL 4 T
100004 1.0
DVPREL1 1000005 PSHELL 5 T
100005 1.0
DVPREL1 1000006 PSHELL 6 T
100006 1.0
DVPREL1 1000007 PSHELL 7 T
100007 1.0
DVPREL1 1000008 PSHELL 8 T
100008 1.0
DVPREL1 1000009 PSHELL 9 T
100009 1.0
DVPREL1 1000010 PSHELL 10 T
100010 1.0
$
$
DESVAR 100001 X1 .08 .01 1.0
DESVAR 100002 X2 .08 .01 1.0
DESVAR 100003 X3 .08 .01 1.0
DESVAR 100004 X4 .08 .01 1.0
DESVAR 100005 X5 .08 .01 1.0
DESVAR 100006 X6 .08 .01 1.0
DESVAR 100007 X7 .08 .01 1.0
DESVAR 100008 X8 .08 .01 1.0
DESVAR 100009 X9 .08 .01 1.0
DESVAR 100010 X10 .08 .01 1.0
```

Developed by The Engineering Lab

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.

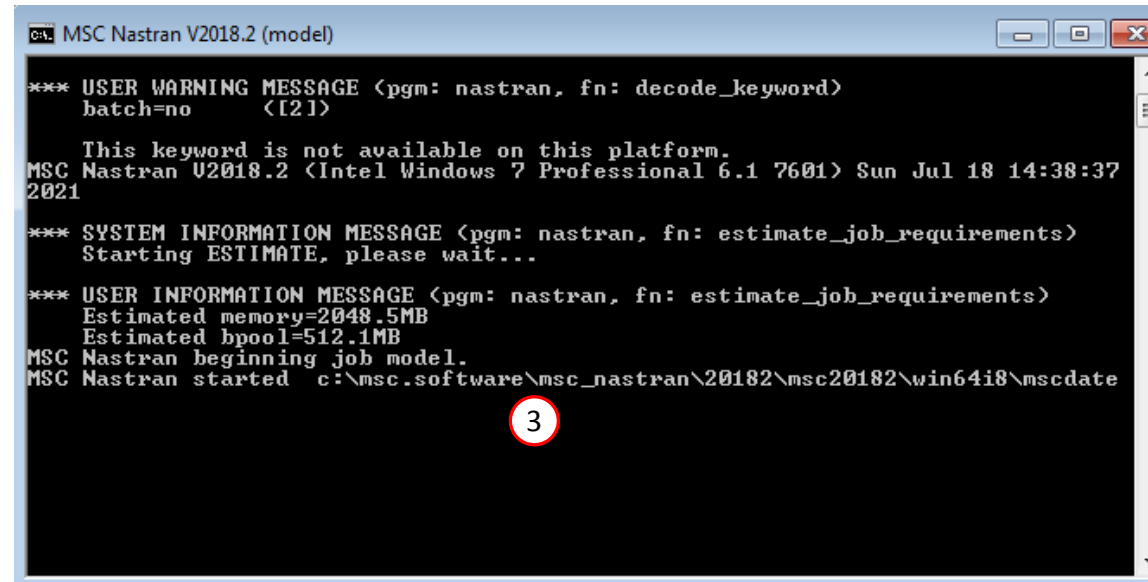
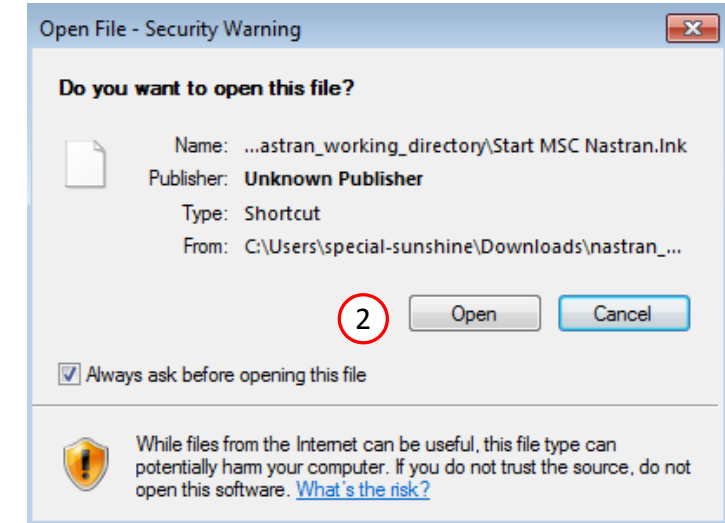
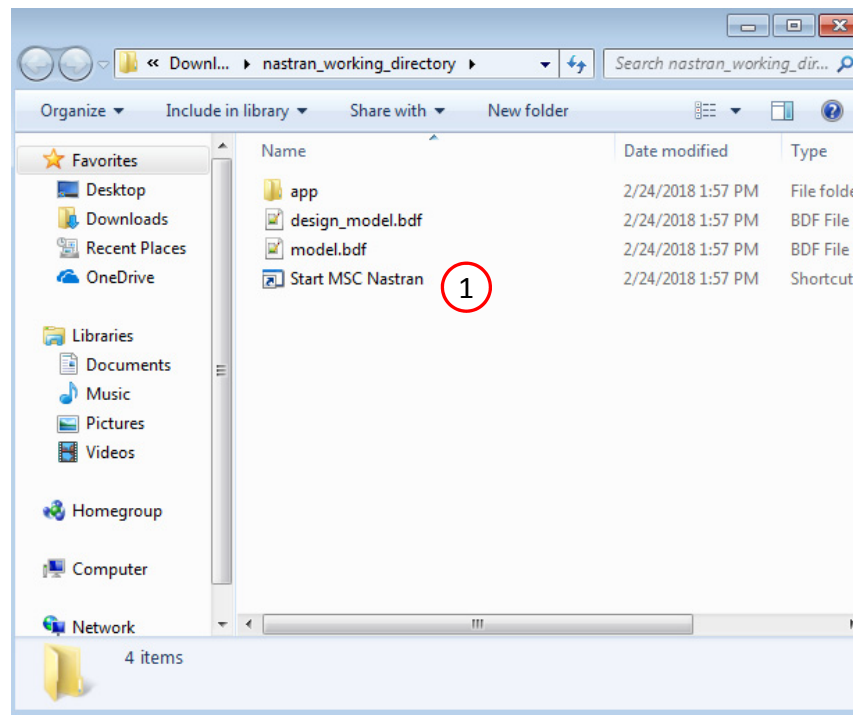
Using Linux?

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. Ensure the messages shown have green checkmarks. This is indication of success. Any red icons indicate challenges.
2. The final value of objective, normalized constraints (not shown) and design variables can be reviewed.

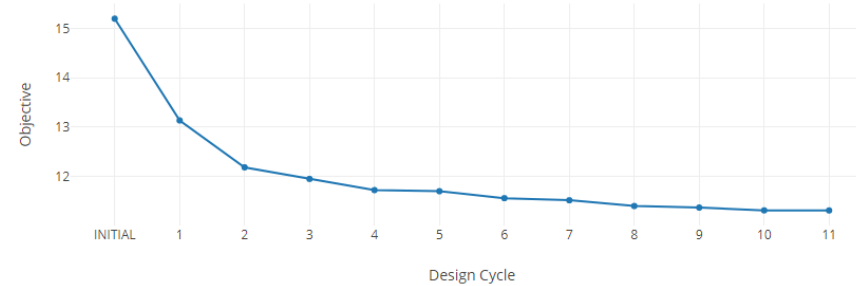
- After an optimization, the results will be automatically displayed as long as the following files are present: BDF, F06 and LOG.

Final Message in .f06

1

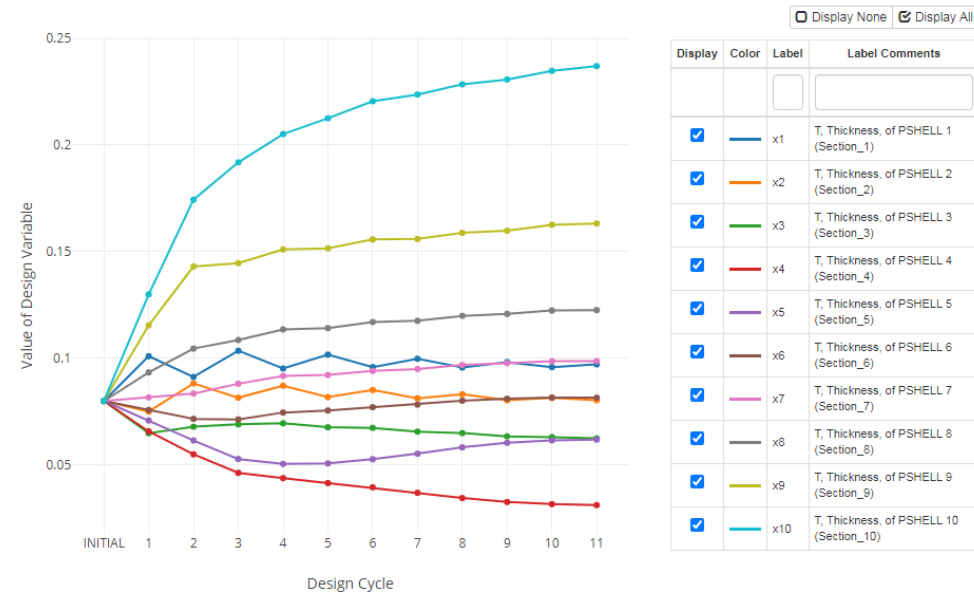
✓ RUN TERMINATED DUE TO HARD CONVERGENCE TO AN OPTIMUM AT CYCLE NUMBER = 11.

Objective



2

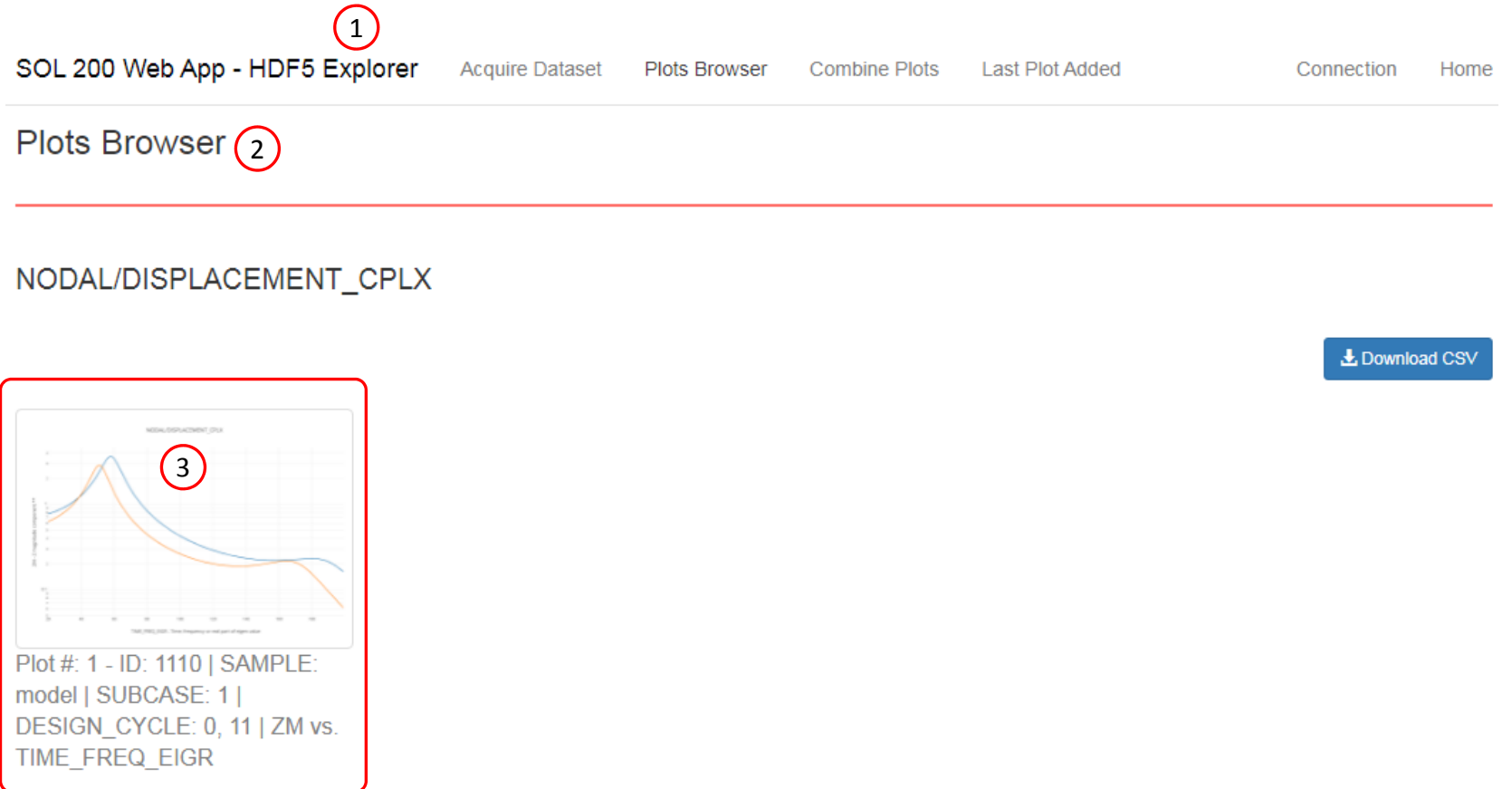
Design Variables



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



Review Dynamic Results

1. The plot contains the INITIAL and FINAL values of the dynamic response

- The objective of this exercise was to minimize the RSS value of the displacement response across all forcing frequencies. A reduction in the RSS value is confirmed by inspecting the plot of the new response. By comparing the initial response (blue) with the new response (orange) it is shown that the new response (orange) has been minimized.

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



Vertical Axis



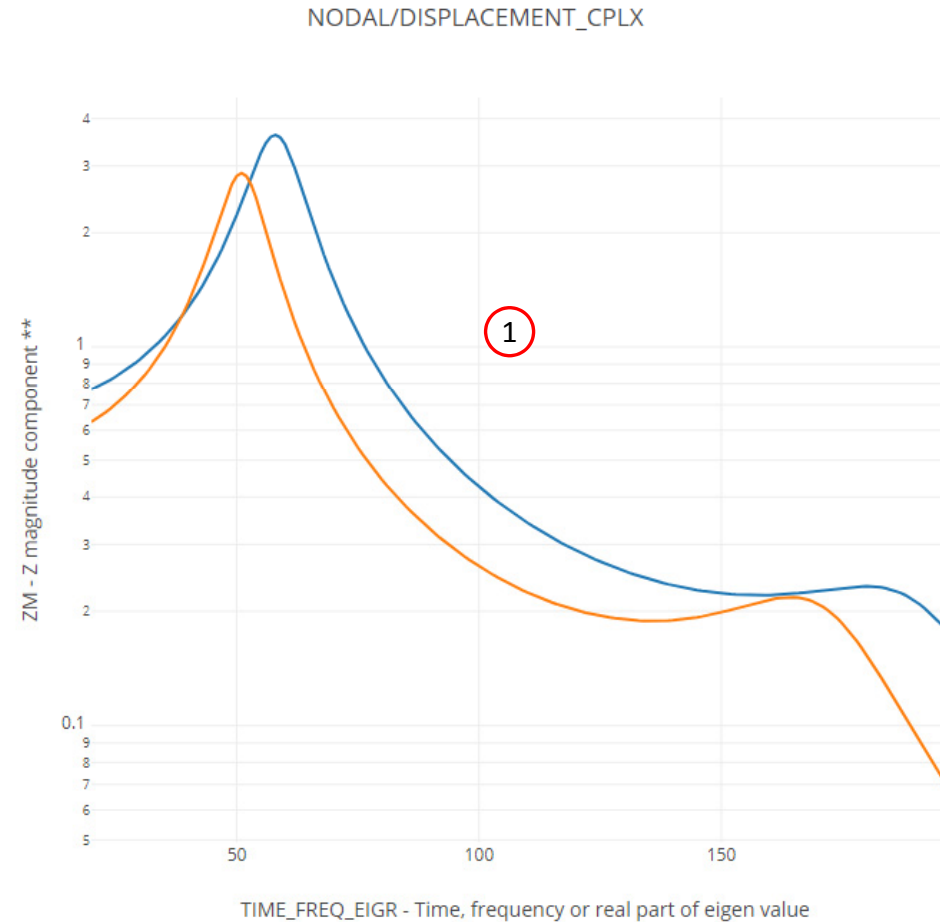
ZM - Z magnitude compo

Horizontal Axis

TIME_FREQ_EIGR - Tim

[+ Options](#)☐ Display None ☒ Display All

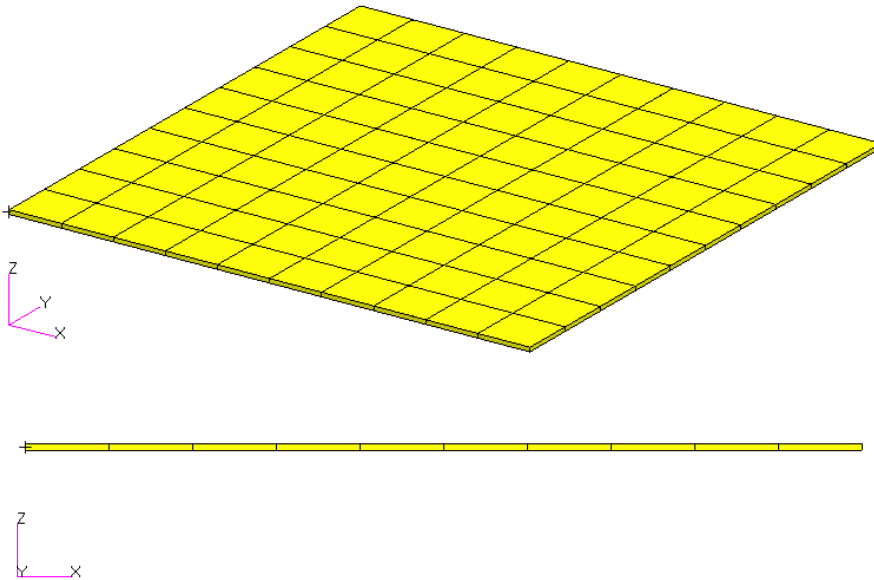
Display	Color	Name
<input checked="" type="checkbox"/>	Blue	0 - ID: 1110 SAMPLE: model SUBCASE: 1 DESIGN_CYCLE: 0
<input checked="" type="checkbox"/>	Orange	1 - ID: 1110 SAMPLE: model SUBCASE: 1 DESIGN_CYCLE: 11

[+ View Filters and Plotted Values](#)

Results

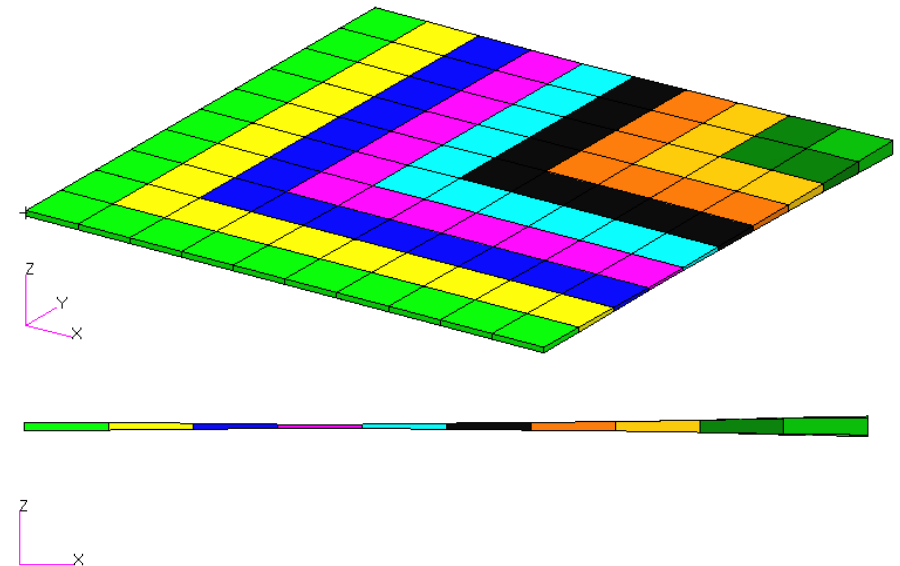
Before Optimization

- RSS displacement at node 1110: 15.2 in.
- Volume: 8.00 in³



After Optimization

- RSS displacement at node 1110: 11.3 in.
- Volume: 7.99 in³

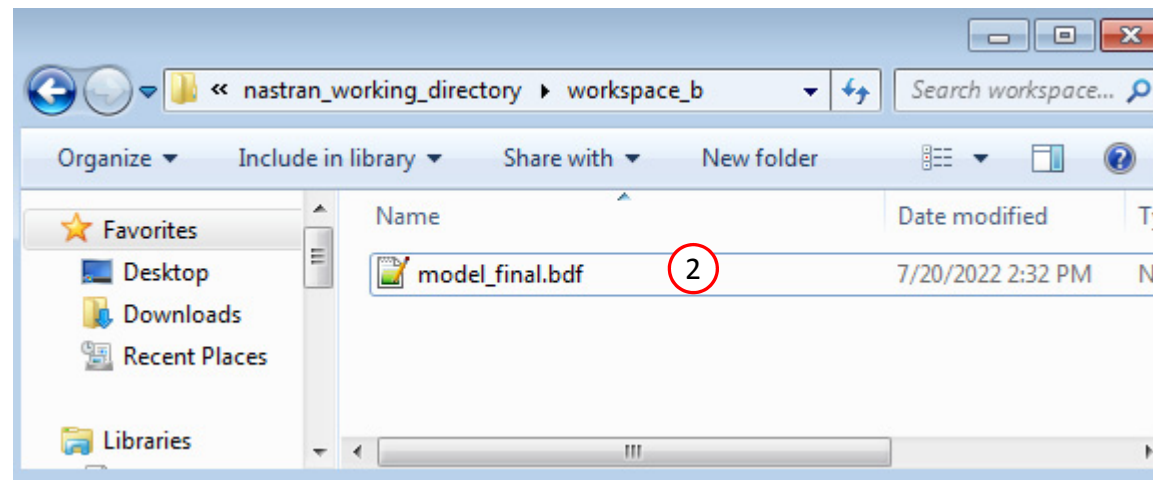


*MSC Nastran Design Sensitivity and Optimization User's Guide
Chapter 8 - Example Problems - Dynamic Response Optimization*

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

```

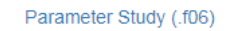
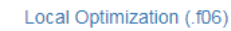
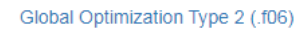
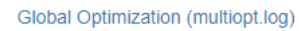
$ Elements and Element Properties for region : Section_1
PSHELL 1 150 .08 150
$ Elements and Element Properties for region : Section_2
PSHELL 2 150 .08 150
$ Elements and Element Properties for region : Section_3
PSHELL 3 150 .08 150
$ Elements and Element Properties for region : Section_4
PSHELL 4 150 .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
    
```

Updated BDF File (model_final.bdf)

```

$ Elements and Element Properties for region : Section_1
PSHELL 1 150 .097151 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_2
PSHELL 2 150 .08035 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_3
PSHELL 3 150 .06248 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_4
PSHELL 4 150 .03119 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_5
PSHELL 5 150 .061859 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_6
PSHELL 6 150 .081547 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_7
PSHELL 7 150 .098685 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_8
PSHELL 8 150 .122625 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_9
PSHELL 9 150 .163274 150 1.0 0 .833333 0.0
$ Elements and Element Properties for region : Section_10
PSHELL 10 150 .237017 150 1.0 0 .833333 0.0
    
```

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.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

Select files model.pch **1**

Inspecting: 100%

☐ List of Selected Files

PCH Entries

PSHELL	1	150	.097151 0	150	1.0	0	.833333	0.0
PSHELL	2	150	.08035 0	150	1.0	0	.833333	0.0
PSHELL	3	150	.06248 0	150	1.0	0	.833333	0.0
PSHELL	4	150	.03119 0	150	1.0	0	.833333	0.0

Step 2 - Select BDF Files

Select files dsoug7.bdf **2**

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

3

PSHELL	9	150	.163274 0	150	1.0	0	.833333	0.0
PSHELL	10	150	.237017 0	150	1.0	0	.833333	0.0



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

Line	Original BDF/DAT File	Downloaded BDF/DAT File
253	PLOAD2 730 1.0 901 THRU 910	PLOAD2 730 1.0 901 THRU 910
254	PLOAD2 730 1.0 201 THRU 210	PLOAD2 730 1.0 201 THRU 210
255	PLOAD2 730 1.0 101 THRU 110	PLOAD2 730 1.0 101 THRU 110
256	PLOAD2 730 1.0 401 THRU 410	PLOAD2 730 1.0 401 THRU 410
257	PLOAD2 730 1.0 501 THRU 510	PLOAD2 730 1.0 501 THRU 510
258	PLOAD2 730 1.0 601 THRU 610	PLOAD2 730 1.0 601 THRU 610
259	PLOAD2 730 1.0 701 THRU 710	PLOAD2 730 1.0 701 THRU 710
260	PLOAD2 730 1.0 801 THRU 810	PLOAD2 730 1.0 801 THRU 810
261	PLOAD2 730 1.0 301 THRU 310	PLOAD2 730 1.0 301 THRU 310
262	PLOAD2 730 1.0 1001 THRU 1010	PLOAD2 730 1.0 1001 THRU 1010
263	\$ Elements and Element Properties for region : Section_1	
264	PSHELL 1 150 .08 150	PSHELL 1 150 .097151 150 1.0 0 .833333 0.0
265	\$ Elements and Element Properties for region : Section_2	
266	PSHELL 2 150 .08 150	PSHELL 2 150 .08035 150 1.0 0 .833333 0.0
267	\$ Elements and Element Properties for region : Section_3	
268	PSHELL 3 150 .08 150	PSHELL 3 150 .06248 150 1.0 0 .833333 0.0
269	\$ Elements and Element Properties for region : Section_4	
270	PSHELL 4 150 .08 150	PSHELL 4 150 .03119 150 1.0 0 .833333 0.0
271	\$ Elements and Element Properties for region : Section_5	
272	PSHELL 5 150 .08 150	PSHELL 5 150 .061859 150 1.0 0 .833333 0.0
273	\$ Elements and Element Properties for region : Section_6	
274	PSHELL 6 150 .08 150	PSHELL 6 150 .081547 150 1.0 0 .833333 0.0
275	\$ Elements and Element Properties for region : Section_7	
276	PSHELL 7 150 .08 150	PSHELL 7 150 .098685 150 1.0 0 .833333 0.0
277	\$ Elements and Element Properties for region : Section_8	
278	PSHELL 8 150 .08 150	PSHELL 8 150 .122625 150 1.0 0 .833333 0.0
279	\$ Elements and Element Properties for region : Section_9	
280	PSHELL 9 150 .08 150	PSHELL 9 150 .163274 150 1.0 0 .833333 0.0
281	\$ Elements and Element Properties for region : Section_10	
282	PSHELL 10 150 .08 150	PSHELL 10 150 .237017 150 1.0 0 .833333 0.0
283	\$ Elements and Element Properties for region : Section_11	
284	RLOAD1 700 730 800	RLOAD1 700 730 800
285	SPC1 100 246 1101 1102 1103 1104 1105 1106 ++0000	SPC1 100 246 1101 1102 1103 1104 1105 1106 ++0000
286	++0000041107 1108 1109 ++0000	++0000041107 1108 1109 ++0000
287	SPC1 100 246 1110 ++0000	SPC1 100 246 1110 ++0000
288	++000001106 107 108 109 110 200 300 400 ++0000	++000001106 107 108 109 110 200 300 400 ++0000
289	++000002500 600 700 800 900 1000 1100 ++0000	++000002500 600 700 800 900 1000 1100 ++0000
290	TABDMP1 2000 ++0000	TABDMP1 2000 ++0000
291	++0000080.0 0.20 1000.0 0.20 ENDT	++0000080.0 0.20 1000.0 0.20 ENDT
292	TABLED1 800 ++0000	TABLED1 800 ++0000
293	++0000060.0 1.0 1.0E3 1.0 ENDT	++0000060.0 1.0 1.0E3 1.0 ENDT
294	ENDDATA	ENDDATA
295		

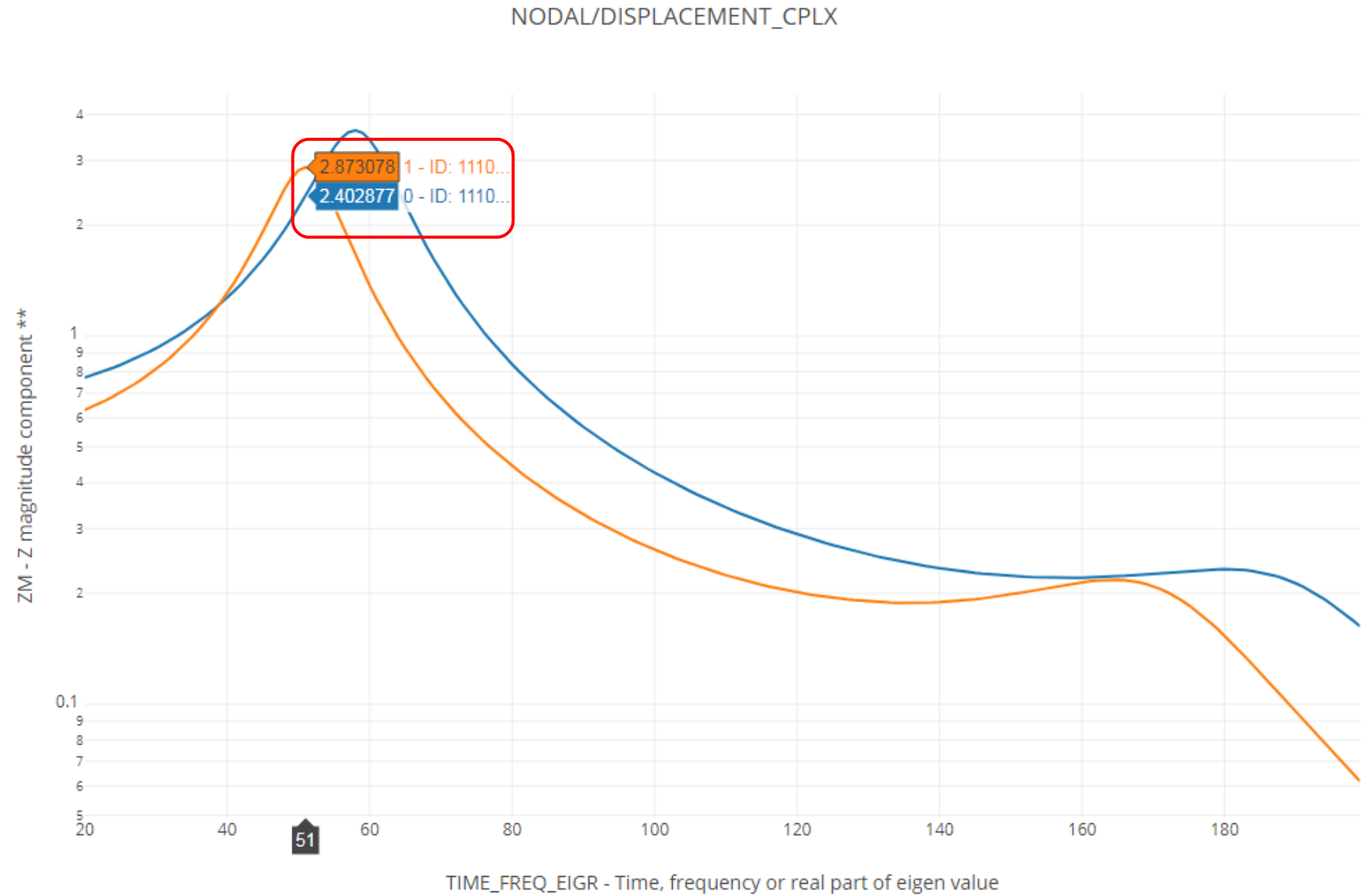
Original BDF/DAT File

Downloaded BDF/DAT File

Inspection of MSC Nastran Results with the Post-processor Web App

Post-processor Web App

- Consider the z component, magnitude, of displacement at grid 1110 at 51 Hz.

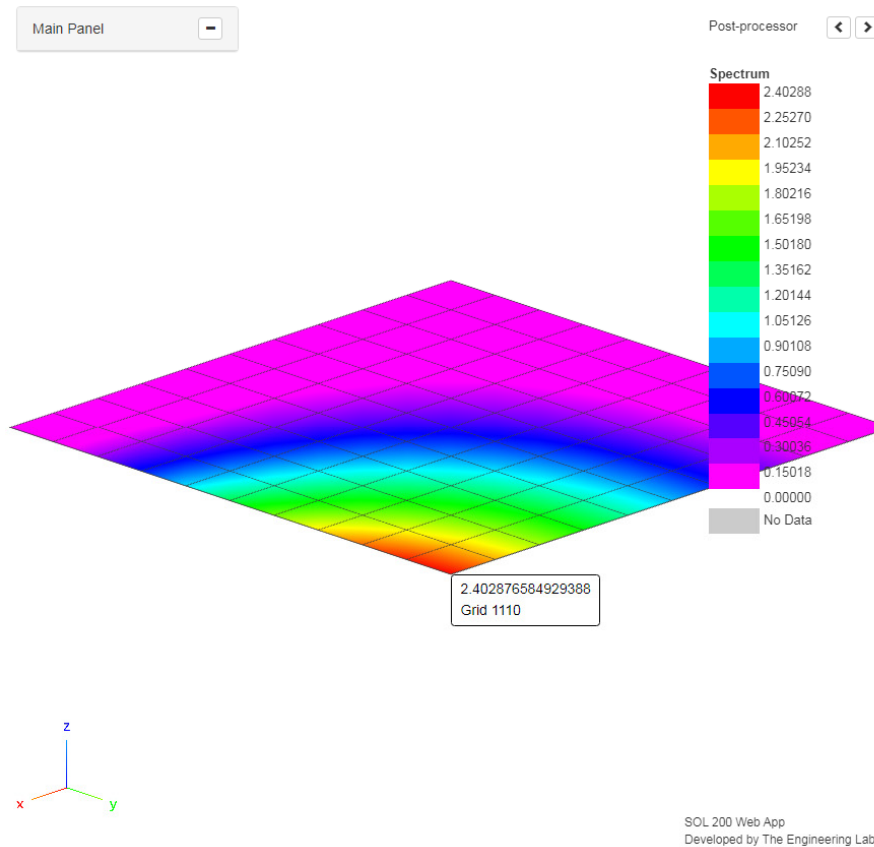


Post-processor Web App

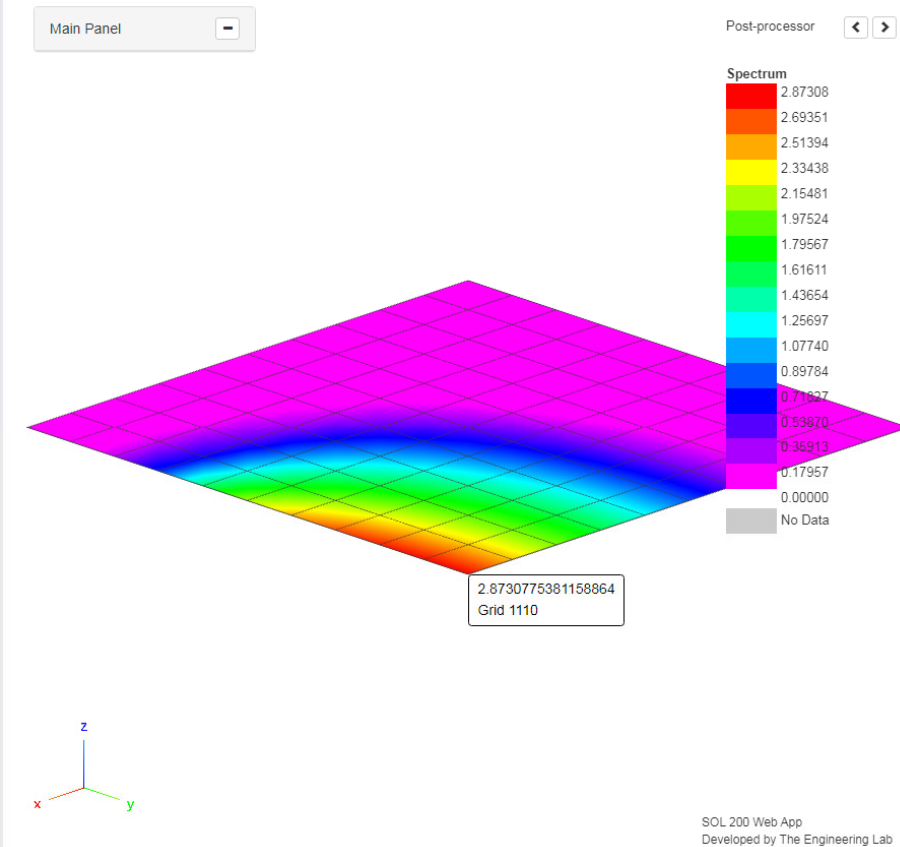
- The Post-processor web app is used to inspect the MSC Nastran results.
- The displacements are displayed for the z component, magnitude, at 51 Hz. Note the displacements at grid 1110 match the values from the graph (XY plot) on the previous page.

- Refer to the Post-processor web app tutorials to learn more about MSC Nastran results.

Displacements, z component, magnitude



Initial Design



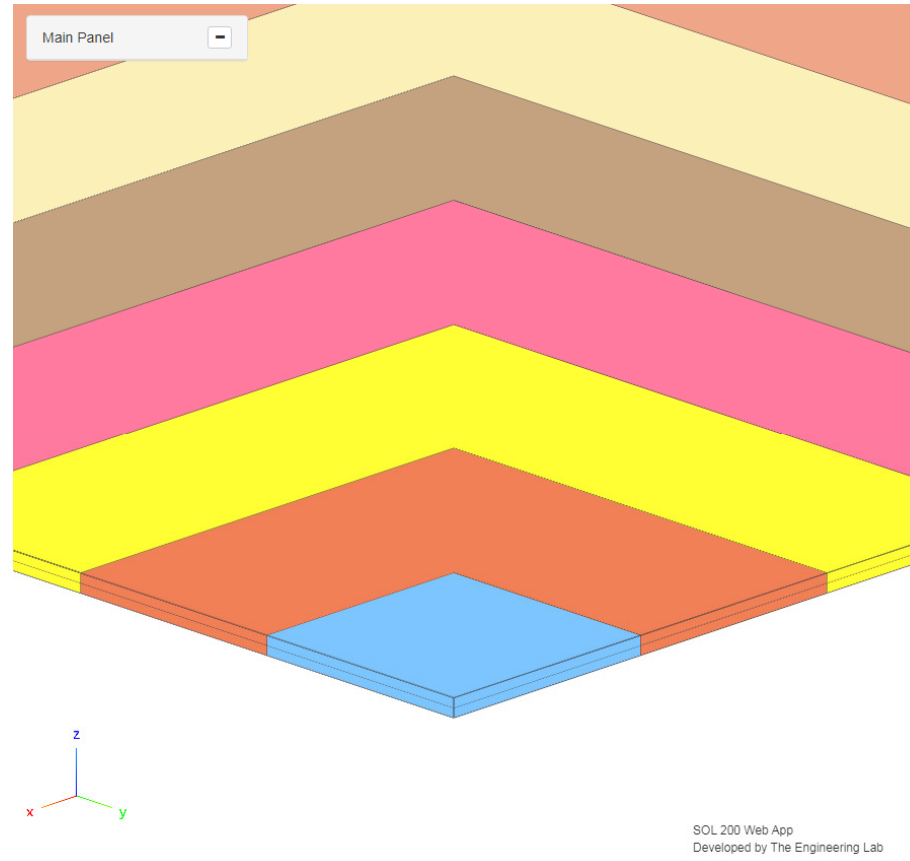
Final Design

Post-processor Web App

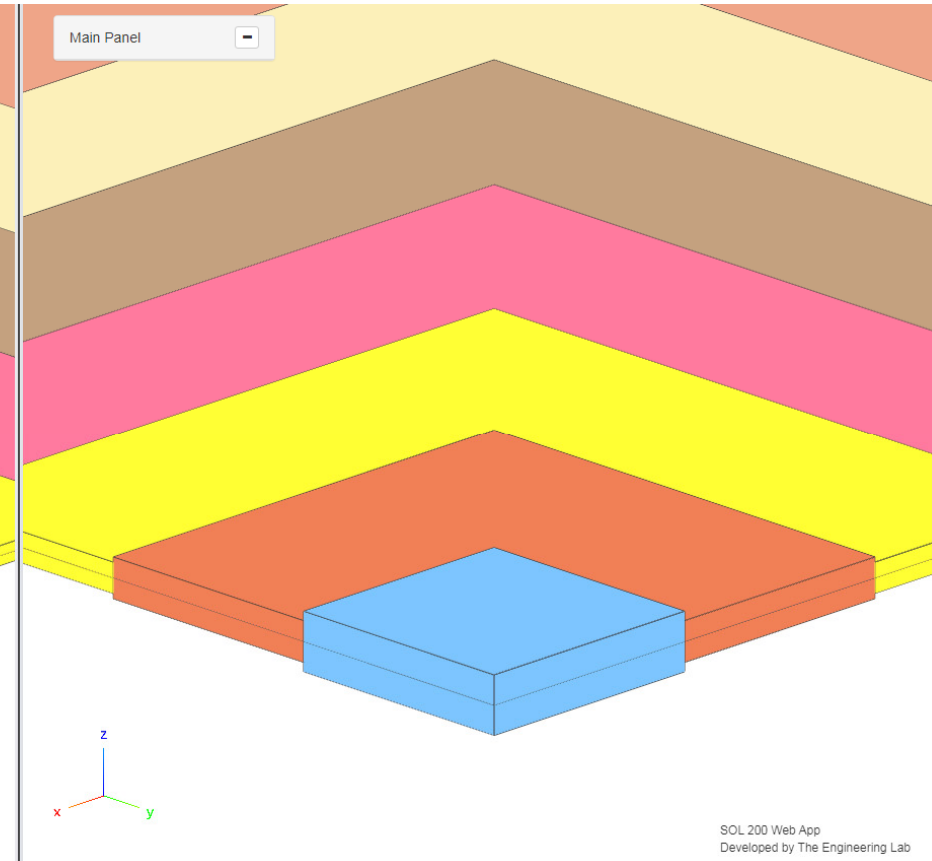
- The thicknesses of the PSHELL entries of the initial and final design are compared.

- Refer to the Post-processor web app tutorials to learn more about MSC Nastran results.

Thicknesses of PSHELL entries



Initial Design



Final Design

End of Tutorial

Appendix

Appendix Contents

- Frequently Asked Questions
 - What are global constraints?

Frequently Asked Questions

Question:

- What are global constraints?

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



Step 1 - Assign constraints to subcases

Display Columns

Global Constraints
SUBCASE 1

☐ Uncheck visible boxes ☒ Check visible boxes

+ Options

	Status ▼	Label ↕	Response Type ▼	Description	Global Constraints ↕	SUBCASE 1 ↕
		<input type="text" value="Search"/>	<input type="text" value="Search"/>	<input type="text" value="Search"/>		
		r1	VOLUME	Volume of entire model	<input checked="" type="checkbox"/>	

Frequently Asked Questions

Answer:

- A structural model will only have one value for weight or volume regardless of subcase
- These quantities are known as global responses and requires a special step to define as a constraint
- Such global constraints are applied using the DESGLB command in the Case Control Section

SOL 200 Web App - Size Variables Objective Constraints Subcases Exporter Results Settings Match Other User's Guide Home

Step 1 - Assign constraints to subcases

Display Columns

Global Constraints
SUBCASE 1

+ Options

Status	Label	Response Type	Description	Global Constraints	SUBCASE 1
	Search	Search	Search		
	r1	VOLUME	Volume of entire model	<input checked="" type="checkbox"/>	

Constraint Group Classic

DCONADD ID	Constraints in Group	Constraint Group Type
40000000	r1	DESLB

BDF Output - Model

```
assign userfile = 'optimization_results.csv', status = unknown,
form = formatted, unit = 52
ID MSC DSOU67 $ v2004 ehj 25-Jun-2003
TIME 200
SOL 200
CEND

TITLE = Synthesis of Responses across Different Frequencies: DSOU67
ECHO = NONE
SET 10 = 1110
$ ANALYSIS AS WELL AS SENSITIVITY ANALYSIS
$ DESOBJ(MIN) = 8000000
$ DESGLB = 40000000
$ DSAPRT(FORMATTED, EXPORT, END=SENS) = ALL
SUBCASE 1
ANALYSIS = MPREQ
$ DESSUB slot
$ DRSPAN slot
SPC = 100
DLOAD = 700
FREQ = 740
REIHOU = 500
sdamping = 2000
output
disp(plot, case) = ALL
output(xyout)
```

BDF Output - Design Model

```
$
$
$
$
$
DCONADD 40000000 30001
```

Developed by The Engineering Lab

Mark this checkbox to display the additional sections ☒