Workshop - Dynamic Response Optimization with Nastran Optimization

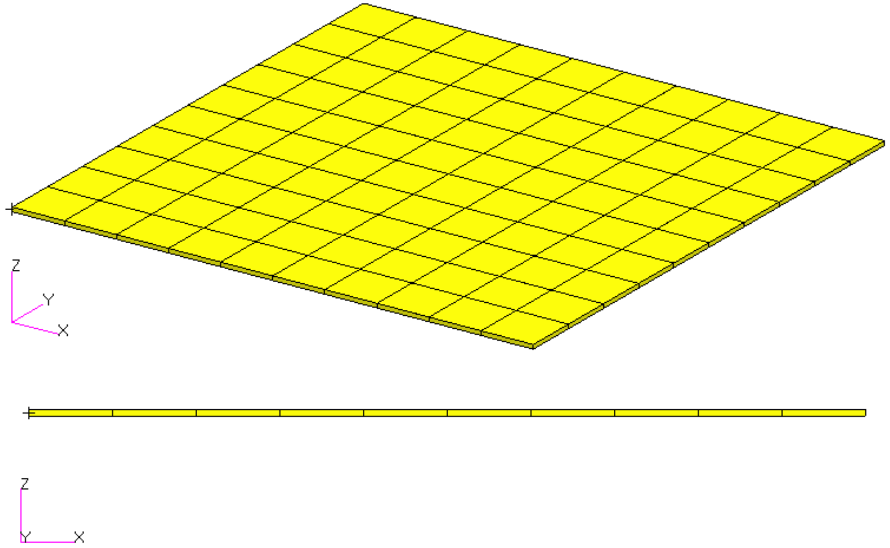
AN MSC NASTRAN SOL 200 TUTORIAL

Goal: Use Nastran SOL 200 Optimization

Minimize the RSS displacement while maintaining a constant volume

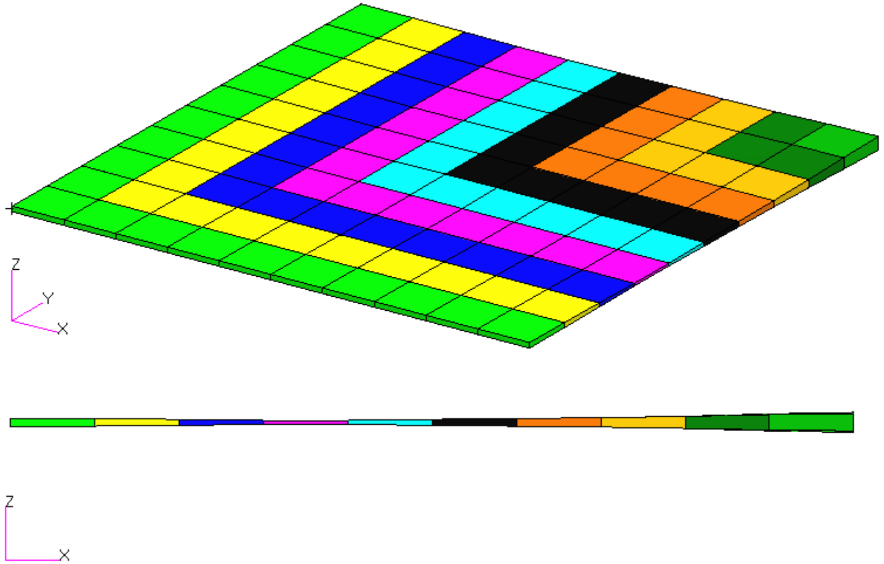
Before Optimization

- RSS displacement at node 1110: 15.2 in.
- Volume: 8.00 in^3



After Optimization

- RSS displacement at node 1110: 11.3 in.
- Volume: 7.99 in^3



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 $1.0\ \mathrm{lb_f/in^2}$ 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.

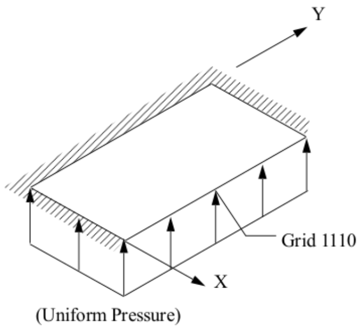
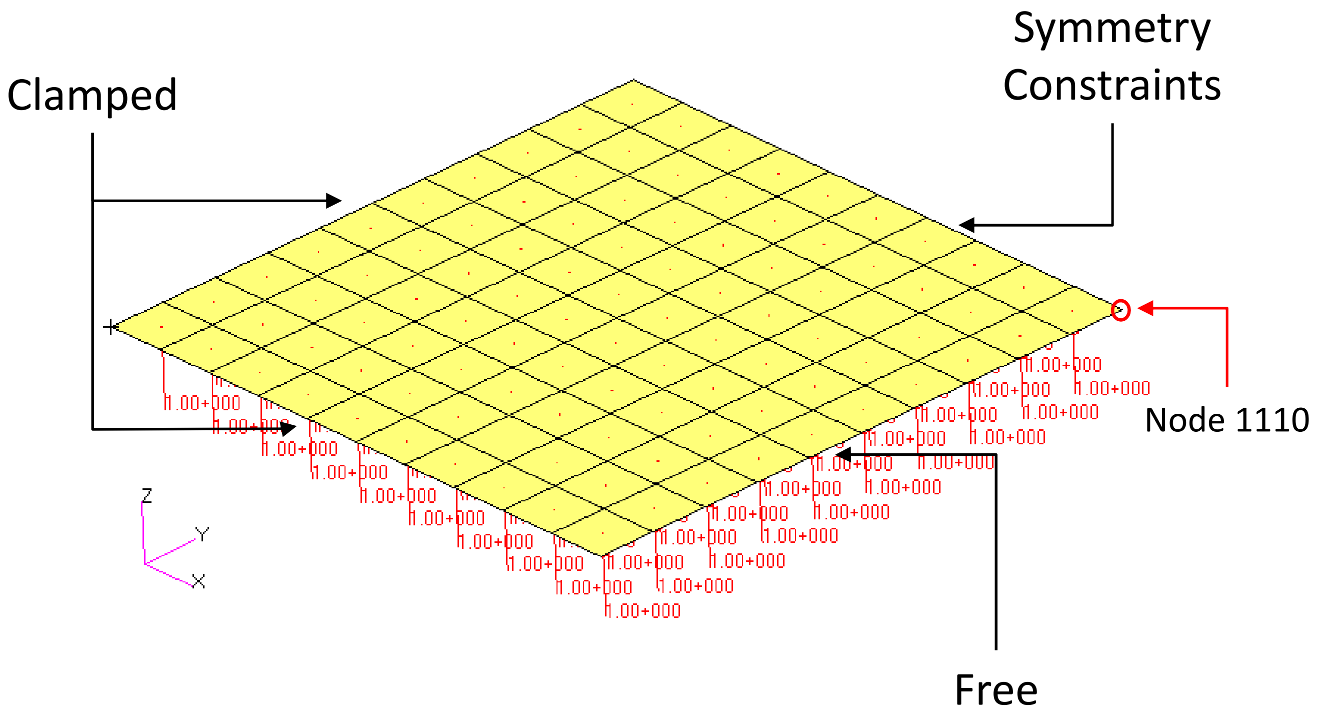


Figure 8-21 Pressure-Loaded Flat Plate

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

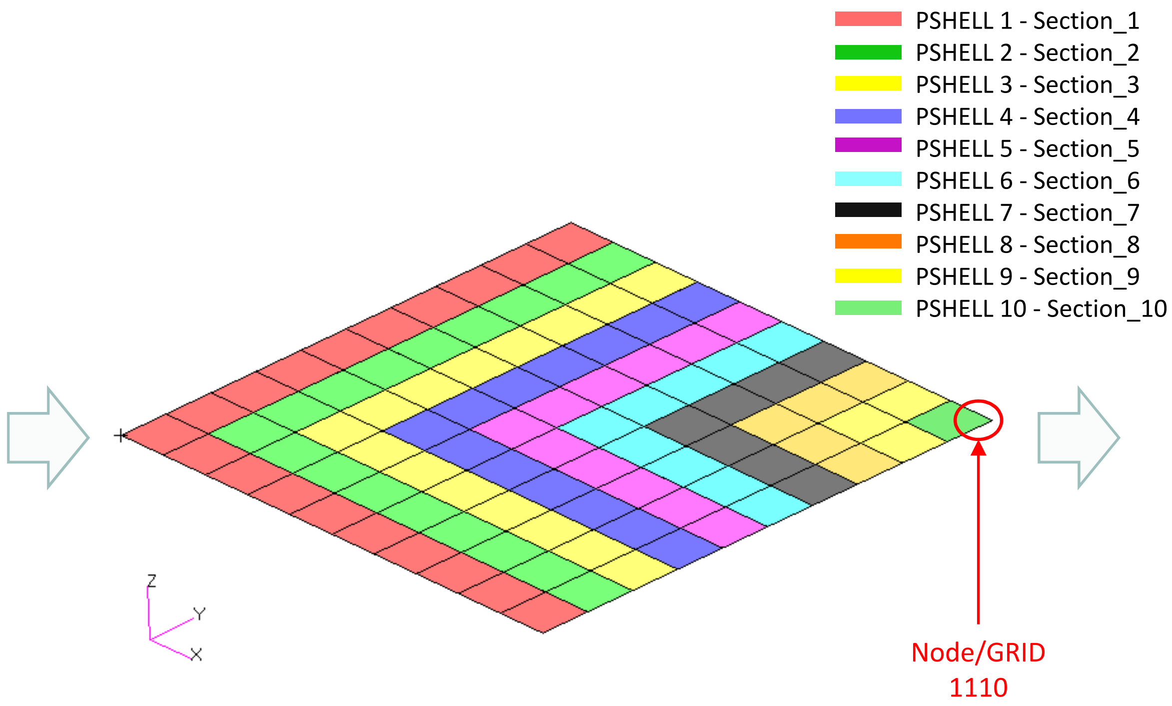


Optimization Problem Statement

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 < xi < 1.0



Design Objective

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

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

Design Constraints

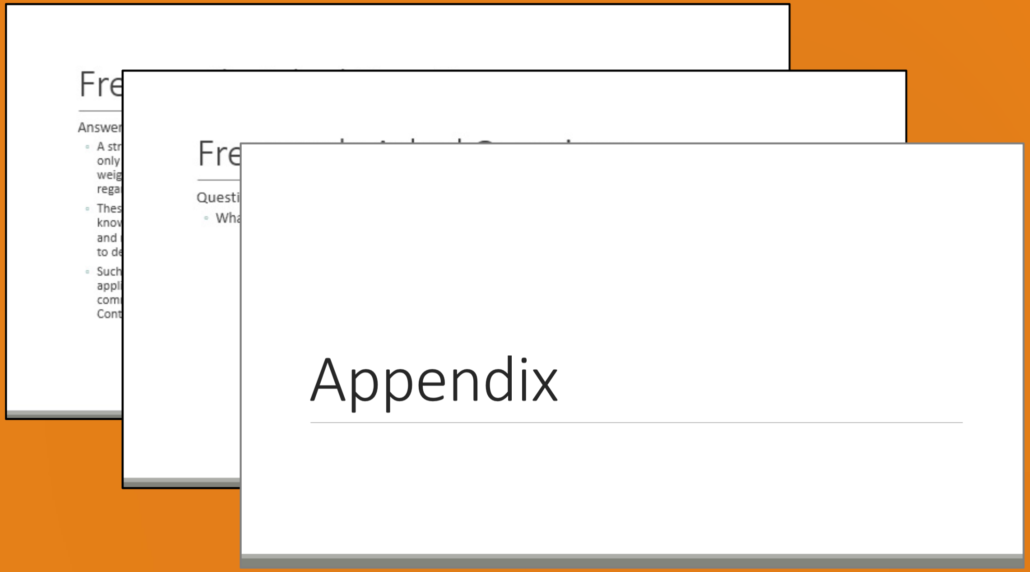
r1: Volume

7.99 < r1 < 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

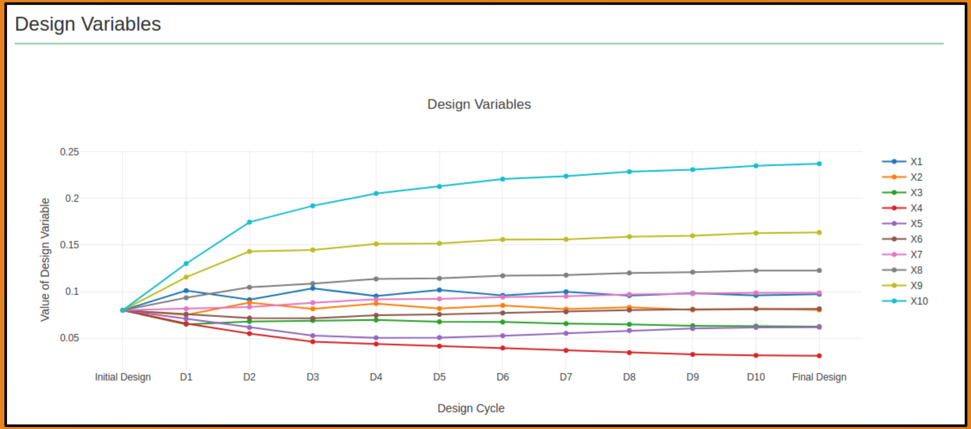
Tutorial

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.

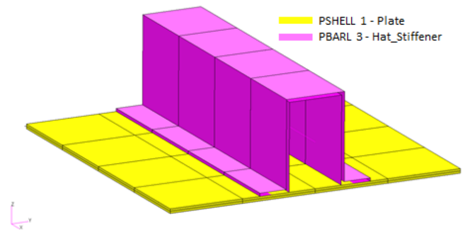
Compatibility

- 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.

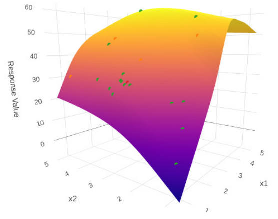
Benefits

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

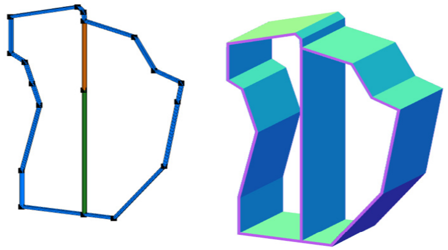
Web Apps



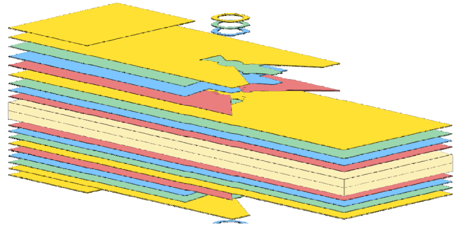
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200. Support for size, topology, topometry, topography, multi-model optimization.



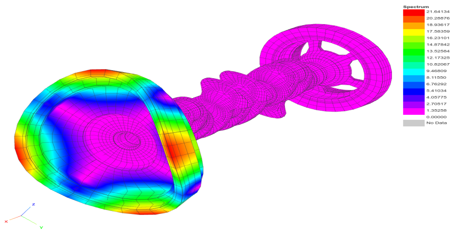
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



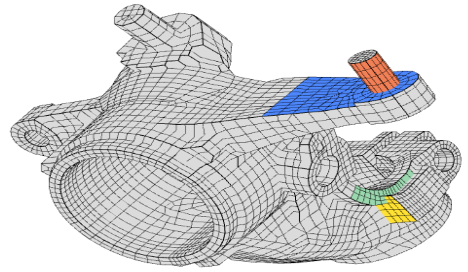
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



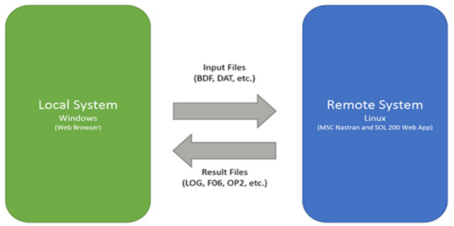
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



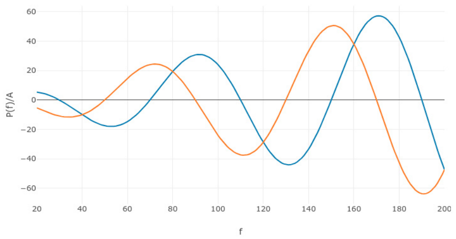
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



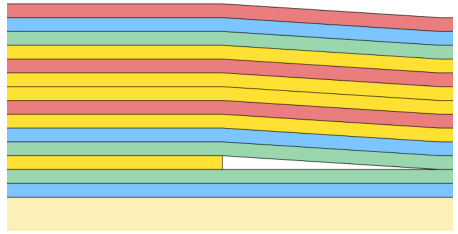
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



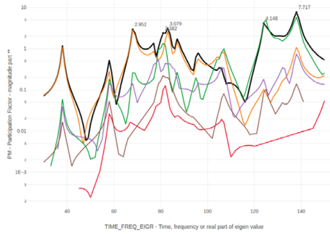
Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



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



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

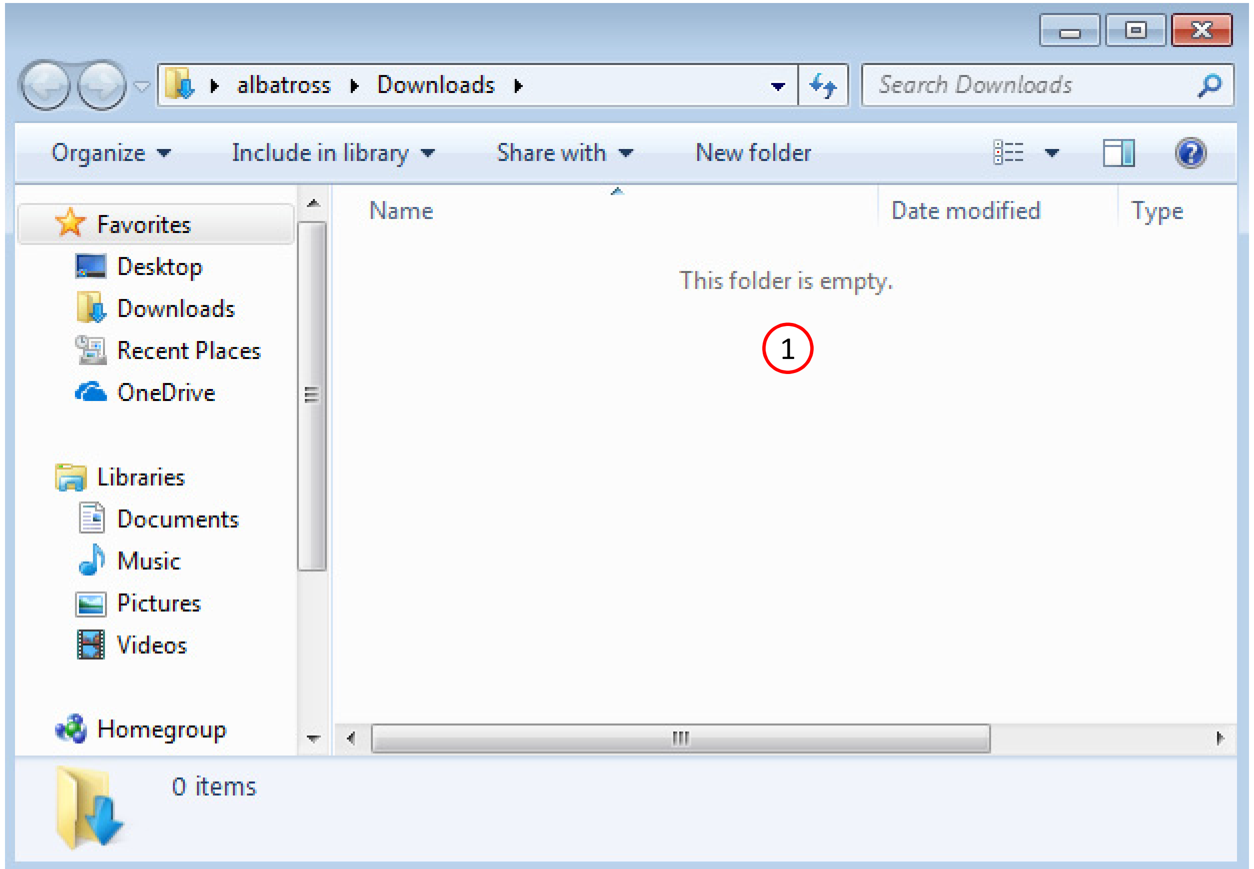


HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

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

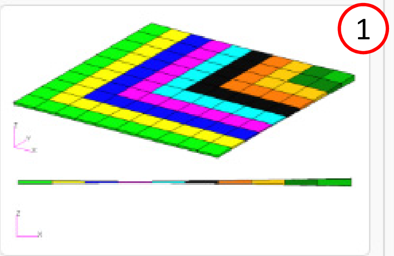
1. Click on the indicated link

- 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.

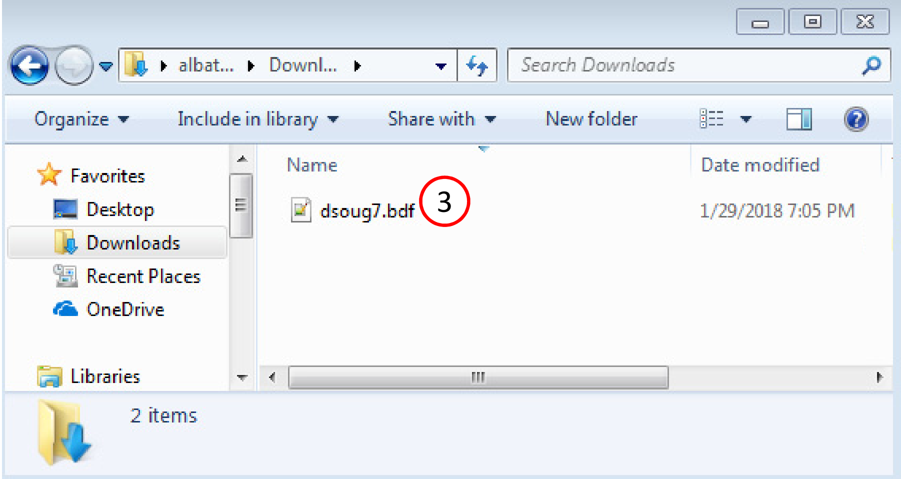


(1) **Dynamic Response Optimization with MSC Nastran Optimization** Link

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

Starting BDF Files: Link (2)
Solution BDF Files: Link



Open the Correct Page

1. Click on the indicated link

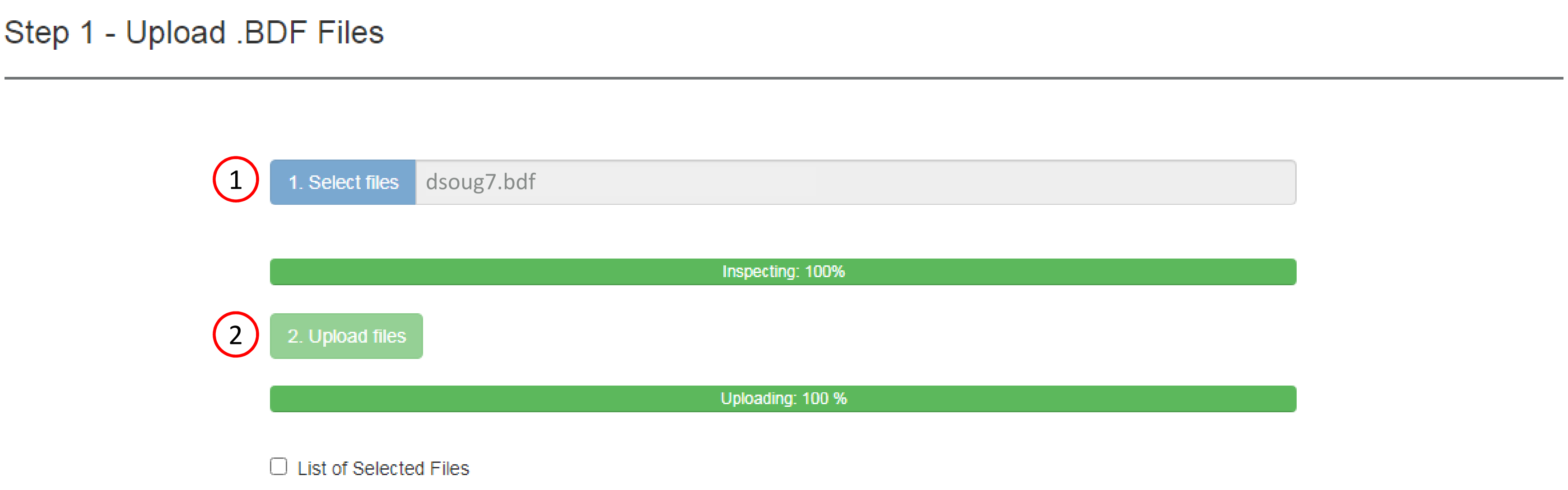
- MSC Nastran can perform many optimization types. The SOL 200 Web App includes dedicated web apps for the following:
    - Optimization for SOL 200 (Size, Topology, Topometry, Topography, Local Optimization, Sensitivity Analysis and Global Optimization)
    - Multi Model Optimization
    - Machine Learning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

The Engineering Lab

Upload BDF Files

1. Click 1. Select Files and select dsoug7.bdf
2. Click Upload Files

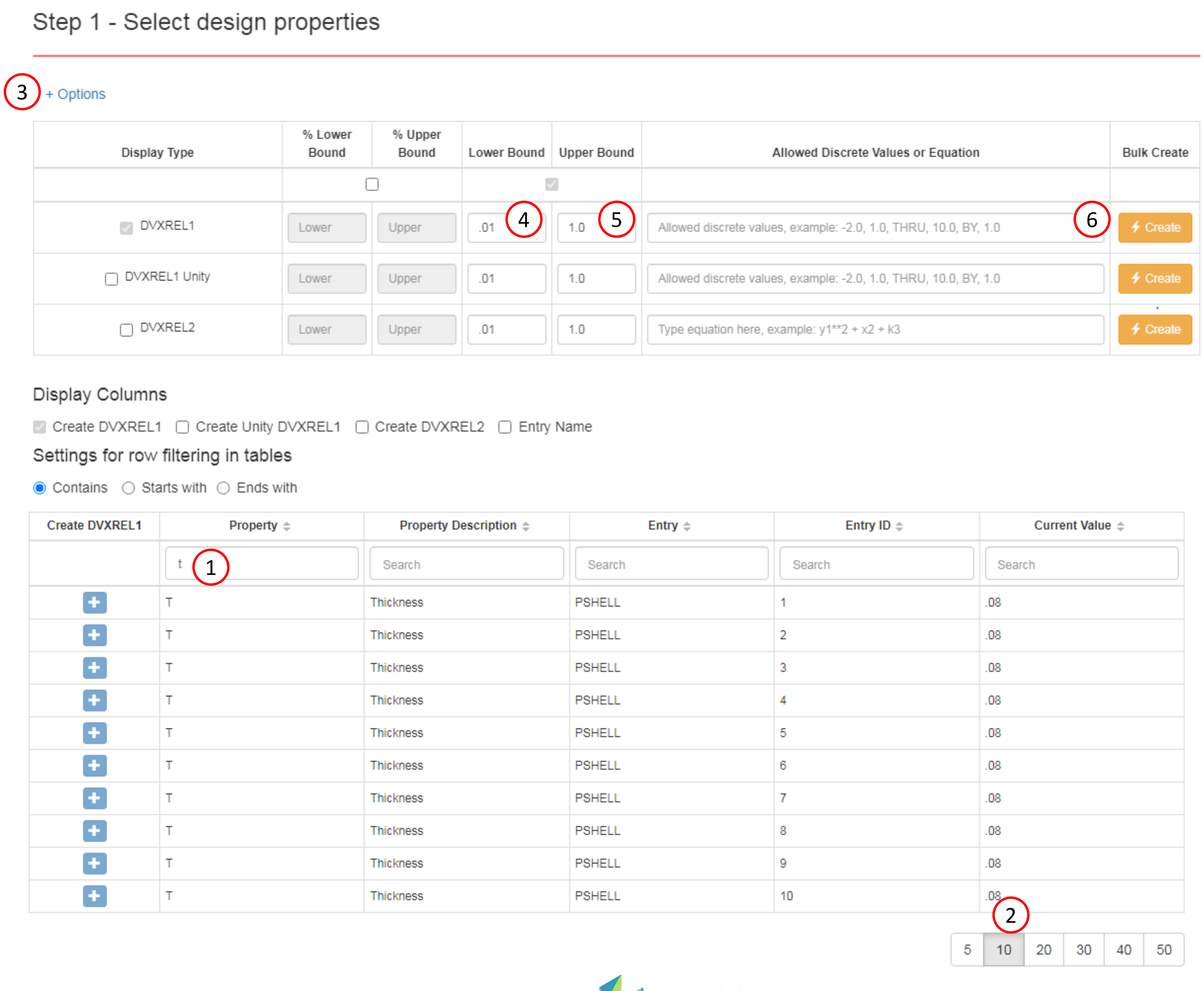
- The process starts by uploading all the necessary BDF files. The BDF files can be files of your own or files found in the Tutorials section of the User's Guide.



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.



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
	Search	Search	Search	Search	Search	Search	Search	Search	Search	Search
✖	x1	✔	T	Thickness	PSHELL	1	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x2	✔	T	Thickness	PSHELL	2	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x3	✔	T	Thickness	PSHELL	3	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x4	✔	T	Thickness	PSHELL	4	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x5 (2)	✔	T	Thickness	PSHELL	5	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x6	✔	T	Thickness	PSHELL	6	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x7	✔	T	Thickness	PSHELL	7	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x8	✔	T	Thickness	PSHELL	8	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x9	✔	T	Thickness	PSHELL	9	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,
✖	x10	✔	T	Thickness	PSHELL	10	.08	.01	1.0	Examples: -2.0, 1.0, THRU, 10.0,

5 | 10 | 20 | 30 | 40 | 50

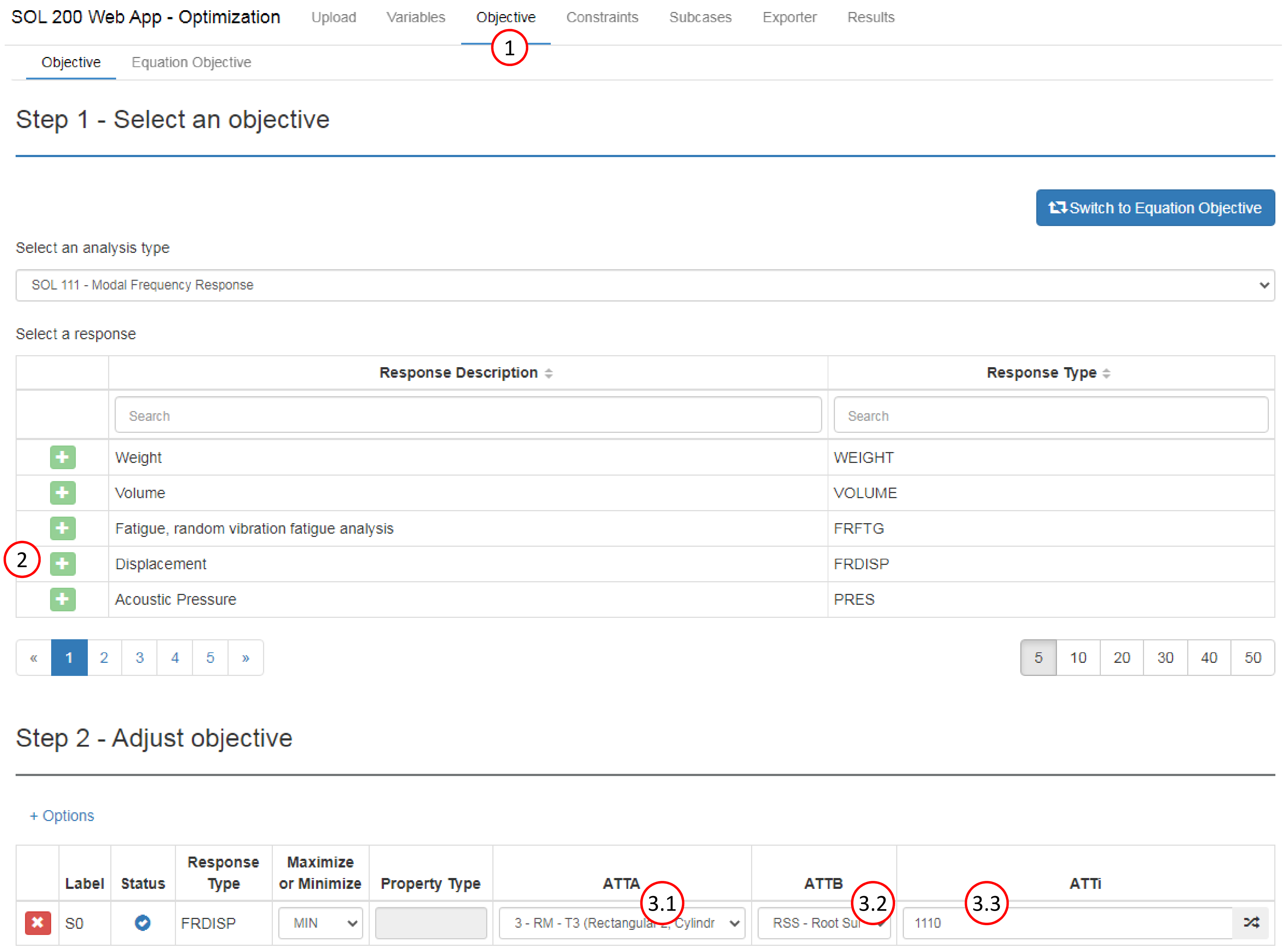
(1)

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,

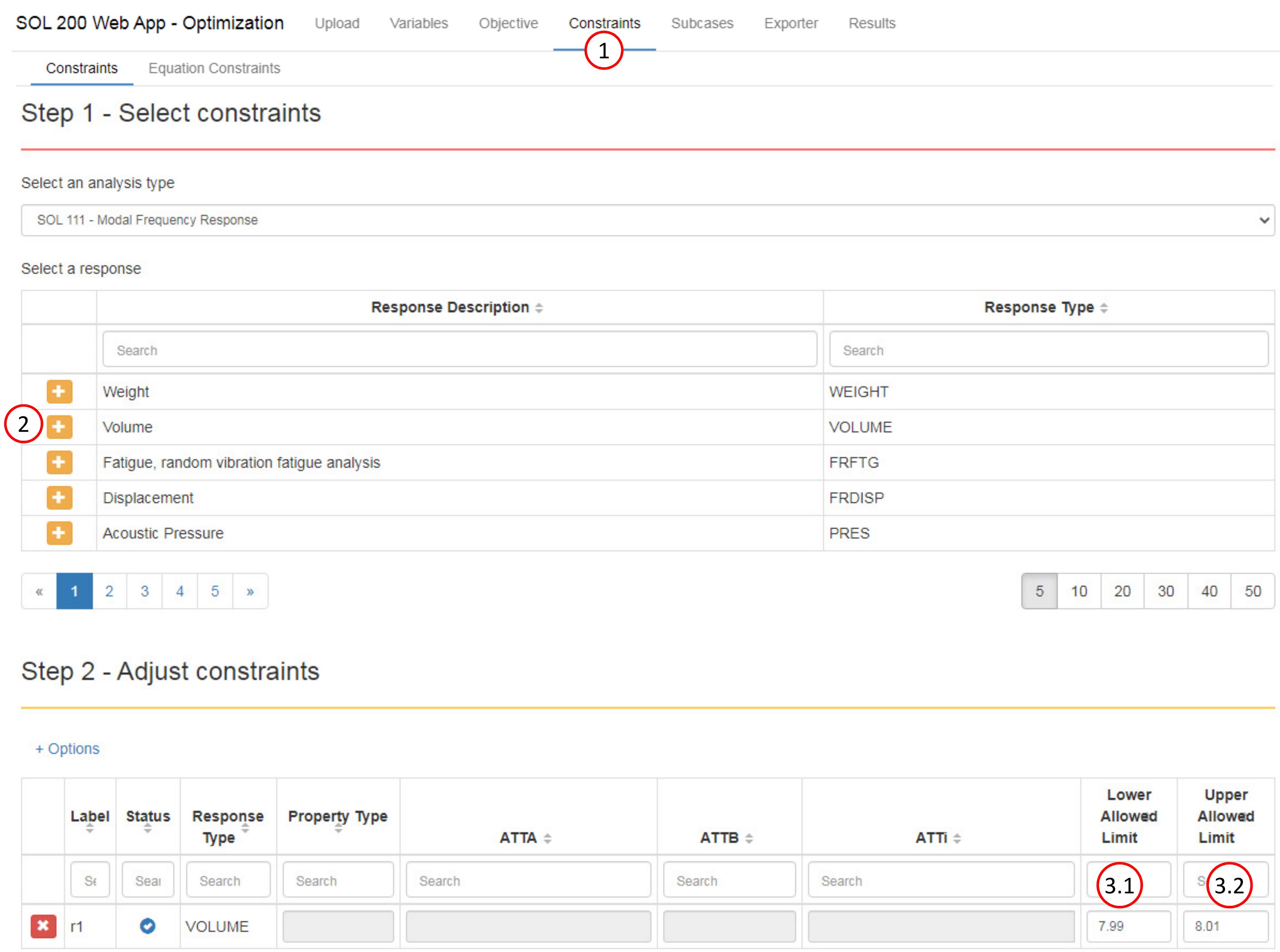
$$S0 = RSS = \sqrt{.3^2 + 1^2 + .7^2} = 1.26$$



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.

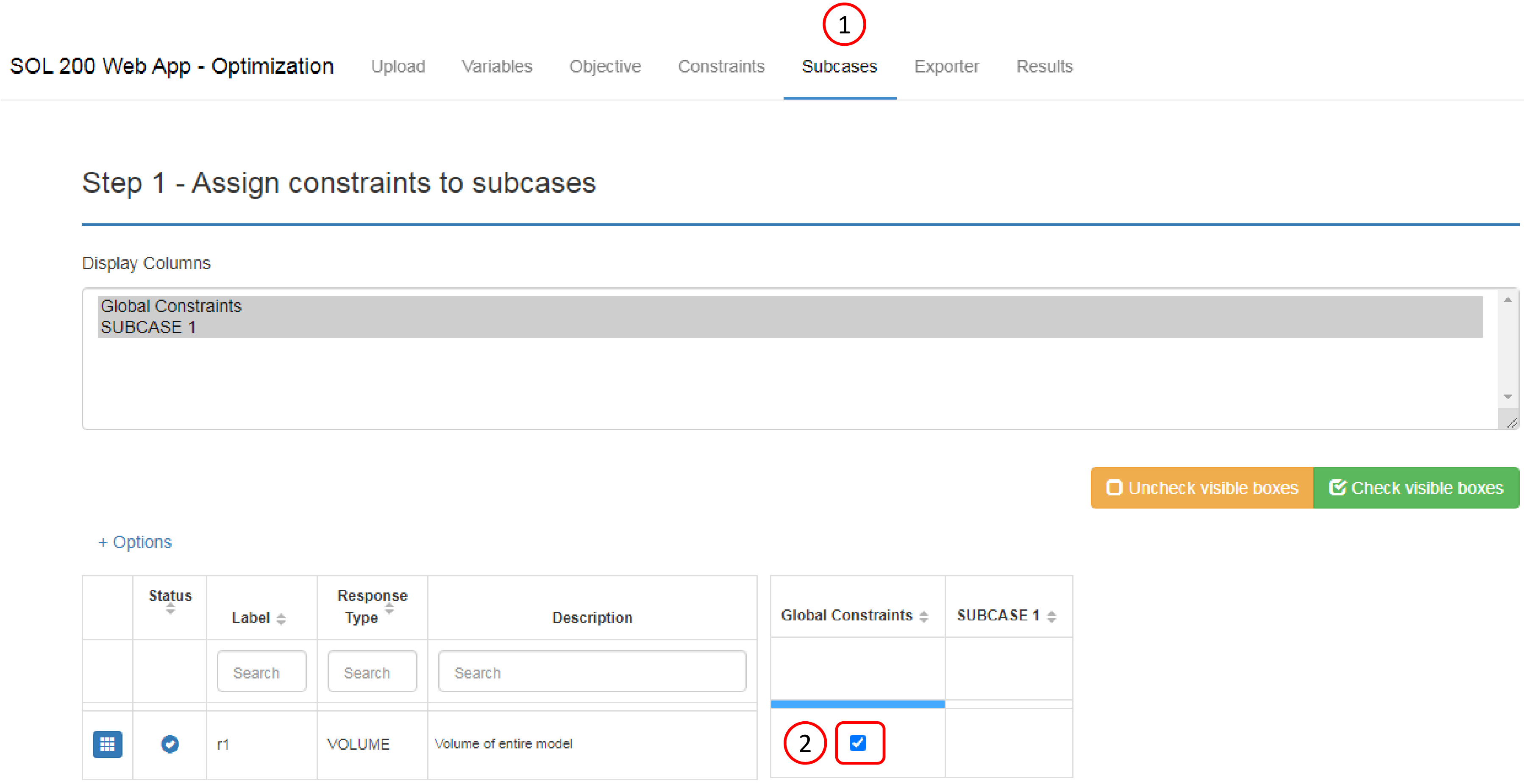


Assign Constraints to Load Cases (SUBCASES)

1. Click Subcases
2. Mark the checkbox

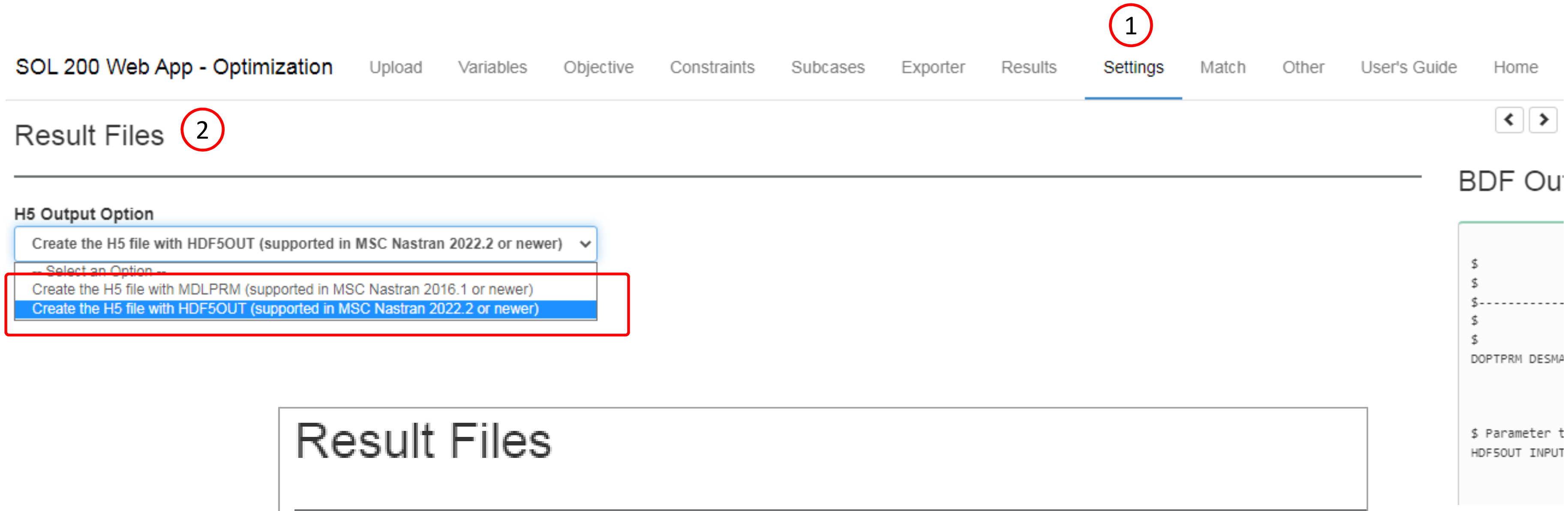
r1 or the Volume is applied as a Global Constraint

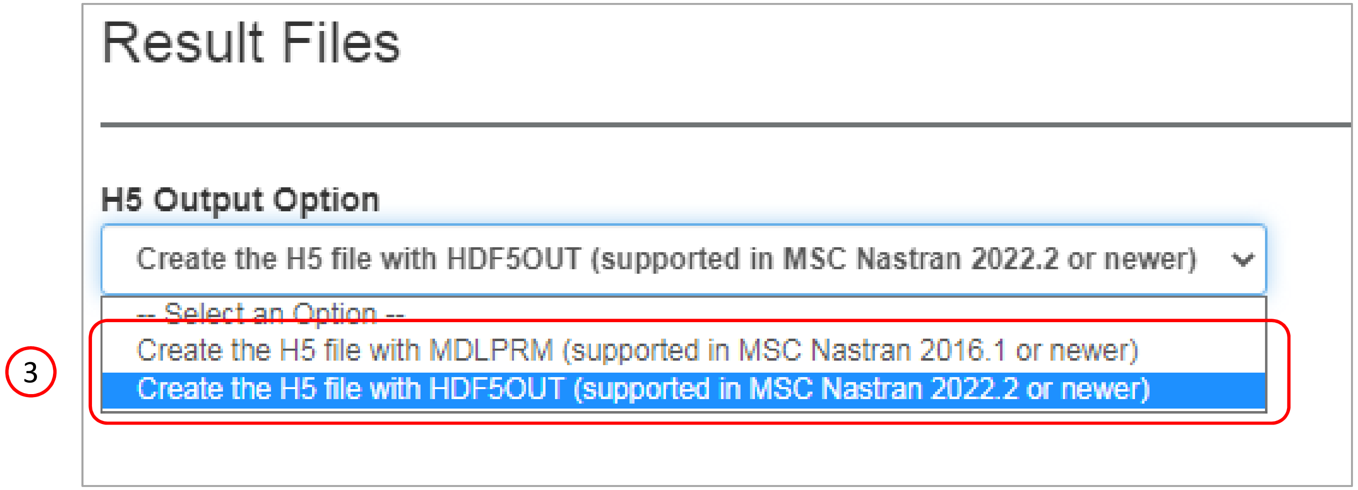
- There are 2 types of responses: Global and Subcase Dependent responses. Global responses are the same regardless of subcase and examples include volume, weight, etc. Subcase Dependent responses vary across subcases. For example, stress or strain will vary from subcase to subcase.
- In this example,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



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

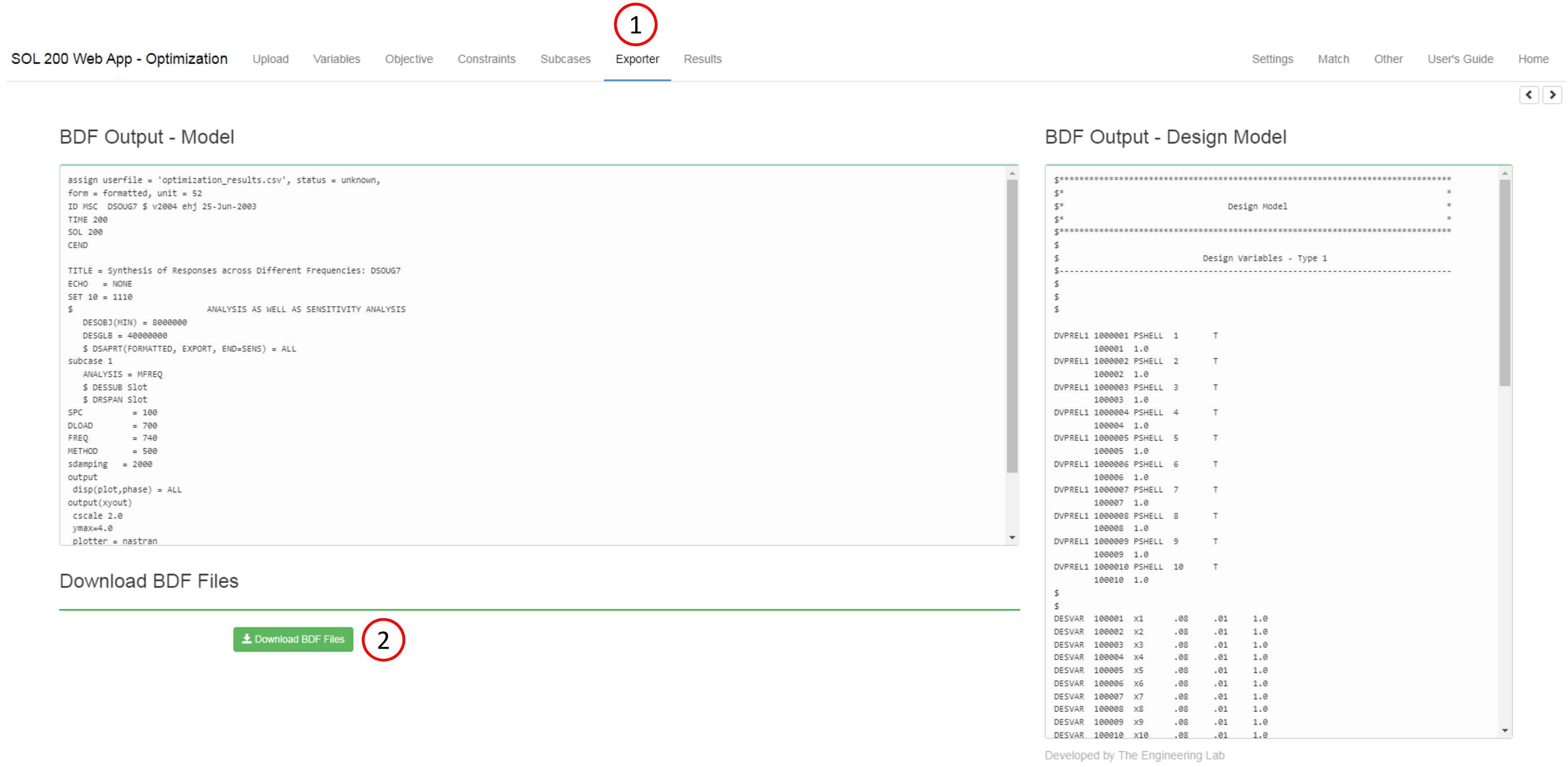




- The H5 file is used by the Post-processor web app to display MSC Nastran results.
- The H5 file is used by the HDF5 Explorer to create graphs (XY Plots) of MSC Nastran results.

Export New BDF Files

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

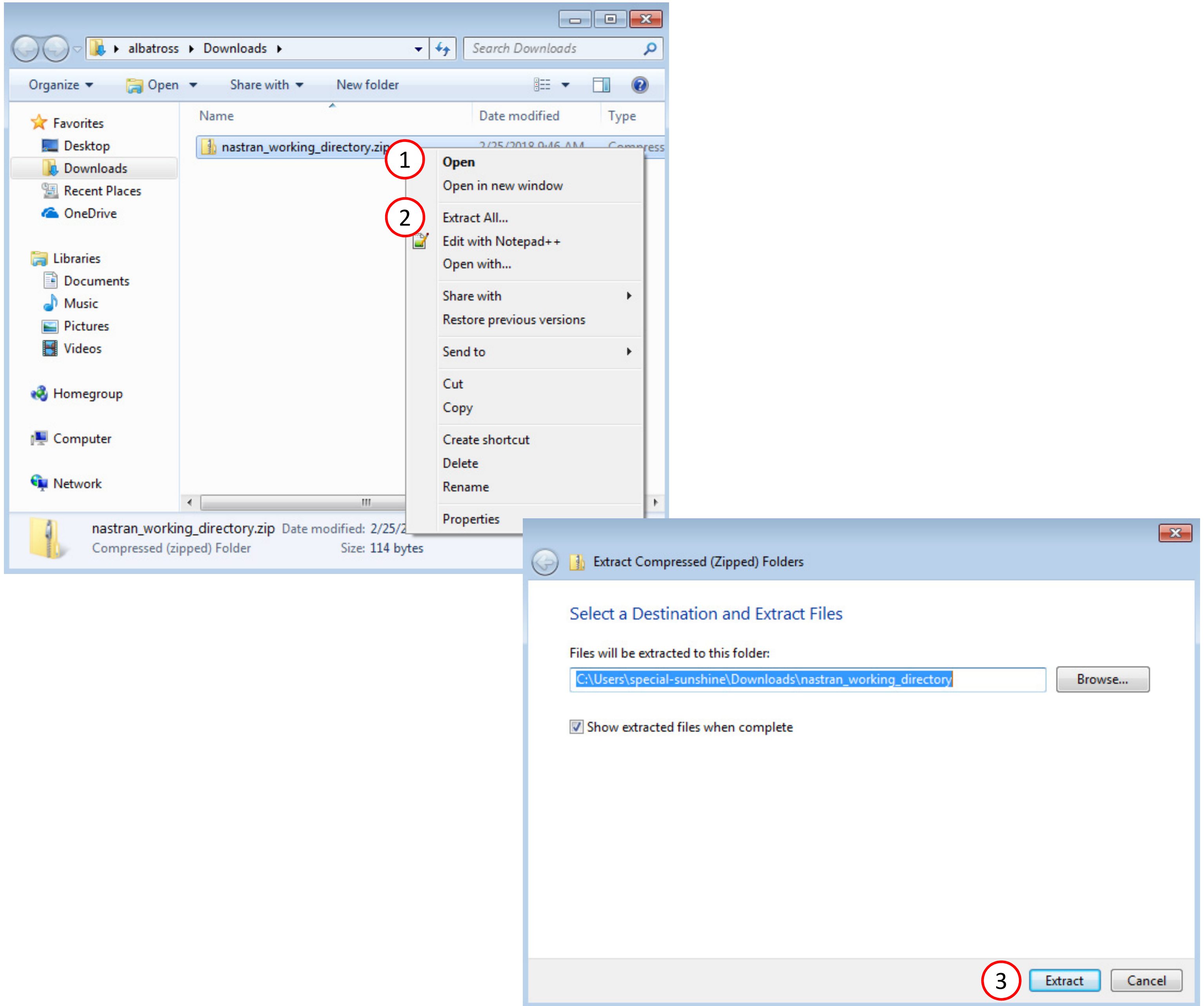


- When the download button is clicked a new file named “nastran_working_directory” is downloaded. If the file already exists in your local folder, the folder name is appended with a number, e.g. “nastran_working_directory (1).zip”

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

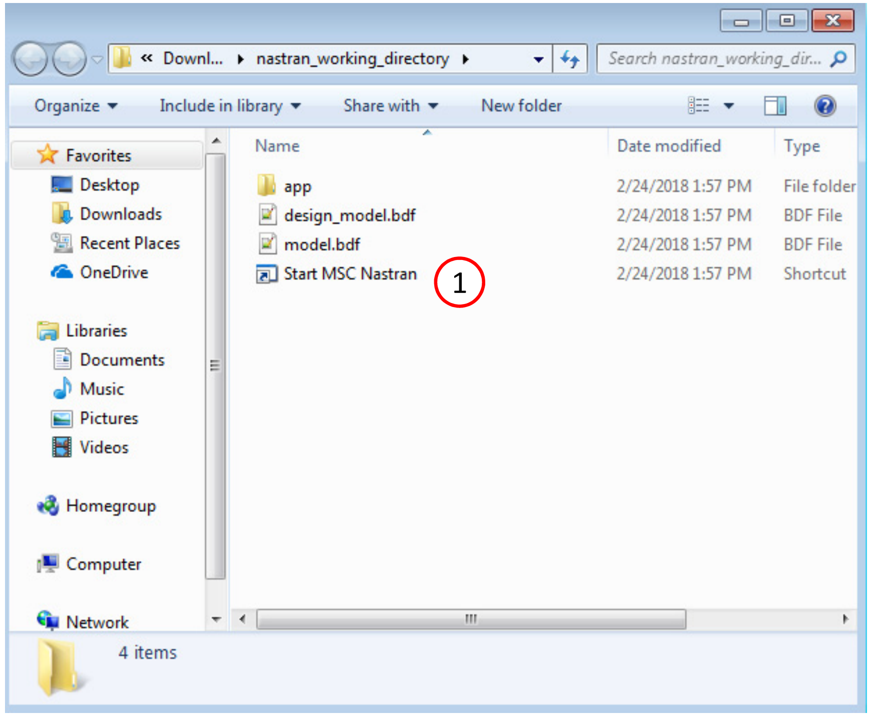
- After a successful optimization, the results will be automatically displayed as long as the following files are present: BDF, F06 and LOG.
- One can run the Nastran job on a remote machine as follows:
  1) Copy the BDF files and the INCLUDE files to a remote machine. 2) Run the MSC Nastran job on the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

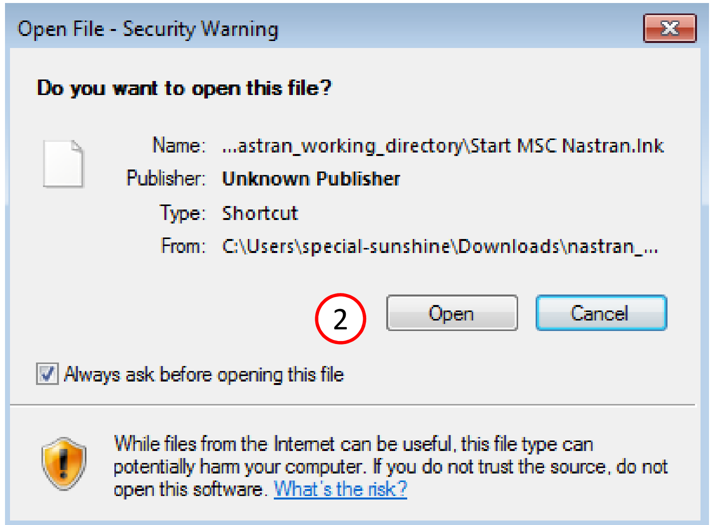
Using Linux?

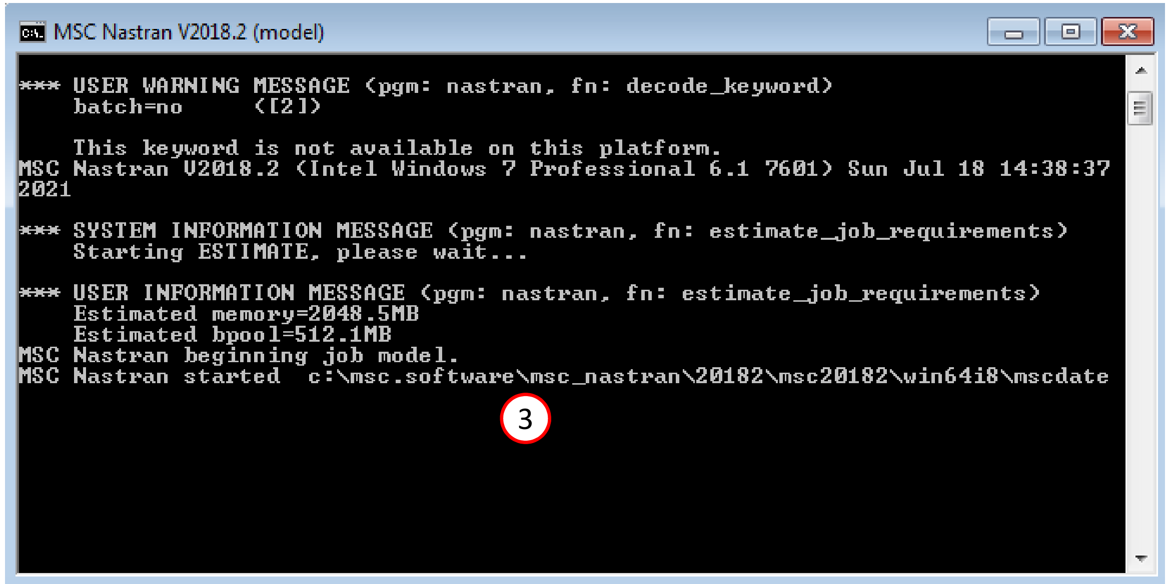
Follow these instructions:
1) Open Terminal
2) Navigate to the nastran_working_directory
   cd ./nastran_working_directory
3) Use this command to start the process
   ./Start_MSC_Nastran.sh

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.

SOL 200 Web App - Local Optimization Results

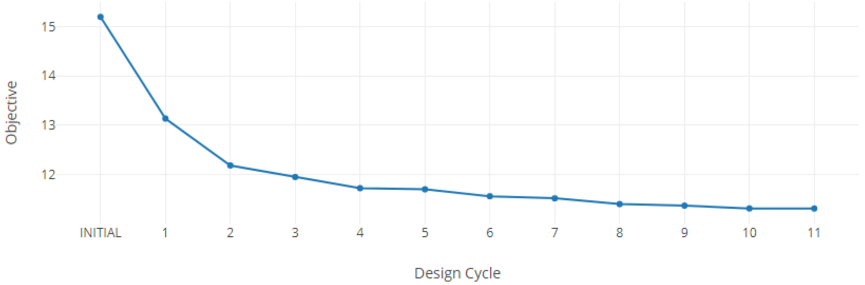
Home

Final Message in .f06

1

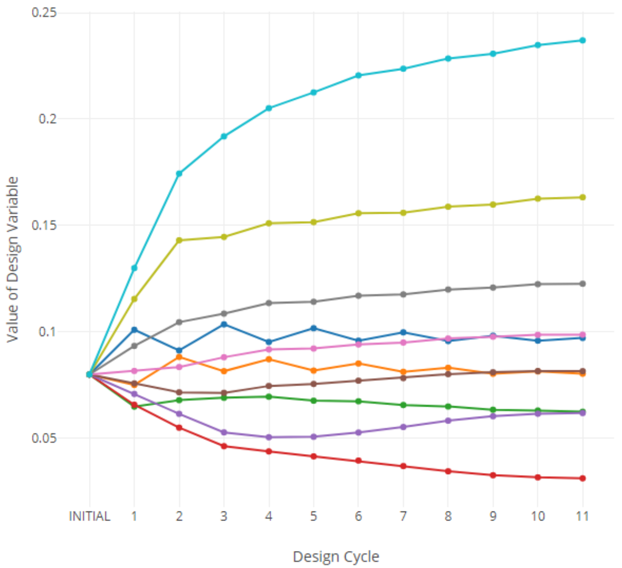
RUN TERMINATED DUE TO HARD CONVERGENCE TO AN OPTIMUM AT CYCLE NUMBER = 11.

Objective



2

Design Variables



Display None Display All

Display	Color	Label	Label Comments
☑		x1	T, Thickness, of PSHELL 1 (Section_1)
☑		x2	T, Thickness, of PSHELL 2 (Section_2)
☑		x3	T, Thickness, of PSHELL 3 (Section_3)
☑		x4	T, Thickness, of PSHELL 4 (Section_4)
☑		x5	T, Thickness, of PSHELL 5 (Section_5)
☑		x6	T, Thickness, of PSHELL 6 (Section_6)
☑		x7	T, Thickness, of PSHELL 7 (Section_7)
☑		x8	T, Thickness, of PSHELL 8 (Section_8)
☑		x9	T, Thickness, of PSHELL 9 (Section_9)
☑		x10	T, Thickness, of PSHELL 10 (Section_10)

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

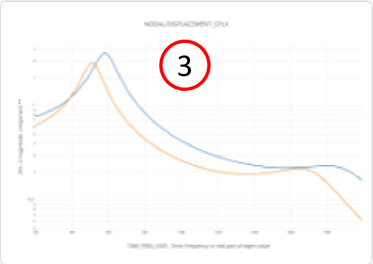
1

SOL 200 Web App - HDF5 Explorer | Acquire Dataset | Plots Browser | Combine Plots | Last Plot Added | Connection | Home

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

Review Dynamic Results

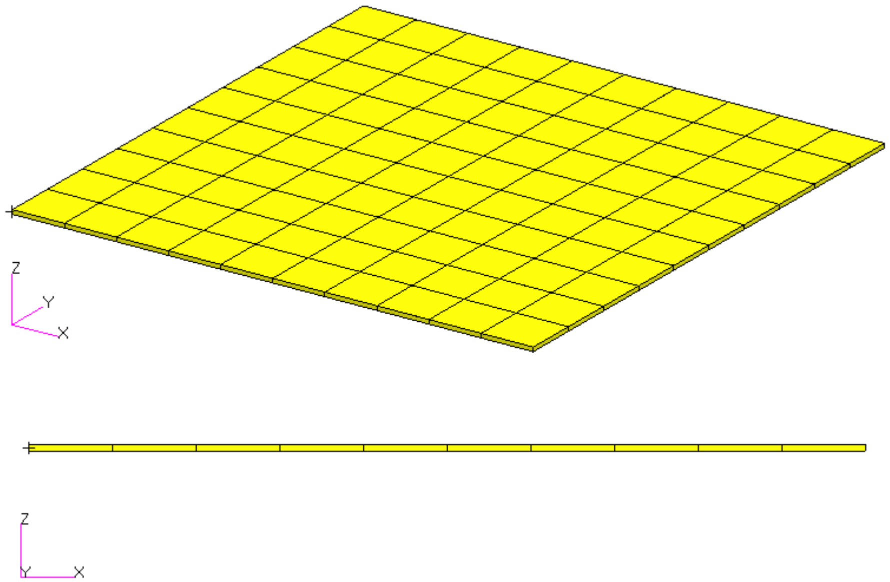
1. The plot contains the INITIAL and FINAL values of the dynamic response

- 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.

Results

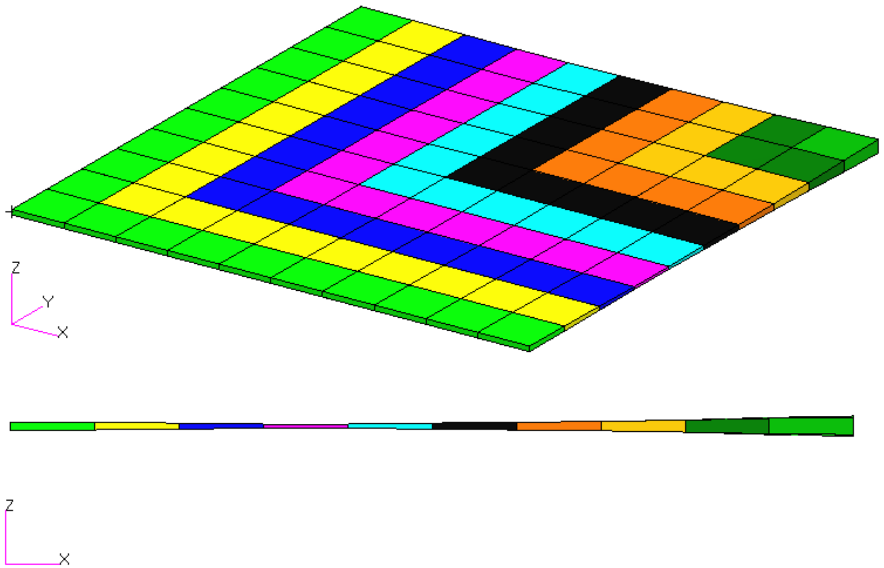
Before Optimization

- RSS displacement at node 1110: 15.2 in.
- Volume: 8.00 in^3



After Optimization

- RSS displacement at node 1110: 11.3 in.
- Volume: 7.99 in^3

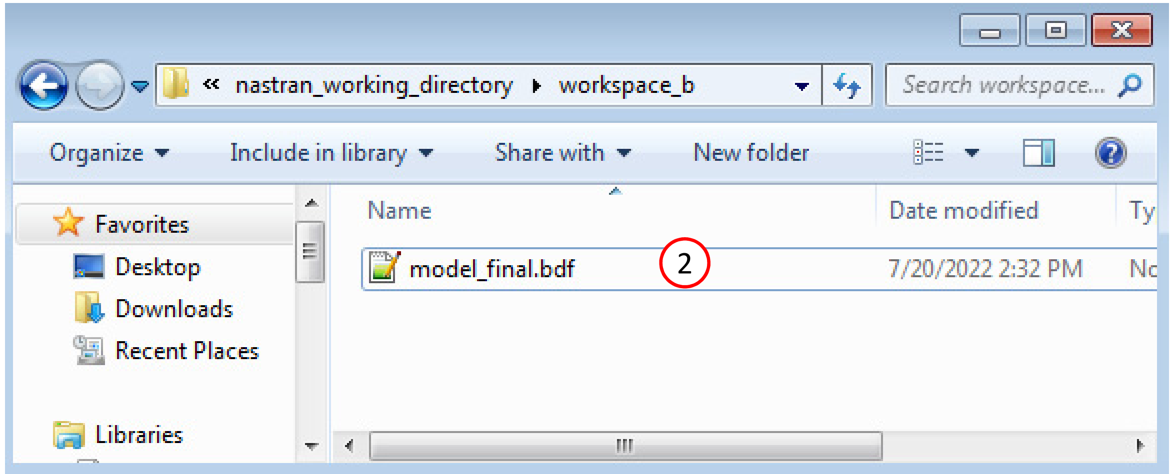


MSC Nastran Design Sensitivity and Optimization User's Guide
Chapter 8 - Example Problems - Dynamic Response Optimization

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

1

```
$ Elements and Element Properties    region : Section_1
PSHELL  1       150     .08     15
$ 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
```

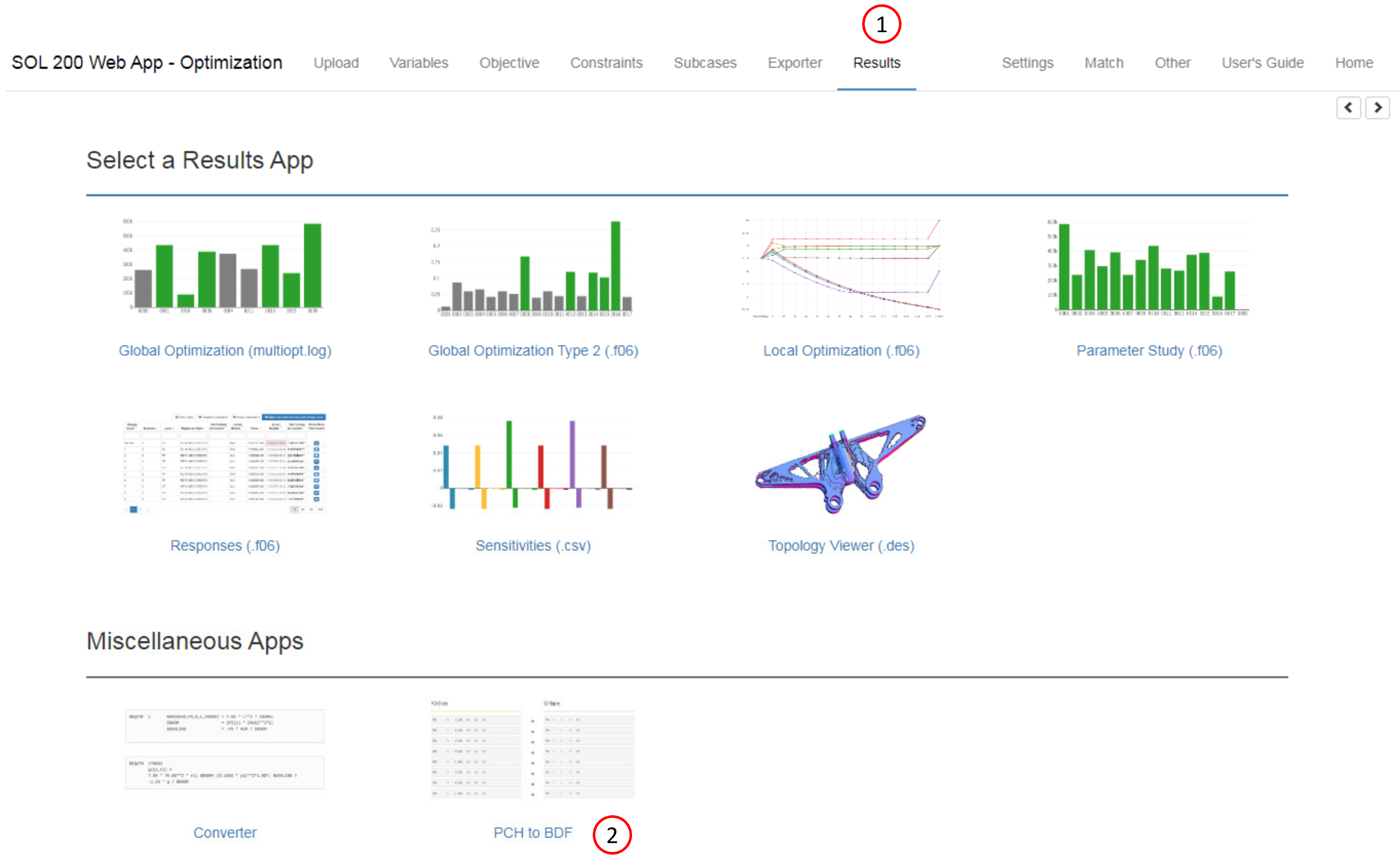
Updated BDF File (model_final.bdf)

3

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

Update the Original Model

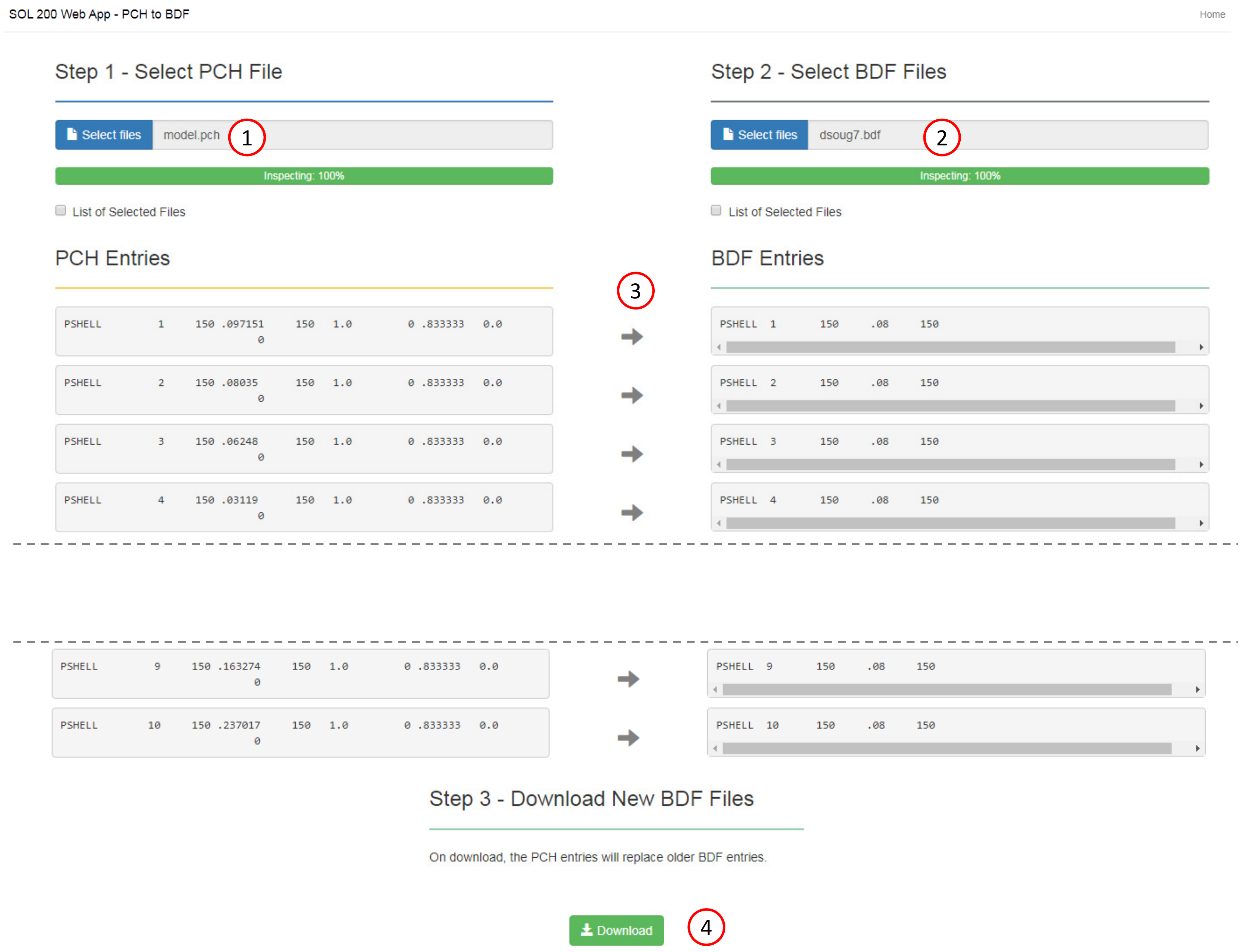
1. Click Results
2. Click PCH to BDF



Update the Original Model

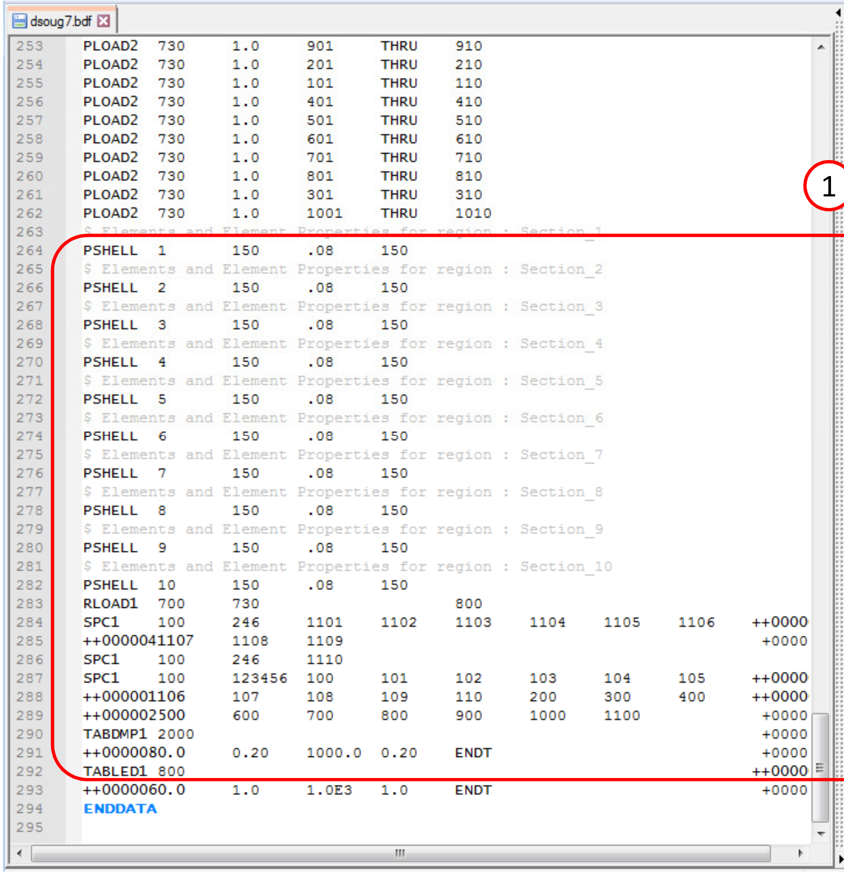
The original .bdf/.dat file has old information about the properties. The properties will be updated.

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



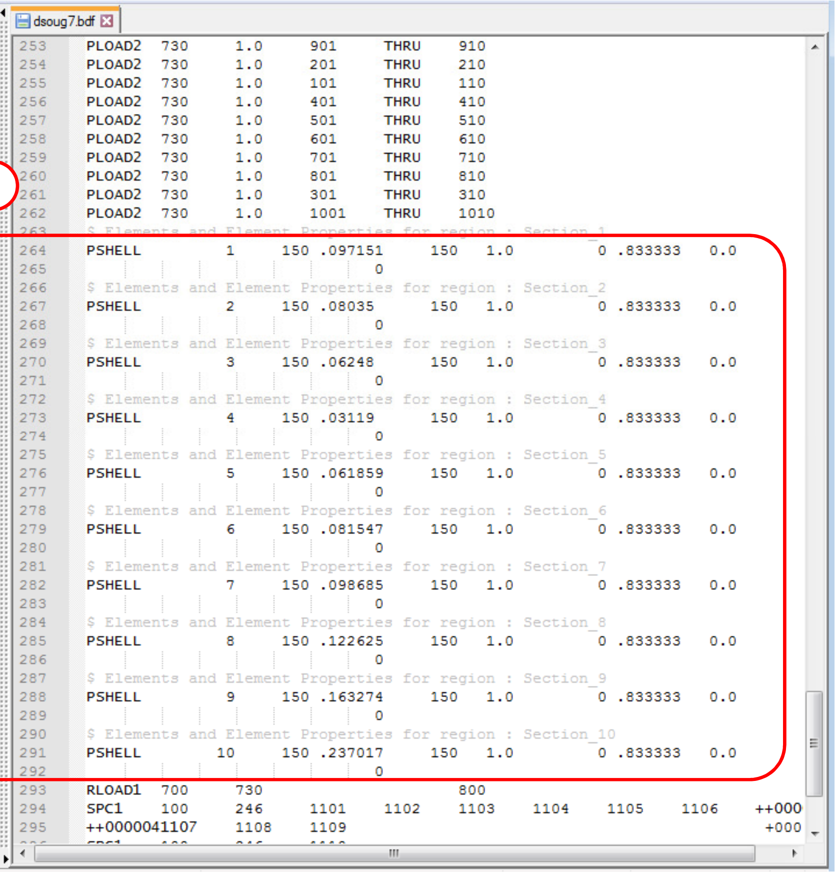
Update the Original Model

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



```
dsoug7.bdf
PLOAD2  730     1.0     901     THRU    910
PLOAD2  730     1.0     201     THRU    210
PLOAD2  730     1.0     101     THRU    110
PLOAD2  730     1.0     401     THRU    410
PLOAD2  730     1.0     501     THRU    510
PLOAD2  730     1.0     601     THRU    610
PLOAD2  730     1.0     701     THRU    710
PLOAD2  730     1.0     801     THRU    810
PLOAD2  730     1.0     301     THRU    310
PLOAD2  730     1.0     1001    THRU    1010
$ 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
SPC1    100     246     1101    1102    1103    1104    1105    1106    ++0000
++0000041107    1108    1109                                             +0000
SPC1    100     246     1110
SPC1    100     123456  100     101     102     103     104     105     ++0000
++000001106     107     108     109     110     200     300     400     ++0000
++000002500     600     700     800     900     1000    1100             +0000
TABDMP1 2000                                                             +0000
++0000080.0     0.20    1000.0  0.20    ENDT                             +0000
TABLED1 800                                                             ++0000
++0000060.0     1.0     1.0E3   1.0     ENDT                             +0000
ENDDATA
```

Original BDF/DAT File



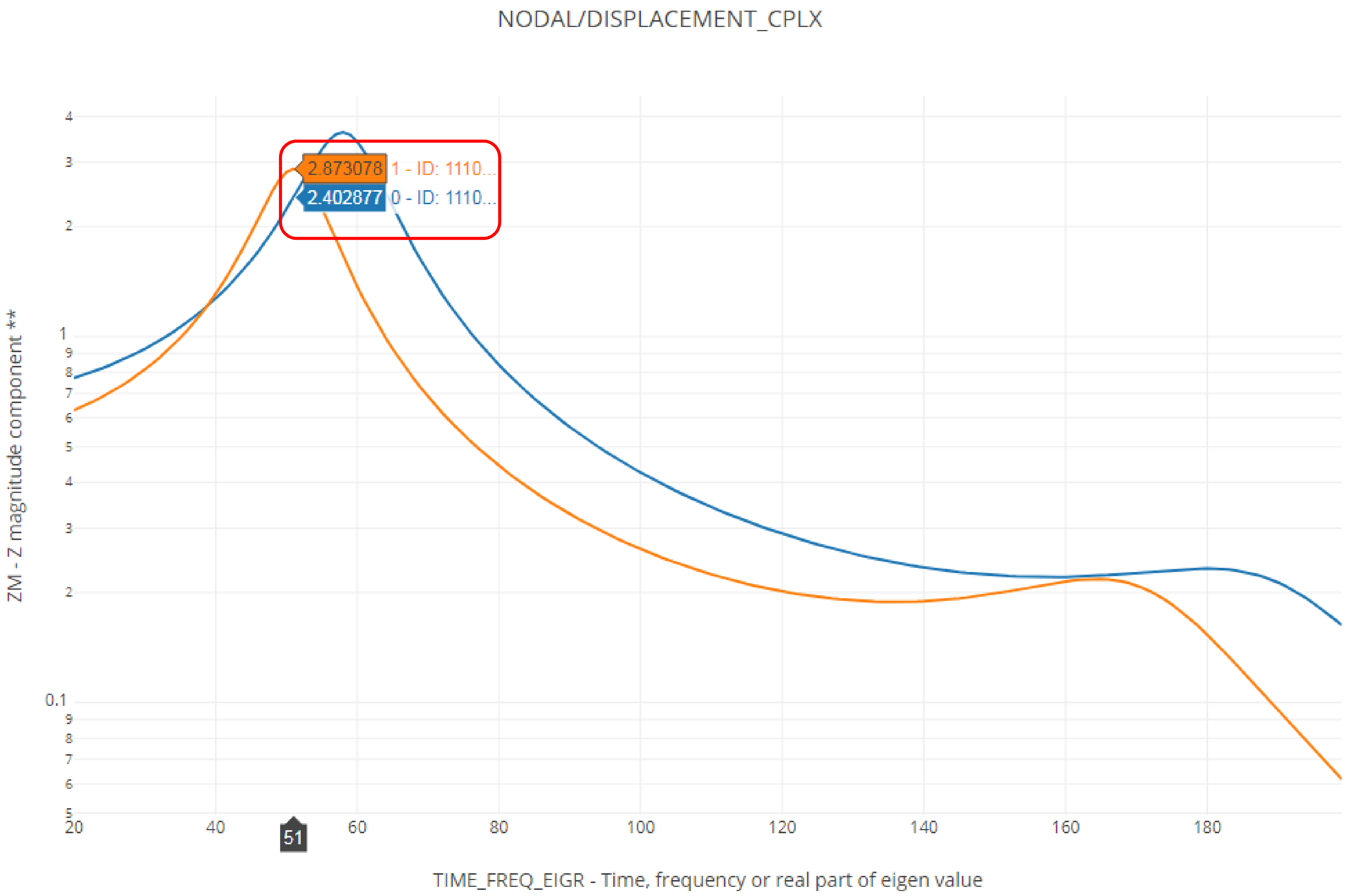
```
dsoug7.bdf
PLOAD2  730     1.0     901     THRU    910
PLOAD2  730     1.0     201     THRU    210
PLOAD2  730     1.0     101     THRU    110
PLOAD2  730     1.0     401     THRU    410
PLOAD2  730     1.0     501     THRU    510
PLOAD2  730     1.0     601     THRU    610
PLOAD2  730     1.0     701     THRU    710
PLOAD2  730     1.0     801     THRU    810
PLOAD2  730     1.0     301     THRU    310
PLOAD2  730     1.0     1001    THRU    1010
$ Elements and Element Properties for region : Section_1
PSHELL         1     150 .097151     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_2
PSHELL         2     150 .08035      150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_3
PSHELL         3     150 .06248      150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_4
PSHELL         4     150 .03119      150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_5
PSHELL         5     150 .061859     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_6
PSHELL         6     150 .081547     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_7
PSHELL         7     150 .098685     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_8
PSHELL         8     150 .122625     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_9
PSHELL         9     150 .163274     150     1.0               0 .833333     0.0
                               0
$ Elements and Element Properties for region : Section_10
PSHELL        10     150 .237017     150     1.0               0 .833333     0.0
                               0
RLOAD1  700     730                     800
SPC1    100     246     1101    1102    1103    1104    1105    1106    ++000
++0000041107    1108    1109                                             +000
```

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.

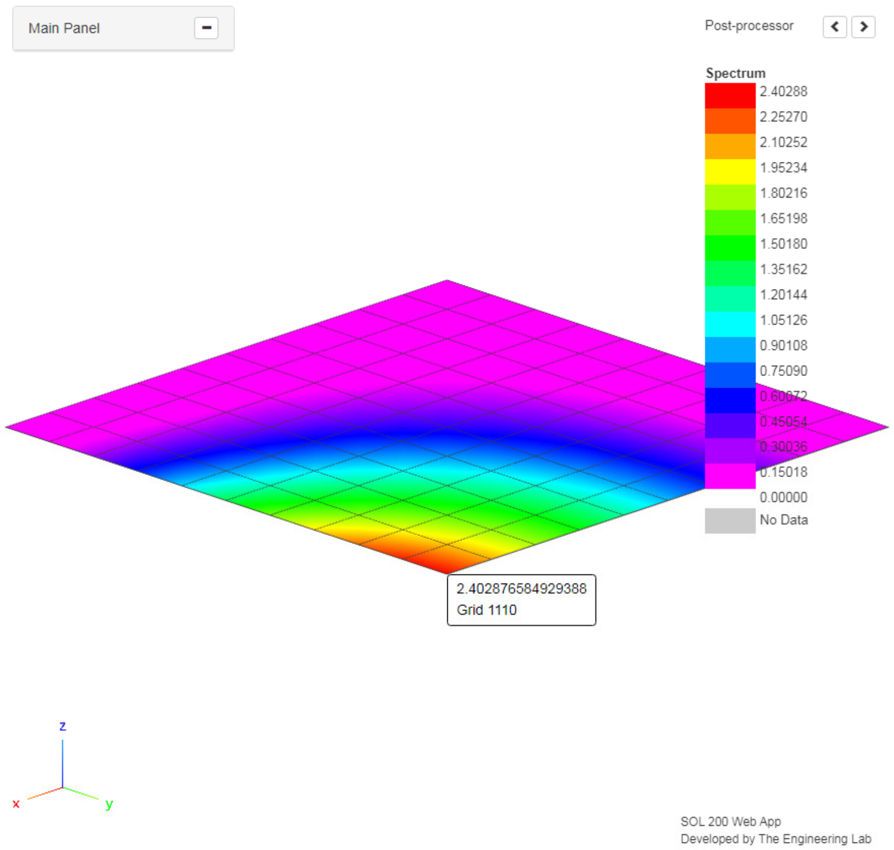


Post-processor Web App

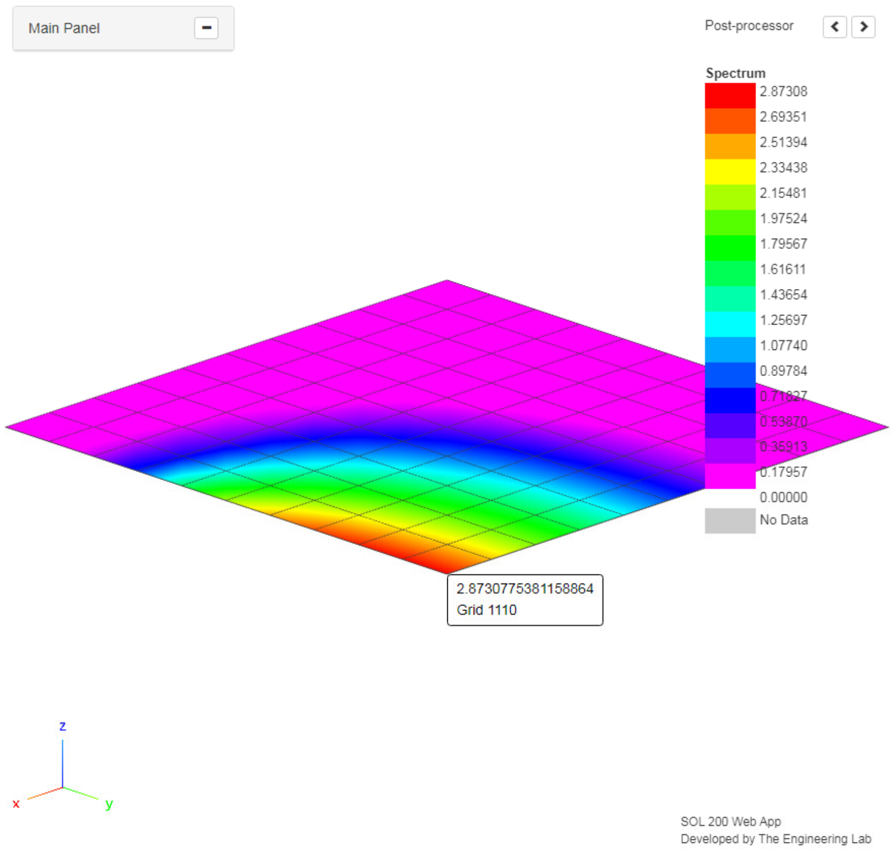
- The Post-processor web app is used to inspect the MSC Nastran results.
- The displacements are displayed for the z component, magnitude, at 51 Hz. Note the displacements at grid 1110 match the values from the graph (XY plot) on the previous page.

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

Displacements, z component, magnitude

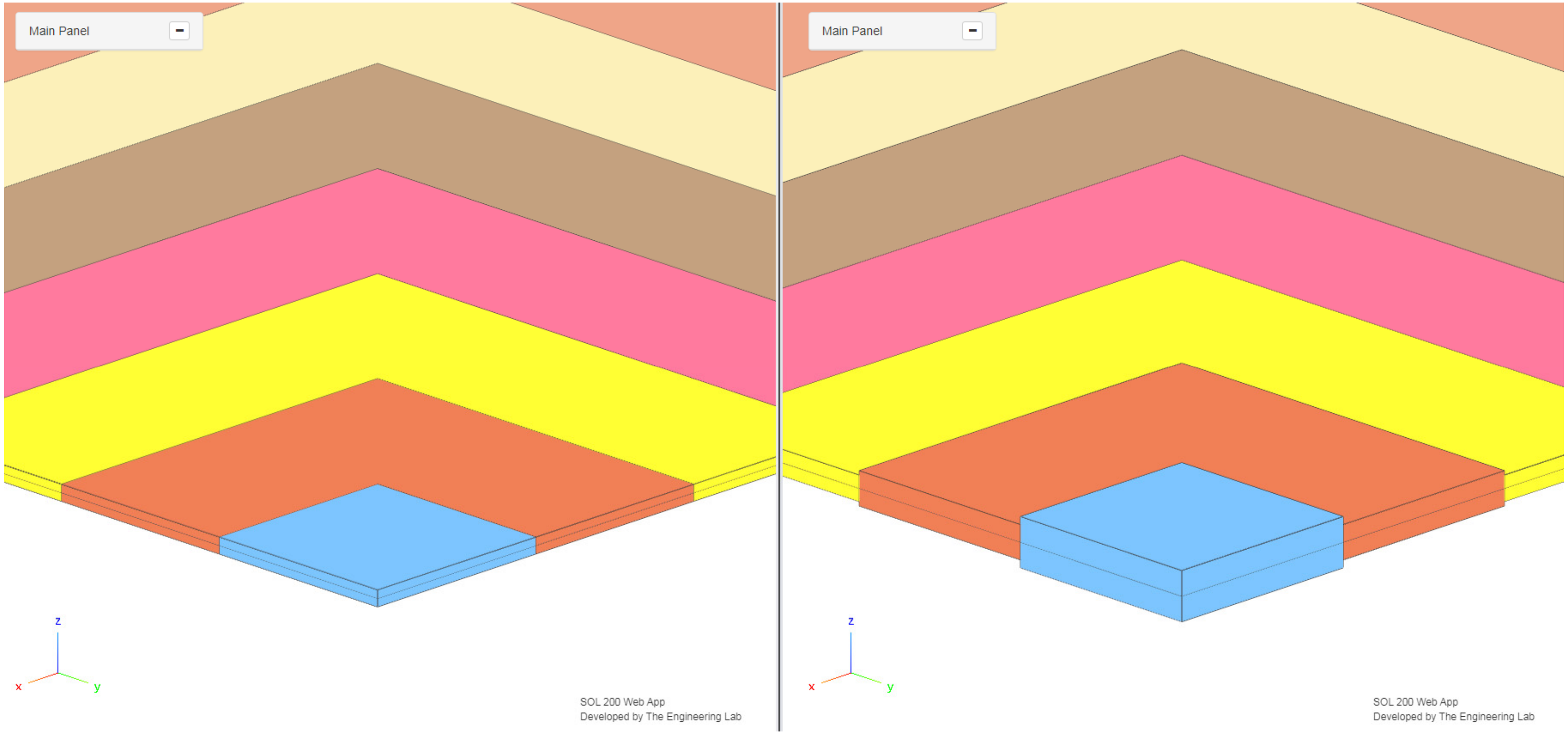


Initial Design



Final Design

Thicknesses of PSHELL entries



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.

End of Tutorial

Appendix

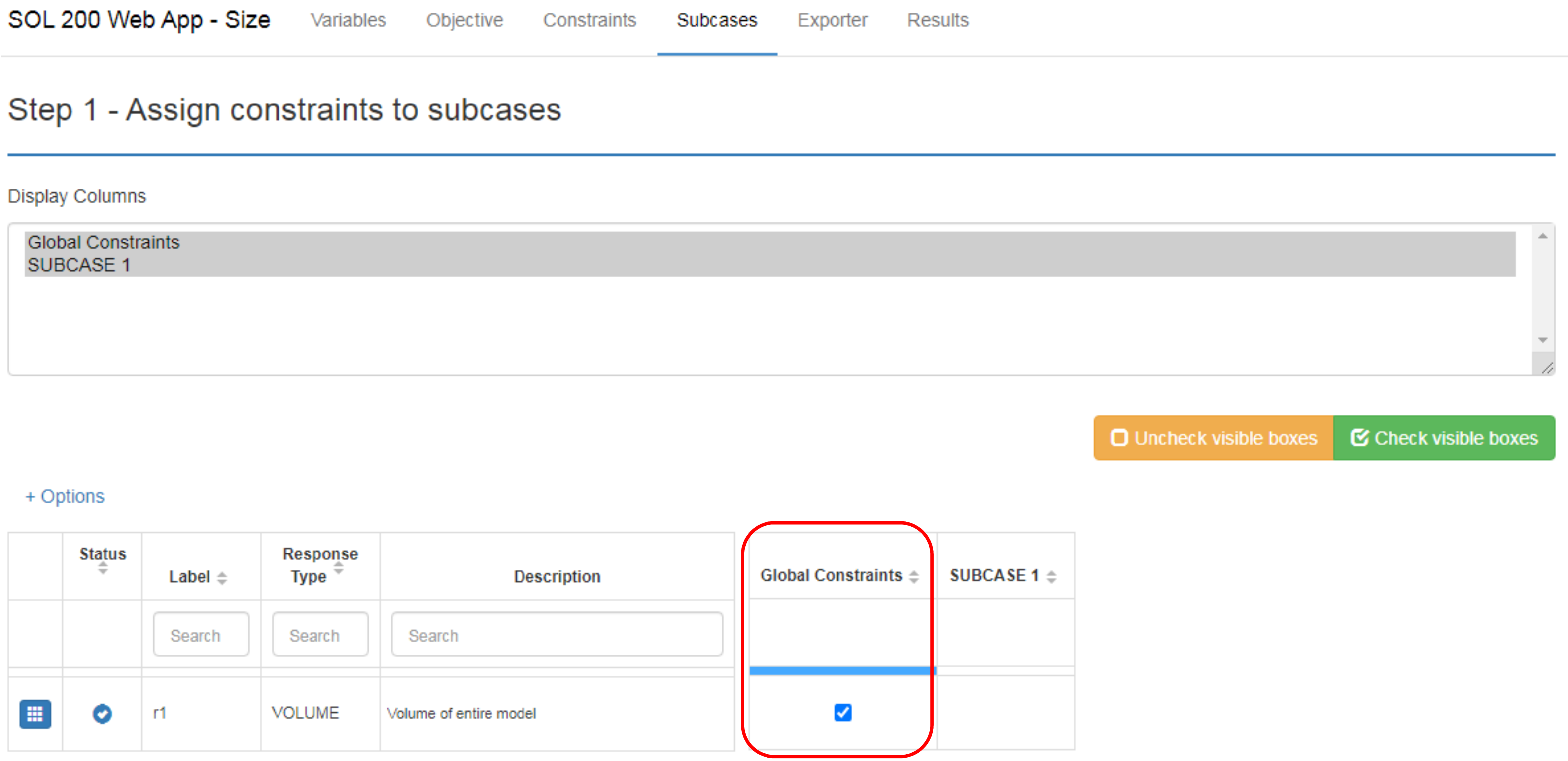
Appendix Contents

- Frequently Asked Questions
  - What are global constraints?

Frequently Asked Questions

Question:

- What are global constraints?



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