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**Review Article**

# NUMERICAL AND EXPERIMENTAL INVESTIGATION OF CONCEPT OF REPLACING VEHICLES SHEET METAL ROOF BY PLASTIC-METAL HYBRID COMPOSITE STRUCTURE FOR WEIGHT AND COST REDUCTION

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**ABSTRACT:-**

The Plastic-Metal hybrid composite technology, complimentary to metals, used for automotive structural applications where stiffness, impact resistance and functional integration are combined to form a cost effective, lightweight solution. The use of Plastic/composite structures as a means to reduce weight while maintaining or improving performance of automotive roof structure. The metal is used where the high stiffness and strength can be exploited, while the plastic composite gives a balance of stiffness and impact resistance and enables functional integration through the formation of complex shapes in the molding process. This work would address the baseline of compliance norms while developing the alternative.

## RELEVANCE:-

Although plastics already represent the state of the art in many automotive applications, the use of plastics in load-bearing structures has been low for mechanical and safety-related reasons and with the progressive reduction in weight of metal structures, reductions in strength became increasingly apparent.

A rise in failure due to dents was identified at nodal points and force transmission points as sheet metal becames thinner and thinner. The deformation that occurs under load in this manner prevents full utilization of the load capacity of metal components. With relatively little effort, however, metal structures can be kept in their proper shape even under load. With the help of injection molding technology, plastic ribbings and bracings are molded onto the metal parts or metal profiles. These plastic structures enhance the capacity of the metal construction through optimal transmission and distribution of the forces in the component.

Worldwide OEMs equate one kilogram of weight reduction to savings of 2-5 Euros by enabling improved fuel economy, improved vehicle balance and handling. As a result, hybrid body structures specifically those incorporating plastic and composite materials in combination with traditional steel and light-alloy components are finding favor with many automotive designers.

In the case of Metal-Plastic hybrid composite technology, the properties of two materials are combined in an optimal manner, resulting in synergistic effects that cannot be achieved with the respective materials alone.

| Advantages of steel | Advantages of plastics |
|---|---|
| Higher modulus of elasticity | used for complex design |
| Ductile behavior during failure | outstanding integration capability |
| Simple, flat deep-drawn parts | weight advantage over steel sheet |
| Easy to produce with punching | corrosion resistant |
| Tested for many years in automobile | molded in color |

Composite Plastic-Metal designs can have a higher load capacity than open or even closed metal sections. With optimized ribbing the hybrid solution is similar to a closed metal solution, even under torsional load.

## LITERATURE REVIEW:-

A lot of research work has been reported on application of advance composites & reinforced plastic materials for automotive structural, interior and other functional parts.However very little work has been reported on use of Plastic-Metal hybrid composite materials for automotive structural applications. A brief review of some selected references is presented below.

Alexander Droste, et al. [1] have investigated Bonded metal-plastic composite structures for their lightweight, cost-effective performance. The choice of adhesive is discussed in combination with the plastic and metal bonded parts. The paper focused towards analyzing the overall structural strength as well as bonding strength between metal & plastic materials for automotive load carrying applications.

C. Korson, Lanxess and D. Stratton [2] has studied the plastic-metal hybrid composite technology for automotive roof panels. The paper presents a roof module concept utilizing PMH to create roof frame welded to the body in white (BIW) structure with E-coat process. Variety of roof modules has been discussed with PUR composite protected by coating.

Prof. Henning Wallentowitz, et al [3] have summarized the application of materials for vehicle parts considering economic effectiveness, safety, recyclability and lightweight performance. The paper describes various lightweight material options & structural design types to reduce the automotive structural weight.

Aviva Brecher, et al.[4] have focused on weight and space savings available through part consolidation as a method to enhance and facilitate the deployment of integrated safety concepts. In particular, the ability to tailor shape and stiffness could be used to “tune” the vehicle’s structure and may create sufficiently enhanced maneuverability to optimize some crash avoidance strategies.

## PROPOSED WORK:

The proposed work under this title is to Investigation the concept of replacing the vehicles sheet metal Roof by Plastic-Metal hybrid composite structure for weight & cost reduction.

The detail work includes designing & analyzing different shapes and arrangements of metal intruded FRP panels, in order to increase the structural stiffness and to find the optimum alternate design as

an replacement for conventional Automotive sheet metal roof structures.

The above said work is planned in following phases.

**Phase I:** Review of literature regarding the work done.

a. In detail literature review is to be carried out at initial stages. Collection of literature from various available resources and thorough study of relevant literature is involved in this phase.
b. Studying the concepts of automotive structural (roof) design, materials and strength requirements.

**Phase II:**

a. Selecting an existing General design of automotive sheet metal roof structure for study.
b. CAD modeling of the selected design.
c. Static structural & dynamic analysis of the modeled sheet metal roof structure for standardizing the strength & performance requirements for roof structure for particular case.

**Phase III:**

Evaluating the concept of Plastic-Metal hybrid composite structure for a simple plate structure and comparing its strength & performance characteristics with respect to with equivalent sheet metal plate structure through Analytical, Numerical and Experimental methods.

**Phase IV:**

a. Designing the selected automotive roof structure with alternate Plastic-Metal hybrid composite material.
b. Analyzing various shapes and arrangements of metal stiffeners to increase strength of roof structure in order to compete with conventional sheet metal structure.
c. Proposing the optimum alternate design for roof structure & associated cost and weight reduction benefits.
d. Obtaining the comparative statistics between conventional sheet metal roof structure and proposed alternate Plastic-Metal hybrid composite roof structure.

**FACILITIES AVAILABLE:-**

The following facilities are available to carryout dissertation work at Annasaheb Dange college of Engineering, Ashta.

- Hand Books, reference books and e-journals available at college library.
- Computer facility, Internet facility.
- Workshop and Experimental testing facilities required.
- Software packages are available.

For Modeling: CATIA V5 / Pro-E Wildfire / Unigraphics etc.

For Analysis: ANSYS, Hyper mesh, MSC-NASTRAN, MSC-PATRAN etc.

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