Design And Structural Analysis On A Frameless Chassis Construction Of Bus For Different Loads

K. Hemanth Kumar Reddy[1], S. Sai Kumar[2], Sk. Irfan[3], Y. Venkata Krishna[4], T. Ramesh[5], Syed. Abdulla[6]

12345, B.Tech students, Dept. of Mechanical Engineering, Dr. Samuel George Institute of Engineering and Technology, Markapur, Andhra Pradesh

6, Assistant professor, Dept. of Mechanical Engineering, Dr. Samuel George Institute of Engineering and Technology, Markapur, Andhra Pradesh

ABSTRACT

Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions. Bus chassis is the design and quality of bus chassis depends on the capacity of bus. It can be tailor made according to the needs and can be availed with features like transverse mounted engine, air suspension as well as anti-roll bars. A well manufactured bus chassis offers various benefits like high torque from low revs, superior brake performance and more. Bus chassis designed for urban routes differs from the one manufactured for suburban routes. For bus frameless chassis construction is used. In this frame less chassis type all the components is attached to the body. All the functions of the frame carried out by the body itself. Due to elimination of long frame it is cheaper and due to less weight most economical also. Only Disadvantage is repairing is difficult. This type of frames will affect more in collision of vehicle. The aim of the project is to analyze the frameless chassis with existing material at different load conditions. Presently steel is used for chassis construction. Modeling of the frameless chassis will be done by using modeling software CATIA and structural analysis was performed in ANSYS software to determine deformations and stresses.

1. INTRODUCTION

Every vehicle body consists of two parts; chassis and bodywork or superstructure. The chassis is the framework of any vehicle. Its principal function is to safely carry the maximum load for all designed operating conditions. It must also absorb engine and driveline torque, endure shock loading and accommodate twisting on uneven road surfaces. The chassis receives the reaction forces of the wheels during acceleration and braking and also absorbs aerodynamic wind forces and

road shocks through the suspension. So the chassis should be engineered and built to maximize pay load capability and to provide versatility, durability as well as adequate performance. To achieve a satisfactory performance, the construction of a heavy vehicle chassis is the result of careful design and rigorous testing.

It should be noted that this ‘ladder’ type of frame construction is designed to offer good downward support for the body and payload and at the same time provide tensional flexibility, mainly in the region between the gearbox cross member and the cross member ahead of the rear suspension. This chassis flexing is necessary because a rigid frame is more likely to fail than a flexible one that can ‘weave’ when the vehicle is exposed to arduous conditions. A torsionally flexible frame also has the advantage of decreasing the suspension loading when the vehicle is on uneven surfaces.

2. LITERATURE REVIEW

Dynamic Loading (2025): Focusing on dynamic analysis of an electric vehicle chassis subjected to transient suspension forces, this paper prThis literature review examines studies conducted between 2017 and 2025 that focus on the design, analysis, and application of frameless (monocoque) chassis constructions in buses, particularly emphasizing the use of composite materials to enhance structural performance and impact resistance.

Development and Analysis of Bus with Composite-Material-Reinforced Frames (2022): This study investigates reinforcing a bus frame by coating steel with composite materials. Structural analysis, aligned with ECE R66 regulations, was performed using LS-DYNA simulations, demonstrating that composite reinforcement enhances structural integrity and safety.

Design and Fabrication of Composite Monocoque Chassis for Formula Student Racing Car (2023): Although focused on a racing car, this research provides insightsinto composite monocoque chassis design. It emphasizes identifying critical performance indicators through static modeling, material selection, aerodynamic properties, and performance simulations, offering guidelines applicable to bus chassis design.

Design and Impact Analysis on a Frameless Chassis Construction of Volvo Bus for Different Speeds (2017): This project analyzes a Volvo bus's frameless chassis, comparing traditional steel with composite materials like Carbon Epoxy and E-Glass Epoxy. Impact analyses at various speeds indicate that composites can reduce weight and improve impact resistance.

Conceptual Design and Numerical Validation of a Composite Monocoque Chassis (2018): This research develops a composite monocoque chassis and evaluates its structural integrity through iterative finite element analysis, highlighting the potential of composites in achieving lightweight and robust chassis structures.

3. INTRODUCTION TO CATIA

Welcome to **CATIA** (Computer Aided Three-Dimensional Interactive Application). As a new user of this software package, you will join hands with thousands of users of this high-end CAD/CAM/CAE tool worldwide. If you are already familiar with the previous releases, you can upgrade your designing skills with the tremendous improvement in this latest release.

CATIA V5, developed by Dasssault Systems, France, is a completely re- engineered, Next-generation family of CAD/CAM/CAE software solutions for Product Lifecycle Management. Through its exceptionally easy-to-use and state-of-the-art user interface, CATIA V5 delivers innovative technologies for maximum productivity and creativity, from the inception concept to the final product. CATIA V5 reduces the learning curve, as it allows the flexibility of using feature-based and parametric designs

CATIA V5 provides three basic platforms: P1, P2, and P3. P1 is for small and medium-sized process-oriented companies that wish to grow toward the large scale digitized product definition. P2 is for the advanced design engineering companies that require product, process, and resource modeling. P3 is for the high-end design applications and is basically for Automotive and Aerospace Industry, where high quality surfacing or Class-A surfacing is used. The subject of interpretability offered by CATIA V5 includes receiving legacy data from the other CAD systems and even between its own product data management modules. The real benefit t is that the links remain associative. As a result, any change made to this external data gets notified and the model can be updated quickly.

4. MODELING OF FRAMELESS CHASSIS OF BUS IN CATIA

To create the above mentioned part we need to enter into part module of CATIA by selecting yz-plane we created a line using profile tool as shown in the figure. The required dimensions were assigned using constrained tool

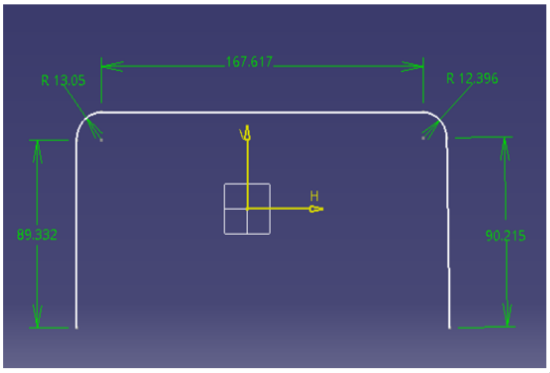

Fig 4.1: 2D view of single frame

Using rectangular pattern option the remaining number of channels was created with required distance between them in y direction.

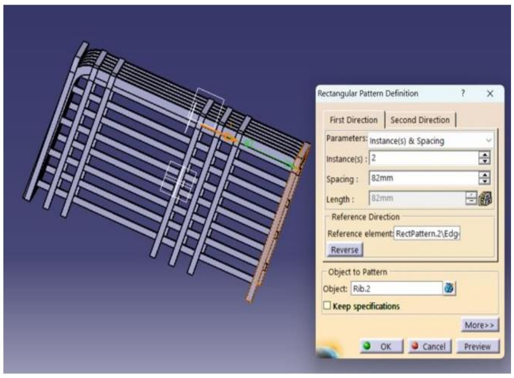

Fig 4.2:3D view of frames arranged in two directions

Chassis was created at the bottom of the frames by selecting yz , plane. The options used to develop chassis are profile , circle , trim ,constrained and pad .The final 3D model of frameless chassis was shown in the following figure.

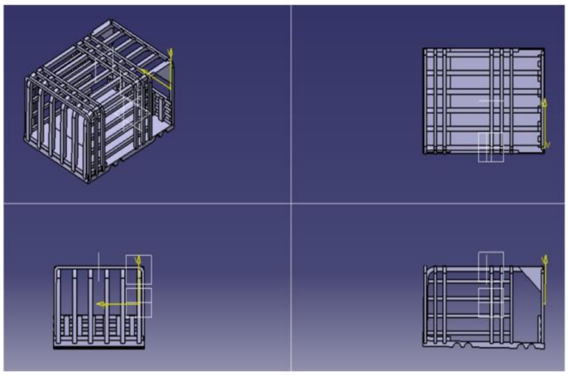

Fig 4.3: Final 3D view of frame less chassis of bus in multi views

5. STRUCTURAL ANALYSIS OF FRAMELESS CHASSIS OF BUS IN ANSYS

5.1 Analysis Procedure in ANSYS

Analysis in ANSYS can be either linear or non-linear. The procedure for any analysis consists of these main steps.

- Pre-Processor Phase(Build the model)
- Solution Phase (Obtain the solution)
- Post-Processor Phase(Review the results)

PRE-PROCESSOR	SOLUTION PROCESSOR	POST-PROCESSOR
Assigning element type	Analysis definition	Read results
Geometry definition	Constant definition	Plot results on graphs
Assigning real constants	Load definition	View animated results
Material definition	Solve	
Mesh generation		
Model display		

Table 5.1 steps involved in Ansys

5.2 Analysis Procedure for Frameless Chassis Of Bus In ANSYS

ExplicitDynamics-SelectGeometry–SelectRightclick–SelectImportgeometry- Select browse - - Select Igs file – Select open. Now we can see the imported model in ANSYS as shown below.

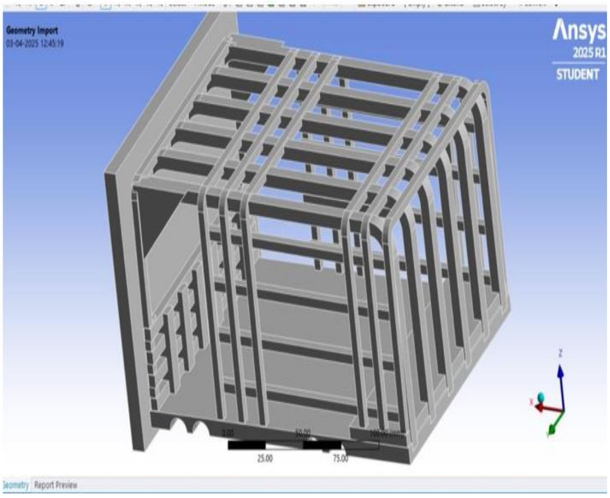

Fig 5.1: Geometry imported into ANSYS

Model - Select model - Select right click - Select edit - Select geometry – Select material data – Select material apply

Property	Steel	Carbon Epoxy Composite	E-Glass Epoxy Composite
Density (kg/m³)	~7850	~1550–1600	~1900–2000
Young's Modulus (GPa)	200–210	130–160 (longitudinal)	70–85 (longitudinal)
Tensile Strength (MPa)	400–550	600–1500	500–1200
Compressive Strength (MPa)	~250–400	500–800	300–500
Flexural Strength (MPa)	~350–500	800–1200	600–1000
Poisson's Ratio	0.27–0.3	0.25–0.3	0.25–0.3
Impact Resistance	Moderate	High	Very High
Corrosion Resistance	Low	Excellent	Excellent
Cost	Low	High	Moderate
Thermal Conductivity (W/m·K)	~50	~5–10	~0.3–1.0

Table 5.2: Material properties data

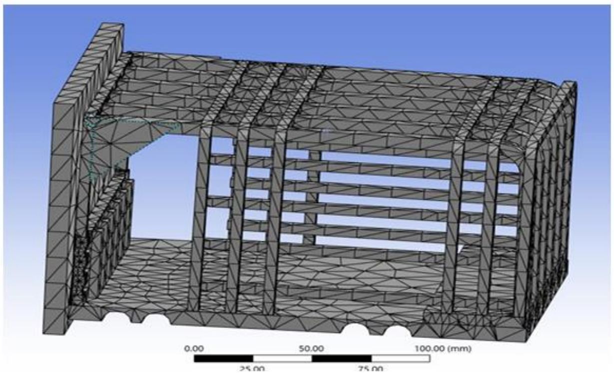

Fig 5.2: Meshed Model of frameless chassis

Fixed support was applied on the bottom of the chassis and static load of 750N, 1500N and 3000N was applied on the model to know the structural behavior.

6. RESULTS

6.1 Structural Analysis Results with 750N Load

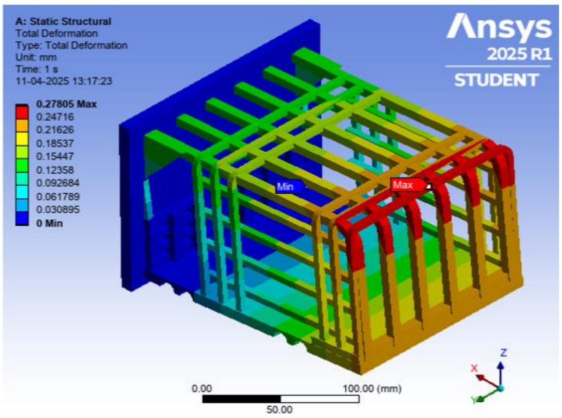

Fig 6.1: Total deformation on the frameless chassis with load 750 N

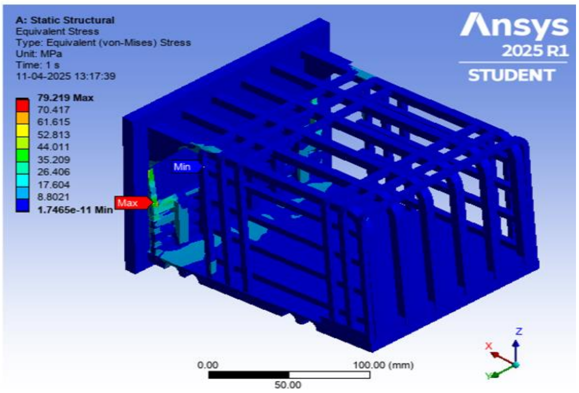

Fig 6.2: Equivalent (Von-Mises) stress on the frameless chassis with load 750 N

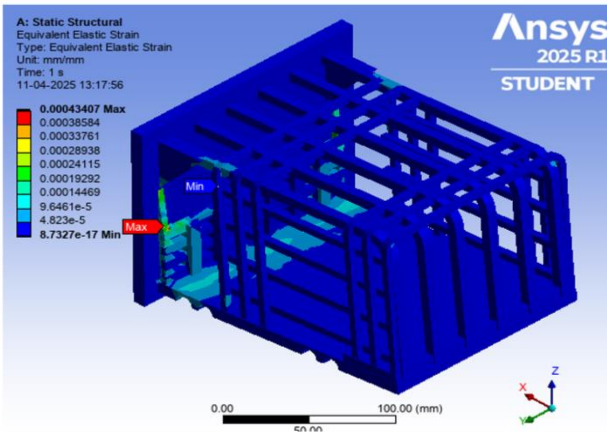

Fig 6.3: Equivalent strain on the frameless chassis with load 750N

6.2 Structural Analysis Results with 1500N Load

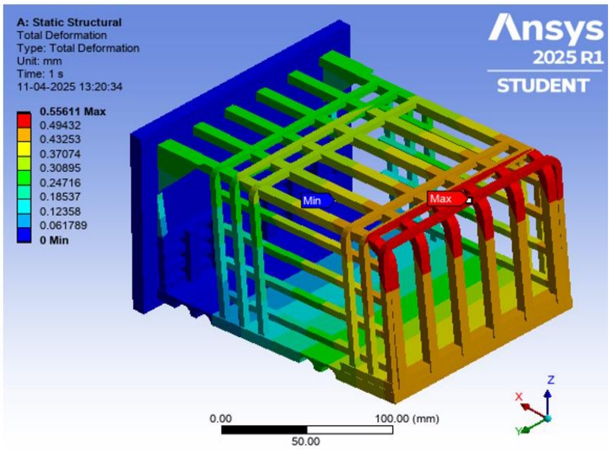

Fig 6.4: Total deformation on the frame less chassis with load1500 N

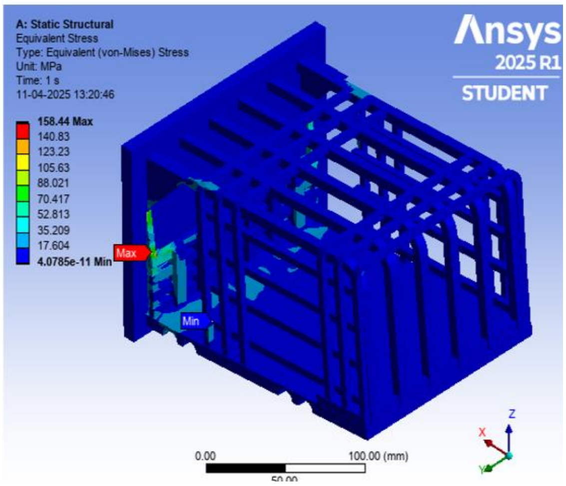

Fig 6.5: Equivalent (Von-Mises) stress on the frameless chassis with load1500N

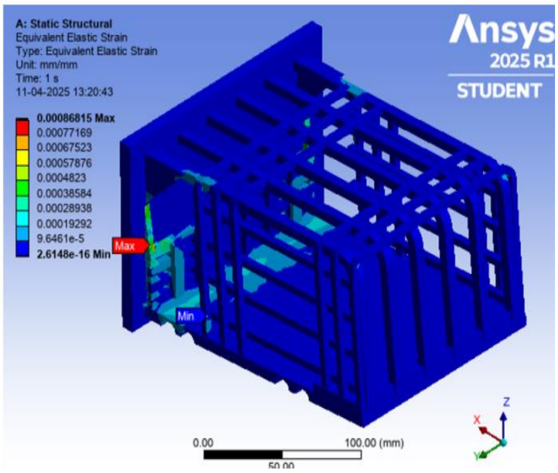

Fig 6.6: Equivalent strain on the frameless chassis with load 1500N

6.3 Structural Analysis Results with 3000N Load

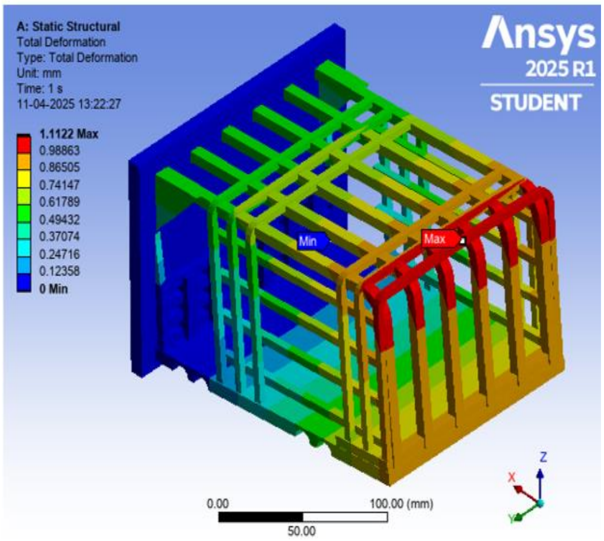

Fig 6.7: Total deformation on the frameless chassis with load 3000 N

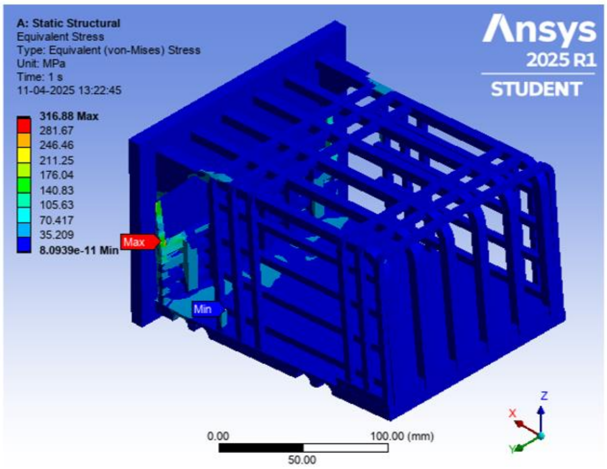

Fig 6.8: Equivalent (Von-Mises) stress on the frameless chassis with load 3000N

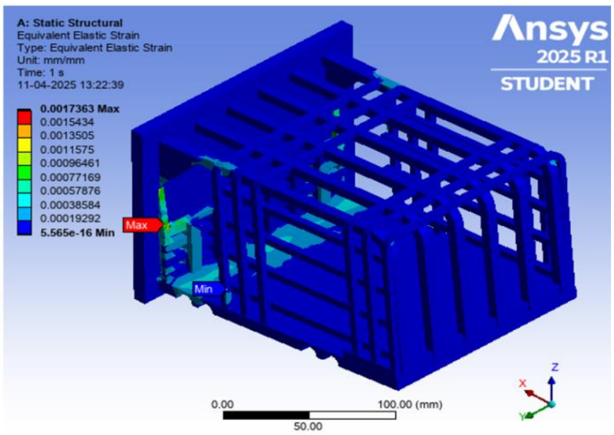

Fig 6.9: Equivalent strain on the frameless chassis with load 3000N

Load (N)	Total deformation (mm)	Equivalent stress (MPa)	Equivalent Strain
750	0.27805	79.219	0.000434
1500	0.55611	158.44	0.000868
3000	1.1122	316.88	0.001736

Table6.1: Comparative results of frameless chassis with different loads

7. CONCLUSIONS

The present work initially focused on importance of chassis in the construction of automobiles. The chassis was classified in different ways based on its construction. This work is focused on frameless chassis used for bus.
The main objective of the project is to make structural analysis on frameless chassis of bus at different loading conditions. The design data for the modeling of frameless chassis was collected and the model was created in CATIA software. By selecting steel as material property the analysis was carried out at 750, 1500 and 3000 N loading conditions.

The total deformations occurred on the frameless chassis of bus at 750N, 1500N and 3000N are 0.278 mm, 0.556 mm and 1.112 mm respectively. The maximum equivalent stress occurred at these loads are 79.219 MPa, 158 MPa and 316.88 MPa. The obtained values are within the safe condition of the material property. Finally it is concluded that the obtained values are under the maximum yield strength of the material and design is safe for the selected conditions.

REFERENCES

1. 1. Kiran, B., & Prasad, M.S. (2018)."Impact analysis of chassis frame using composite materials." Materials Today: Proceedings, Elsevier.
2. 2. Singh, A., & Verma, R. (2019). "Finite element analysis of composite chassis under impactloading."InternationalJournalofEngineeringResearch&Technology (IJERT).
3. 3. Mehta, H., et.al. (2020)."Crash worthiness of composite automotive structures: A review." International Journal of Vehicle Structures & Systems.
4. 4. Ramesh,M.,et al.(2021)."Evaluation of natural and synthetic hybrid composite materials for automotive chassis." Composite Structures, Elsevier.
5. 5. Jain, R., & Arora, S.(2022)."Design and optimization of electric bus chassis using hybrid composites." SAE Technical Paper.
6. Thomas, J., et al. (2023)."Finite Element Simulation of Impact Response in Bus Chassis." International Journal of Mechanical and Production Engineering.
7. Alam,S.&Roy,A.(2024). "Dynamic response of composite bus chassis under crash loads." Journal of Reinforced Plastics and Composites.
8. Choudhary,N.,etal.(2025)."ComparativeStudyofSteelandCompositeFrameless Chassis using FEA." International

Journal of Vehicle Engineering &Research.

9. Rajput ,R. K.*A* TextbookofAutomobileEngineering. Laxmi Publications, 2007.
10. SadhuSingh.StrengthofMaterials.KhannaPublishers, 2014.