Bauhaus-Universität Weimar

Aluminum Plate Free State

Group 9

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Experimiental Structural Dynamic and Structural Monitoring

Bauhaus Universitat Weimar

2020

Bauhaus-Universität Weimar

General Information

Aluminum Plate Hanging on Wire

Dimension = 33.5 cm x 25.5 cm x 1.3 cm

Number of Sensor = 61 accelerometer

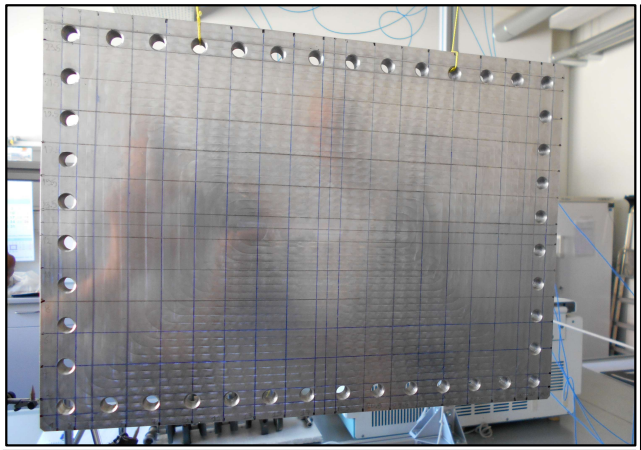
Sample Rate = 10000 Hz

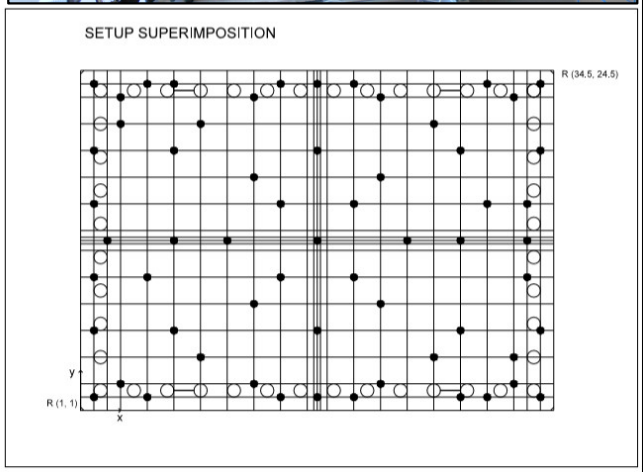
Number of Setup = 6 setup

Type Excitation = Impulse (Hammer)

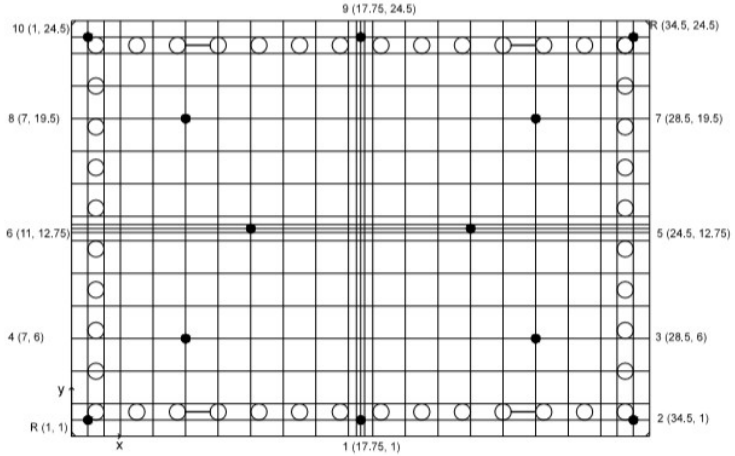
Record's Duration = 31 s

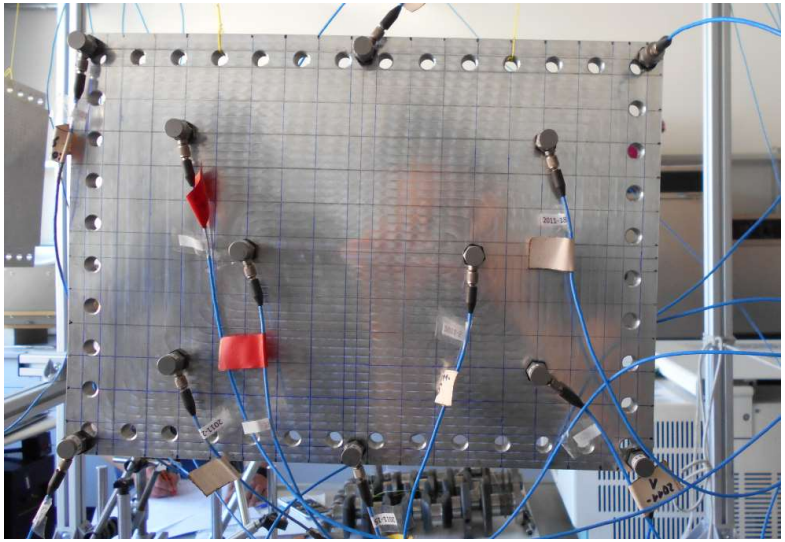
Date of Experiment : 18.05.2017





SETUP 1





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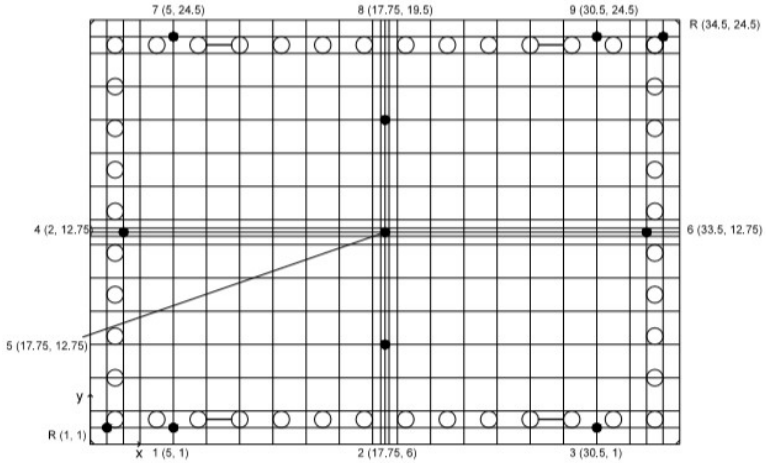

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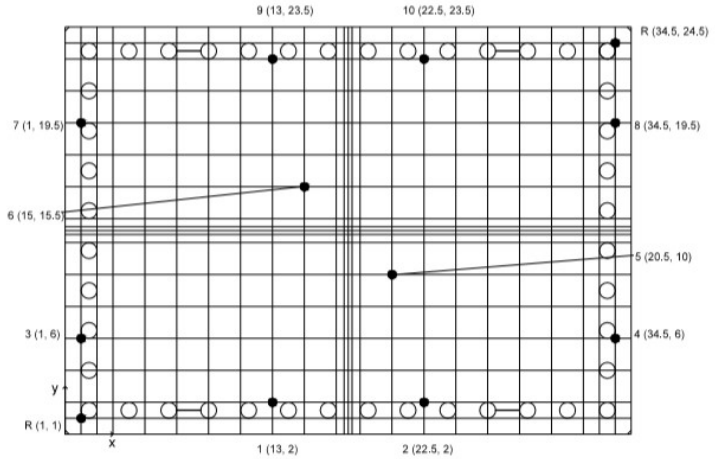
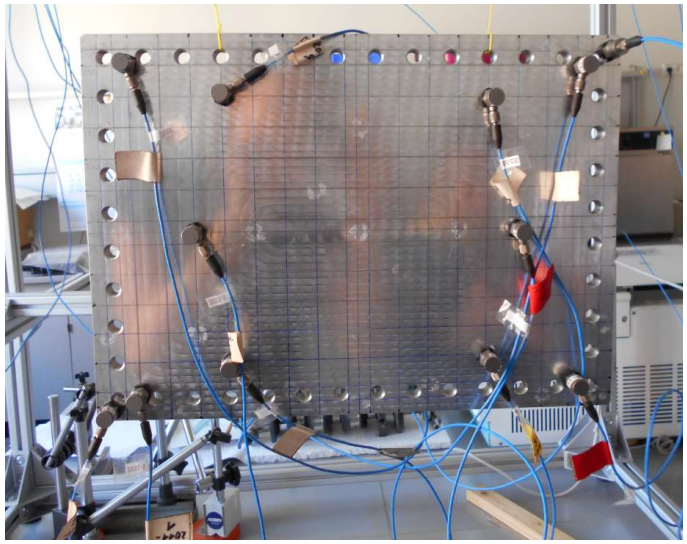
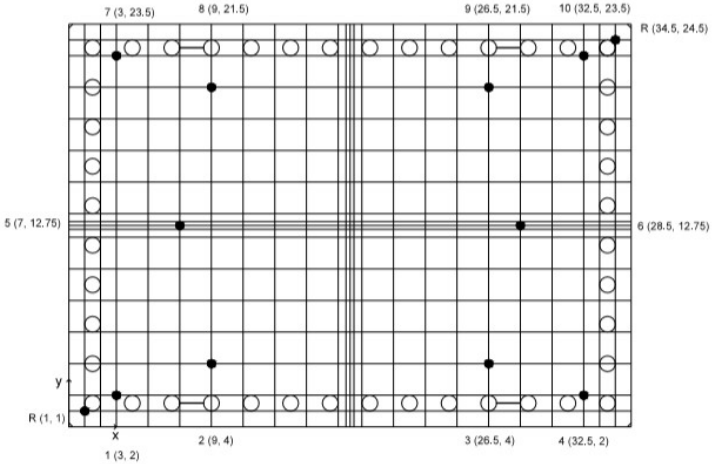
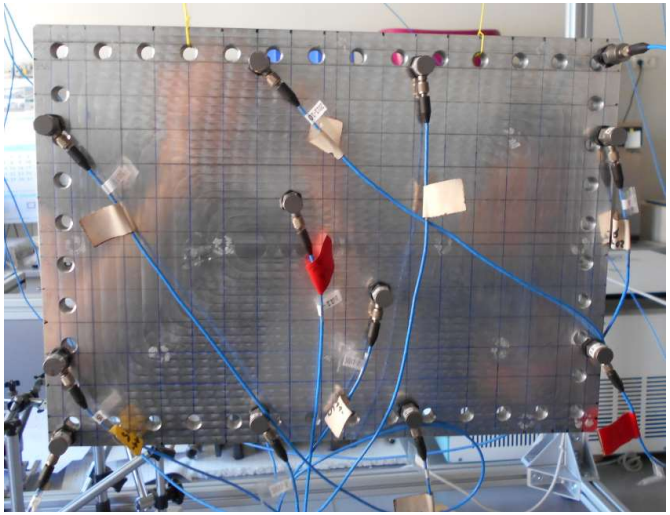


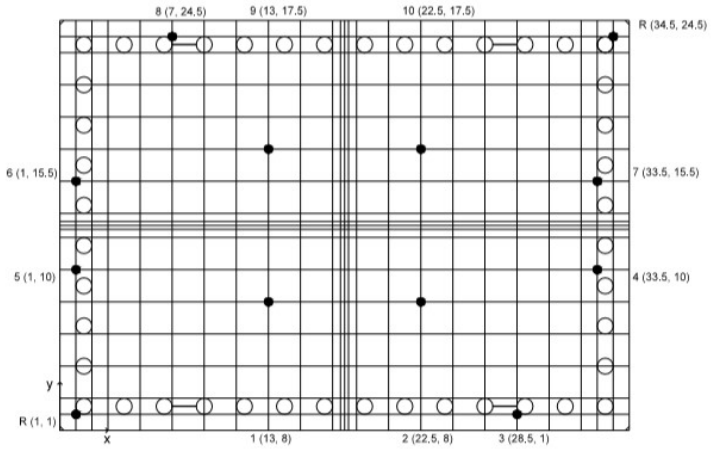


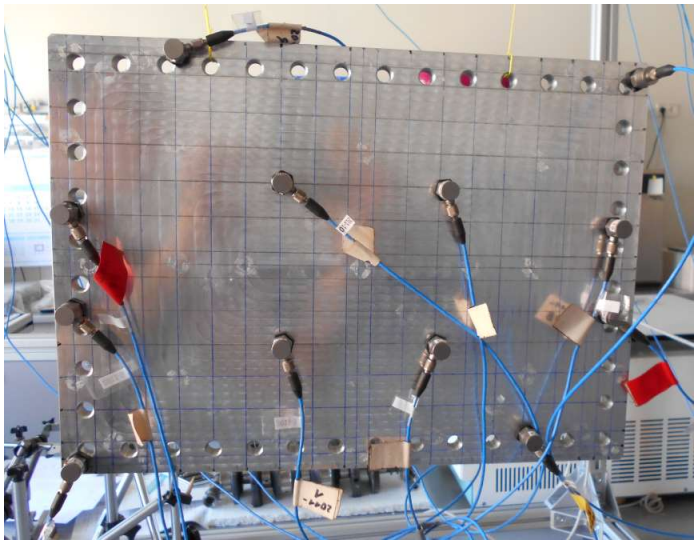
SETUP 4



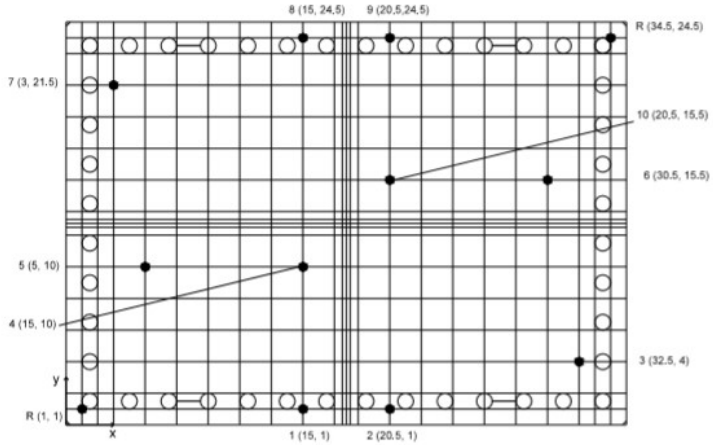


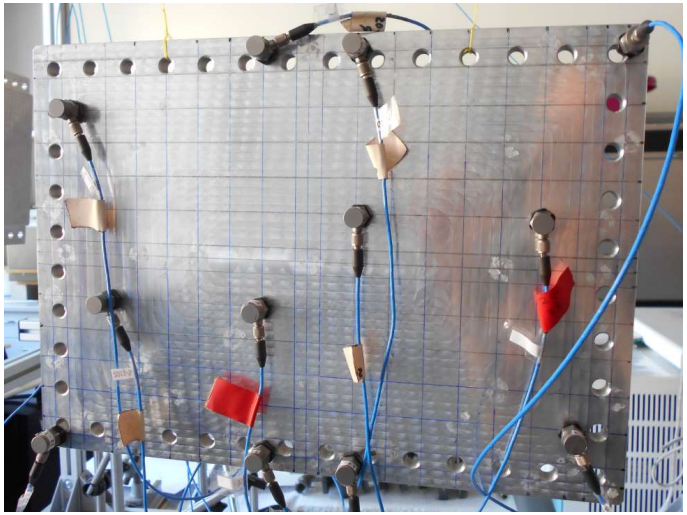
SETUP 5





SETUP 6





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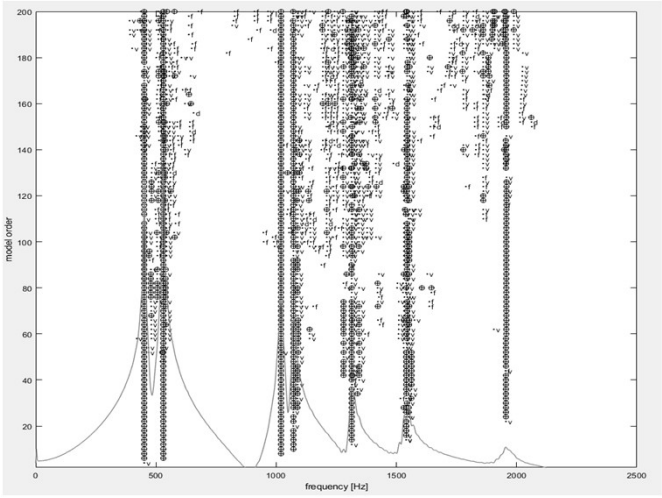
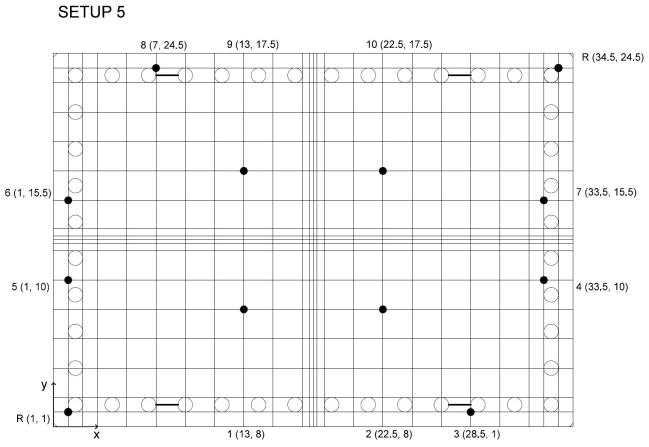
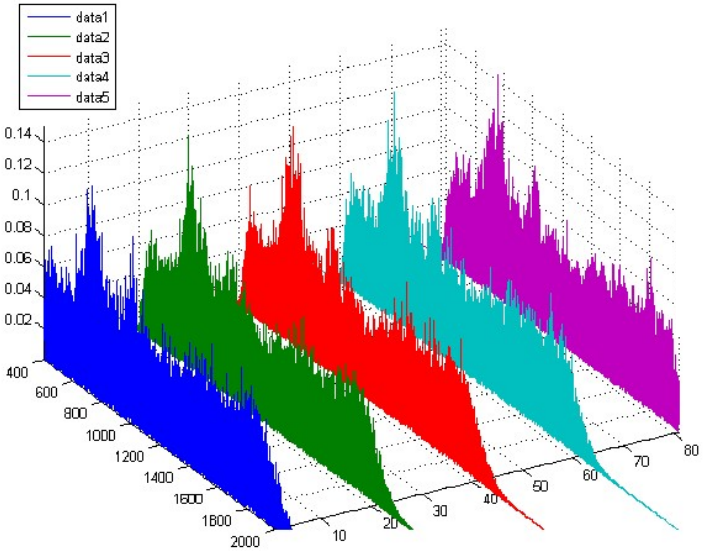
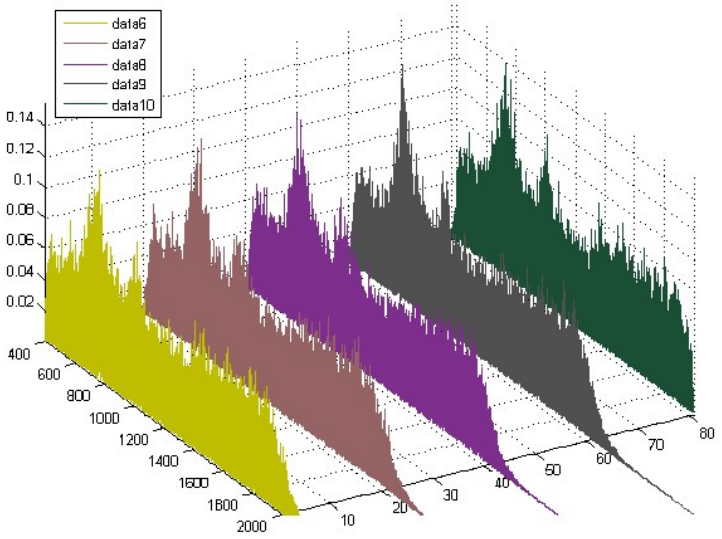
Analysis Setup 5









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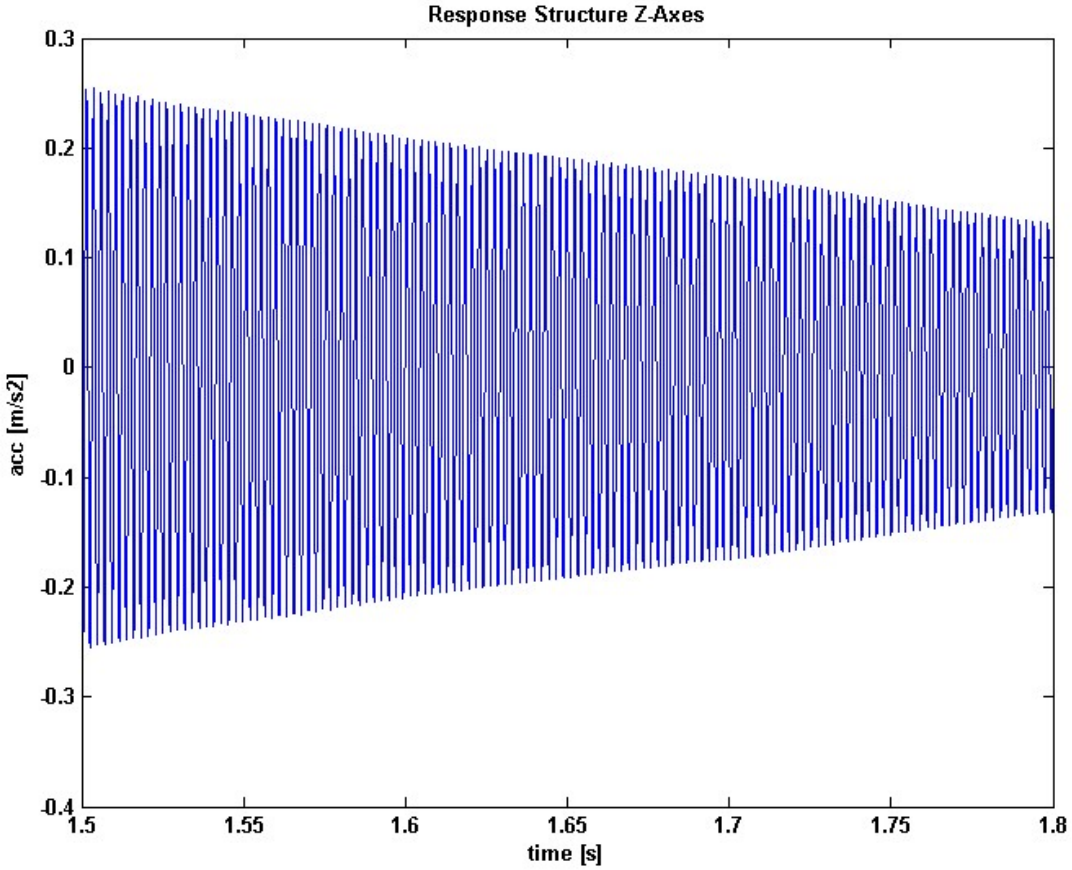
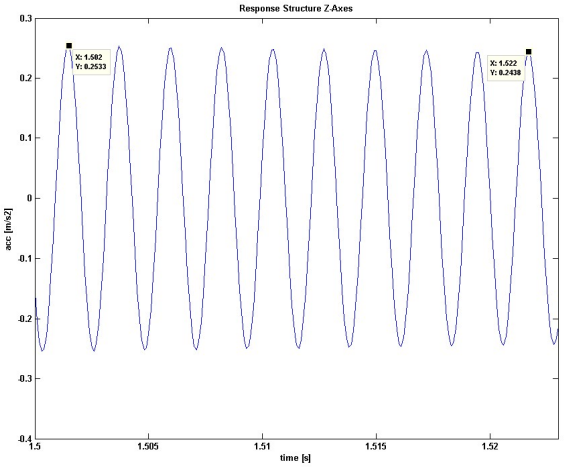
Analysis Setup 5



Filter algorithm : butterworth filter

Cut off Frequency for 1st mode : 444 Hz – 445 Hz



$\ddot{x}(t_0)$ =0,253

$\ddot{x}(t_{10})$ = 0,244

ζ = 0,57% (1st Mode Damping)

$$\zeta = \frac{1}{2\pi n}\ln\left(\frac{x(t_0)}{x(t_0+nT_d)}\right) = \frac{1}{2\pi n}\ln\left(\frac{\ddot{x}(t_0)/\omega_n^2}{\ddot{x}(t_0+nT_d)/\omega_n^2}\right) = \frac{1}{2\pi n}\ln\left(\frac{\ddot{x}(t_0)}{\ddot{x}(t_0+nT_d)}\right)$$

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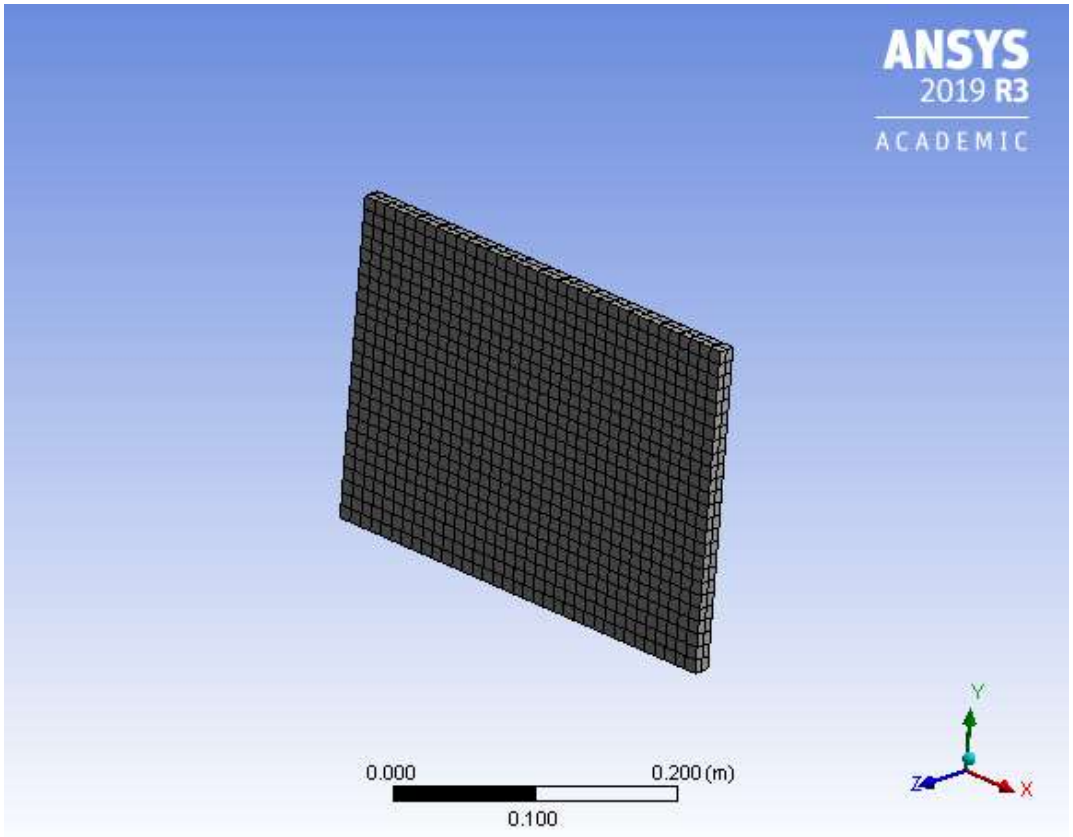
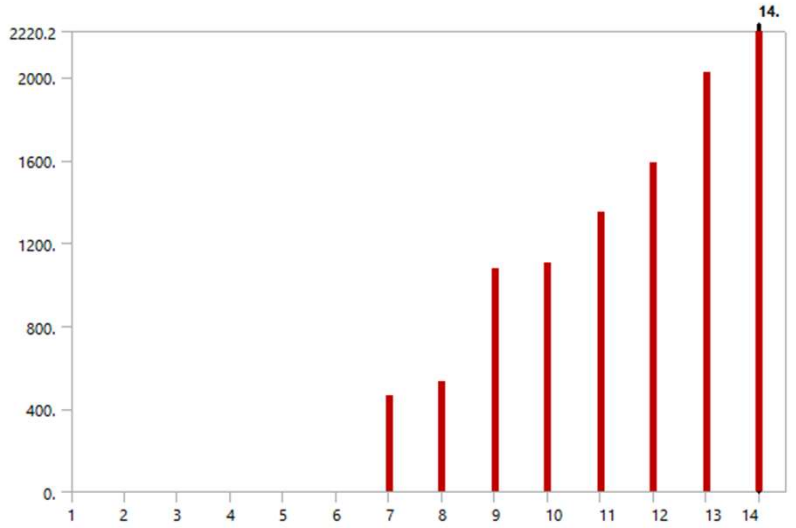
Numerical Model



- Young Modulus = 60000 MPa
- Density = 2.33 g/cm^3

Analysis were conducted in ANSYS due to its capability of modelling free-state vibration.



Natural Frequencies of the Plate

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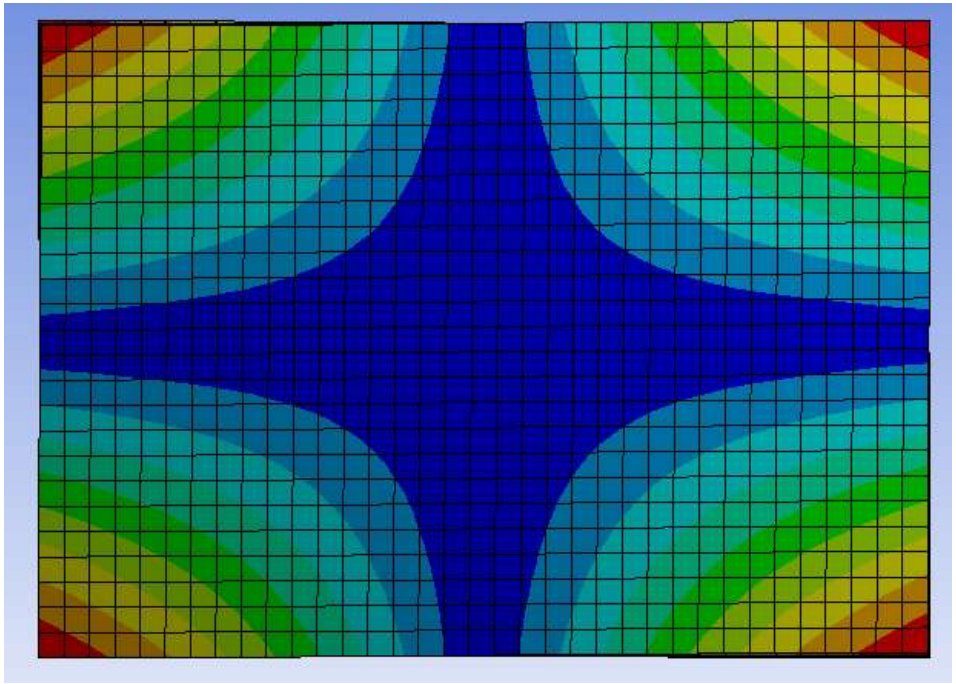
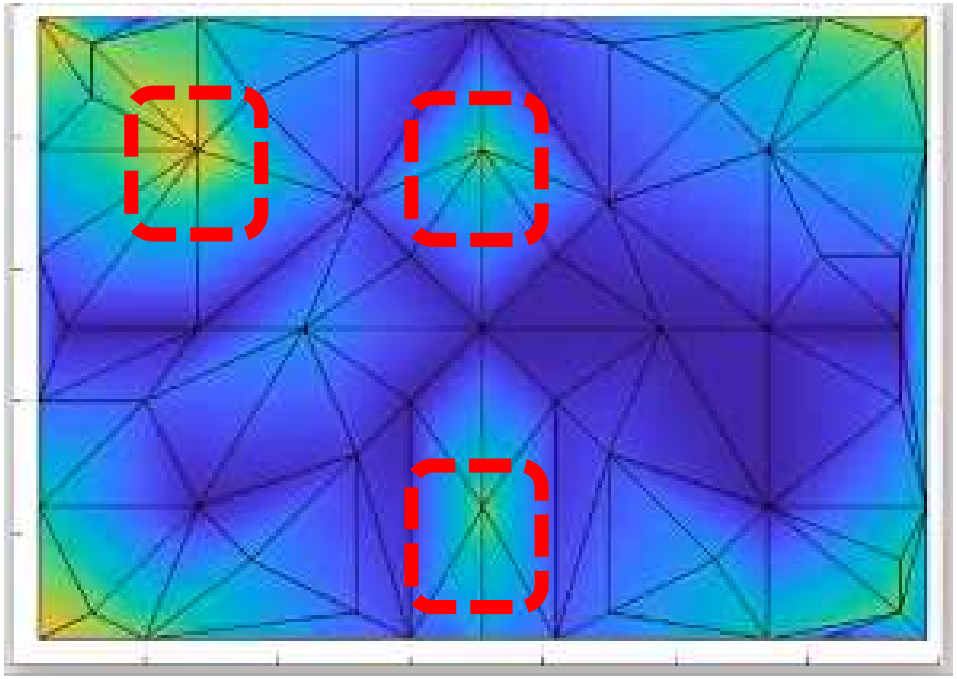
Comparison between Numerical model and Experiment

1st Mode (459 Hz) (445 Hz)

ANSYS (Numerical Model)



Experiment



= Anomaly

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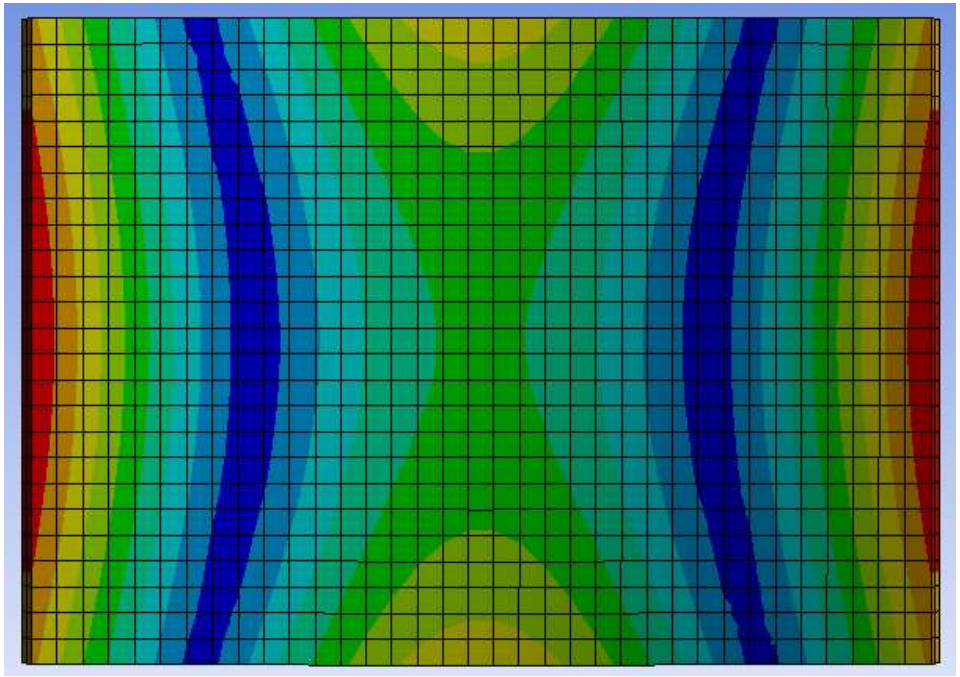
Comparison between Numerical model and Experiment

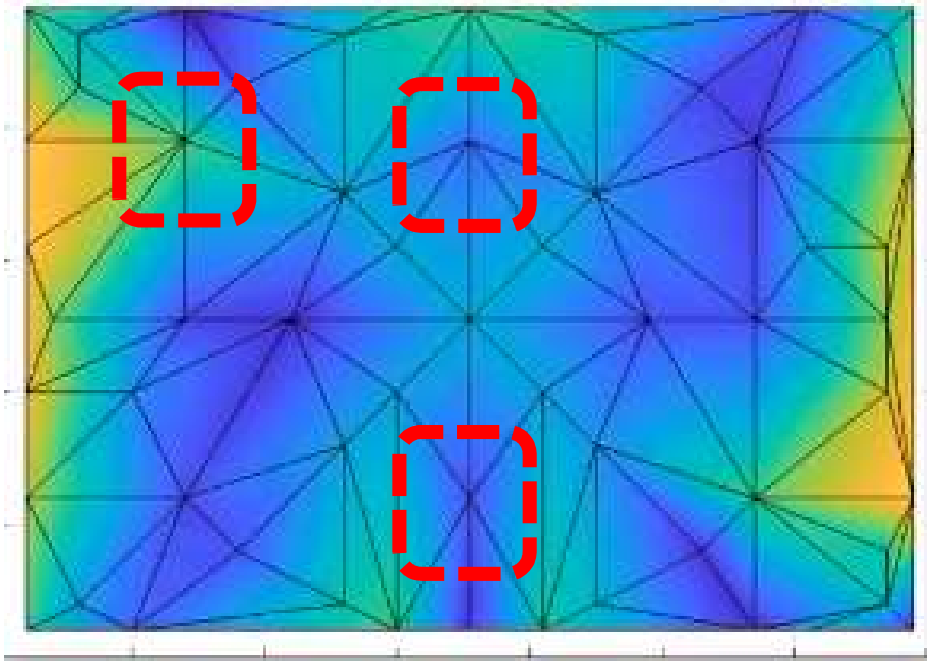
2nd Mode (532 Hz)

ANSYS (Numerical Model)



(532 Hz)

Experiment



= Anomaly

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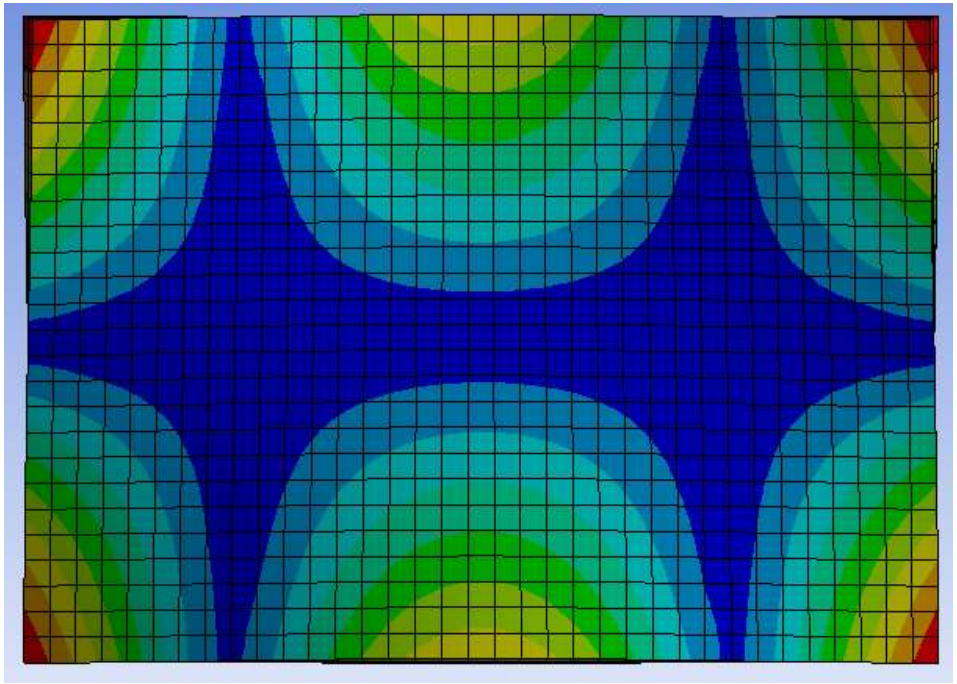
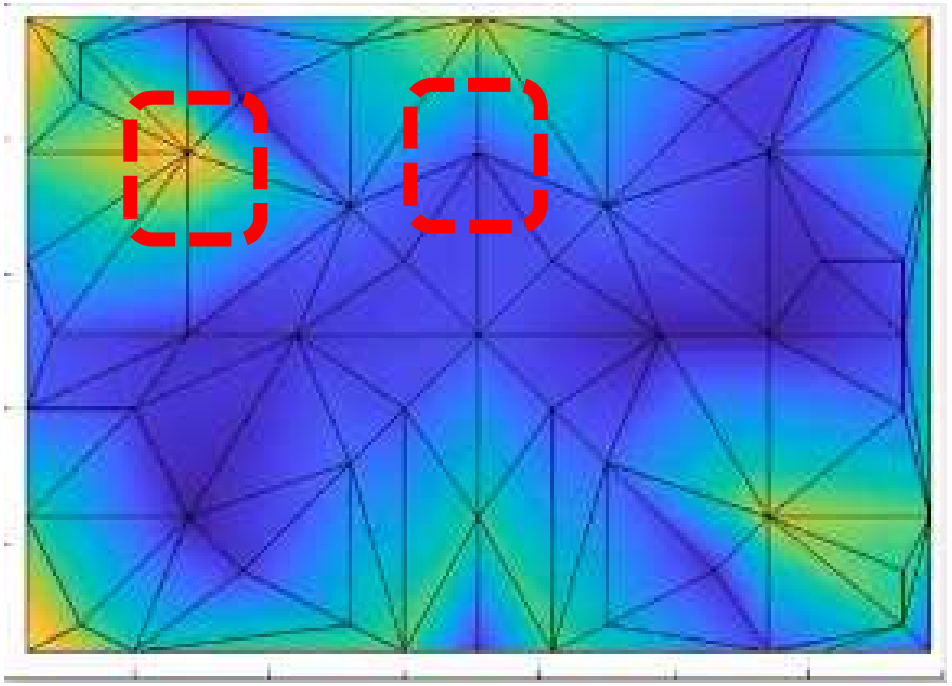
Comparison between Numerical model and Experiment

3rd Mode (1074 Hz) (1016 Hz)

ANSYS (Numerical Model)



Experiment



= Anomaly

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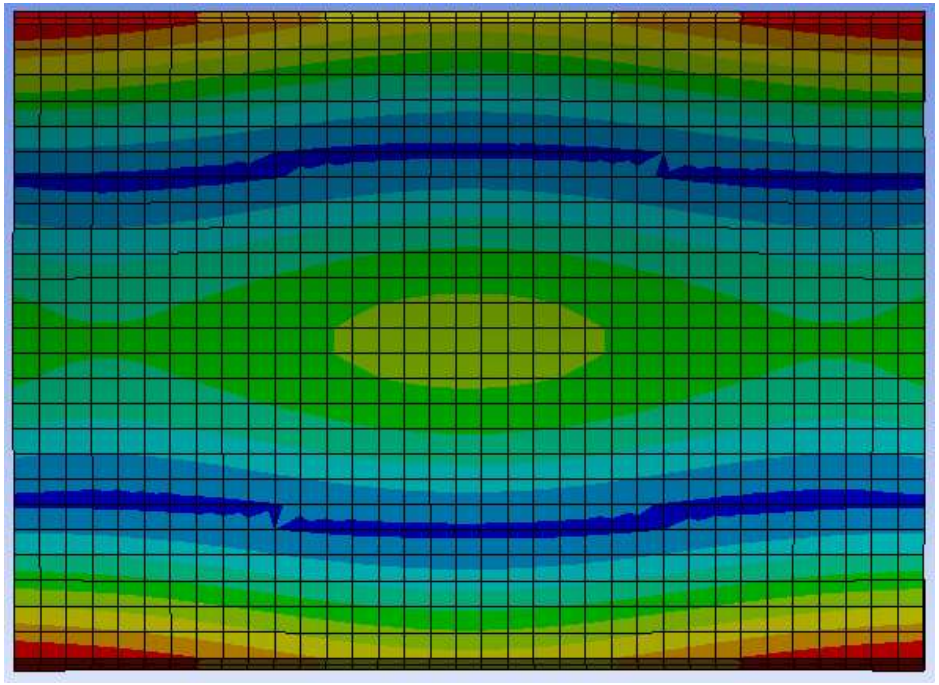
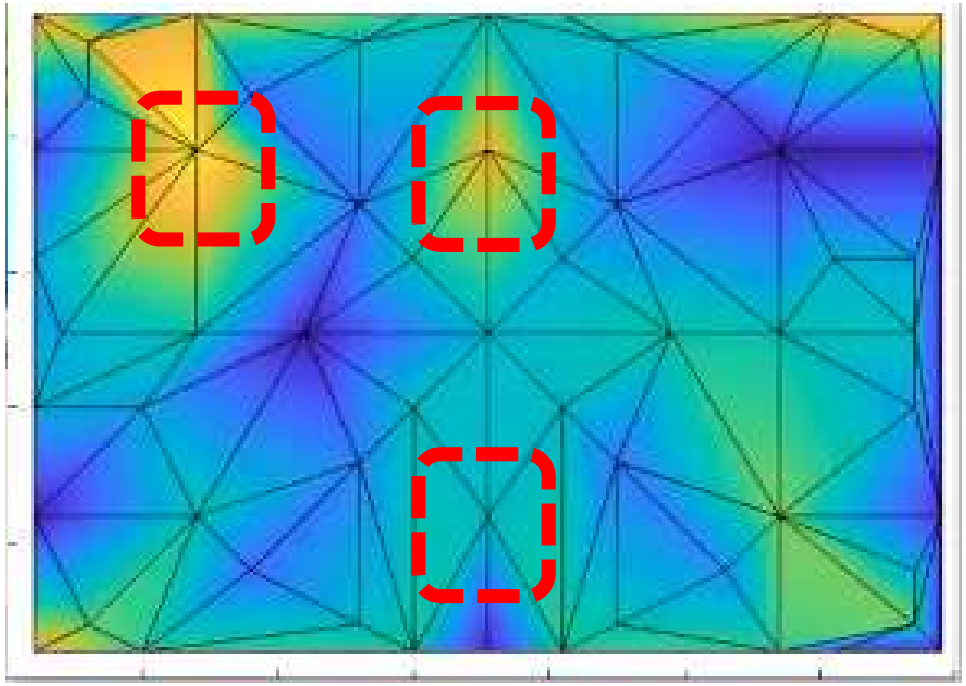
Comparison between Numerical model and Experiment

4th Mode (1102.06 Hz) (1064 Hz)

ANSYS (Numerical Model)



Experiment



= Anomaly

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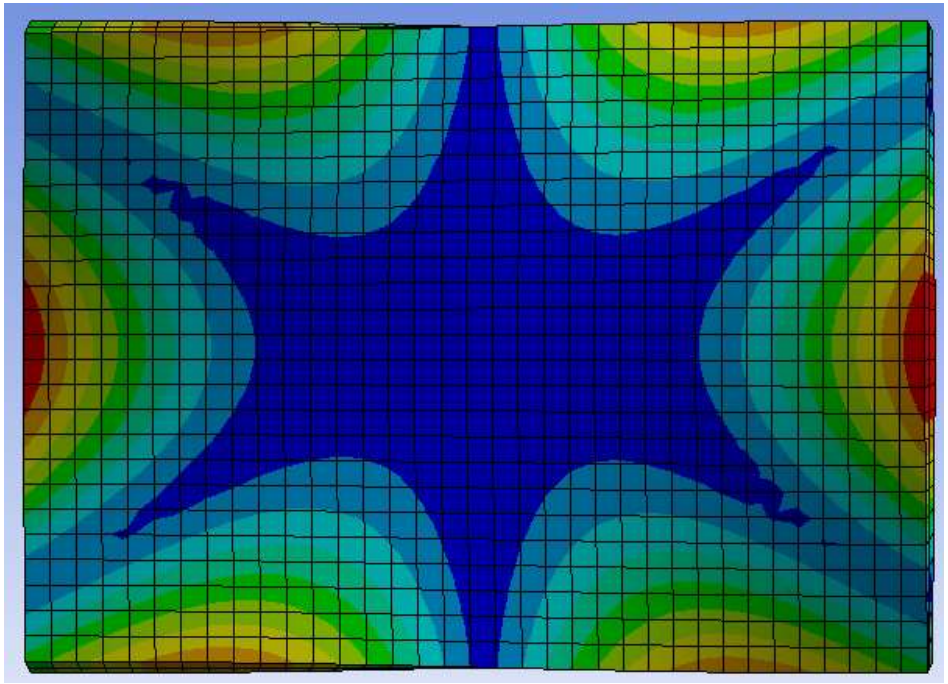
Comparison between Numerical model and Experiment

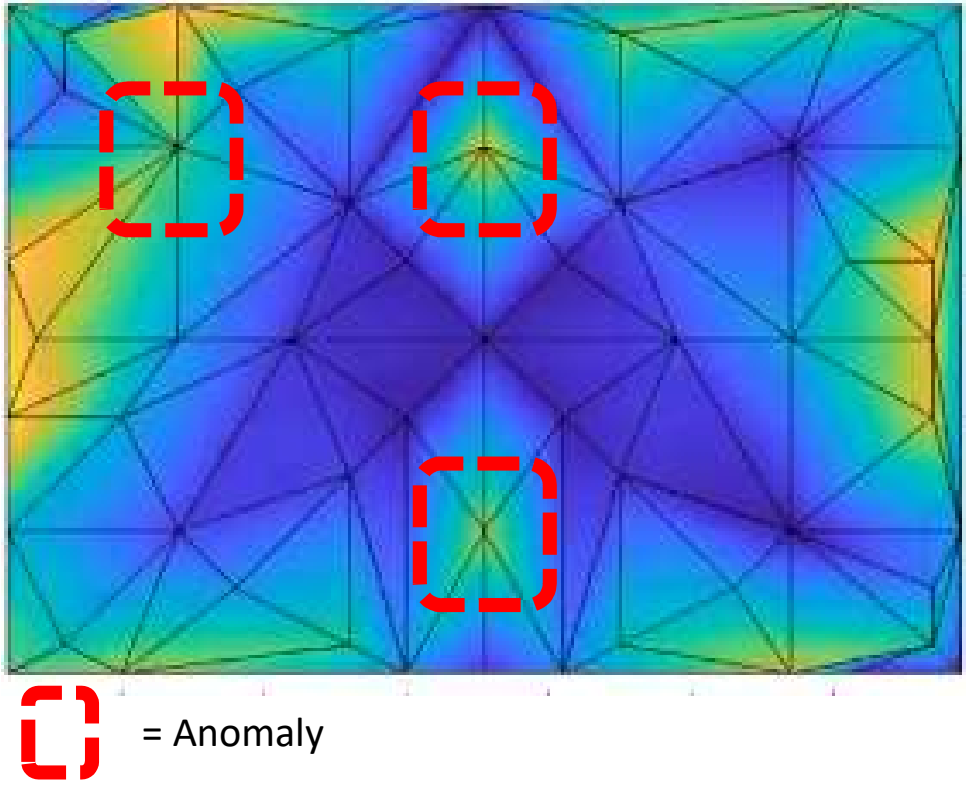
5th Mode (1345 Hz)

ANSYS (Numerical Model)



(1317 Hz)

Experiment



= Anomaly

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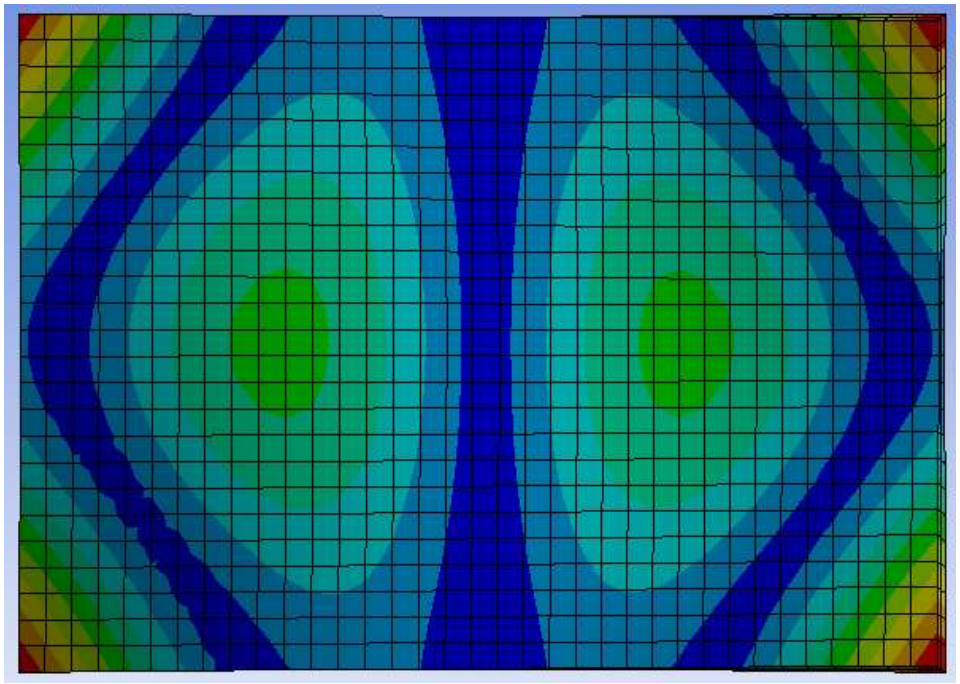
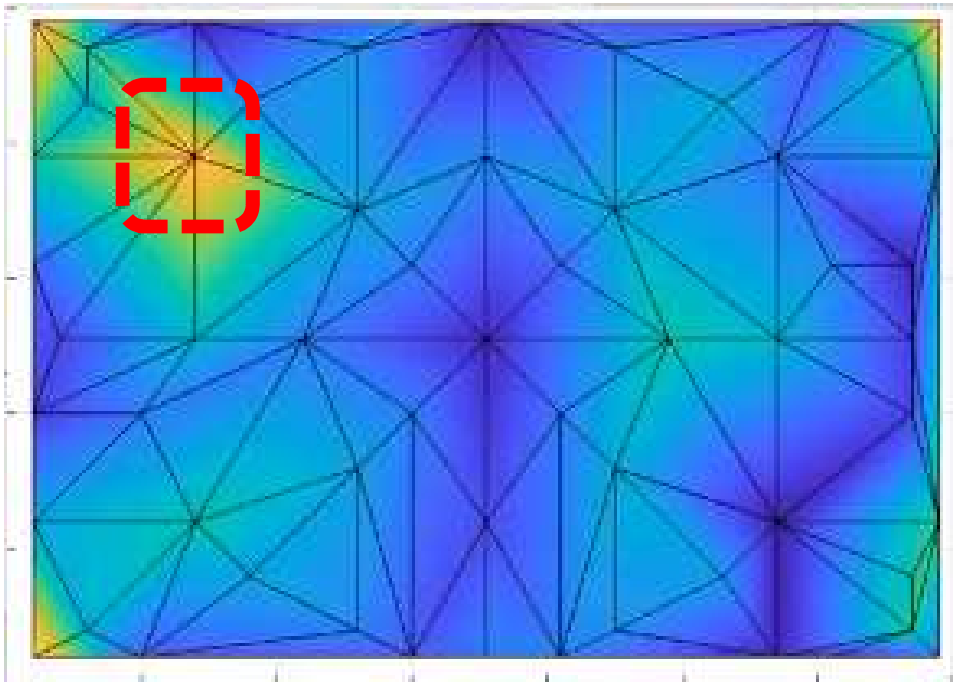
Comparison between Numerical model and Experiment

6th Mode (1586.9) (1508 Hz)

ANSYS (Numerical Model)



Experiment



= Anomaly

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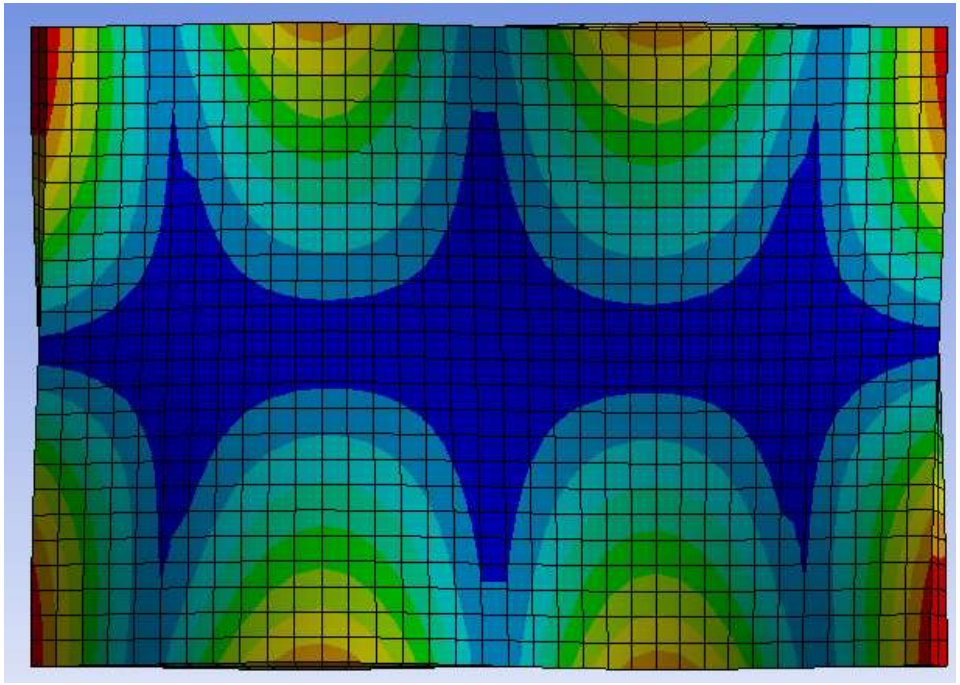
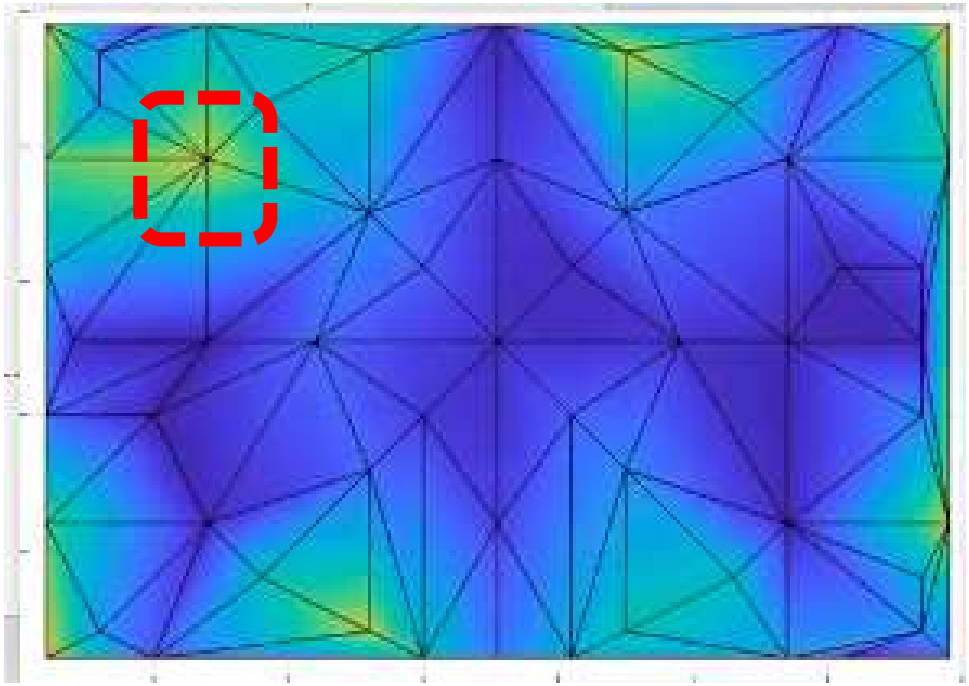
Comparison between Numerical model and Experiment

7th Mode (2021.9) (1928 Hz)

ANSYS (Numerical Model)



Experiment



= Anomaly

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Modal Analysis

The purpose of Modal analysis is to identified mode shape and natural Frequencies

- The frequencies are similar to numerical, but the Mode Shape is diverse.
- Anomaly were found from sensors in setup 1 and 2
- Those sensors cause ambiguity in mode shapes comparison
- By excluding those setups, a new analysis were conducted
- The new result shows agreement with numerical model

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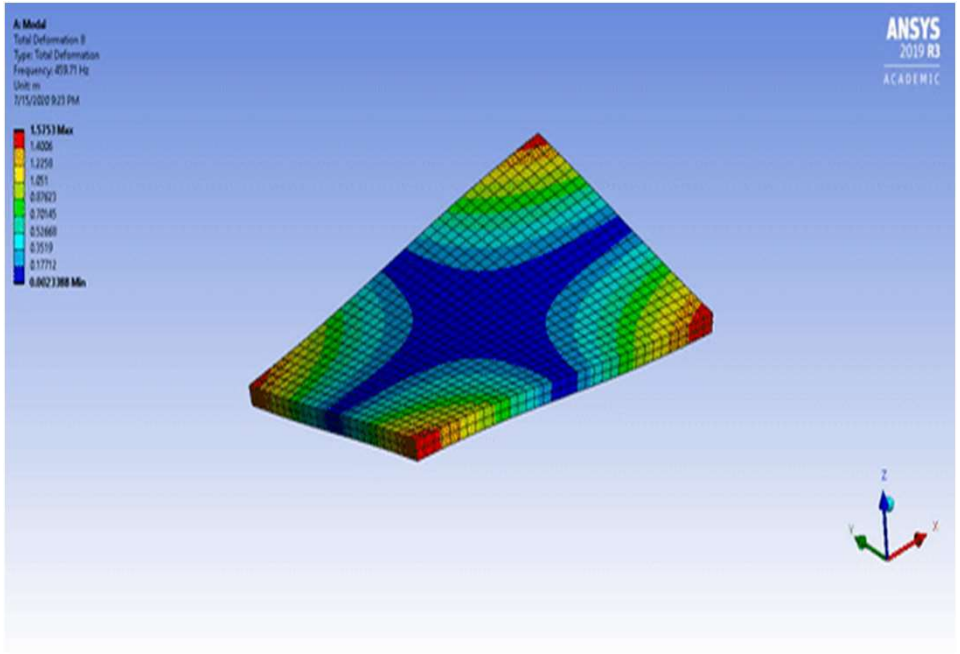
Final Result

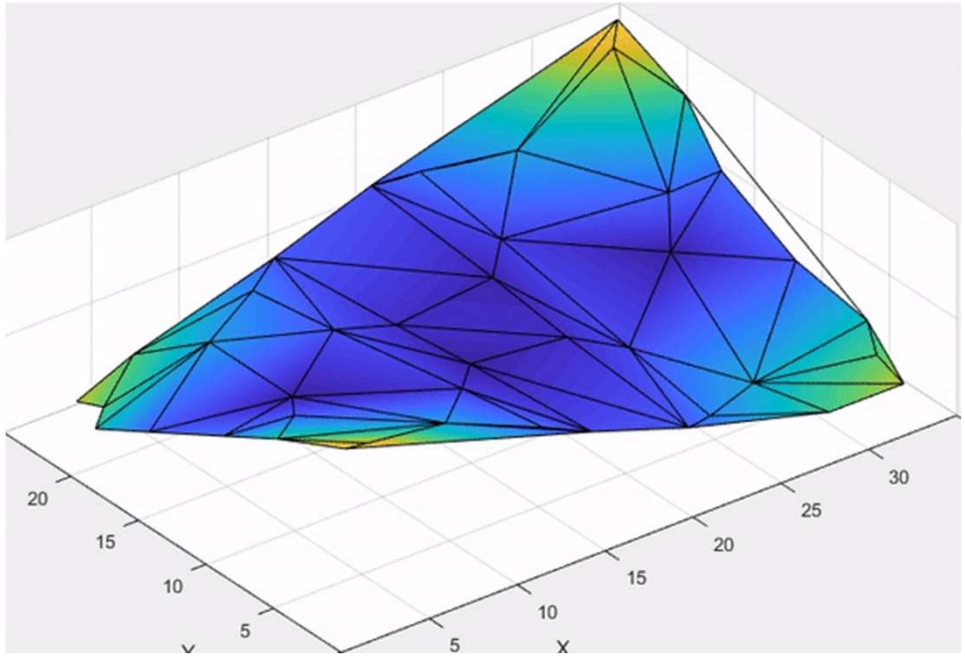
1st Mode (459 Hz)

ANSYS (Numerical Model)



(445 Hz)

Experiment



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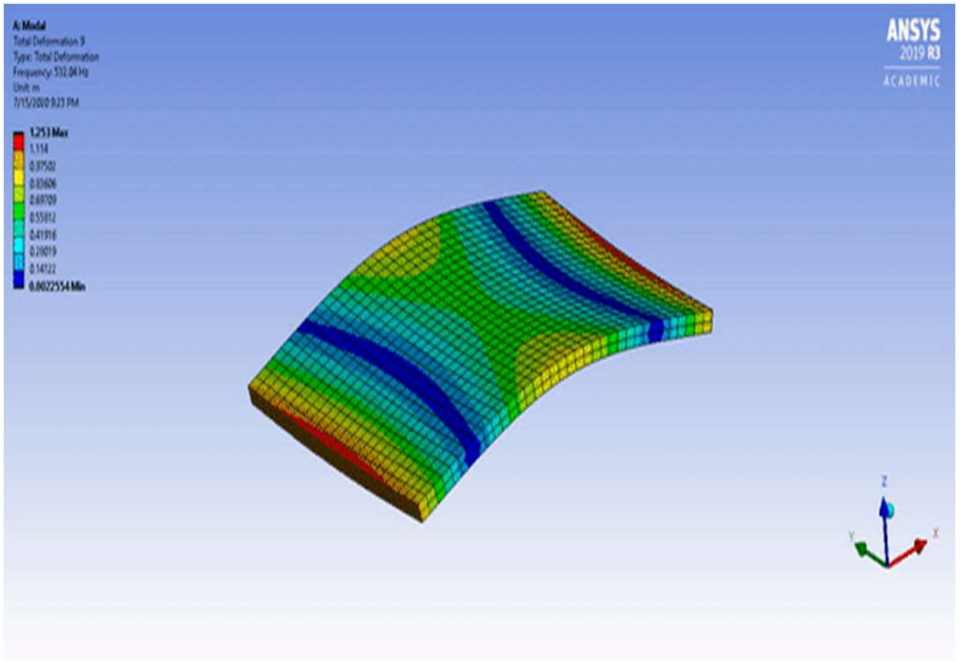
Final Result

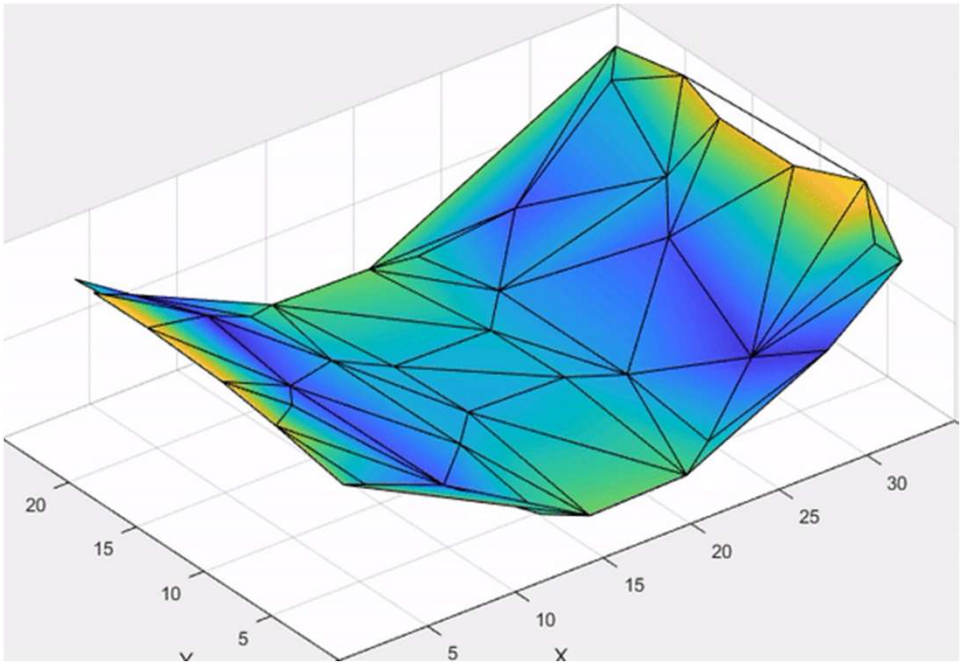
2nd Mode (532 Hz)

ANSYS (Numerical Model)



(532 Hz)

Experiment



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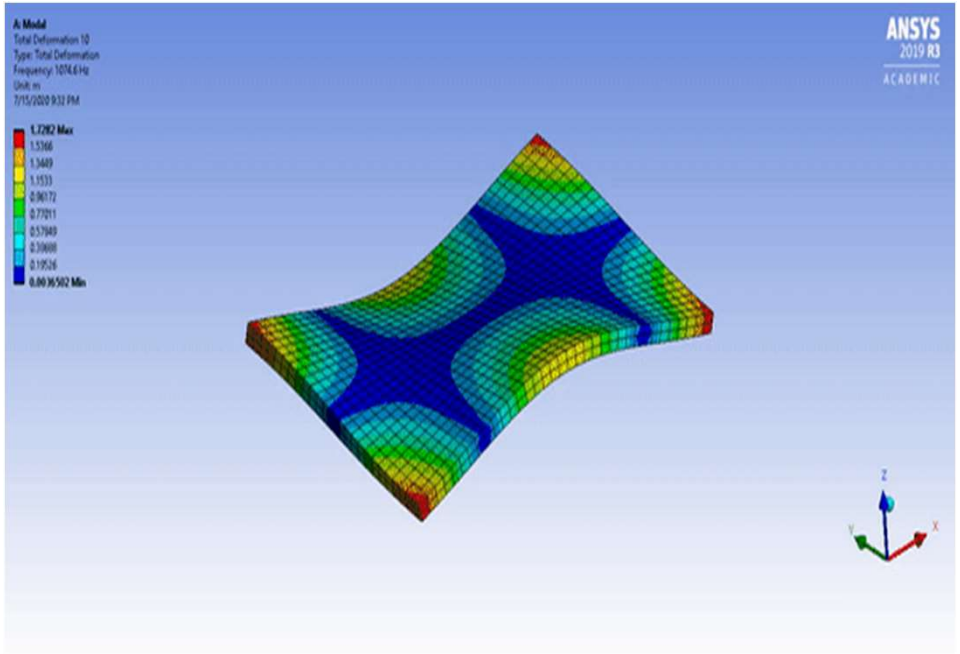
Final Result

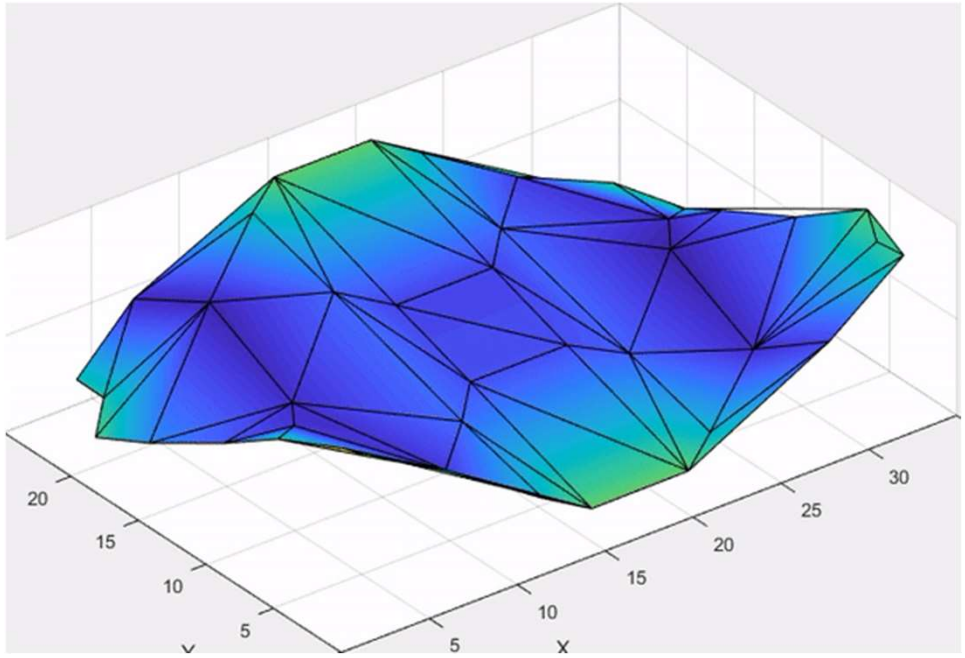
3rd Mode (1074 Hz)

ANSYS (Numerical Model)



(1016 Hz)

Experiment



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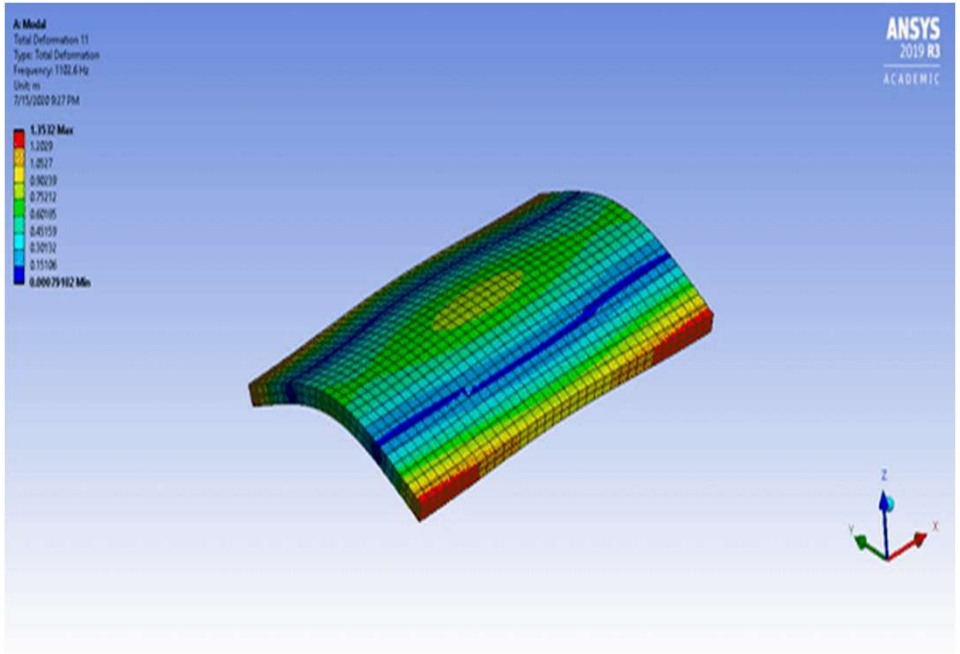
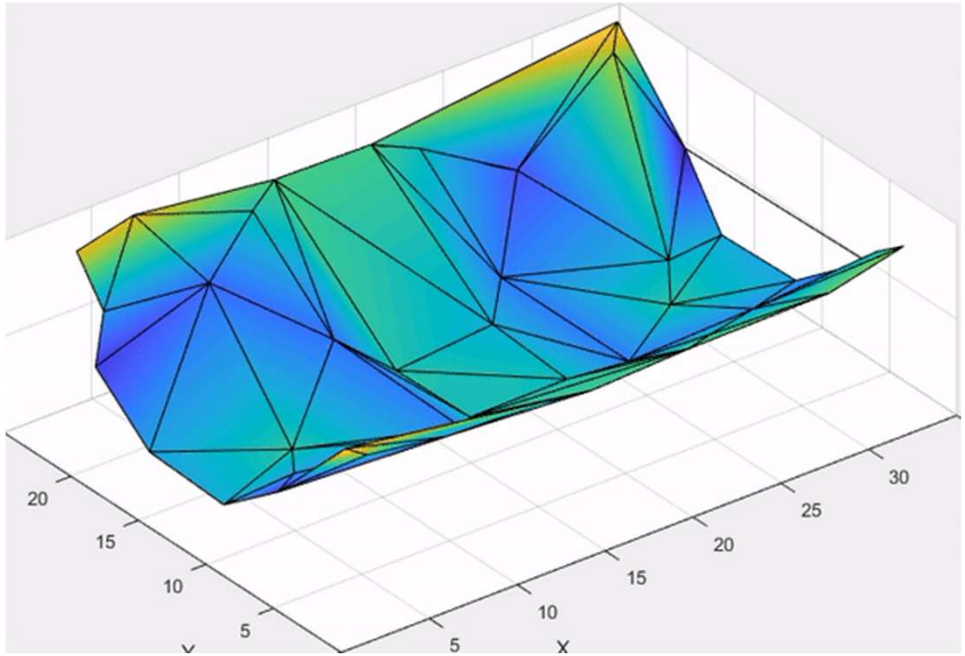
Final Result

4th Mode (1102.06 Hz) (1064 Hz)

ANSYS (Numerical Model) **Experiment**





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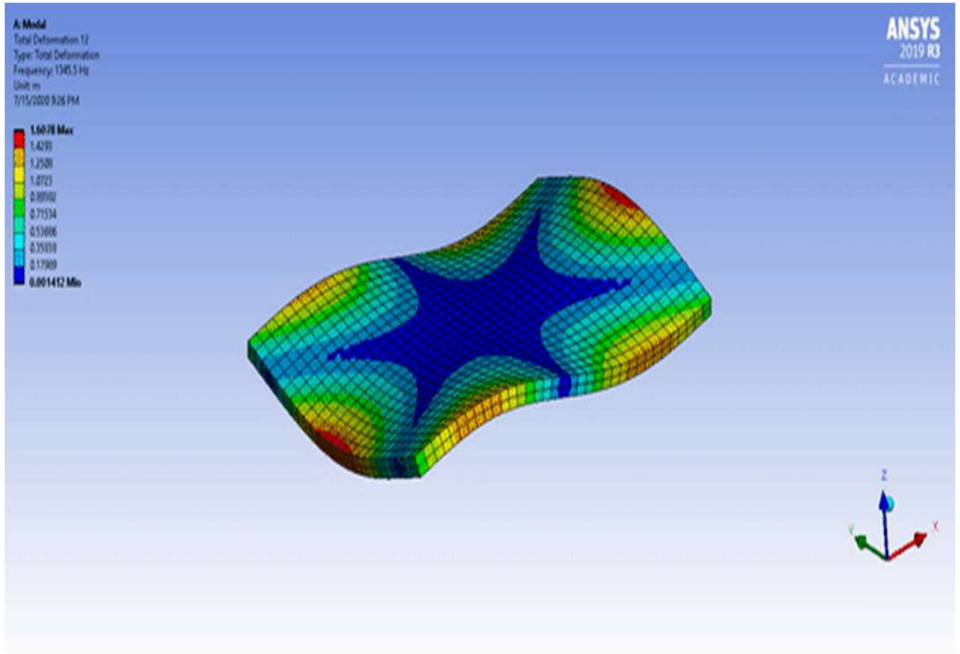
Final Result

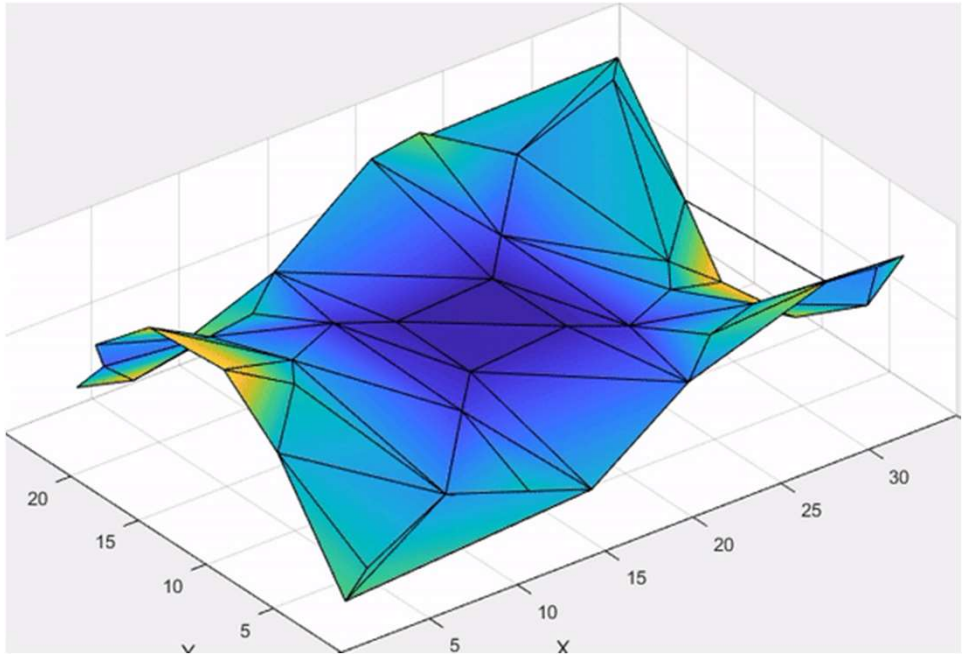
5th Mode (1345 Hz)

ANSYS (Numerical Model)



(1317 Hz)

Experiment



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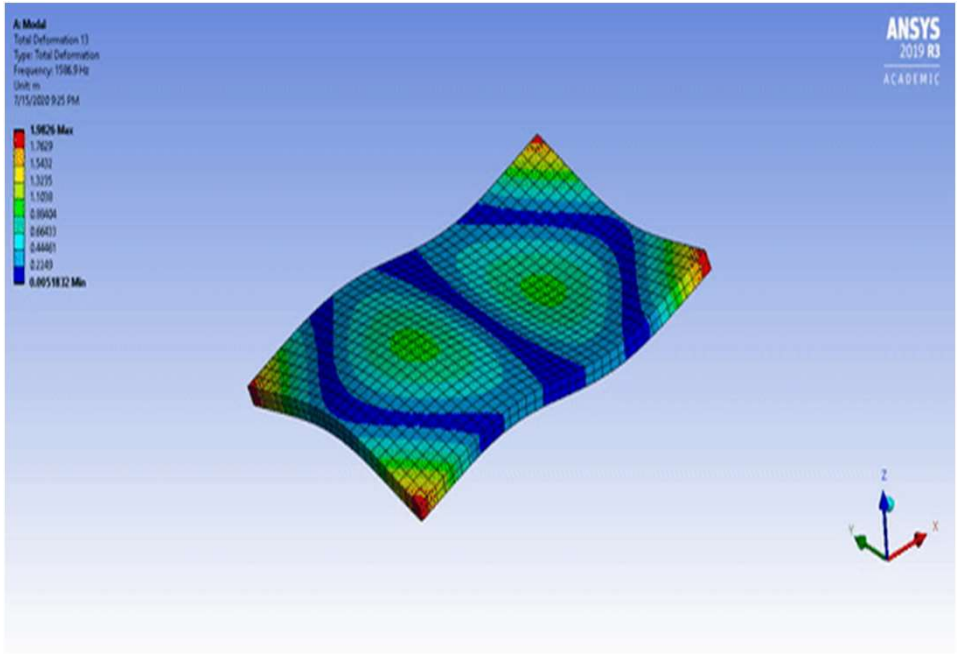
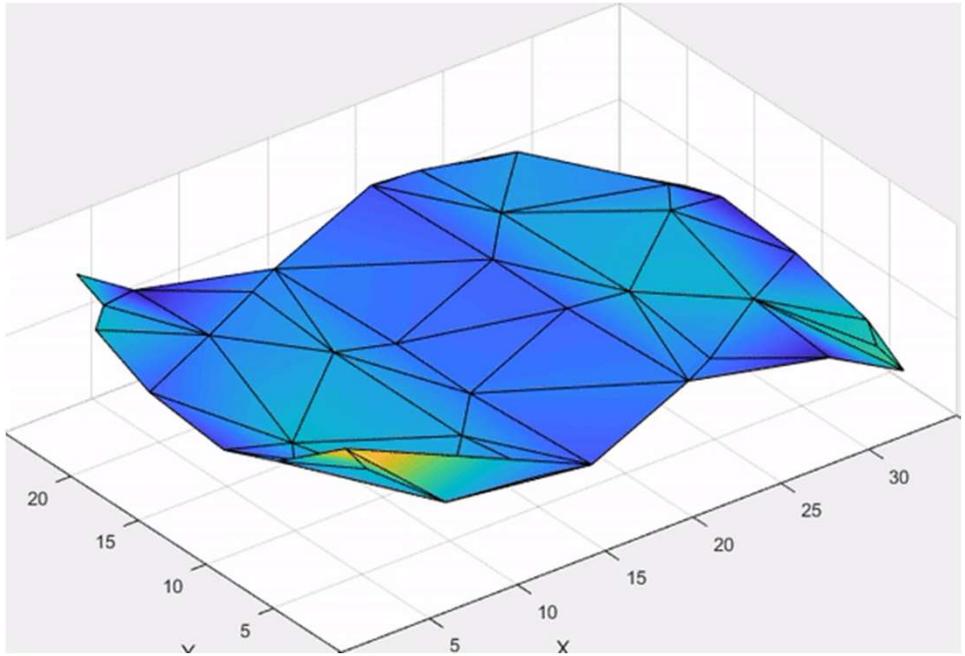
Final Result

6th Mode (1586.9) (1508 Hz)

ANSYS (Numerical Model)



Experiment



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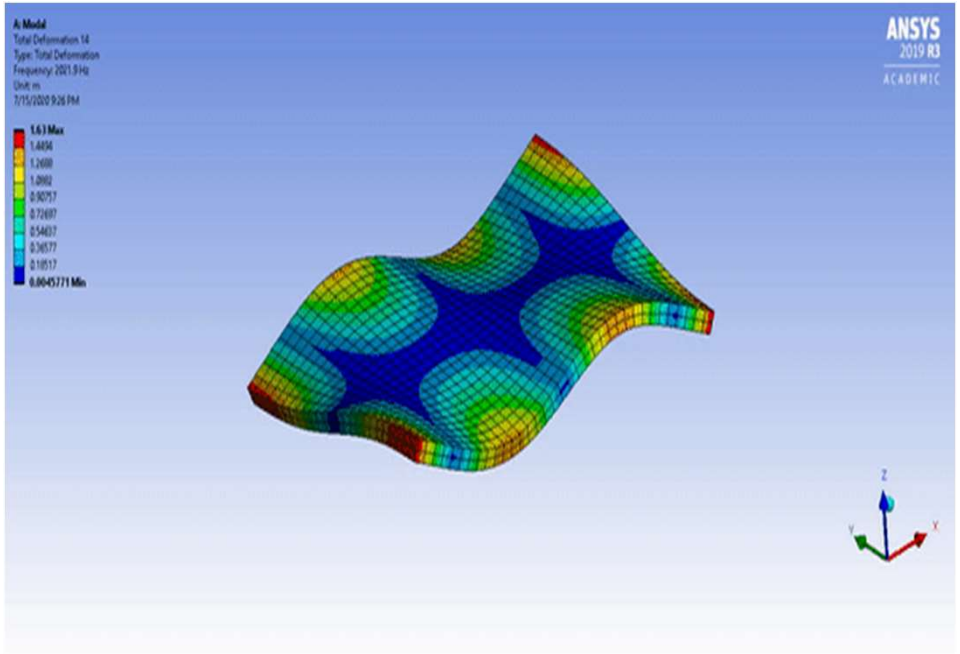
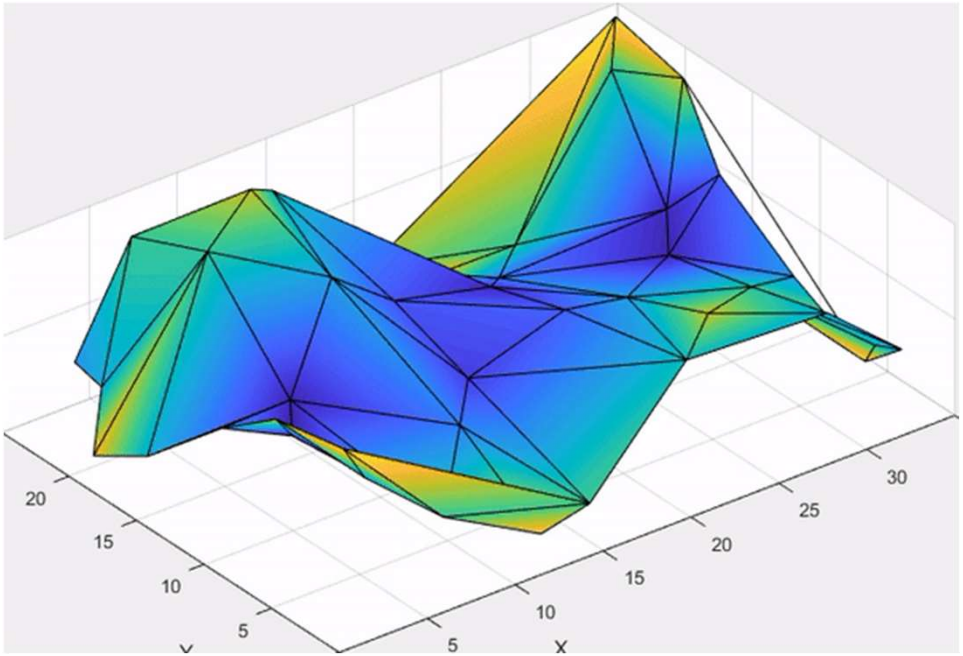
Final Result

7th Mode (2021.9) (1928 Hz)

ANSYS (Numerical Model)



Experiment



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Summary

- Numerical and experimental approach shows similar result in Natural frequency and Mode Shape of a plate
- For rectangular plate, location of sensor is better installed in symmetrical way and also not placed in the nodal line.
- From the experiment, 2 out of 6 setup shows anomaly in result.
- By excluding two setup, the result still shows similarities to numerical model.
- **Increasing number of sensors does not guarantee better result.**
- **More Sensor means more analysis effort.**

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Terima Kasih

Thank You

Vielen Dank