INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

Report on ExEED Research Based Learning

1. Student Details:

Name of the Student	Roll Number	Branch	Mobile Number
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2. Title of the Research Work:

Flutter analysis of an Airfoil

3. Define the problem and its relevance to today's market/society / industry need(Max: 100 Words)

The problem of flutter analysis of airfoil is highly relevant to today's market, society, and industry needs. Flutter refers to the self-excited vibration that occurs in aircraft structures, particularly in airfoils, due to aerodynamic forces. Flutter analysis is crucial for ensuring the structural integrity and safety of aircraft, as it helps identify and prevent potentially catastrophic flutter phenomena.

With the continuous advancements in aviation technology and the increasing demand for more efficient and high-performance aircraft, flutter analysis plays a vital role in optimizing design, improving aerodynamic performance, and reducing the risk of flutter-related failures. It directly impacts the aviation industry by ensuring the reliability and safety of aircraft, meeting regulatory requirements, and enhancing passenger confidence.

4. Describe the Solution / Proposed / Developed (Max: 100 Words)

The proposed solution for flutter analysis of airfoil involves utilizing advanced computational methods and simulations. By employing computational fluid dynamics (CFD) and finite element analysis (FEA) techniques, engineers can accurately model the aerodynamic forces and structural behaviour of the airfoil. These simulations enable the prediction of potential flutter instabilities and allow for the optimization of airfoil design parameters to mitigate flutter risks. Additionally, experimental testing, such as wind tunnel studies, can be conducted to validate the simulation results. This integrated approach of numerical analysis and experimental validation provides a comprehensive understanding of airfoil flutter behaviour, aiding in the development of safe and efficient aircraft designs.

5. Explain the uniqueness and distinctive features of the product / process / servicesolution (Max: 100 Words)

The uniqueness and distinctive features of the proposed solution for flutter analysis of airfoil lie in its integration of advanced computational methods and experimental validation. By combining computational fluid dynamics (CFD) and finite element analysis (FEA), the solution allows for a comprehensive and accurate prediction of flutter instabilities. The use of simulations enables engineers to optimize airfoil design parameters and mitigate flutter risks, while experimental testing validates the results and provides real-world validation. This integrated approach provides a holistic understanding of airfoil flutter behaviour, ensuring the development of safe and efficient aircraft designs with enhanced reliability and performance.

6. How your proposed / developed (product / process / service) solution is differentfrom similar kind of product by the competitors if any (Max: 100 Words)

The proposed solution for flutter analysis of airfoil differentiates itself from competitors through its combination of advanced computational methods and experimental validation. While other solutions may rely solely on simulations or experimental testing, our approach integrates both, providing a more robust and accurate analysis of flutter phenomena. By leveraging the strengths of both computational and experimental techniques, our solution offers a comprehensive understanding of airfoil flutter behaviour, leading to improved design optimization and enhanced safety in comparison to competing products or services.

7. Utility: Highlight the utility/value proposition (key benefits) aspects of thesolution/innovation* (Max: 100 Words)

The proposed solution for flutter analysis of airfoil offers several key benefits and a compelling value proposition. Firstly, it enhances aircraft safety by accurately predicting and mitigating potential flutter instabilities, reducing the risk of structural failures. Secondly, it optimizes airfoil design parameters, leading to improved aerodynamic performance and fuel efficiency. This not only contributes to cost savings for airlines but also reduces environmental impact. Additionally, the integrated approach of computational methods and experimental validation ensures a higher level of confidence in the analysis results. Overall, the solution provides a reliable and efficient means of addressing flutter-related challenges, offering significant value to the aviation industry and ensuring passenger safety.

8. Scalability: Highlight the market potential aspects of the Solution/Innovation (Potential Market Size, segmentation and Target users/customers etc.) (Max: 100 Words)

The market potential for the proposed solution for flutter analysis of airfoil is significant. The target market includes the aviation industry, including aircraft manufacturers, design engineers, and aerospace research institutions. This market segment is characterized by a large potential customer base, given the global demand for safe and efficient aircraft. The solution's scalability is also evident in its applicability to various types of aircraft, including commercial airliners, military aircraft, and unmanned aerial vehicles (UAVs). As the aviation industry continues to grow and evolve, the need for accurate flutter analysis and optimization will persist, making the solution highly scalable and adaptable to different market segments within the industry.

9. Economic Sustainability: Highlight commercialization/business application aspects of the solution (how it is going to economic profitable and viable) (Max: 100 Words)

The commercialization and business application of the proposed solution for flutter analysis of airfoil can be economically profitable and viable. By offering a comprehensive and reliable solution for flutter analysis, the solution can attract customers from the aviation industry, including aircraft manufacturers, design firms, and research institutions. This creates opportunities for licensing the software or providing consulting services for flutter analysis and optimization. The potential for cost savings through improved aerodynamic performance and fuel efficiency also adds to the economic viability. Moreover, as the solution demonstrates its effectiveness and reliability, it can establish a strong market presence and generate recurring revenue through maintenance and support services.

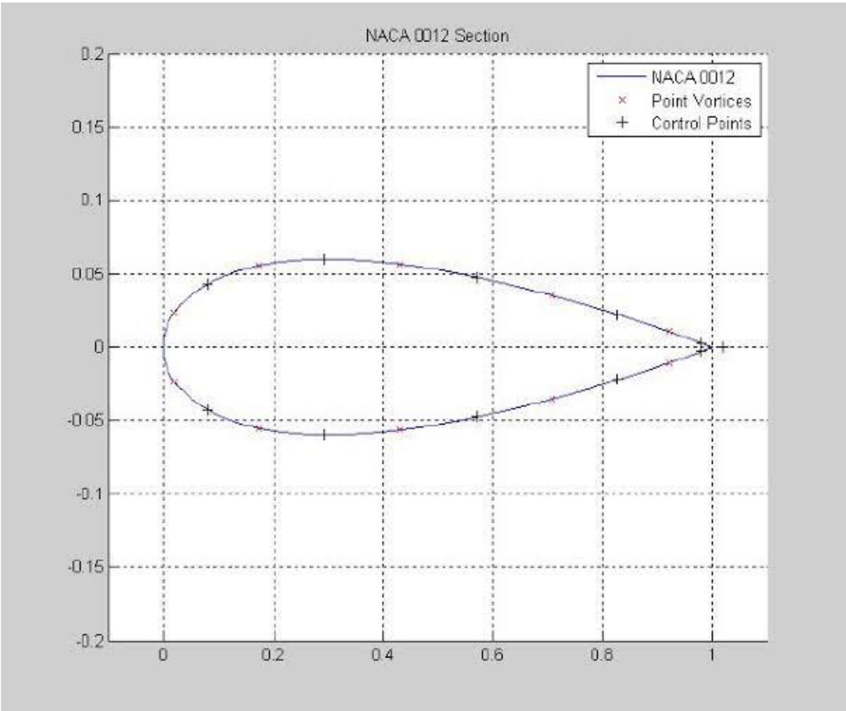
10. Environmental Sustainability: Highlight environmental friendliness aspectsand related benefit of the solution/innovation (Max: 100 Words)

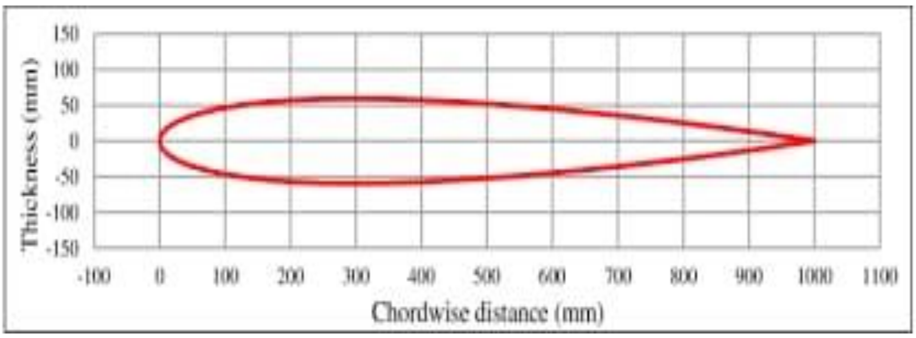
The proposed solution for flutter analysis of airfoil contributes to environmental sustainability by improving aerodynamic performance and fuel efficiency of aircraft. By optimizing airfoil design parameters and mitigating flutter risks, the solution helps reduce drag and improve overall aircraft efficiency, resulting in lower fuel consumption and reduced greenhouse gas emissions. This leads to a positive environmental impact, as it supports the aviation industry's efforts to minimize its carbon footprint and promote sustainable air travel. The solution aligns with the global goal of reducing environmental impact and addresses the industry's need for more eco-friendly aircraft designs.

11. Details of Analysis:

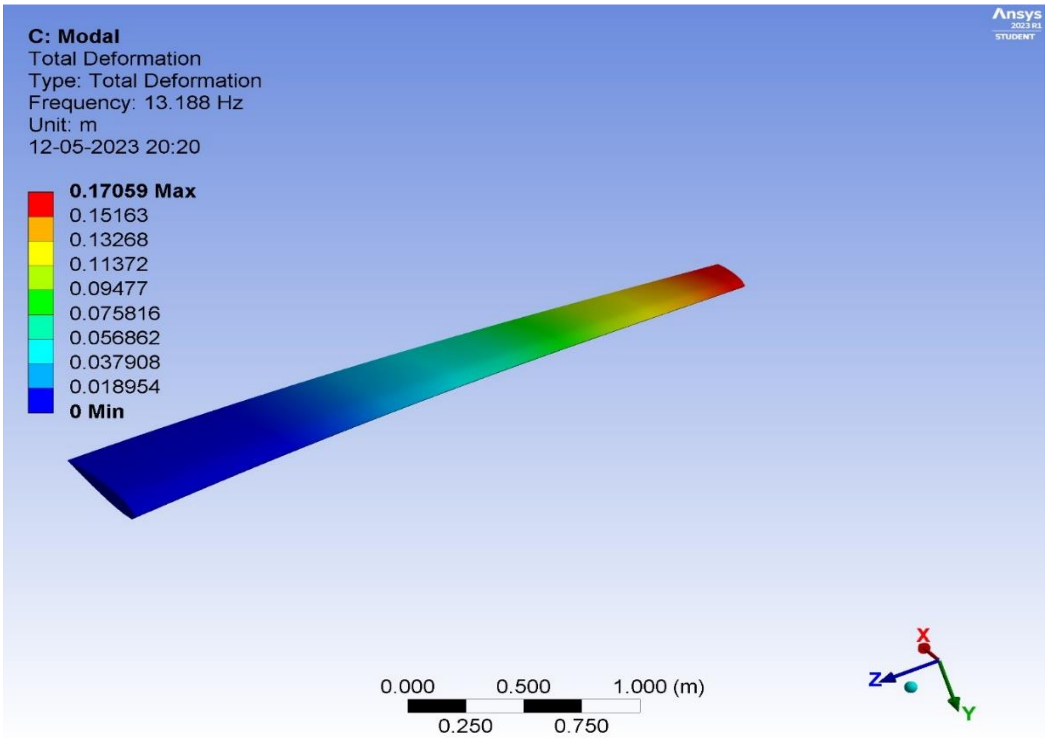
- Software used : Ansys student version R23-2023R2
- Airfoil used : NACA 0012
- Type of Analysis : Modal Analysis
- Boundary Conditions : Force and Pressure

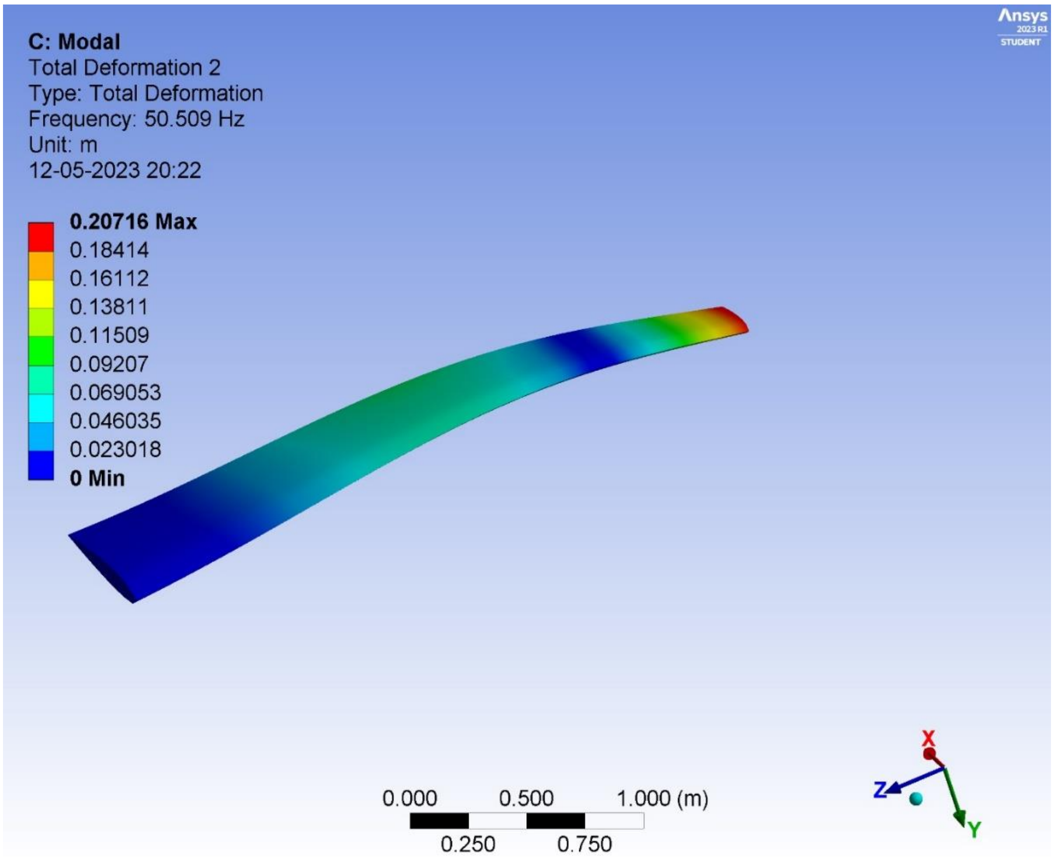
Images of Design:

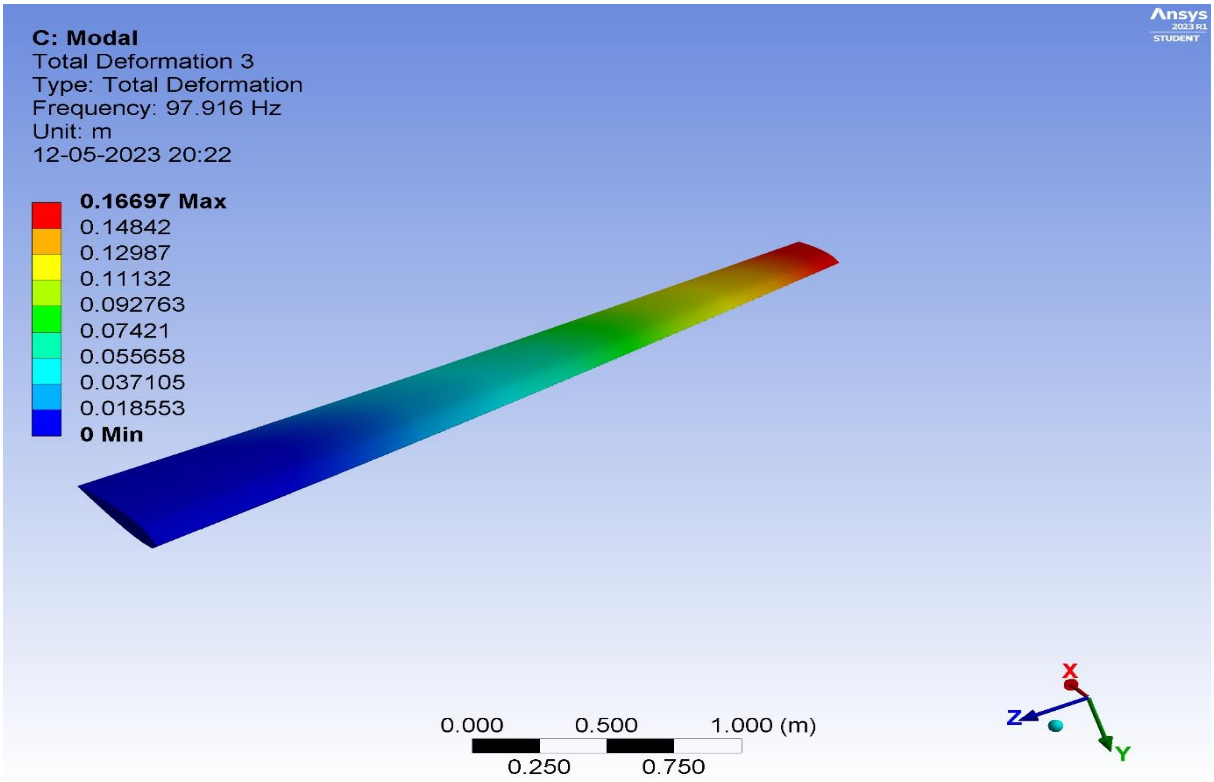




12. Research Output:



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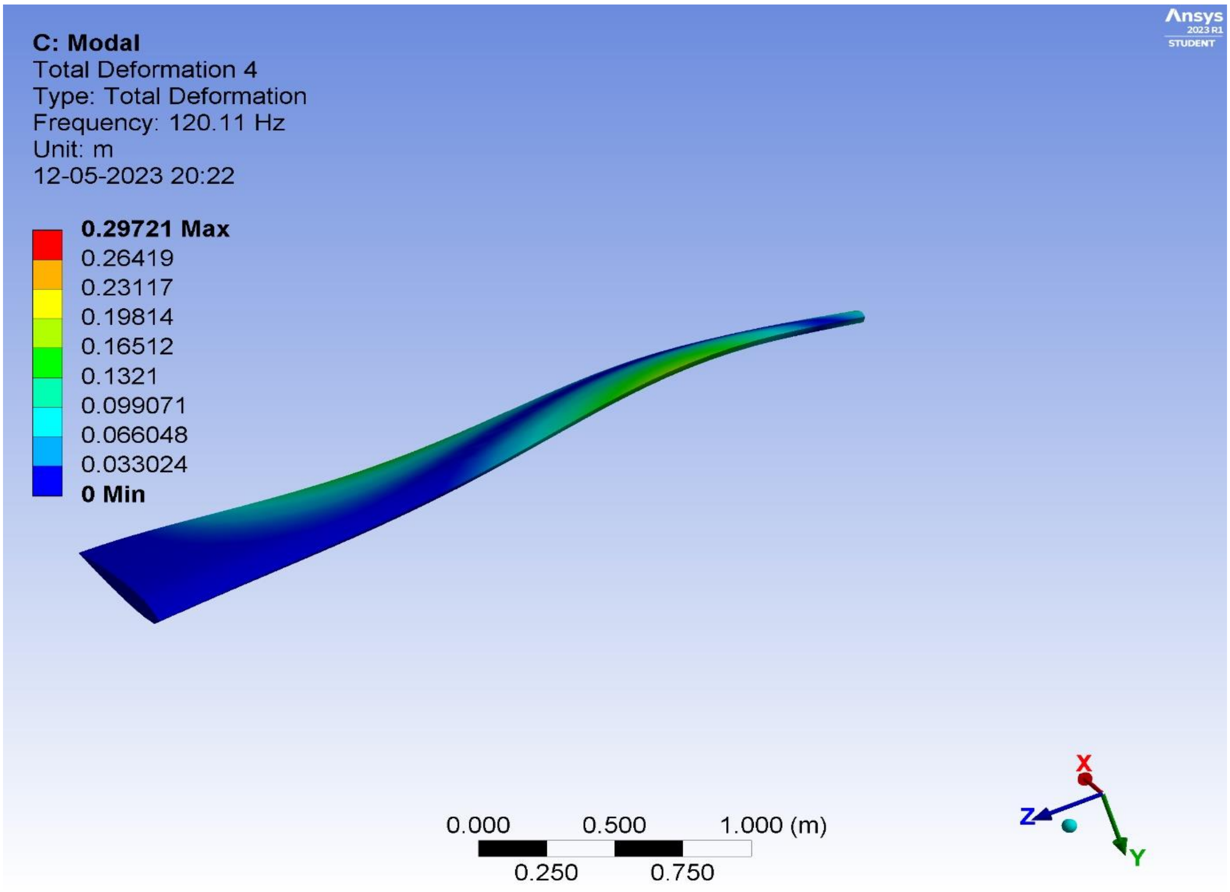
0.750
X
Y
Z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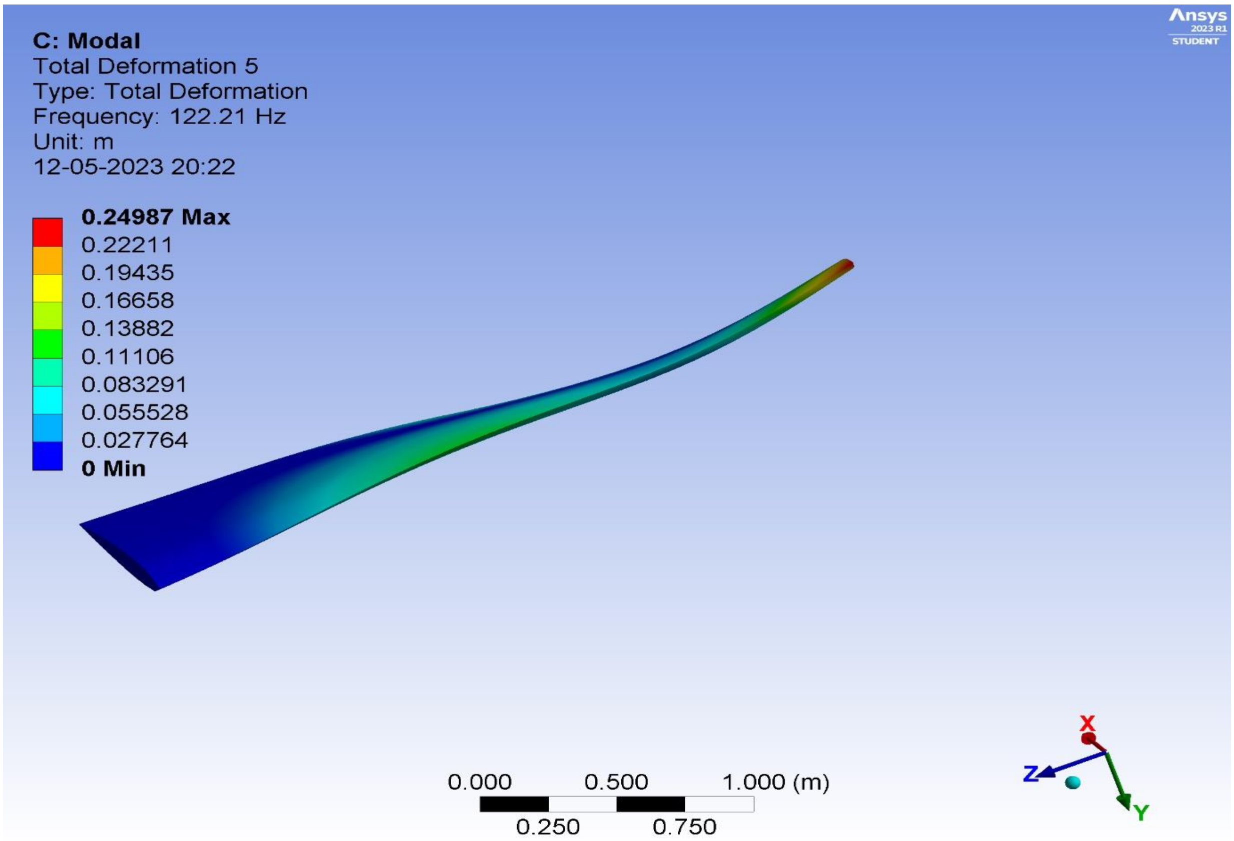
0.250
0.750
X
Y
Z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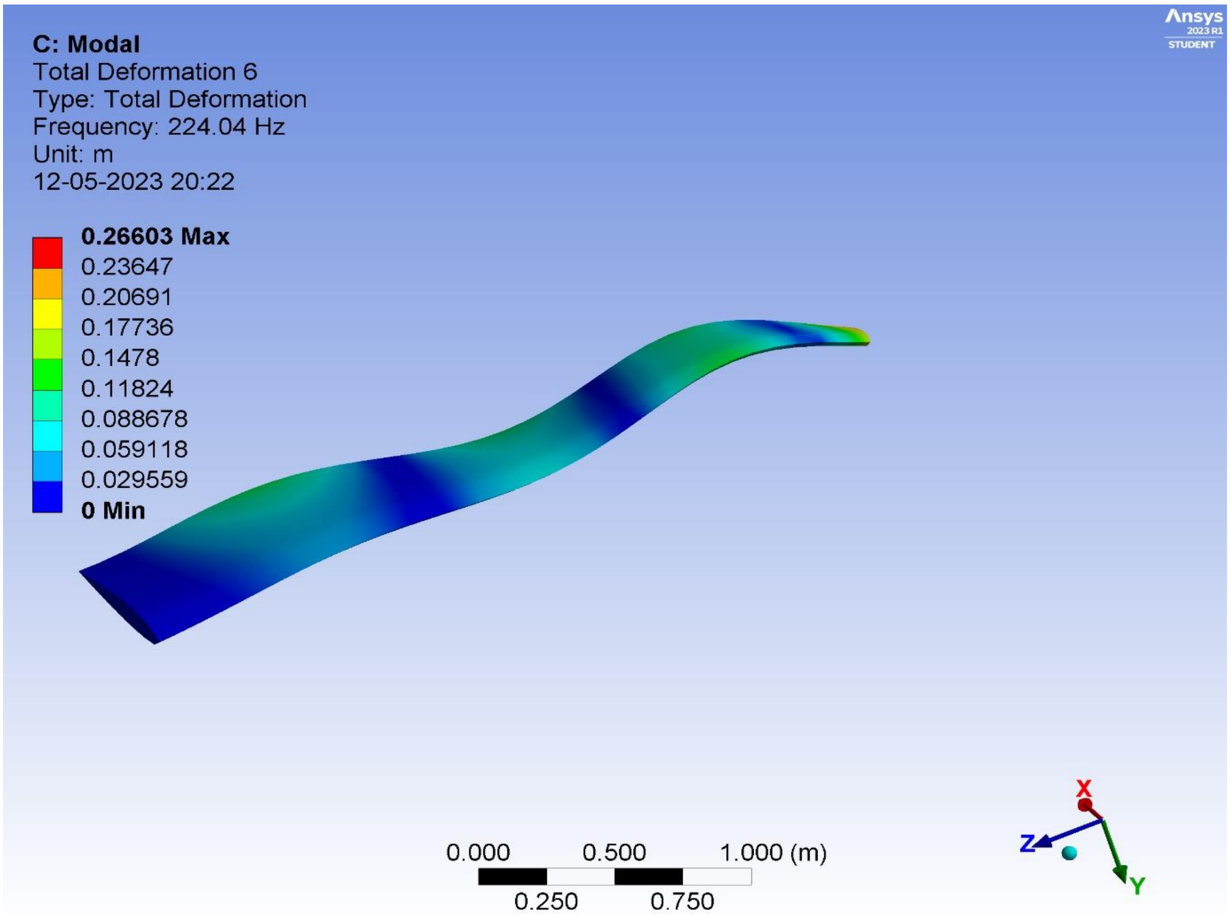
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Ansys
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0.500
1.000 (m)
0.250
0.750
X
Y
Z

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                    S O L U T I O N   O P T I O N S

   PROBLEM DIMENSIONALITY. . . . . . . . . . . . .3-D
   DEGREES OF FREEDOM. . . . . . UX   UY   UZ
   ANALYSIS TYPE . . . . . . . . . . . . . . . . .STATIC (STEADY-STATE)
      RESTART. . . . . . . . . . . . . . . . . . .ON
   LINEAR PERTURBATION . . . . . . . . . . . . . .ON
   OFFSET TEMPERATURE FROM ABSOLUTE ZERO . . . . .  273.15


 *** MAPDL GLOBAL STATUS ***

 TITLE = naca 0012 flutter analysis--Static Structural (B5)
 ANALYSIS TYPE =  STATIC (STEADY-STATE)
         2 ELEM TYPES DEFINED    MAX ELEM TYPE NUMBER =            2
       816 ELEMENTS DEFINED      MAX ELEMENT NUMBER =           1376
       560 NODES DEFINED         MAX NODE NUMBER =               560
         1 MATERIALS DEFINED     MAX MATERIAL NUMBER =             1
         0 REAL CONSTS DEFINED   MAX REAL CONST NUMBER =           0
         0 SECTIONS DEFINED      MAX SECTION NUMBER =              0
         0 COORD SYS DEFINED     MAX COORD SYS NUMBER =            0

 ACTIVE COORDINATE SYSTEM              =          0  (CARTESIAN)
 NUMBER OF DEFINED NODAL CONSTRAINTS   =         48
 NUMBER OF DEFINED NODAL LOADS         =          0
 NUMBER OF DEFINED COMPONENTS          =          2
 NUMBER OF DEFINED ELEM SURFACE LOADS =        544
 NUMBER OF DEFINED ELEM BODY LOADS     =          0
 NUMBER OF DEFINED NODE BODY FORCES    =          0
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 LOAD SET    =        1
 SUBSTEP     =        1
 TIME/FREQ   =    1.0000

 INITIAL JOBNAME = file0
 CURRENT JOBNAME = file0
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Signature of the PBL faculty In-charge