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Reinforcement of Automotive a Pillar

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Abstract:- The paper deals with The A-pillar is a crucial component in automotive vehicles that provides essential support to the roof and enhances occupant safety during a collision. To further strengthen this component, a study was conducted proposing the use of composite materials. The study aimed to evaluate the bending strength of the A-pillar after reinforcing it with a composite material made of carbon fiber and epoxy resin. To achieve this, ANSYS software was used to conduct layer-wise damage experimentation. Afterward, a three-point flexural test was performed on the reinforced A-pillar trim specimen. A comparative analysis was made between the simulation and experimental results, and the results and conclusion were verified.

Literature Survey: A Design and Reinforcement of a B-Pillar for Occupants Safety in Conventional Vehicle Applications" by Aniekan EssienubongIkpe, Ejiroghene Kelly Orhorhoro, Abdul samad Gobir.

This paper is focused on the crucial topic of B-pillar design and reinforcement, with specific criteria in mind. To achieve this, the first and second designs utilize the Surface welding method, while the third design employs spot welding. The fourth design, on the other hand, utilizes seam welding. It is worth noting that the fourth design boasts the least maximum displacement, stress, and weight when compared to the other designs.

Keywords:- *Automotive A pillar, Carbon fiber & Epoxy resin Reinforcement, ANSYS.*

I. INTRODUCTION

The body of a car is a complex structure that is designed to provide safety and support to its occupants. One of the most important components of this structure is the four pillars that make up the side of the car. These pillars, known as the A, B, C, and D pillars, are critical to the car's overall safety and structural integrity. These parts are double-skinned, making them the most sophisticated parts of the car's body. It is essential that these components meet the design requirements and specifications to ensure the safety of the occupants.

II. DESIGN OF SIDE BODY A, B, C, AND D PILLAR

The body of a car is a complex structure that is designed to provide safety and support to its occupants. One of the most important components of this structure is the four pillars that make up the side of the car. These pillars, known as the A, B, C, and D pillars, are critical to the car's overall safety and structural integrity. These parts are double-skinned, making them the most sophisticated parts of the car's body. It is essential that these components meet the design requirements and specifications to ensure the safety of the occupants.

III. PROBLEM STATEMENT

To evaluate the bending strength of the A-pillar in an automobile after reinforcing it with composite materials and compare it with the existing A-pillar made of traditional materials such as steel or aluminium. The study aims to determine whether the use of composite materials can effectively enhance the bending strength of the A-pillar while reducing the weight of the vehicle.

IV. METHODS

- CAD modelling of various layer of specimens and defining material properties.
- Finite element discretization (Meshing) using ANSYS
- Defining layer wise ply orientation angle in ANSYS
- Performing Static Structural Analysis to investigate Stresses, Strains and damage of respective specimen
- Preparing specimens using Hand layup technique and removal of air gap during manufacturing
- Performing Three-point flexural test on A pillar trim using UTM
- Comparative analysis between FEA and Experimental results
- Results and conclusion.

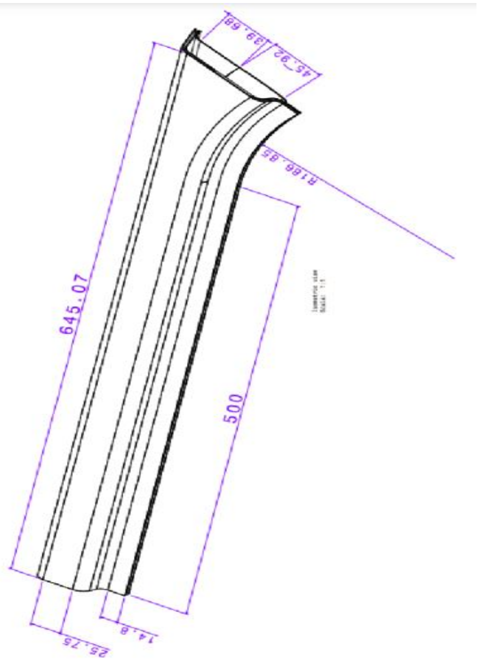

Fig 1: Cad model of A pilar

V. CONSIDERATIONS FOR THE ANALYSIS

When analyzing a A-pillar under a unidirectional force, several considerations need to be taken into account to ensure accurate and reliable results. Here are some key considerations:

- Force Magnitude and Direction: Unidirectional force acting on the A-pillar can be a result of various scenarios, such as a frontal impact, side collision, or roof load. It's essential to accurately define the force to properly simulate and analyze its effects on the A-pillar.
- Material Properties: Identify the material properties of the A-pillar, typically a high-strength steel or aluminum alloy. Obtain the necessary material data, including Young's modulus (elasticity), Poisson's ratio, yield strength, ultimate tensile strength, and any other relevant mechanical properties. These properties are crucial for accurate stress and deformation calculations.
- Meshing: The mesh should capture the geometric details and load transfer paths effectively. Attention to regions of high stress concentrations or potential failure locations to ensure accurate stress analysis is important.
- Boundary Conditions: This includes fixing or constraining specific nodes or surfaces to represent the connection points of the A-pillar to the vehicle frame or other components.
- Load Application: Unidirectional force is applied to the model according to the defined magnitude and direction ensuring that the force is accurately distributed and properly aligned with the loading scenario being simulated.
- Analysis Type: Linear static analysis is to be performed on A pillar. Analysis type should align with the behavior expected from the unidirectional force applied.

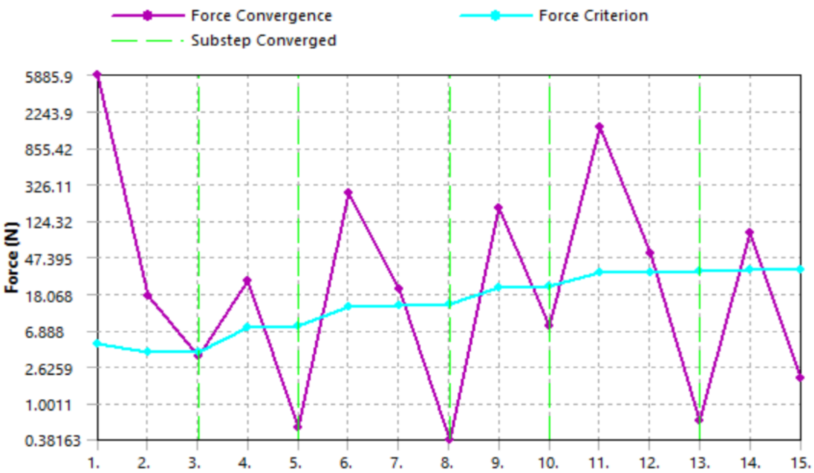

Fig. 2: Analysis (Force)

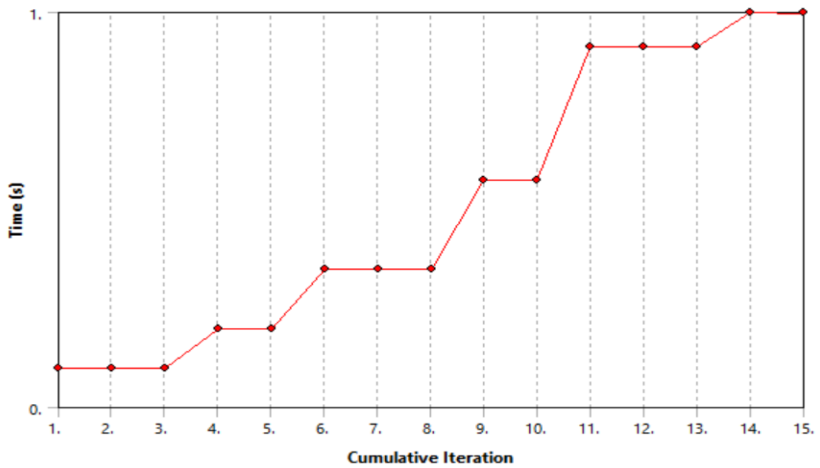

Fig. 3: Analysis (iteration)

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VI. HAND LAY-UP TECHNIQUE

The hand layup technique is a common method used in the reinforcement of car Apillars. It involves manually applying layers of reinforcing material, such carbon fiber to the A-pillar structure to enhance its strength and stiffness. Here's an overview of the hand layup technique used in the reinforcement process:

- Preparation: Before starting the hand layup process, the A-pillar surface needs to be thoroughly cleaned and prepared. Any contaminants, such as dirt, oil, or paint, should be removed to ensure proper adhesion between the reinforcing material and the A-pillar.
- Resin Application: A resin system, such as epoxy or polyester resin, is used to impregnate the reinforcing material and bond it to the A-pillar. The resin is mixed according to the manufacturer's instructions and applied evenly onto the A-pillar surface using a brush or a roller. The resin should be spread in a controlled manner to avoid excessive or insufficient coverage.
- Layering: Once the resin is applied, the reinforcing material is laid onto the Apillar surface. It is important to carefully position the material to ensure good contact with the surface and to minimize air pockets or wrinkles. Multiple layers of reinforcing material may be applied, with each layer being saturated with resin before adding the next.
- Curing: After the hand layup process is completed, the reinforced A-pillar is allowed to cure. The curing time and temperature depend on the type of resin used and are typically specified by the resin manufacturer. Curing can take place at room temperature or in a temperature-controlled environment, such as an oven.
- Finishing: Once the reinforced A-pillar is fully cured, any excess material or irregularities can be trimmed, sanded, and finished to achieve the desired final shape and surface quality. The A-pillar can then be further treated with paint or other coatings, if required.

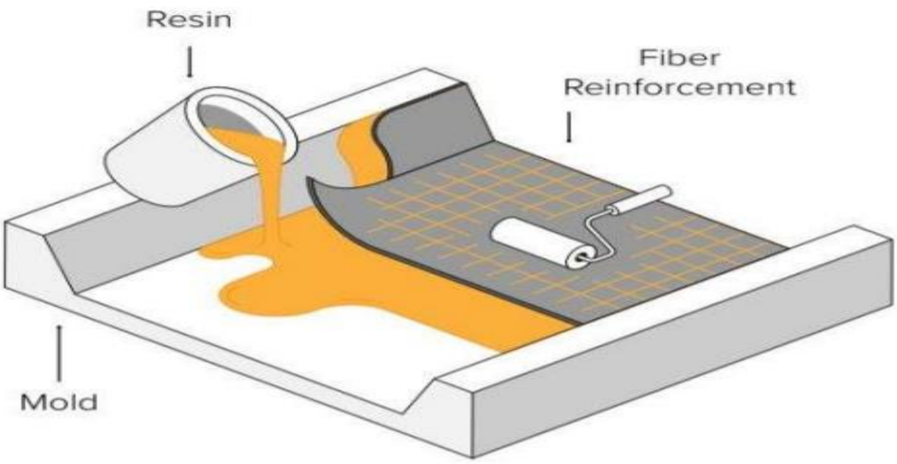

Fig. 4: Hand lay-up technique

VII. THREE-POINT FLEXURE TESTING

Three-point flexure testing is a common method used to evaluate the mechanical properties and performance of materials, including reinforced structures such as pillars. In the case of a reinforced A-pillar, which is typically found in automotive applications, this test can provide valuable information about its strength and stiffness. Here's a general overview of how three-point flexure testing is conducted on a reinforced A-pillar:

- Sample Preparation: A representative section of the A-pillar is usually selected for testing. This section is cut from an actual vehicle The sample should be prepared to meet specific dimensional and surface finish requirements.
- Test Setup: The sample is positioned horizontally on a testing machine or a universal testing machine. The machine consists of two supports placed apart at a specified distance, which will exert the bending force on the A-pillar. The distance between the supports is often determined based on industry standards or specific testing requirements.
- Loading: A loading mechanism, such as a hydraulic actuator, applies a downward force at the midpoint of the A-pillar sample. The force is gradually increased until the desired load or failure occurs. The rate of loading is typically controlled to ensure accurate measurements and prevent sudden failure.
- Measurement: During the test, various parameters are measured, including the applied force, displacement, and strain. Load cells and displacement sensors are commonly used to obtain accurate measurements. The displacement can be measured at multiple locations along the A-pillar to assess its deformation behavior.
- Comparison and Validation: The obtained results from the threepoint flexure test can be compared against design specifications, industry standards, or the performance requirements of the intended application. This helps in evaluating the A-pillar's suitability and identifying any potential weaknesses or areas for improvement.

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Fig. 5: 3 Point flexture test

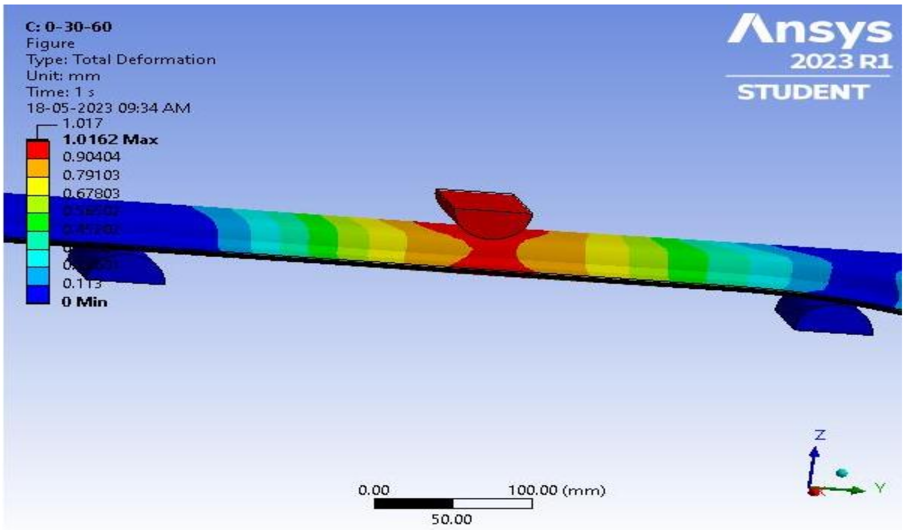

Fig 6: 3 point flexture test

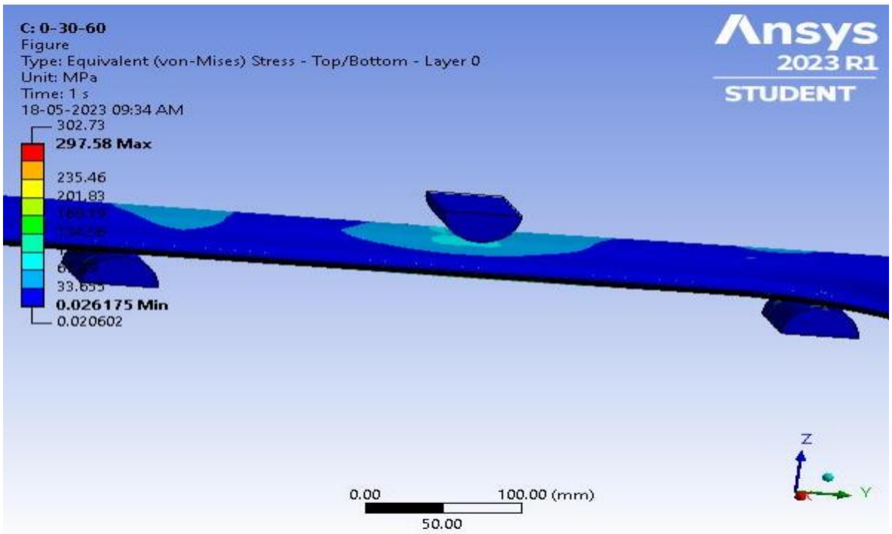

Fig 7 : Ansys Reports

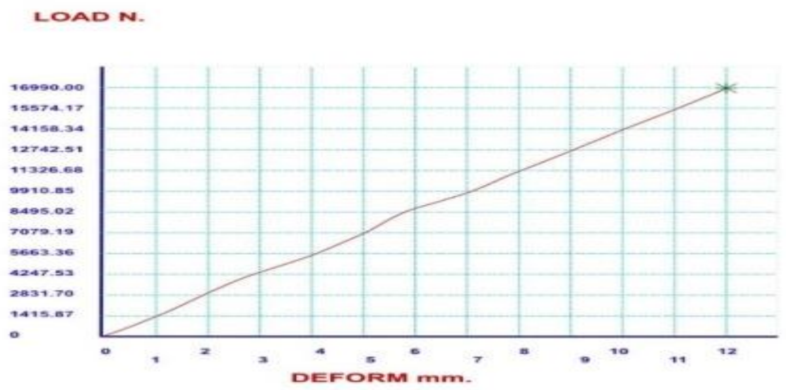

Fig 8: Result Table

VIII. CONCLUSION

In this paper we have discussed about the reinforcement of automotive A-pillars using composite materials and evaluate the bending strength of the reinforced pillars. The application of composite materials for reinforcing automotive A-pillars showed promising results. The use of composites, such as carbon fiber-reinforced polymer (CFRP) or glass fiber-reinforced polymer (GFRP), provided enhanced mechanical properties compared to traditional materials. I thank my colleagues for their immense support and contributions.

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