Experimental structural dynamics and Structural monitoring

Group 3

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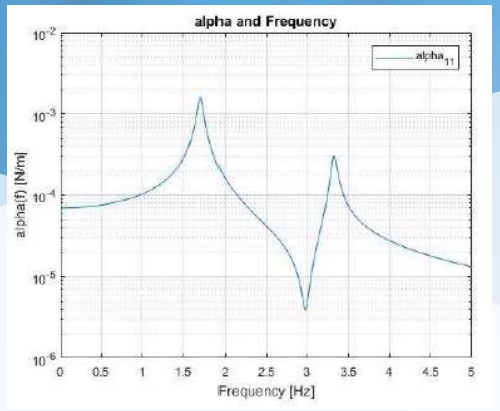
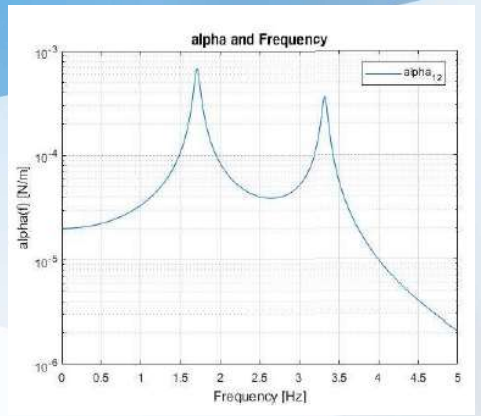
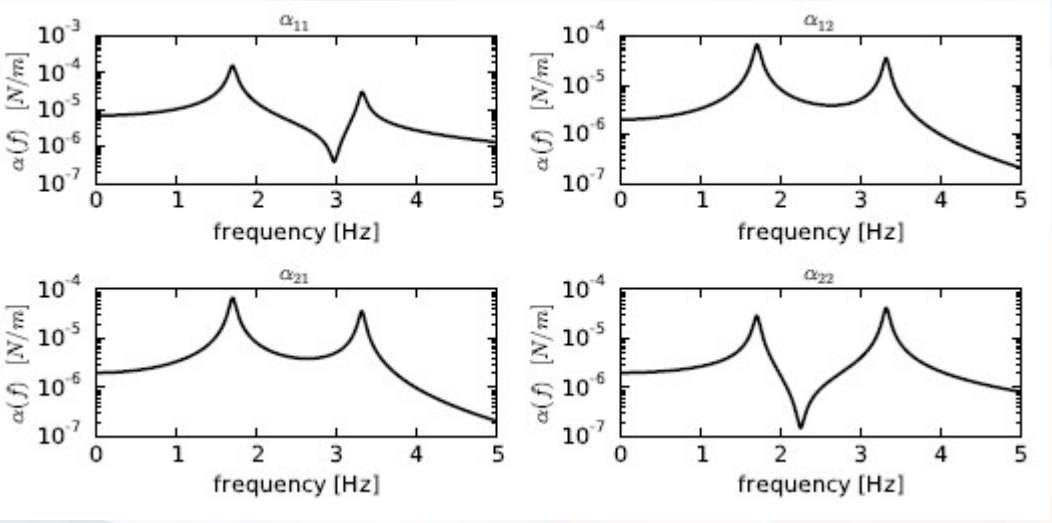
First Phase

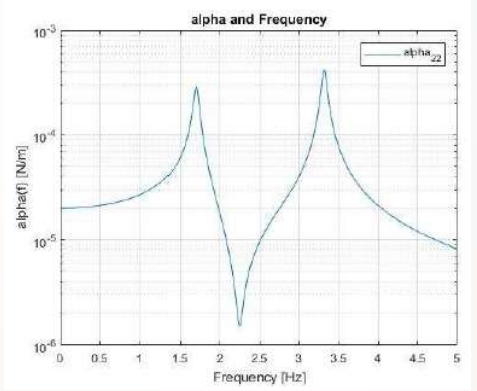
- Matlab





Absolute values of the frequency response functions of the 2-dof system





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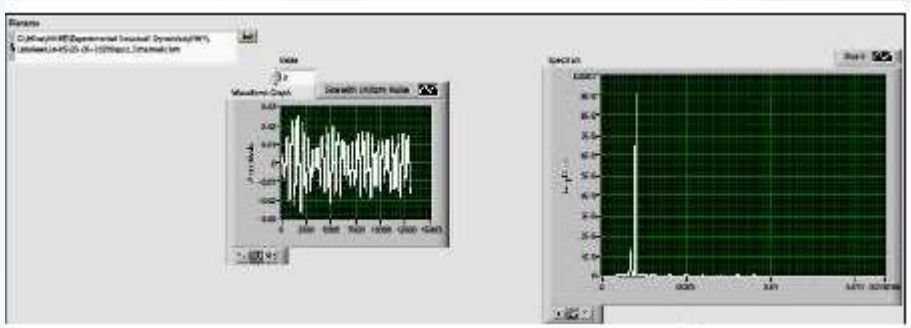
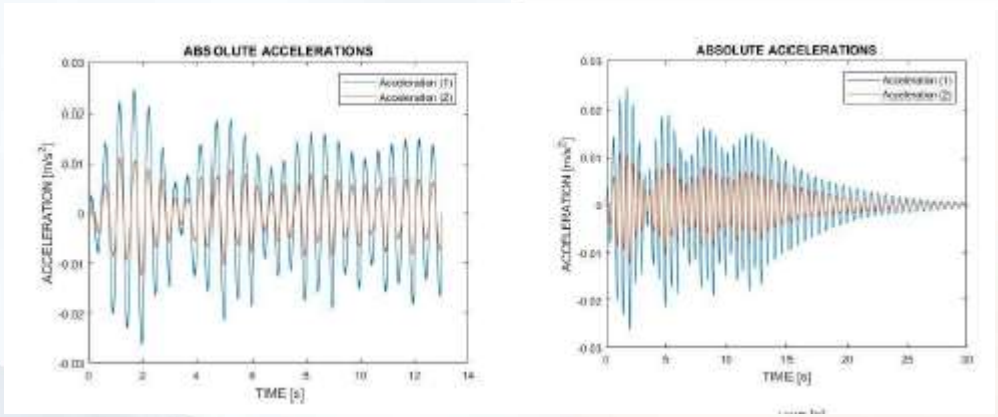
First Phase… (cont.)

- Matlab
- LabVIEW





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Project: Balcony

Balcony Plan details

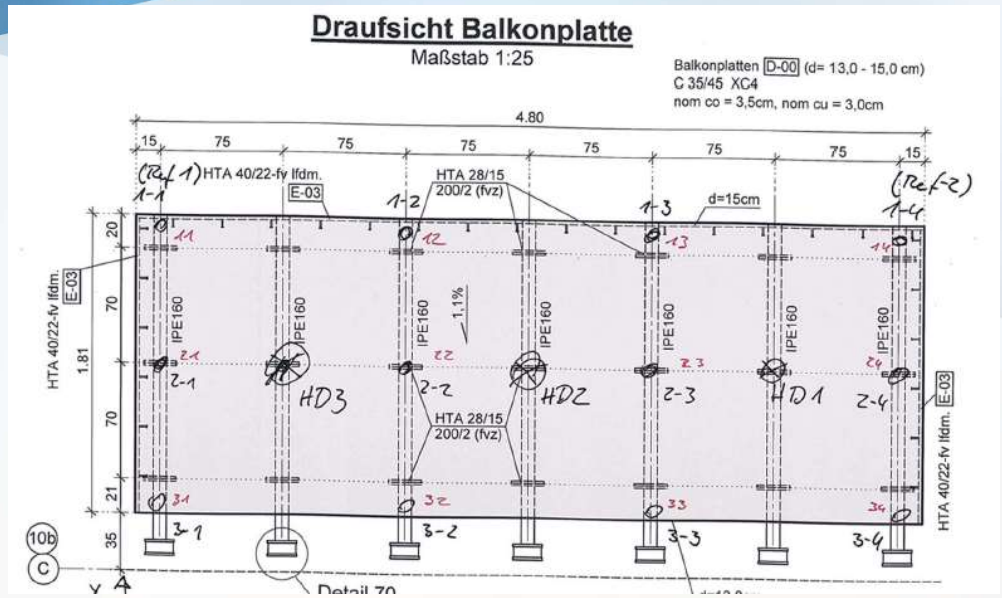
Dimension= 1.81mx 4.80m

Slab depth = 13 -15cm

Average depth= 14cm(used)

Concrete= 35/45

Steel Section= IPE160



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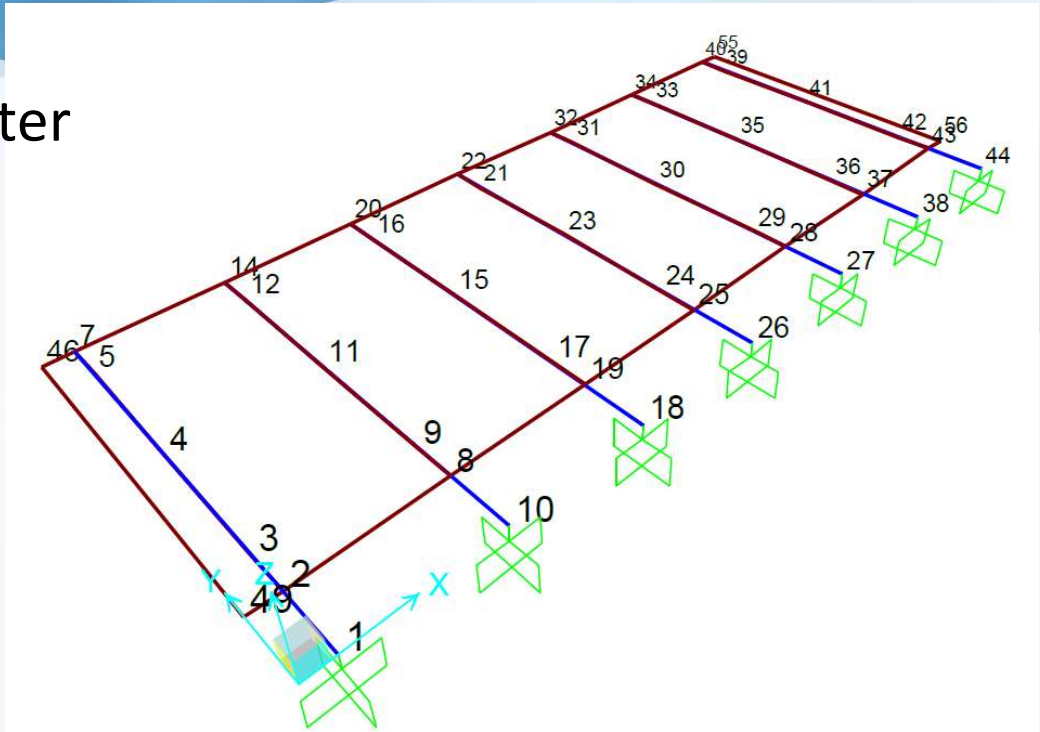
Numerical Model

Sap2000 model

- Assigned same parameter
- Fixed Support



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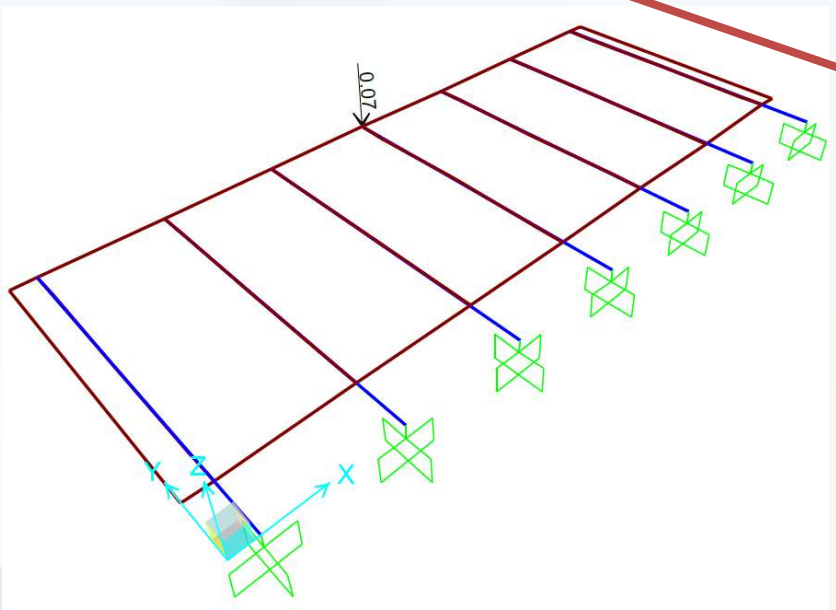
Simulation of Structure

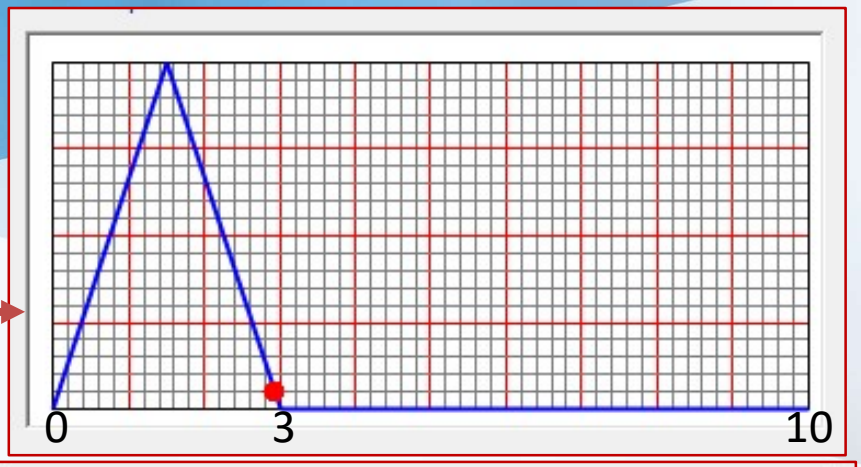
Loads assigned

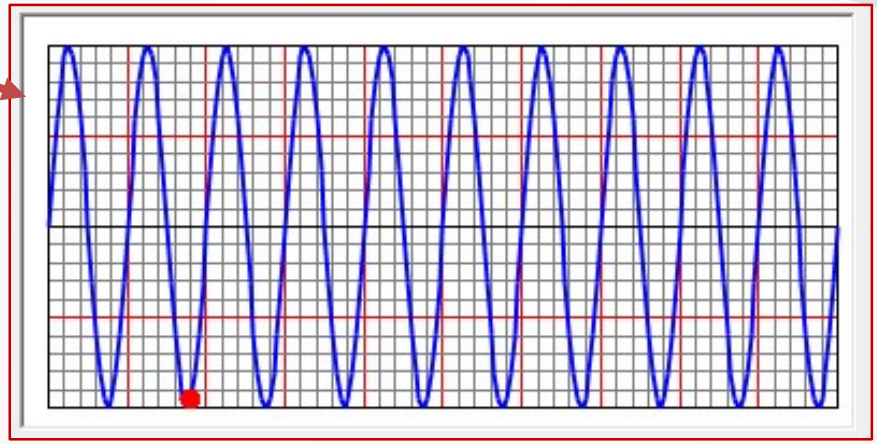
Load= 70N

Impulse load

Sine load







Period: 1

# of steps per Cycle: 20

# of Cycle: 10

Amplitude:10

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Simulation of Structure cont....

- Modal analysis and verification

OutputCase	StepType Text	StepNum Unitless	Period Sec	Frequency Cyc/sec	CircFreq rad/sec	Eigenvalue rad2/sec2
Modal	Mode	1	0.083974	11.9084454...	74.8229694...	5598.47674...
Modal	Mode	2	0.048583	20.5834517...	129.329641...	16726.1561...
Modal	Mode	3	0.02715	36.8321355...	231.423132...	53556.6664...
Modal	Mode	4	0.026762	37.3666852...	234.781807...	55122.4971...
Modal	Mode	5	0.014912	67.0604866...	421.353464...	177538.741...
Modal	Mode	6	0.010339	96.7218047...	607.721022...	369324.840...
Modal	Mode	7	0.009352	106.930584...	671.864677...	451402.145...

Moment of inertia (I') = 6.9×10^{-5} m^4

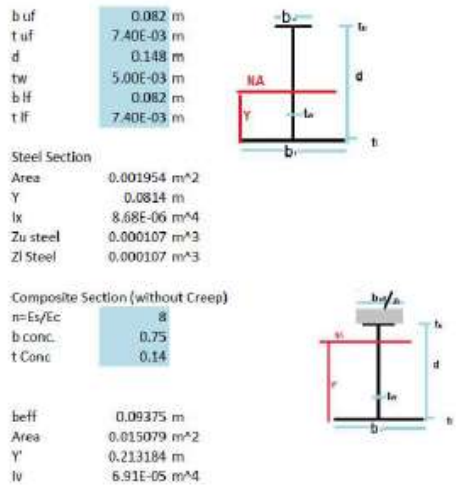
Stiffness (K1) = $\frac{3EI}{L^3}$ [1]= $\frac{3 \times 2.1 \times 10^8 \times 6.9 \times 10^{-5}}{2.16^3}$

= 20125 N/m

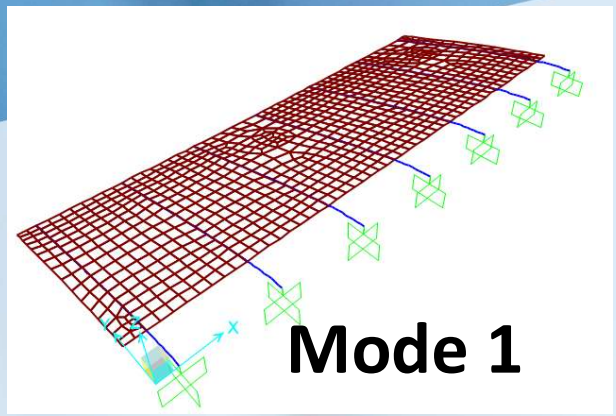
Circular Frequency (w)= $2\pi\sqrt{\frac{K}{M}}$

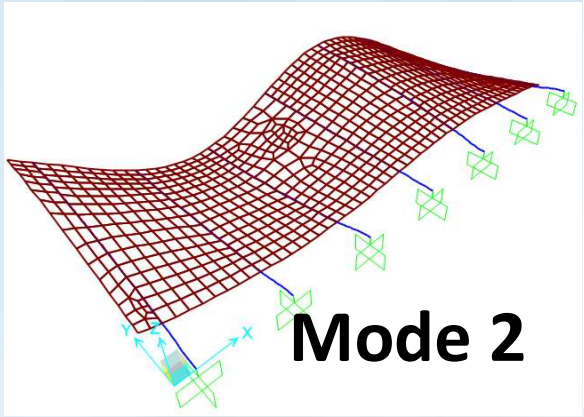
$= 2\pi\sqrt{\frac{20125}{0.25 \, X \, 601.128}}$ =72.67 rad/sec

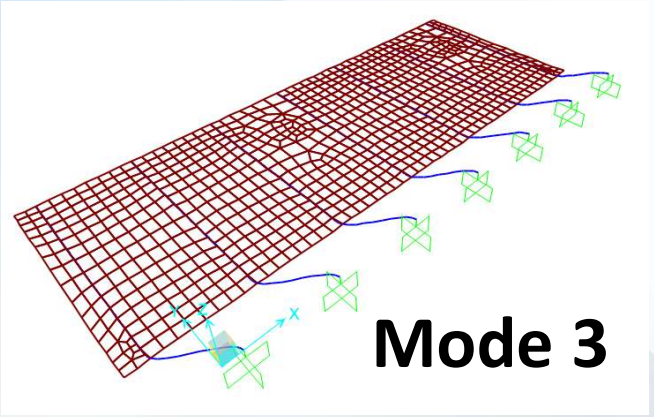
Which is like the value of the circular angular frequency of the 1st Mode calculated by SAP2000.

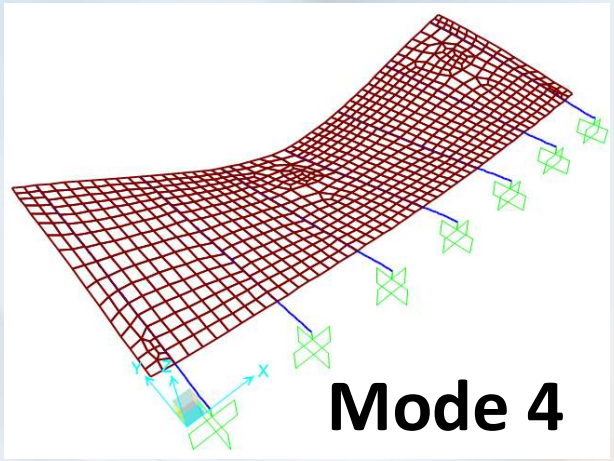


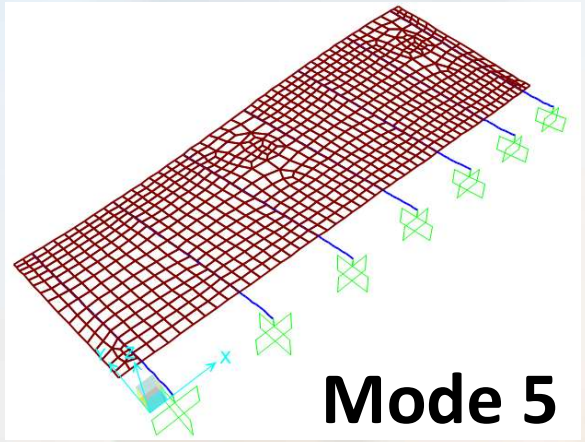
Mode shape form SAP2000

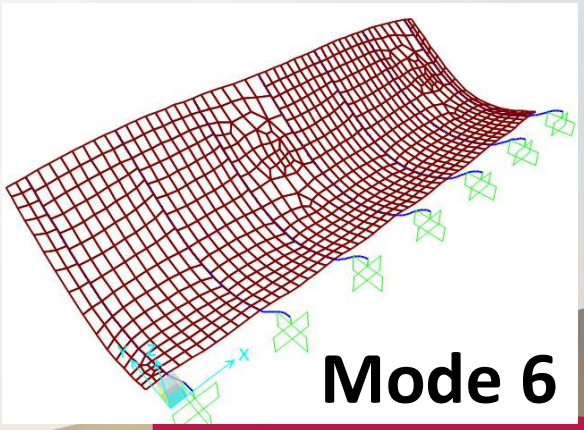












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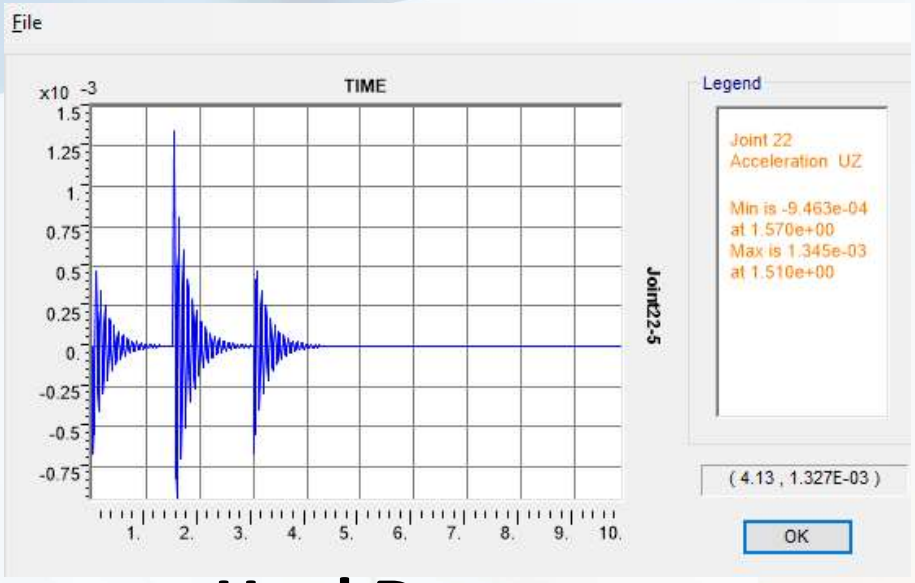
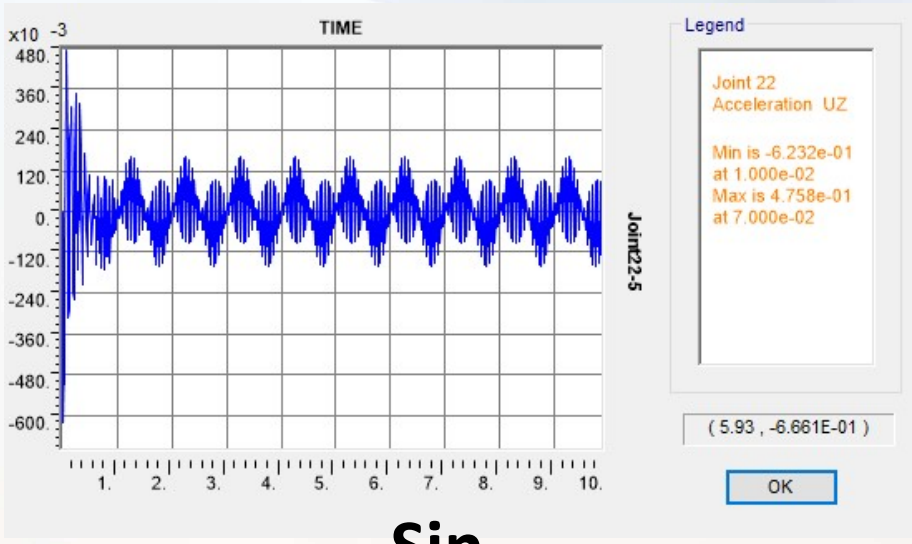
H.Drop and Sin (Force)

H.Drop and Sin (Force) Output (Acceleration)



Heel Drop



Sin

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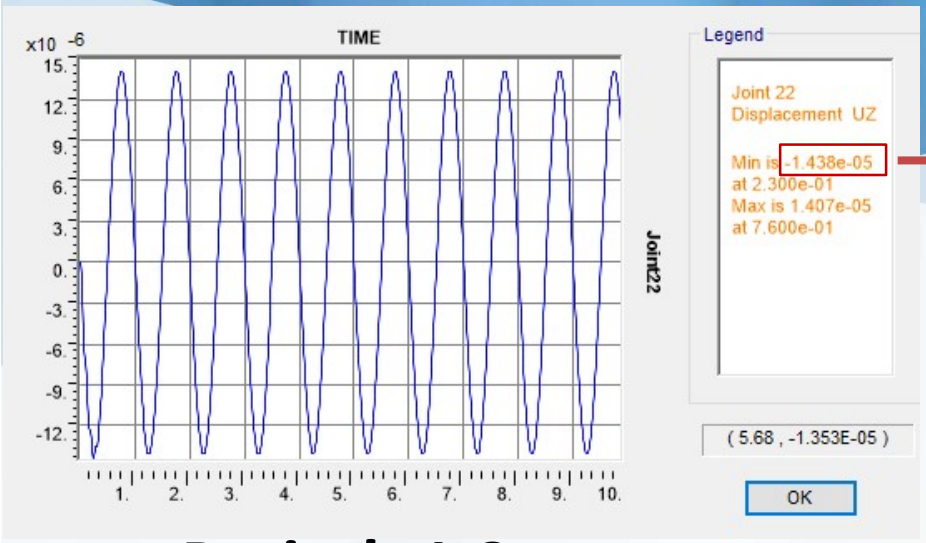
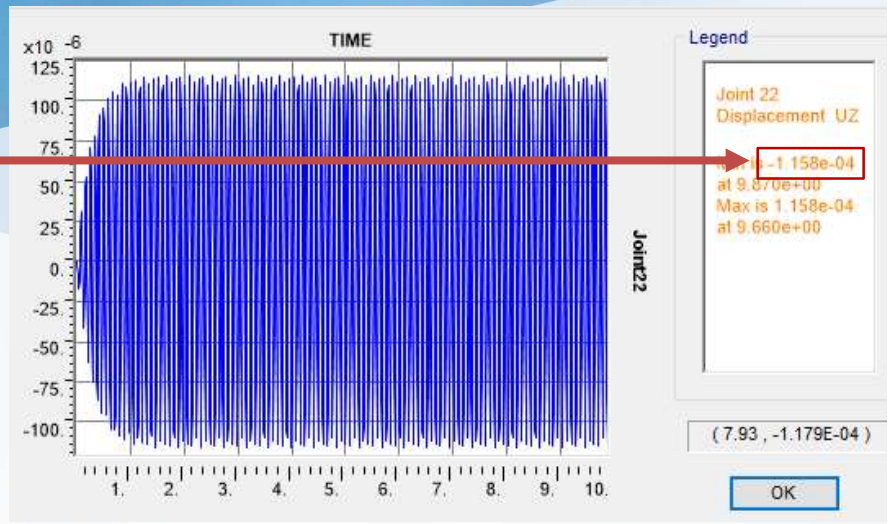
Resonance Trial

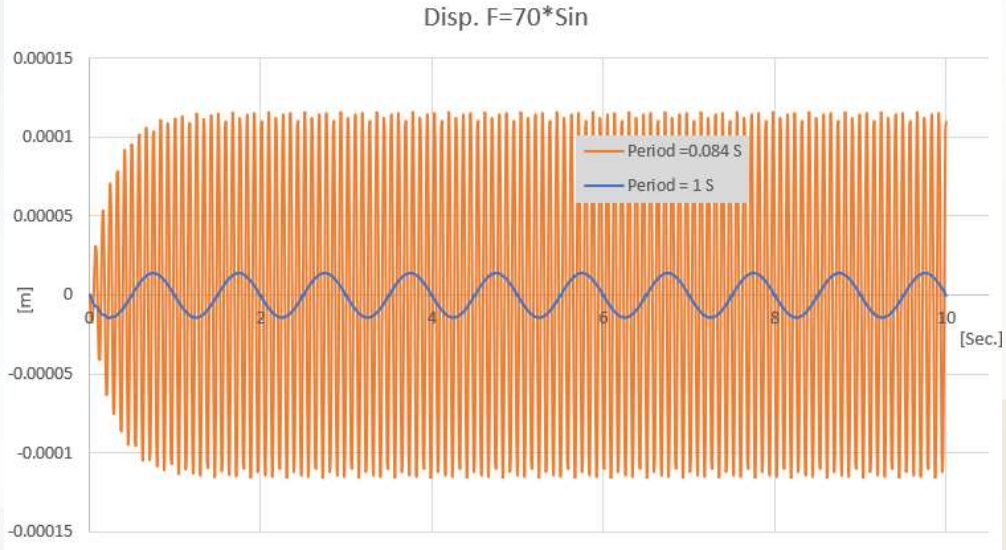


x8



Period=1 Sec.

Period=0.084 Sec.



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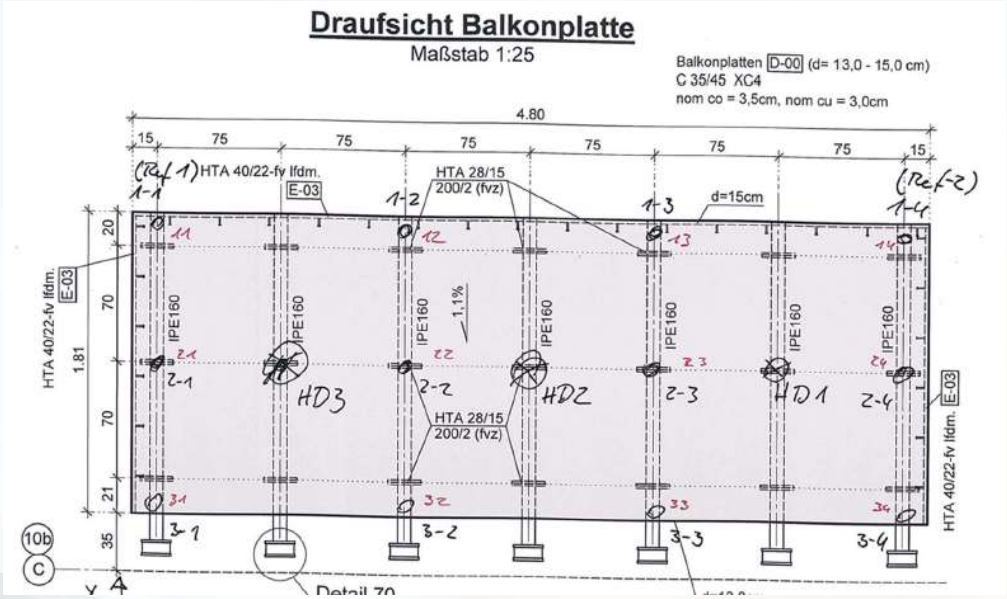
The Test data

- 2 sensor configuration and 5 Experements data (3 data from configuration first and 2 data from second configuration) Sampling frequency: 512 Hz.
- Black and Red mark in balcony plan denote sensor configuration 1 and 2 respectivelly



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Analyzes and results from MACEC

- **MACEC Procedure**
- Firstly, grids and beam were created in Macec
- Sensor data exported and converted with given frequency (512 Hz) then we processed the data.
- In process, removed offset and decimated with factor 4
- Assigned degree of freedom to the each channel for both configuration.
- Stochastic Subspace idenfiction
- Modal (stablization plot)
- Repeted for other data and combined

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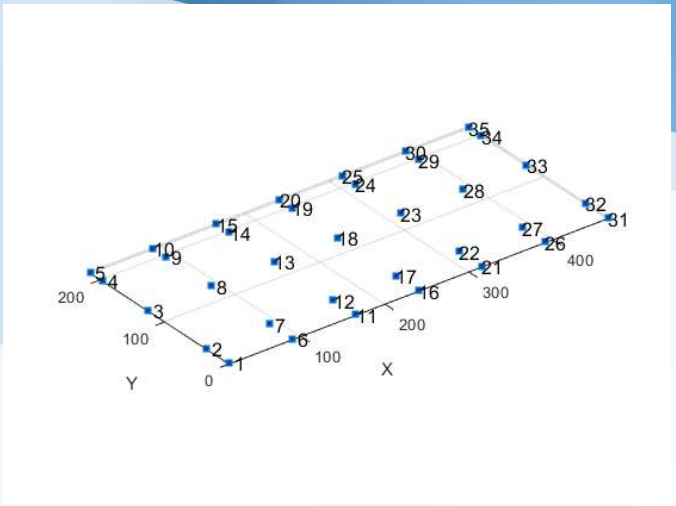
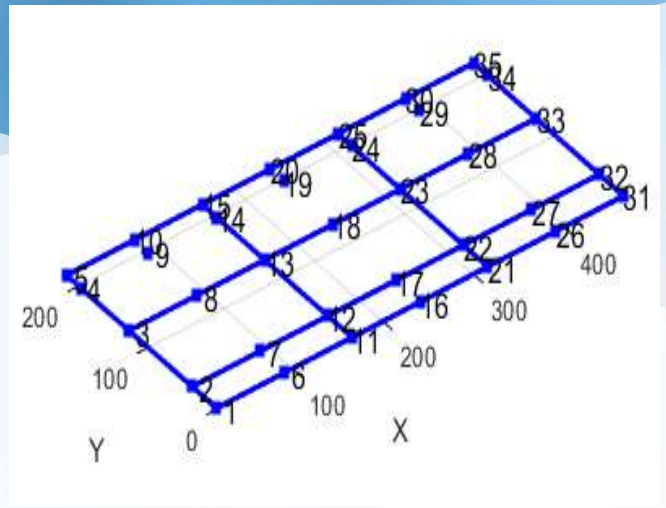
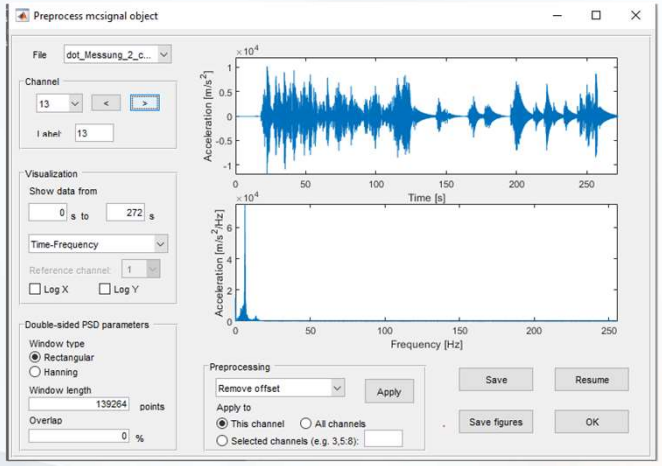
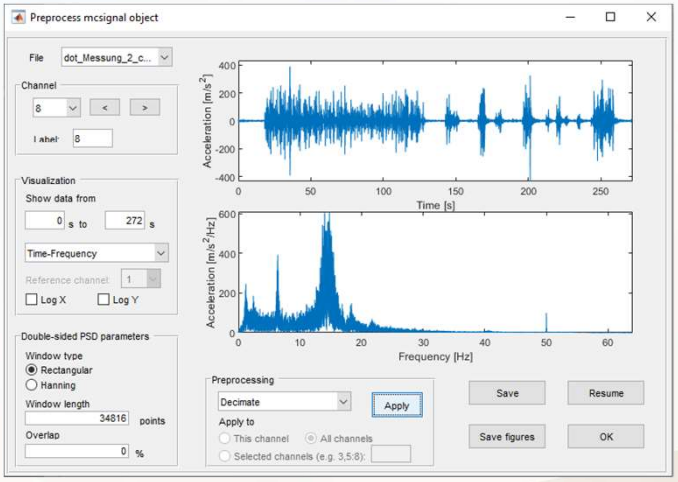
Analyzes and results from MACEC Cont…









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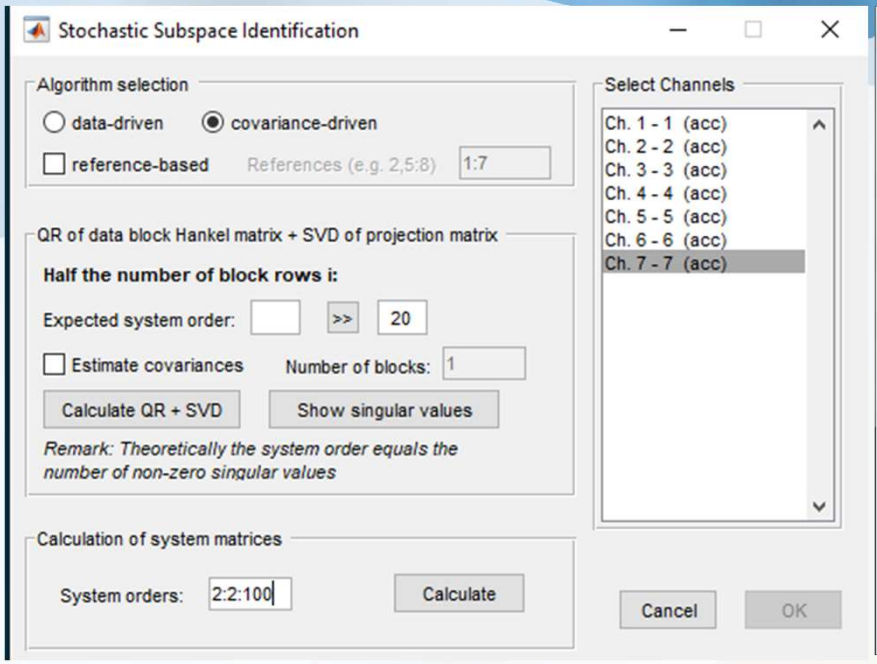
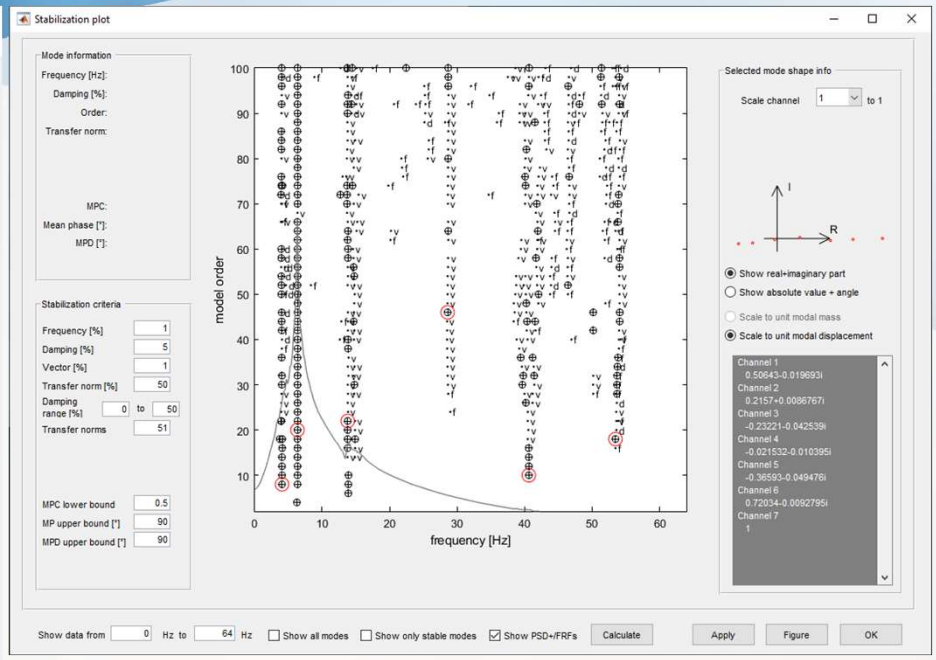
Analyses and results from MACEC Cont…





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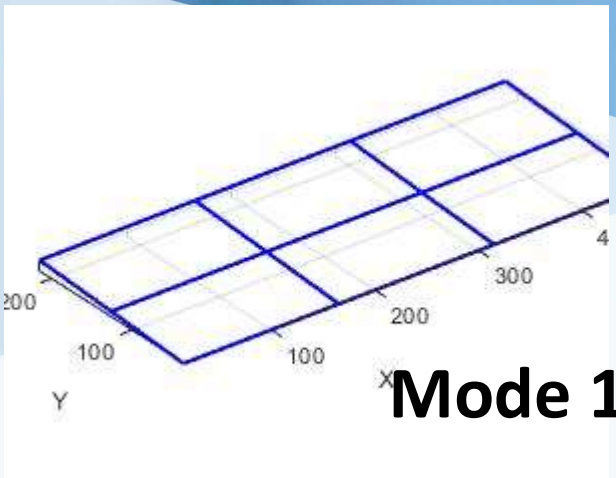
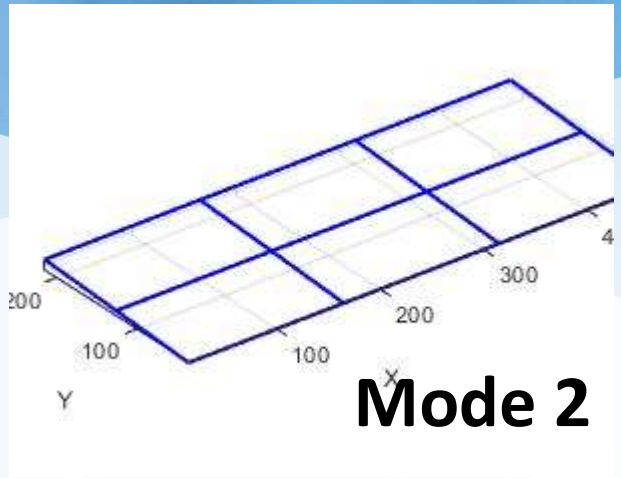
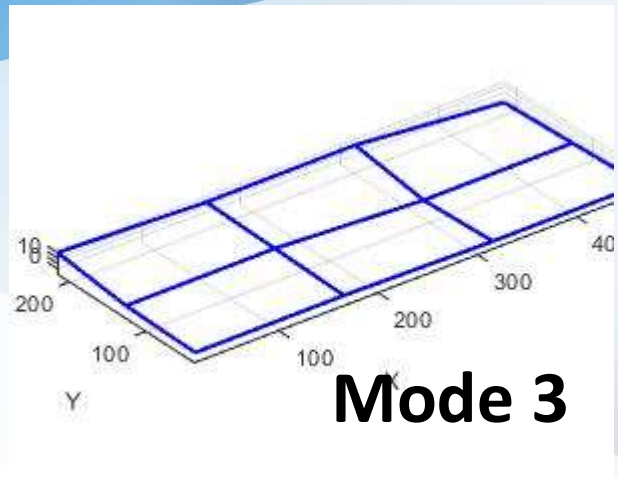
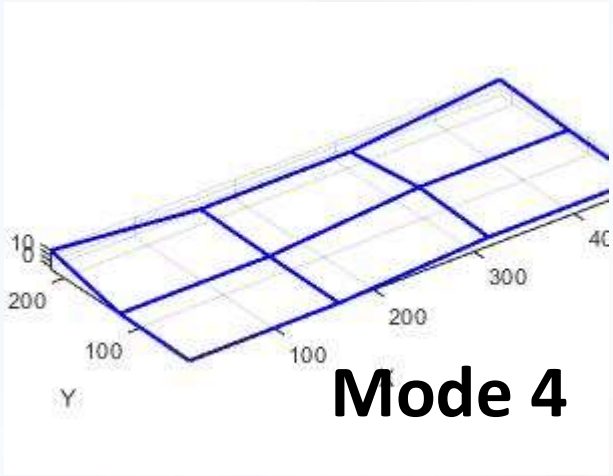
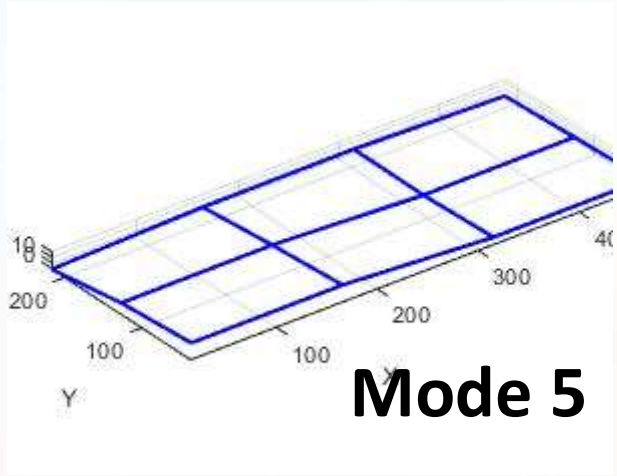
Modes from MACEC

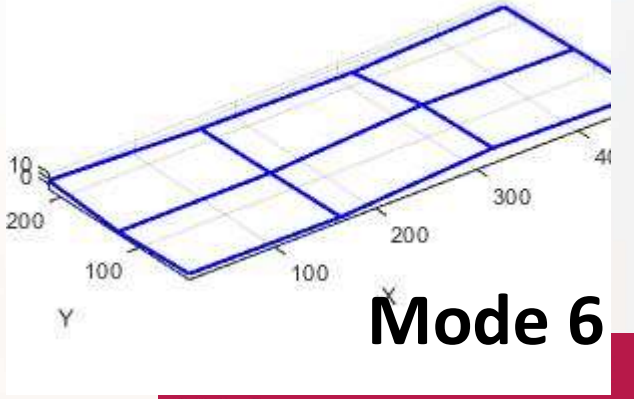












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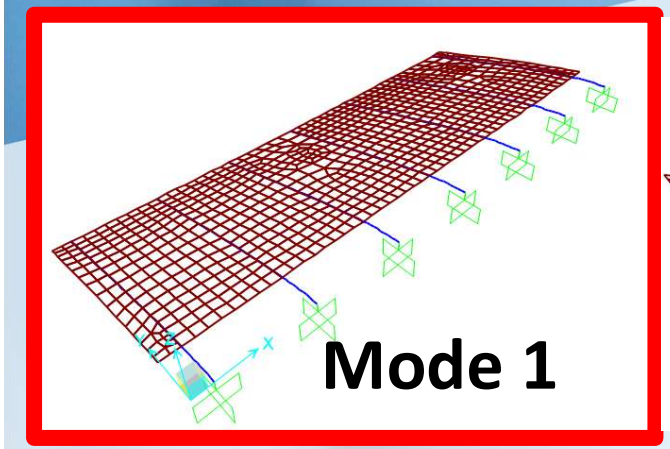
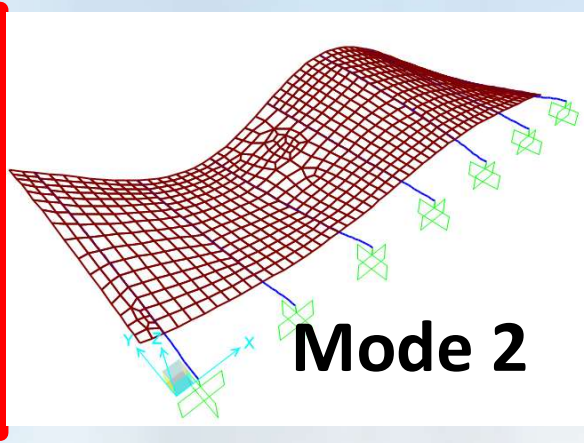
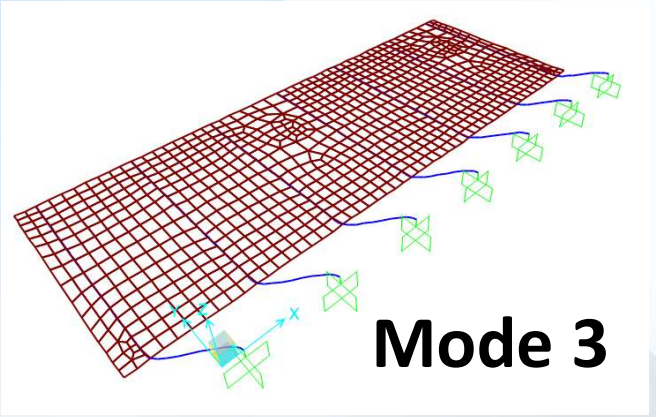
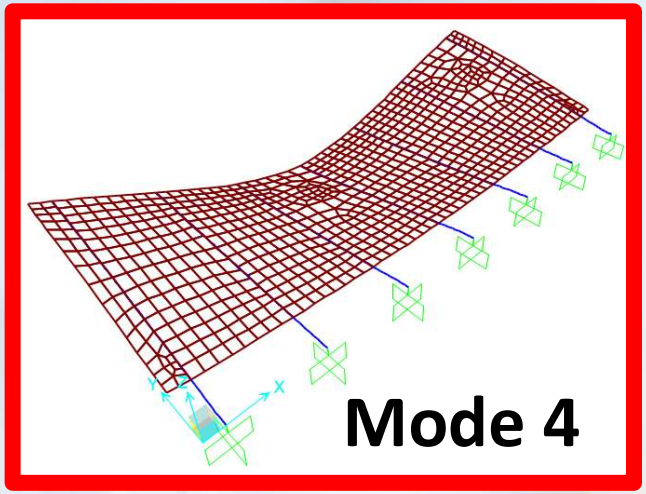
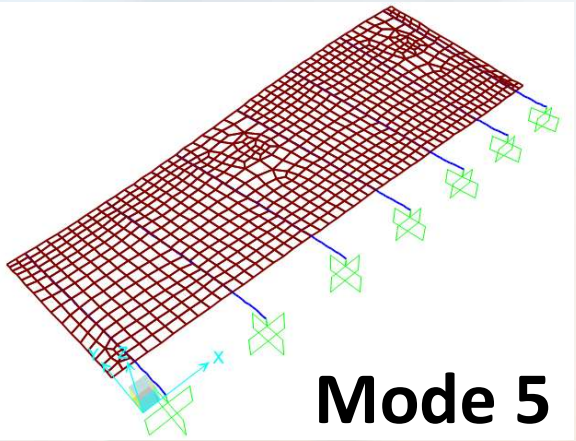
Modes from SAP2000

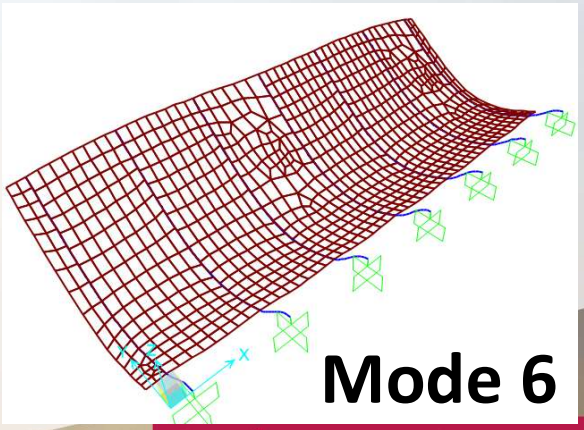












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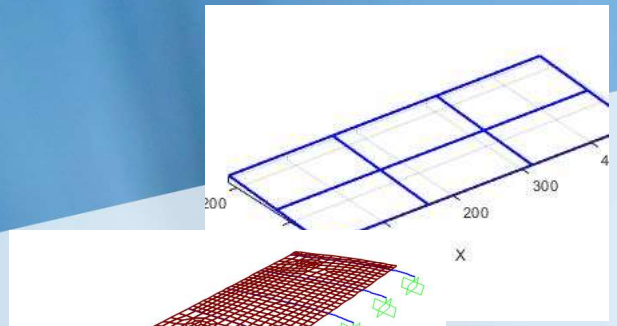
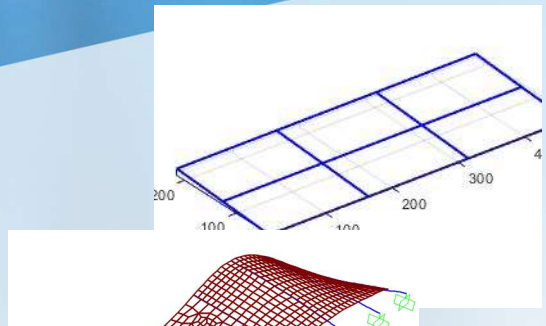
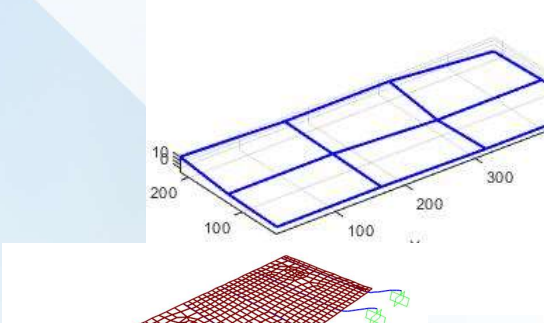
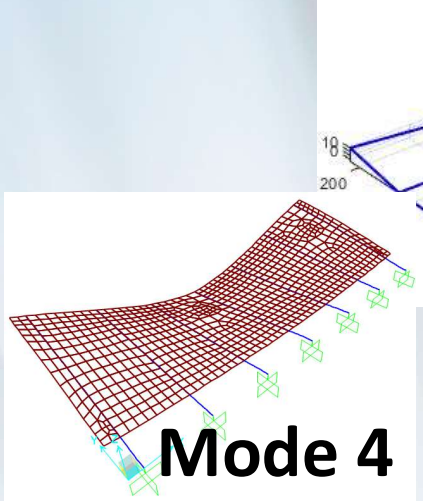
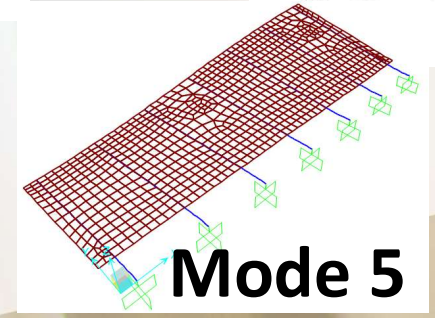
Modes from SAP2000 and MACEC

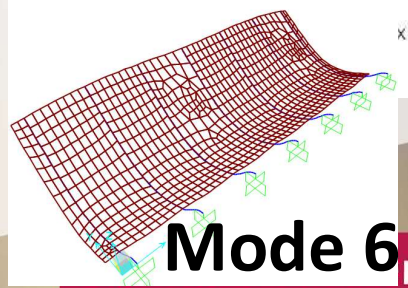












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Comparison of Mode and Frequency from MACEC and SAP2000

MACEC [Hz]	SAP2000 [Hz]
Mode 1 = 3.890	Did not appear
Mode 2 = 6.355	Did not appear
Mode 3= 13.769	Mode 1=11.908
Did not appear	Mode 2=20.583
Mode 4= 28.684	Did not appear
Did not appear	Mode 3=36.832
Mode 5= 40.669	Mode 4=37.367
Mode 6= 53.862	Did not appear
Did not appear	Mode 5=67.06

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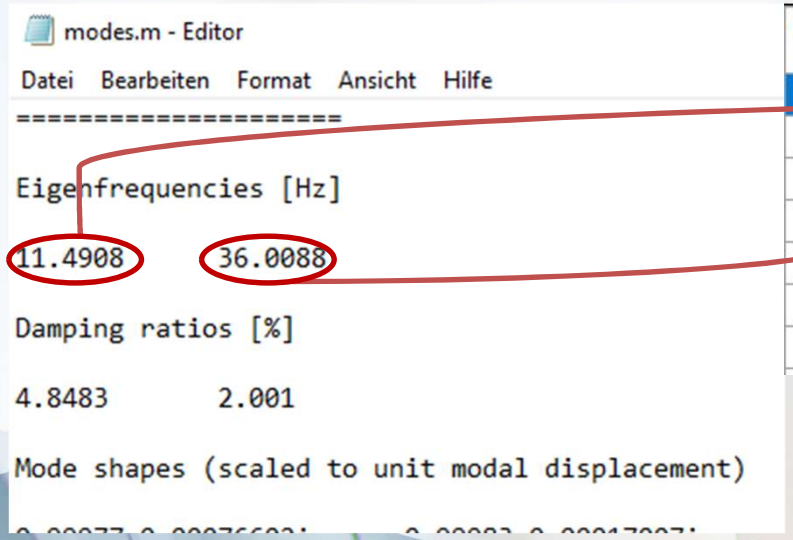
H.Drop Analysis in MACEC Vs SAP2000



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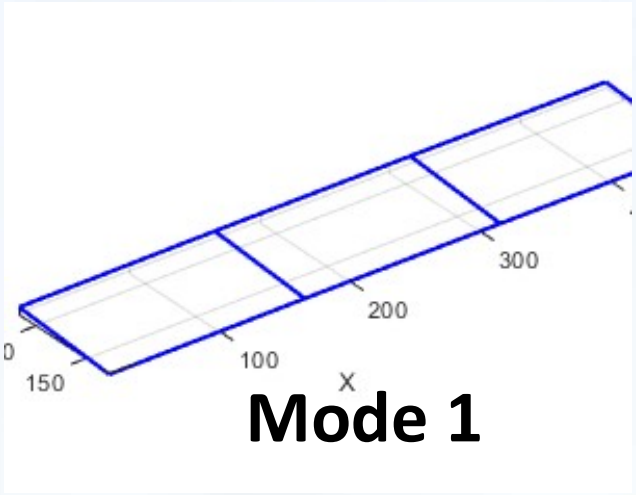
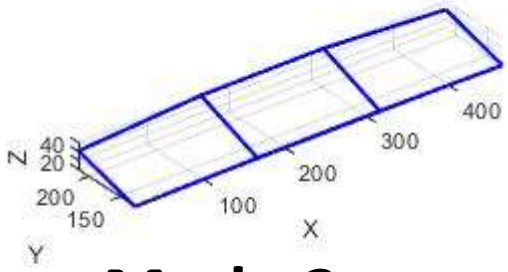
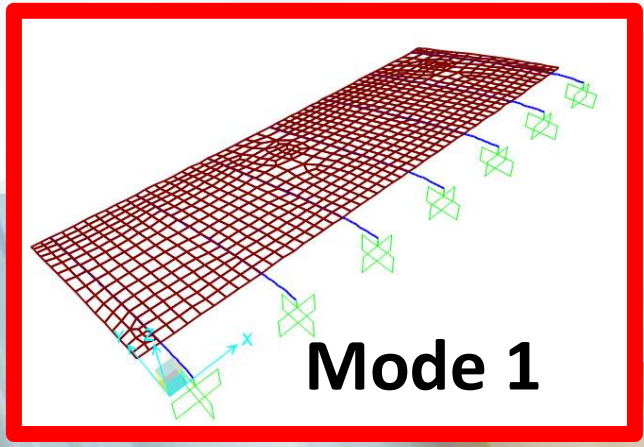
H.Drop Analysis in MACEC Vs SAP2000 cont..



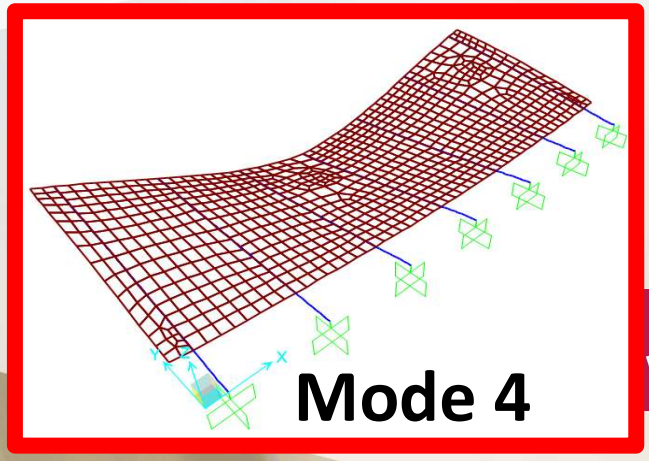
Mode 1



Mode 2



Mode 1



Mode 4

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Conclusion

1. Matlab, MACEC and labView are useful tools that could be used to study the behaviour of structures and their dynamic and modal properties
2. SAP2000 is an easy and well-known commercial software can also be used to determine the dynamic and Modal properties of a structure.
3. Results from the experiment were analyzed using Macec and the results were compared with the Modal Analysis results from SAP2000 few modes were observed to be similar in both cases.
4. Simulated H.Drop using SAP2000 has been analysed in MACEC, similar results were observed in both cases.
5. The Sensors used in performing experiments should be distributed in a way such that all modes could appear.
6. Location of applying exciting loads (in experiments) affect the modes that are activated.

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Thank You!

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