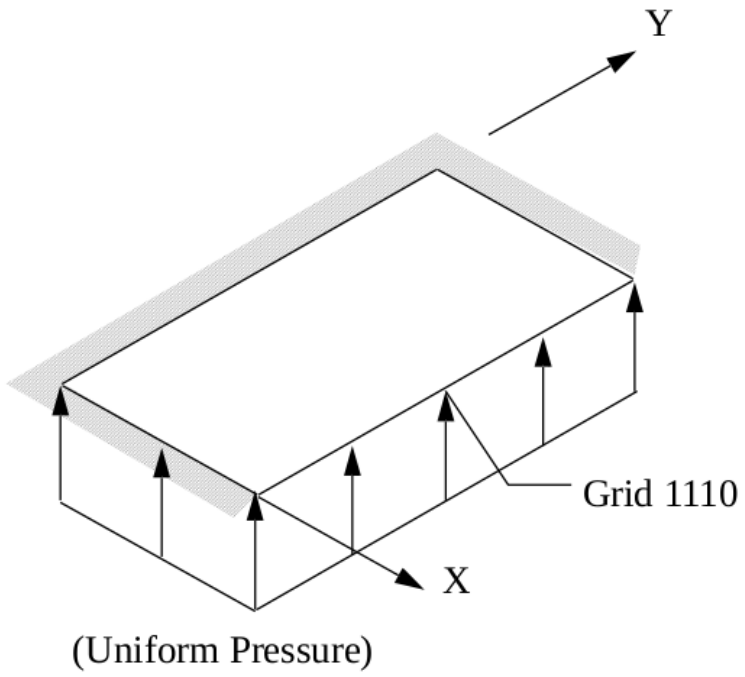
Dynamic Response Optimization with Nastran Optimization

PRESENTED BY CHRISTIAN APARICIO

Goal: Use Nastran SOL 200 Optimization



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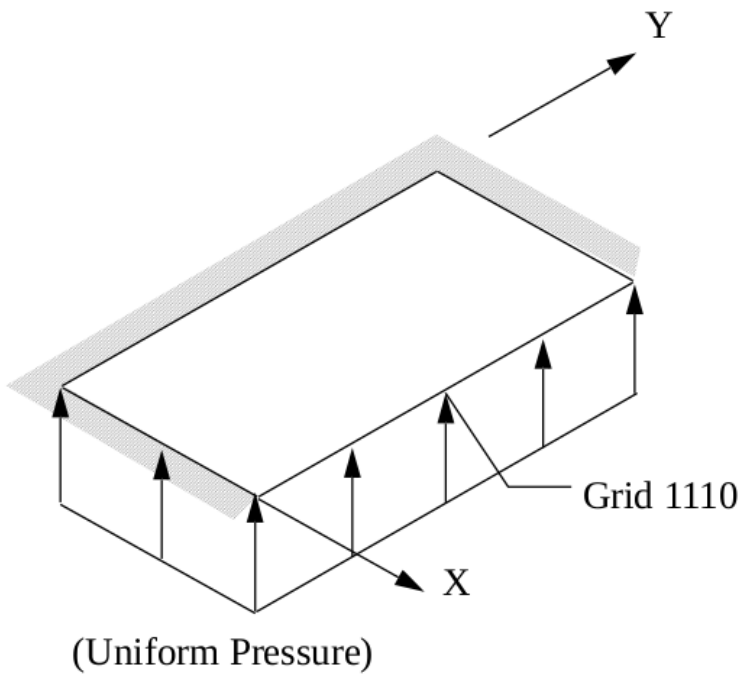
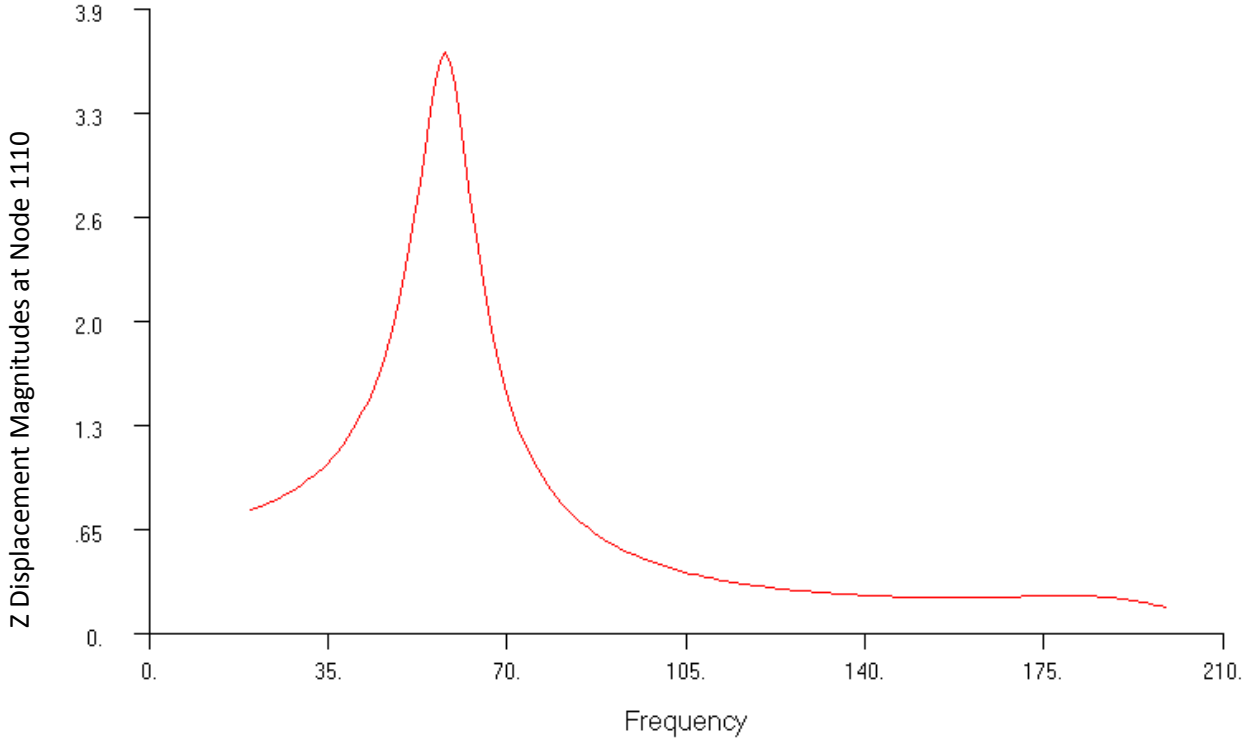
Chapter 8 – Example Problems - Dynamic Response Optimization

Goal: Use Nastran SOL 200 Optimization





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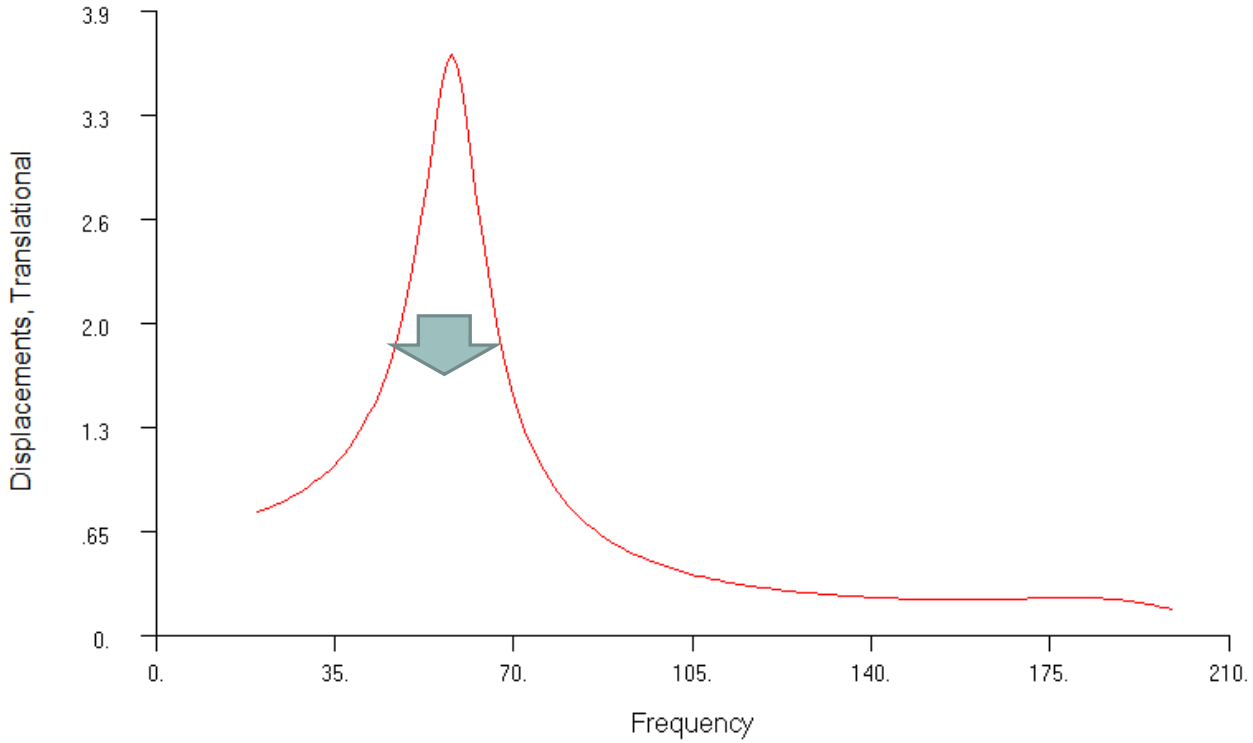

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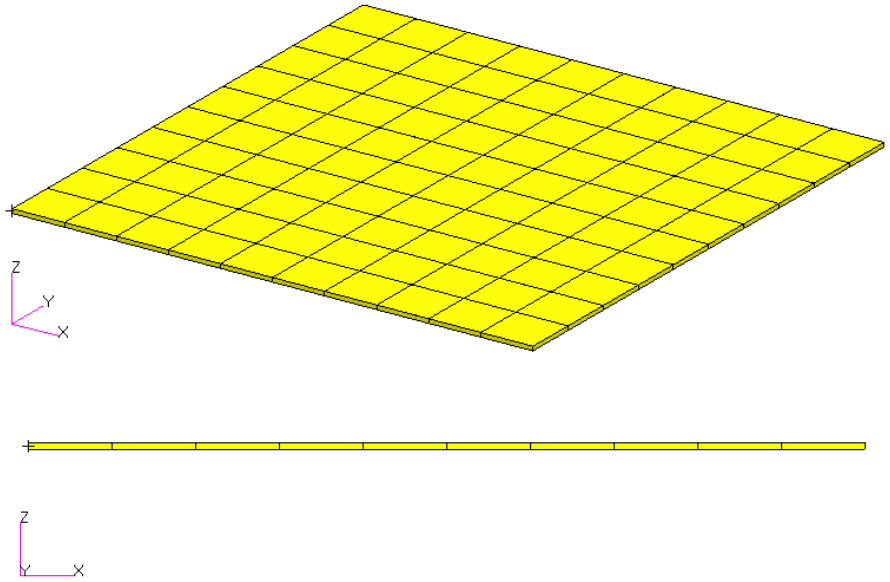
Chapter 8 – Example Problems - Dynamic Response Optimization

Goal: Use Nastran SOL 200 Optimization

Minimize the RSS displacement while maintaining a constant volume

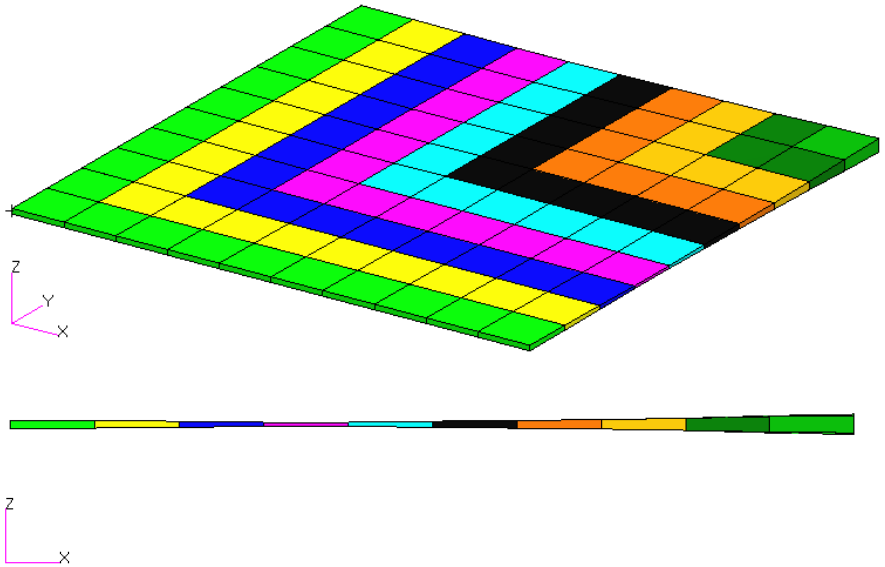
Before Optimization

- 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



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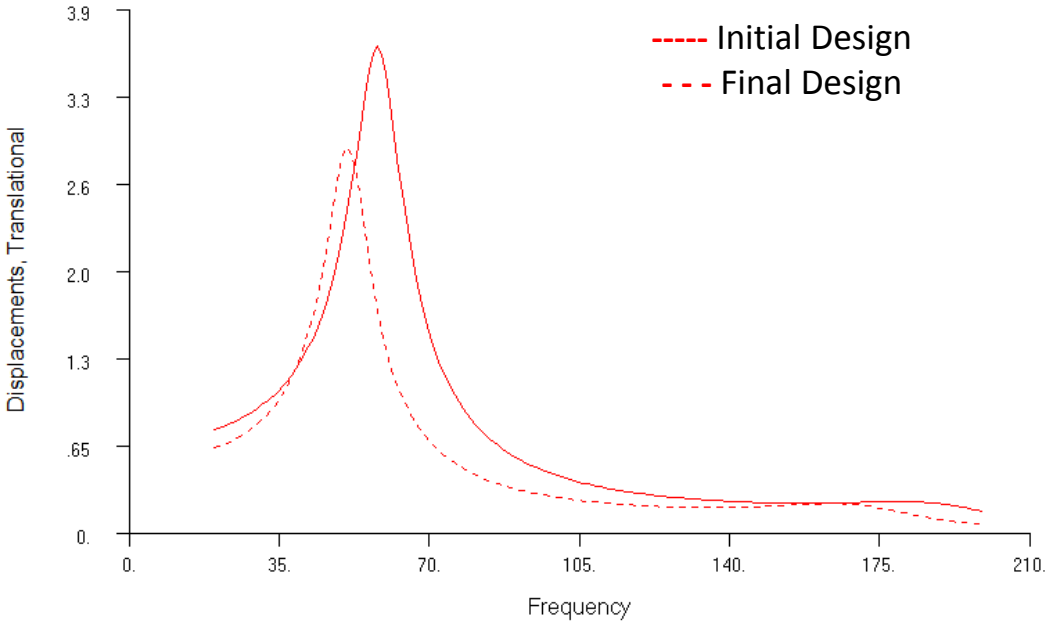
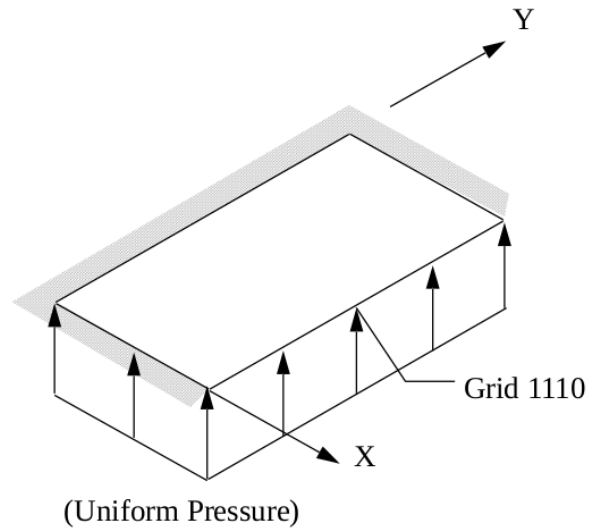
Goal: Use Nastran SOL 200 Optimization

- Optimize plate thicknesses to minimize the vertical displacement magnitudes at node 1110 across all forcing frequencies





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Chapter 8 – Example Problems - Dynamic Response Optimization

Agenda

Details of the structural model

Optimization Problem Statement

Steps to use Nastran SOL 200 (Optimization)
- Convert a .bdf file to SOL 200
- Create:
  - Design Variables
  - Design Objective
  - Design Constraints
- Perform optimization with Nastran SOL 200

View optimization results
- Online Plotter
- Structural Results

Update the original structural model with optimized parameters

Contact me

- Nastran SOL 200 training
- Nastran SOL 200 questions
- Structural optimization questions
- Access to the SOL 200 Web App

christian@ the-engineering-lab.com

Do you have questions? Email me:
christian@ the-engineering-lab.com

The SOL 200 Web App is now available through MSC**One**^{XT}.
Contact your Hexagon sales representative for access.

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 $1.0\ lb_f/in^2$ 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.

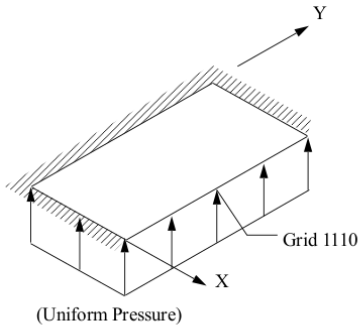

Figure 8-21 Pressure-Loaded Flat Plate

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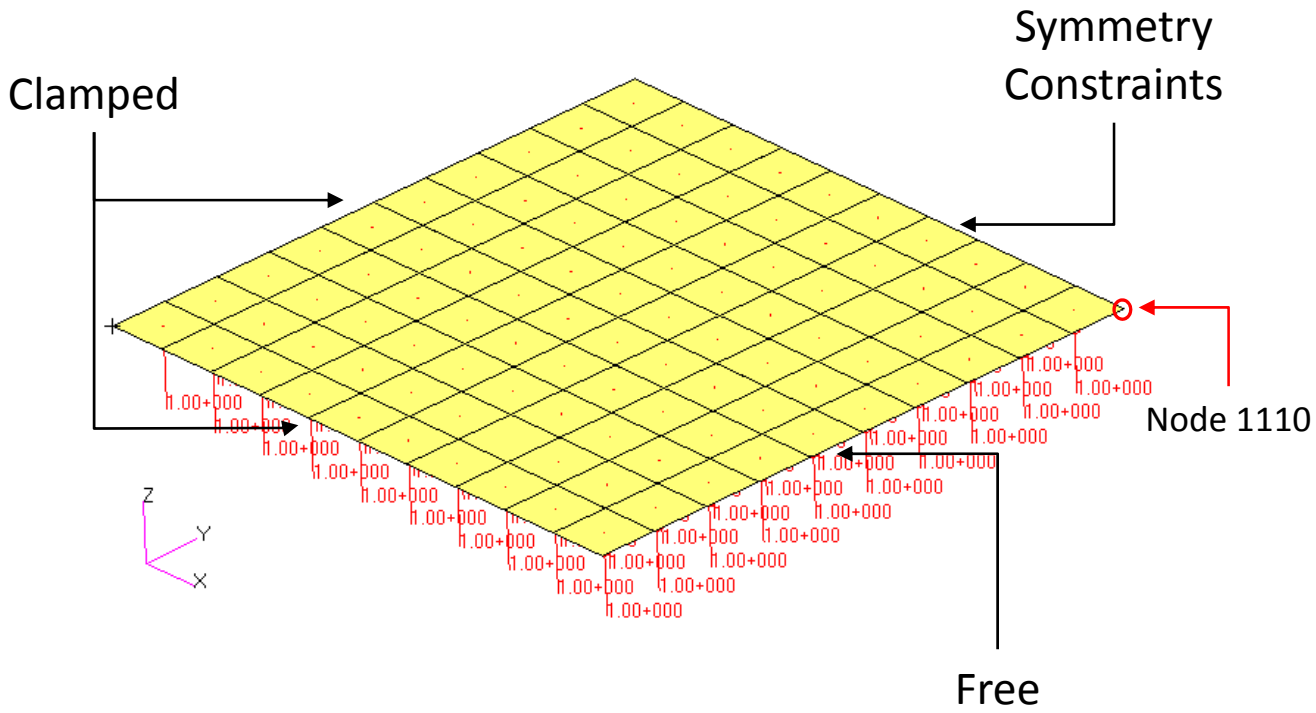
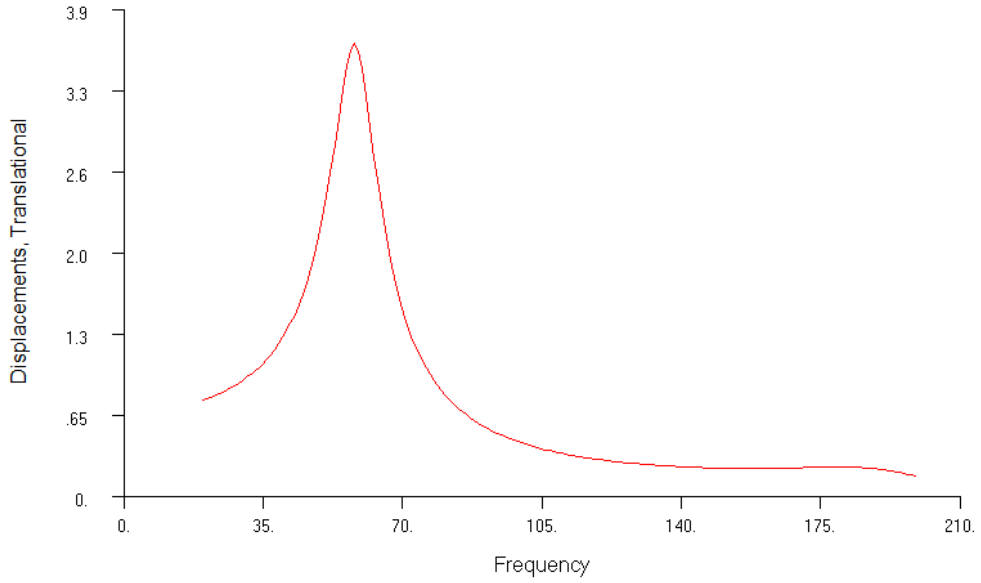
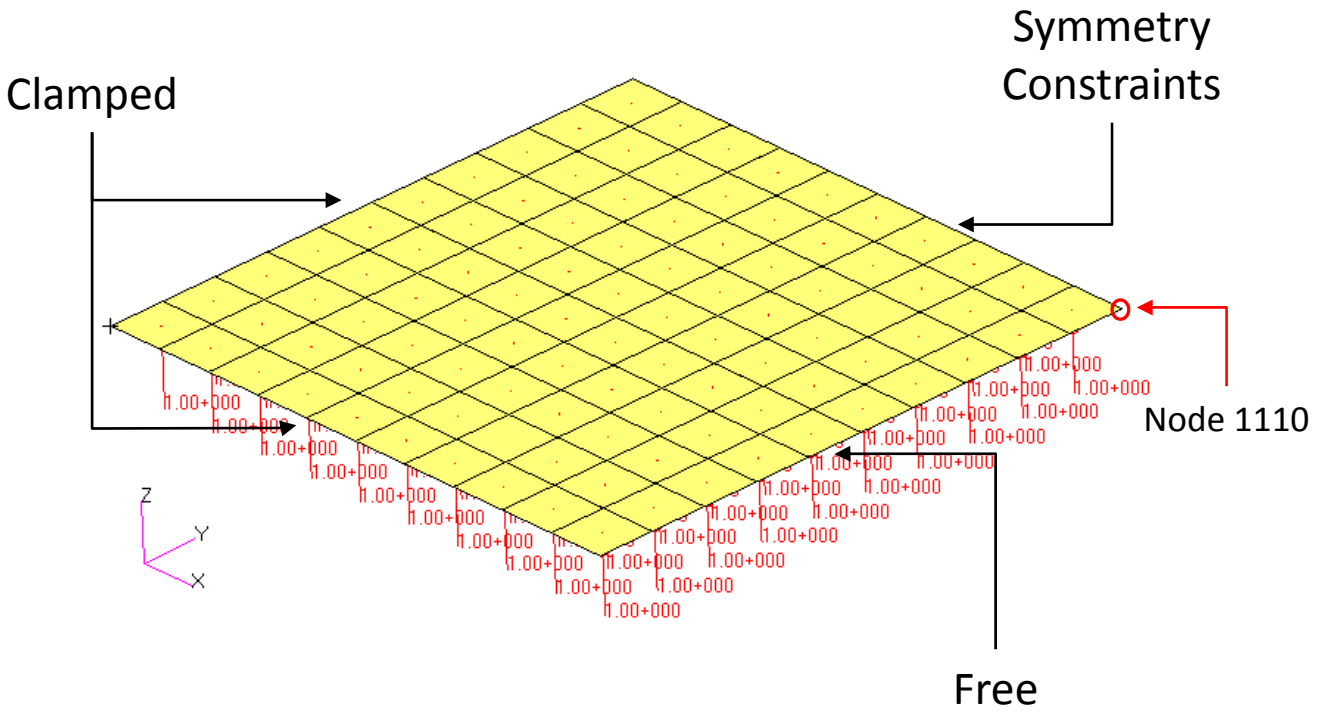
Chapter 8 – Example Problems – Dynamic Response Optimization



Details of the structural model

Z component displacement response at Node 1110 across forcing frequencies

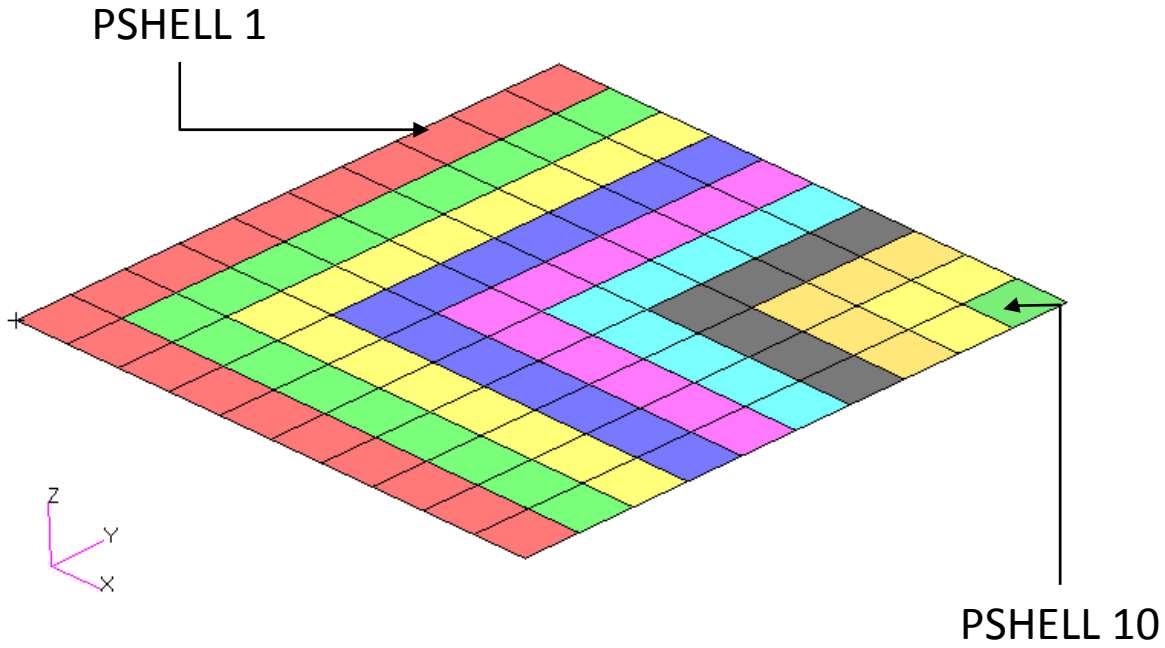




Optimization Problem Statement

Design Variables

- x1: T1 | .01 < x1 < 1.
- x2: T2 | .01 < x2 < 1.
- x3: T3 | .01 < x3 < 1.
- x4: T4 | .01 < x4 < 1.
- x5: T5 | .01 < x5 < 1.
- x6: T6 | .01 < x6 < 1.
- x7: T7 | .01 < x7 < 1.
- x8: T8 | .01 < x8 < 1.
- x9: T9 | .01 < x9 < 1.
- x10: T10 | .01 < x10 < 1.

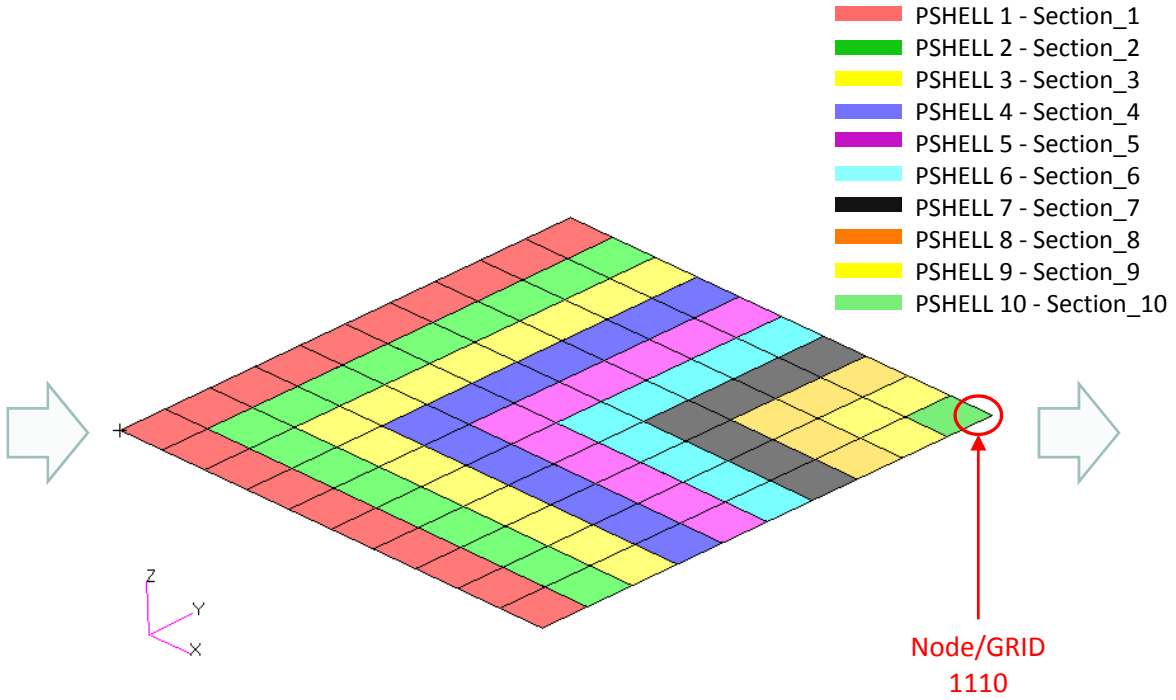


Optimization Problem Statement

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



Responses (Outputs)

- Weight
- Volume
- Displacements
- Strains
- Stresses
- ….
  - In Frequency Domain

Optimization Problem Statement

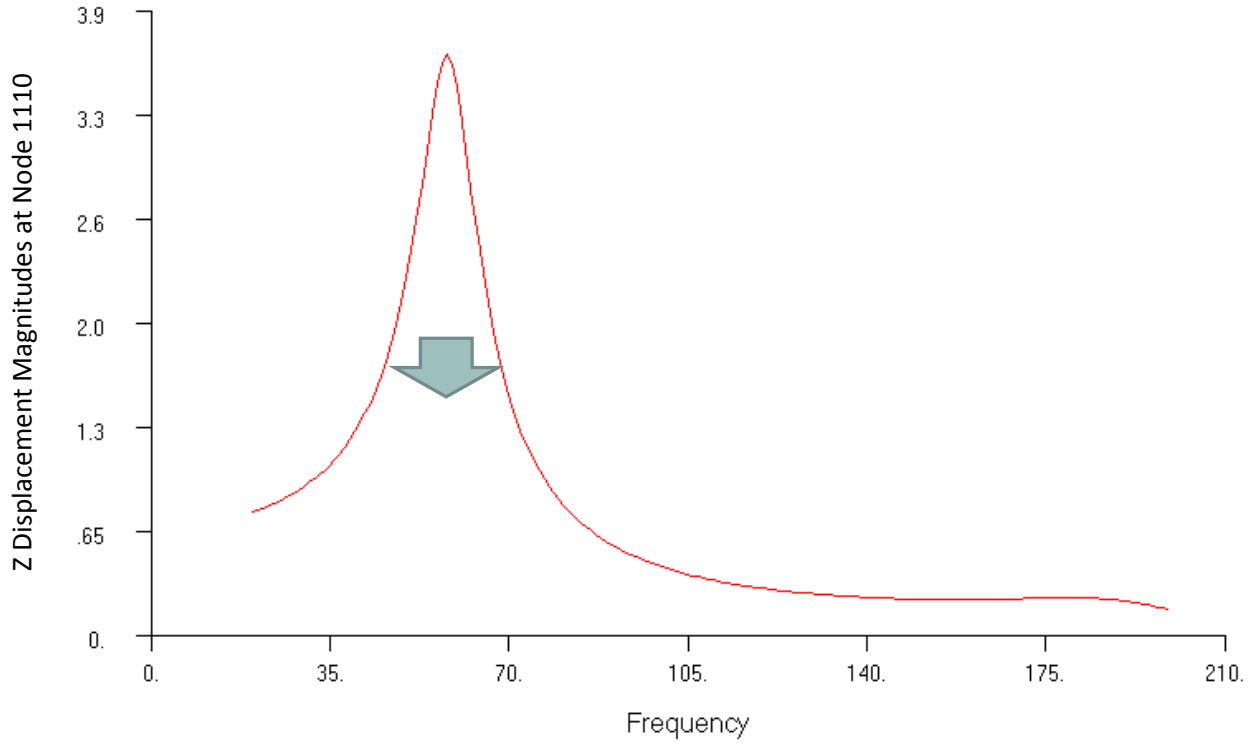
Design Objective

- r0: Minimize the root sum of squares for displacement magnitudes at node 1110 for forcing frequencies 20Hz – 200 Hz

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

Design Constraints

- r1: Volume
  - 7.99 < r1 < 8.01

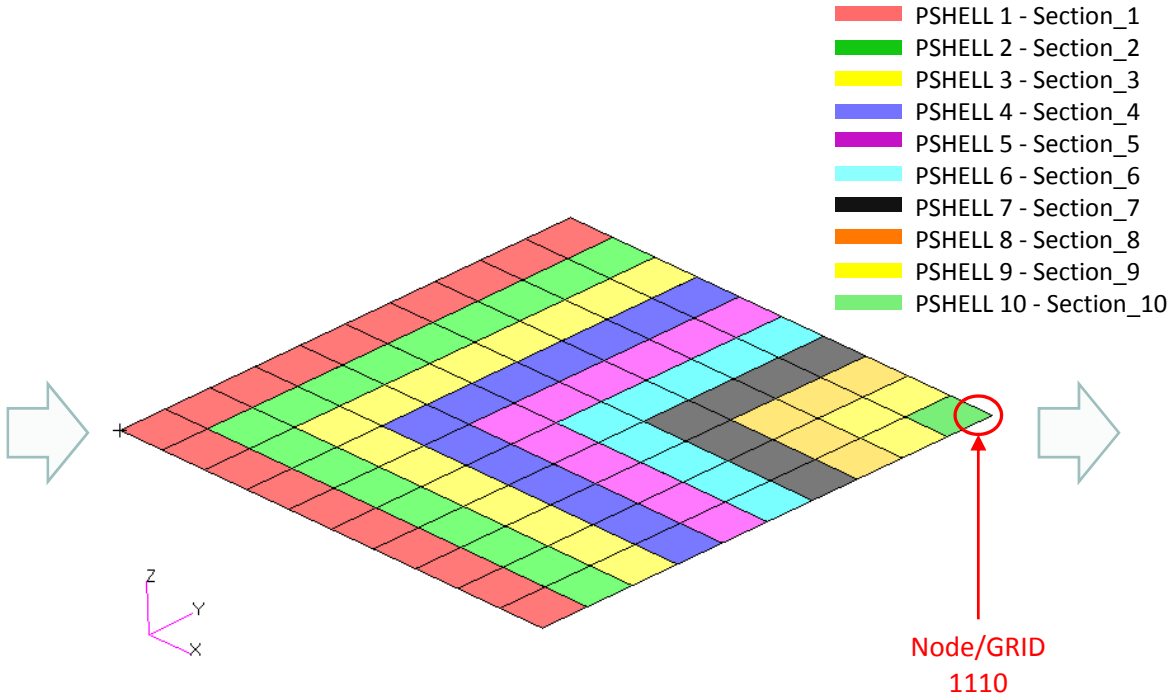


Optimization Problem Statement

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

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

Design Constraints

r1: Volume

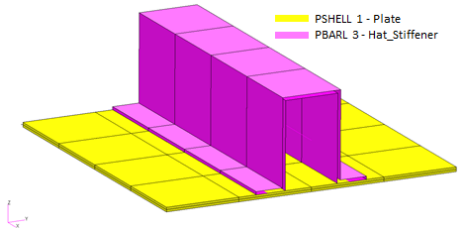
7.99 < r1 < 8.01

Steps to use Nastran SOL 200 (Optimization)

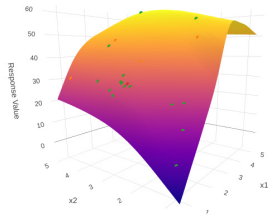
1. Start with a .bdf or .dat file
2. Use the SOL 200 Web App to:
   - Convert the .bdf file to SOL 200
     - Design Variables
     - Design Objective
     - Design Constraints
   - Perform optimization with Nastran SOL 200
3. Review optimization results
   - Online Plotter
   - Optimized structural results
4. Update the original model with optimized parameters

SOL 200 Web App Capabilities

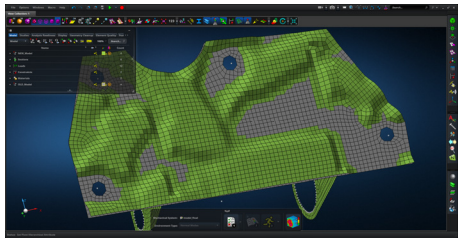
Capabilities



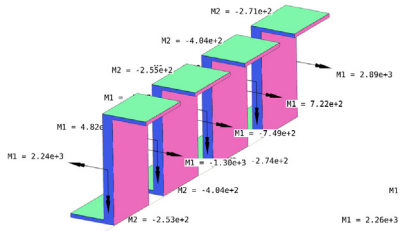
Web Apps for SOL 200
Pre/post for MSC Nastran SOL 200. Support for size, topology, topometry and topography.



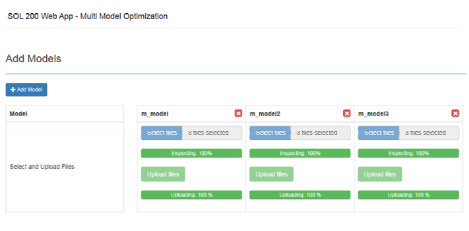
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



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

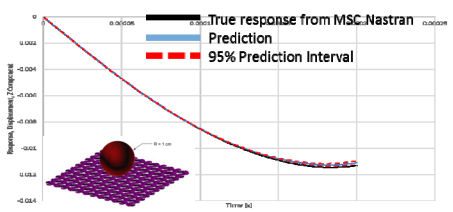


Beams Viewer Web App
Post process 1D element forces, including shear forces, moments, torque and axial forces

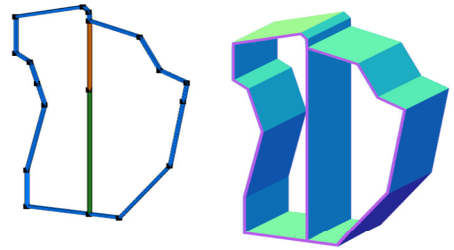


Multi-model Optimization Web App
Pre/post for multi model optimization

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



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



PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically

Benefits

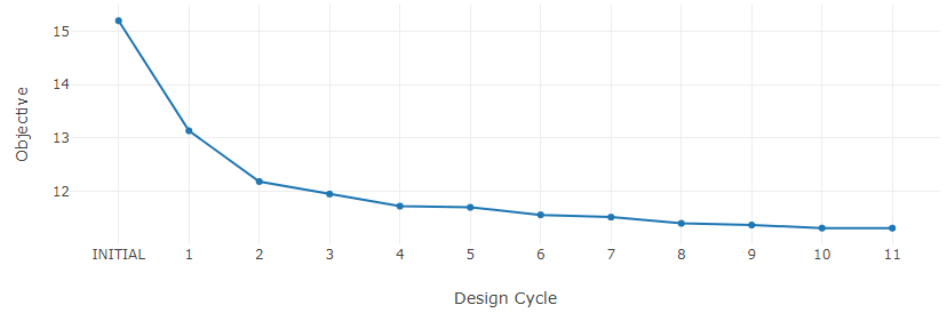
- 200+ error validations (real time)
- Web browser accessible
- Automated creation of entries (real time)
- Automatic post-processing
- 50+ tutorials

View Optimization Results
Online Plotter

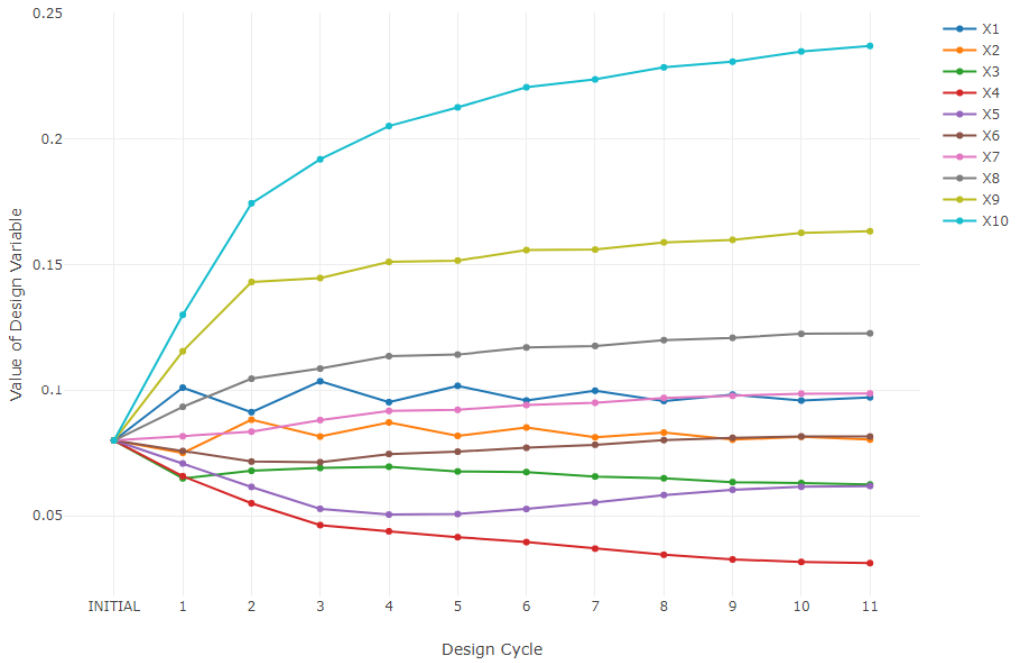
Final Message in .f06

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

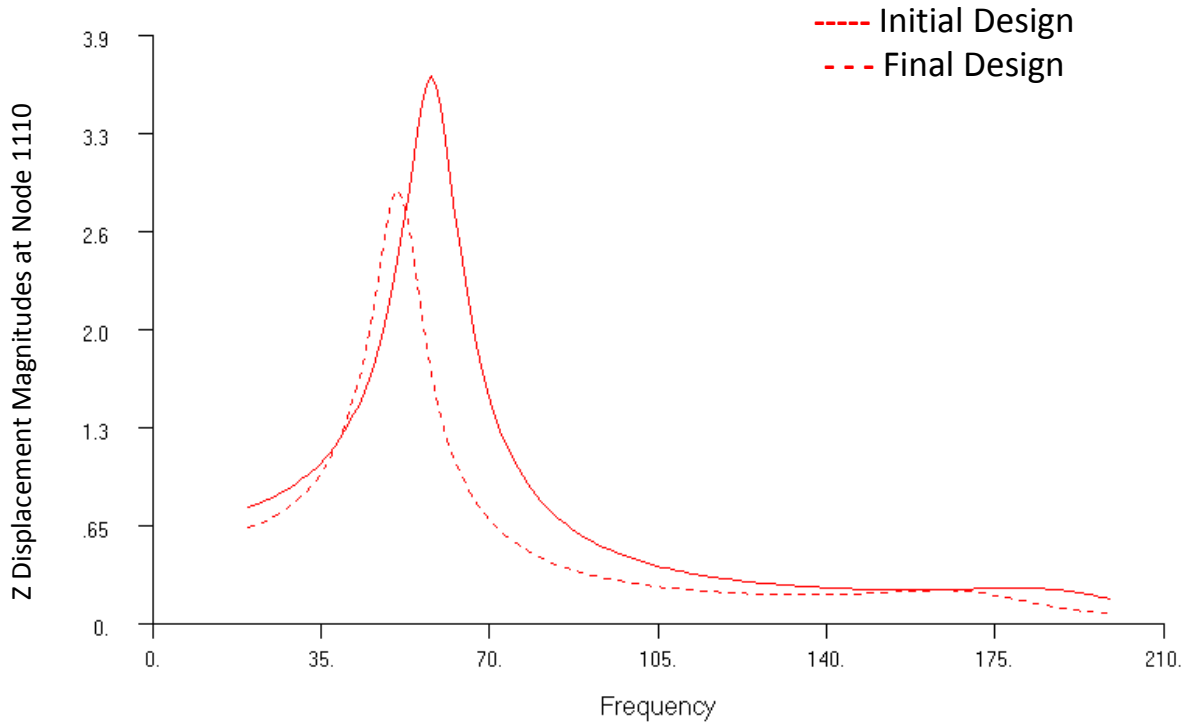
Objective



Design Variables



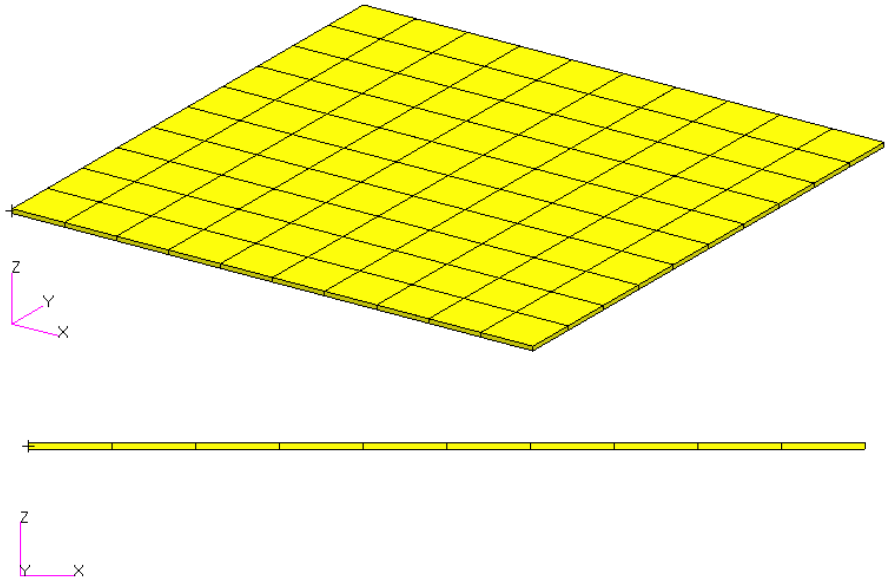
Review Optimization Results, Frequency Results



Review Optimization Results, Structure

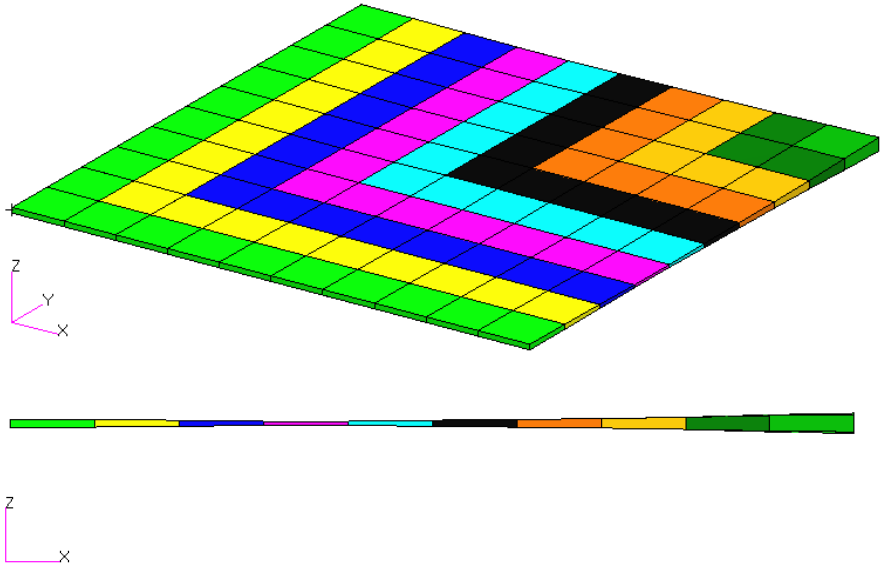
Before Optimization

- 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



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Update the original structural model with optimized parameters

Use the .pch file

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