Vibration analysis of Foam filled Honeycomb Sandwich panel

Vibrations & Control Project presentation

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Objective and Abstract

The objective of the numerical study on the vibration analysis of foam-filled honeycomb sandwich panels is to evaluate the natural frequencies, mode shapes, and damping characteristics under varying conditions. The study aims to assess the impact of foam filling on vibrational performance and structural integrity. Ultimately, the goal is to optimize the panel design for enhanced mechanical properties and validate numerical results with experimental data

We are conducting modal analysis using ANSYS Workbench on a foam-filled honeycomb (HC) structure with two types of polyurethane foam, varying the honeycomb core thickness. Our goal is to compare their modes. For validation, we are referencing formulas from a specific paper (Mozafari, H., & Najafian, S. (2019). Vibration analysis of foam filled honeycomb sandwich panel – numerical study. *Australian Journal of Mechanical Engineering*, *17*(3), 191–198. https://doi.org/10.1080/14484846.2017.1338325). This study aims to investigate the modal characteristics of these composite structures under different configurations for potential engineering applications.

Foam filled honeycomb sandwich panel

Introduction:

Foam honeycomb sandwich panels are advanced composite structures used in aerospace, marine, construction, and transportation. These panels consist of face sheets, a lightweight honeycomb core (typically made of materials like Nomex or aluminum), and optionally, a foam core layer (made of materials like polyurethane or polyethylene) for added insulation and impact resistance.

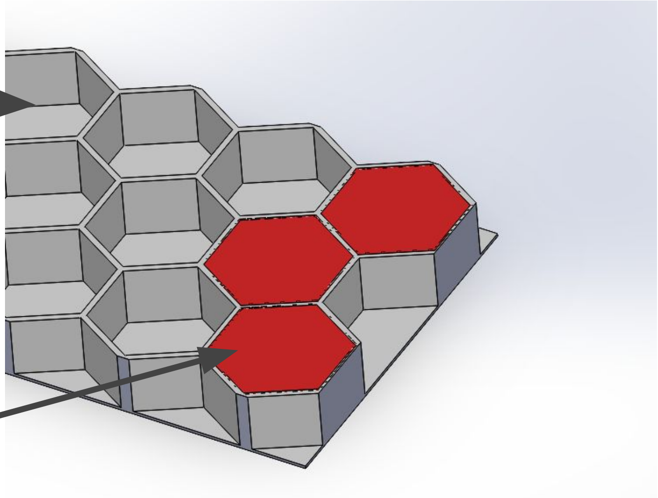
Applications:

1. Aerospace: Used in aircraft components like floors, bulkheads, and interior panels due to their lightweight and high strength properties.
2. Marine: Used for boat hulls, decks, and bulkheads to reduce weight while maintaining structural integrity.
3. Construction: Employed in architectural applications for facade panels, partitions, and cladding.
4. Transportation: Used in automotive applications for interior components, cargo containers, and vehicle bodies.

FEA Parameters

- Material properties:

3		Density	2770	kg m^-3
4	⊞	Isotropic Secant Coefficient of Thermal Expansion		
6	⊟	Isotropic Elasticity		
7		Derive from	Young's Modulus...	
8		Young's Modulus	7.1E+10	Pa
9		Poisson's Ratio	0.33	
10		Bulk Modulus	6.9608E+10	Pa
11		Shear Modulus	2.6692E+10	Pa



Foam Properties:

HC1	HC1F1
HC2	HC1F2
HC3	

- F1:

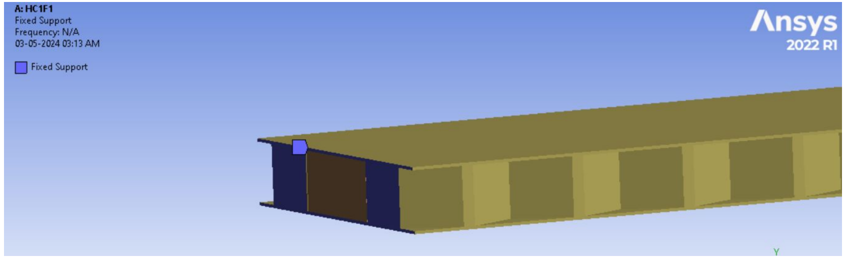
Property	Value	Unit
Density	60	kg m^-3
⊟ Isotropic Elasticity		
Derive from	Young's Modulus...	
Young's Modulus	7E+07	Pa
Poisson's Ratio	0.3	
Bulk Modulus	5.8333E+07	Pa
Shear Modulus	2.6923E+07	Pa

- F2:

Property	Value	Unit
Density	80	kg m^-3
⊟ Isotropic Elasticity		
Derive from	Young's Modulus...	
Young's Modulus	1.02E+08	Pa
Poisson's Ratio	0.3	
Bulk Modulus	8.5E+07	Pa
Shear Modulus	3.9231E+07	Pa

FEA Parameters

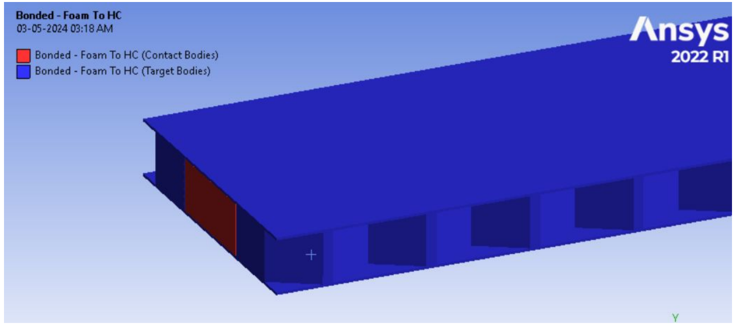
- Boundary Condition:



- Mesh Statistics:

Statistics	
Nodes	85995
Elements	26117

- Contact type:



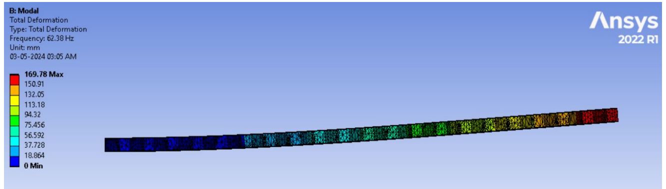
Validation Of Simulation Model

Simulated value of HC2F1	Analytical Value of HC2F1	HC2	Analytical Value of HC2	HC2F2	Analytical Value of HC2F2
65.685	69.4	62.38	68.432	67.328	64.365
195.95	207.0325036	205.25	225.163001	193.99	185.454
366.46	387.1861764	385.3	422.6811414	362.29	346.349
761.03	804.072193	723.29	793.4623482	780.04	745.718

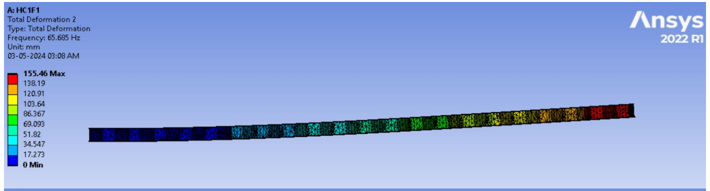
Various shape of modes of HC2 and HC2F1

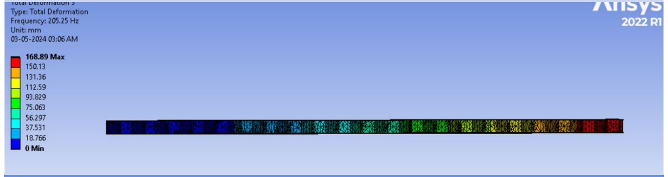
HC2 PANEL

HC2F1

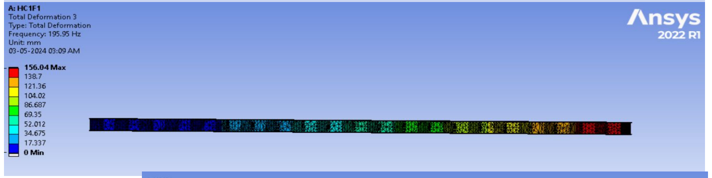


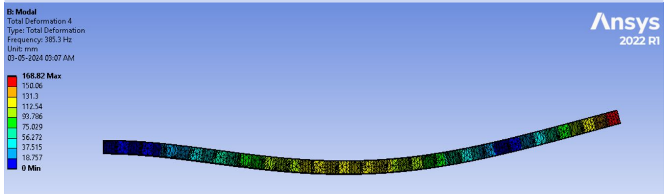
First Bending Mode



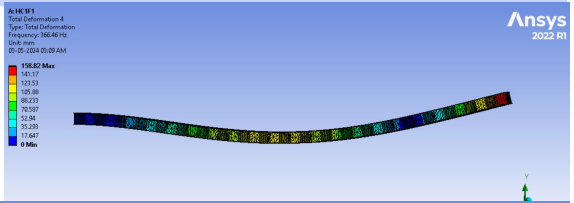


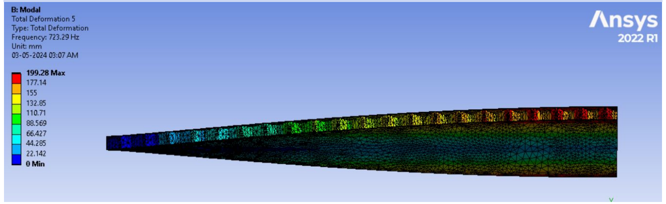
Lateral Mode



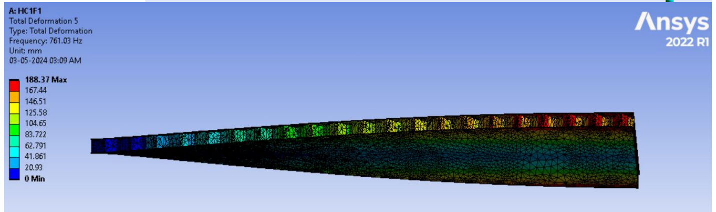


Second Bending Mode



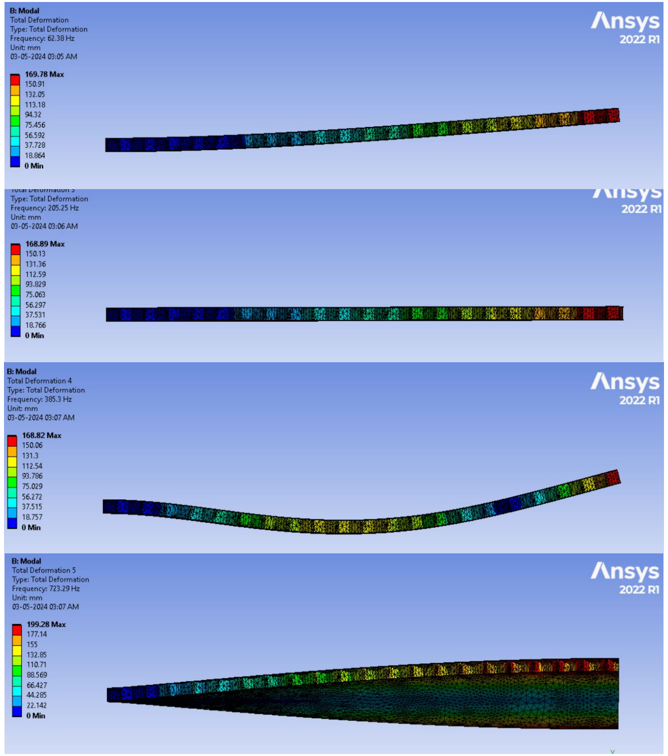


Torsional Mode



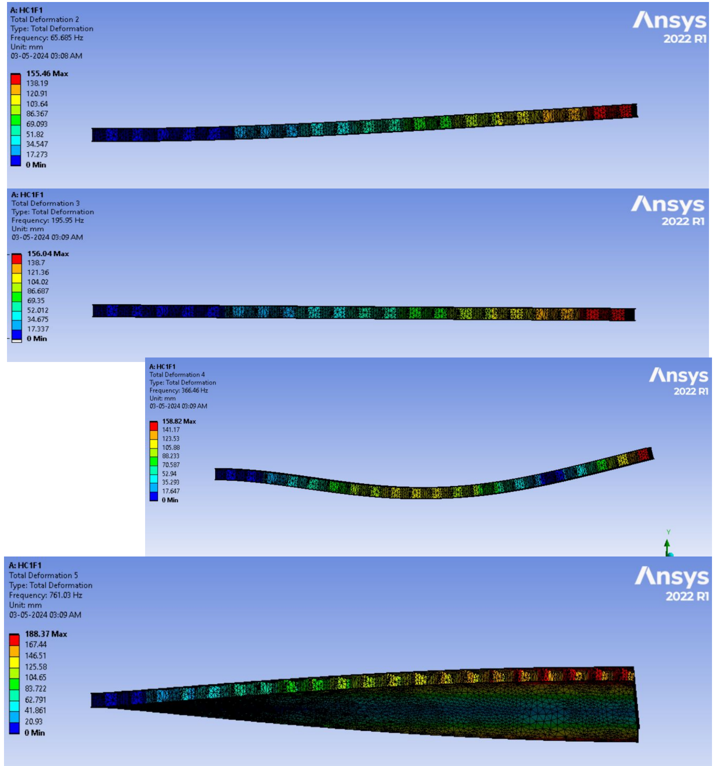
Comparison of frequency modes of HC2 & HC2F1

HC2 PANEL



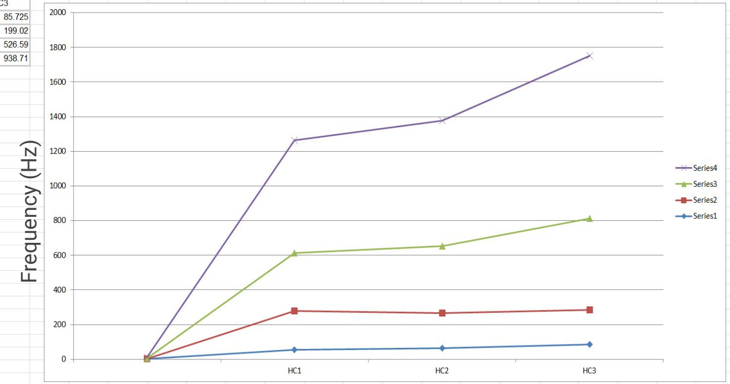
MODES	HC2F1	HC2
1	65.685	62.38
2	195.95	205.25
3	366.46	385.3
4	761.03	723.29
5	988.48	1056.5
6	1108.6	1181.7
7	1876.6	2011.6
8	2087	2176
9	2167.4	2324.3
10	2786.5	2979

HC2F1



Variation of frequency according to core thickness

	HC1	HC2	HC3
1	53.865	62.38	85.725
2	224.91	205.25	199.02
3	334.23	385.3	526.59
4	650.99	723.29	938.71



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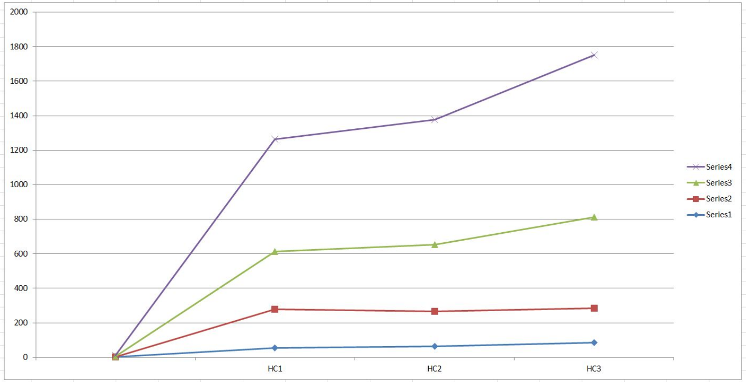

	HC1F2	HC2F2	HC3F2
1	61.064	67.328	83.017
2	211.59	193.99	184.29
3	320.17	362.29	477.74
4	723.89	780.04	927.53