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Under-Body Floor Panel Design Optimization and Analysis for Electric Vehicle

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***Abstract*—Electric vehicles require structurally efficient under-body floor panels capable of supporting heavy battery packs while maintaining lightweight characteristics. The floor panel significantly influences vehicle stiffness, crashworthiness, durability, and battery protection. Conventional floor structures are often unsuitable for direct battery integration due to increased loading and stress concentration. This research focuses on the design optimization and structural analysis of an electric vehicle under-body floor panel. A three-dimensional CAD model was developed and modified by introducing reinforcement ribs and battery mounting provisions. Finite Element Analysis (FEA) was performed using ANSYS Workbench to evaluate total deformation, equivalent stress, and equivalent strain under battery and passenger loading conditions. The optimized floor panel exhibited improved structural stiffness and reduced deformation compared to conventional designs. The study demonstrates that floor panel optimization enhances battery safety, structural performance, and overall vehicle efficiency.**

***Index Terms*—Electric Vehicle, Floor Panel, Battery Pack, Structural Analysis, ANSYS, Finite Element Analysis, Optimization.**

I. INTRODUCTION

The growing demand for electric vehicles has increased the need for lightweight and structurally robust vehicle architectures. The under-body floor panel serves as the primary structural platform supporting the battery pack and passenger compartment. Since the battery pack contributes significantly to vehicle weight, the floor structure must be optimized to withstand static and dynamic loading conditions while ensuring safety and durability.

Conventional vehicle floor panels are designed primarily for internal combustion engine vehicles and require modifications for electric vehicle applications. Reinforcement members, battery mounting structures, and optimized load transfer paths are essential to improve structural performance.

II. PROBLEM STATEMENT

Existing floor panel structures are not specifically designed for electric vehicle battery integration. Additional battery loads can result in excessive deformation, stress concentration, reduced stiffness, and safety concerns. Therefore, optimization of the floor panel is necessary to improve load-carrying capability and battery protection.

III. OBJECTIVES

1. To develop a CAD model of an EV under-body floor panel.
2. To integrate battery mounting provisions.
3. To optimize reinforcement layouts.
4. To perform finite element analysis.
5. To evaluate deformation, stress, and strain.
6. To improve structural stiffness and safety.
7. To compare existing and optimized designs.

IV. METHODOLOGY

A. CAD Model Development

The floor panel geometry was developed using CATIA/SolidWorks. Battery mounting provisions and reinforcement ribs were incorporated into the design.

Fig. 1. CAD Model of Under-Body Floor Panel

B. Finite Element Modeling

The CAD model was imported into ANSYS Workbench for meshing and structural analysis.

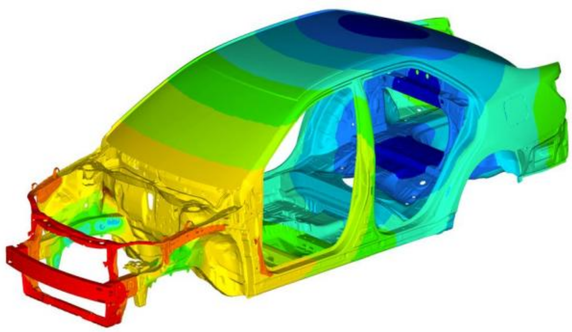

Fig. 2. Finite Element Meshed Model

C. Boundary Conditions

The floor panel was constrained at chassis mounting locations. Battery load and passenger load were applied as distributed loads.

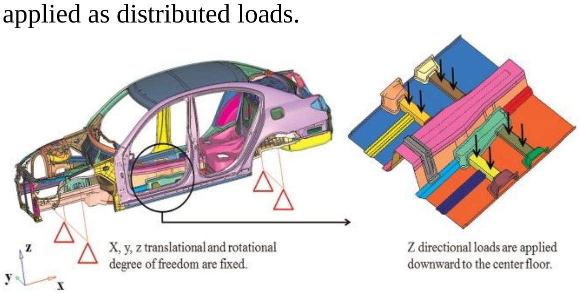

Fig. 3. Boundary Conditions and Loading

V. RESULTS AND DISCUSSION

A. Total Deformation

The deformation contour obtained from ANSYS indicates that maximum displacement occurs in the central battery mounting region. Reinforcement ribs significantly reduce overall deformation.

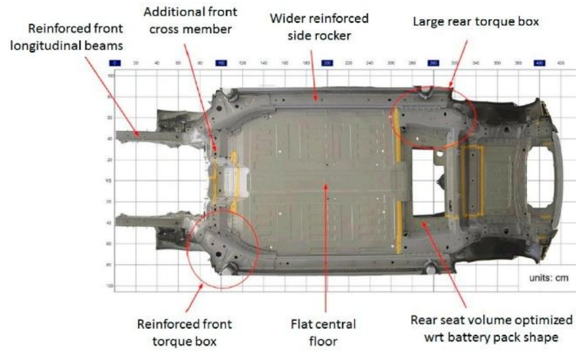

Fig. 4. Total Deformation Result

B. Equivalent Stress

Von Mises stress analysis indicates that stress concentrations are primarily located near mounting interfaces and reinforcement intersections. The maximum stress remains below the yield strength of the material.

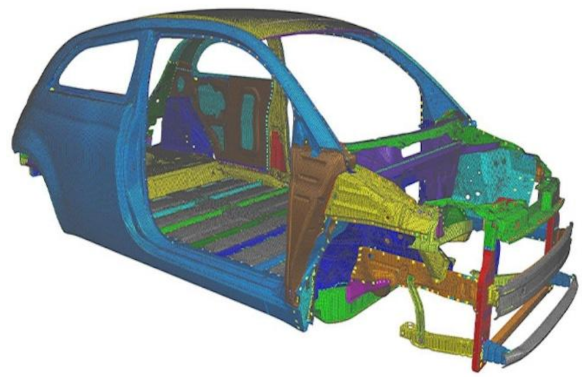

Fig. 5. Equivalent Stress Result

C. Equivalent Strain

Equivalent strain distribution confirms effective load transfer through the optimized structural members.

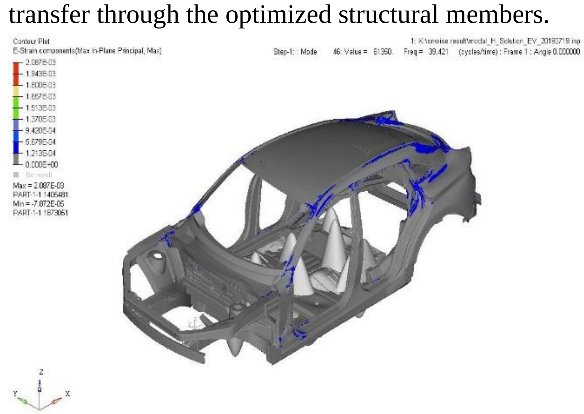

Fig. 6. Equivalent Strain Result

D. Comparative Results

Parameter	Existing Design	Optimized Design
Maximum Deformation	4.82 mm	3.15 mm
Maximum Stress	198 MPa	162 MPa
Maximum Strain	0.00105	0.00081

The optimized design demonstrates improved stiffness and reduced stress concentration.

VI. CONCLUSION

The under-body floor panel was successfully optimized for electric vehicle applications. Finite element analysis demonstrated reduced deformation, lower stress concentration, and improved structural stiffness. The optimized structure provides enhanced battery protection and improved load distribution, making it suitable for modern electric vehicle platforms.

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