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Material Optimization and Analysis on a frameless chassis construction of Volvo bus

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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.

In this project we are reducing the impact by changing the existing design materials. Data is collected from the Body construction work shape in Vijayawada. Presently steel is used for chassis construction. The aim of the project is to analyze the frameless chassis with presently used material steel and replacing with composite materials like Carbon Epoxy, E- Glass epoxy. Impact analysis is conducted on chassis for different speeds by varying the materials. We are conducting above analysis for the existing design and for the modified design. Best of the result we will consider for the chassis design. Also we are going to reduce weight of the chassis by using composite materials replacing with steel.

1. Introduction

Bus manufacturing had its earliest origins in carriage building. Other bus manufacturers had their origins in truck manufacturing. Historically, bus chassis were shared between truck designs, but in later years specific bus chassis have been developed, and the midi bus saw the introduction of a lighter weight bus chassis than normal trucks. Bus manufacture historically developed as chassis and body builds.

Often, large bus operators or authorities would maintain separate stocks of bus bodies, and would routinely refurbish buses in a central works, and refurbished chassis might receive a different body. One of the first integral type bus designs combining the body and chassis was the Route master.
In the 1980s, many minibuses were built by applying bus bodies to van chassis, so called 'van derived' buses. Many of these have been replaced by purpose built designs, although for smaller Minibuses this is still an option. In several parts of the world, the bus is still a basic chassis, front-engine bonneted vehicle; however, where manufacturers have sought to maximize the seating capacity within legal size constraints, the trend is towards rear- and mid-engine designs.
In the 1990s, bus manufacture underwent major change with the push toward low-floor designs, for improved accessibility. Some smaller designs achieved this by moving the door behind the front wheels. On most larger buses, it was achieved with various independent front suspension arrangements, and kneeling technology, to allow an unobstructed path into the door and between the front wheel arches. Accordingly, these 'extreme front entrance' designs cannot feature a front mounted engine or mid-engine layout, and all use a rear-engine arrangement. Some designs also incorporate extendable ramps for wheelchair access.

Figure.1. Volvo bus body.

The bus body builder will build the body onto the chassis. This will involve major consideration of:
- Usage
- Seating capacity
- Staircase position/design (double decker buses)
- Number and position of doors

Bodywork is built for three general uses:
- Bus
- Dual Purpose
- Coach

Bus bodywork is usually geared to short trips, with many transit bus features. Coach bodywork is for longer distance trips, with luggage racks and under-floor lockers. Other facilities may include toilets and televisions.

A dual purpose design is usually a bus body with upgraded coach style seating, for longer distance travel. Some exclusive coach body designs can also be available to a basic dual purpose fitment.

In past double-deck designs, buses were built to a low bridge design, due to overall height restrictions.

2. Introduction to PRO/ENGINEER

Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

Customer requirements may change and time pressures may continue to mount, but your product design needs remain the same - regardless of your project's scope, you need the powerful, easy-to-use, affordable solution that Pro/ENGINEER provides.

3. Model in PRO/ENGINEER

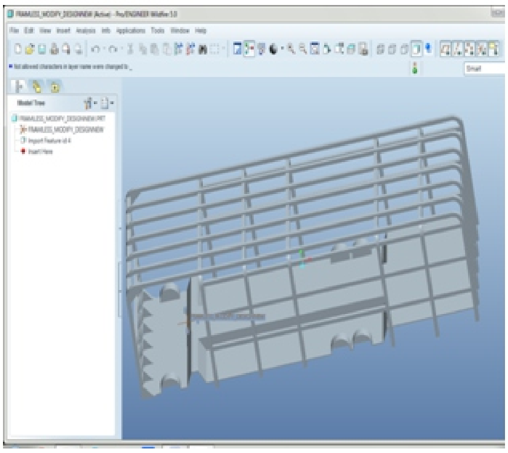

Figure.2. Frameless chasis in PRO/E.

4.Introductin to COSMOS Works

Cosmos works is useful software for design analysis in mechanical engineering. That's an introduction for you who would like to learn more about COSMOS Works. COSMOS Works is a design analysis automation application fully integrated with Solid Works.

This software uses the Finite Element Method (FEM) to simulate the working conditions of your designs and predict their behavior. FEM requires the solution of large systems of equations. Powered by fast solvers, COSMOS Works makes it possible for designers to quickly check the integrity of their designs and search for the optimum solution.

A product development cycle typically includes the following steps:

1Build your model in the Solid Works CAD system.

2Prototype the design.

3Test the prototype in the field.

4Evaluate the results of the field tests.

5Modify the design based on the field test results.
Analysis Steps: You complete a study by performing the following steps:

- Create a study defining its analysis type and options.

- If needed, define parameters of your study.

Parameters could be a model dimension, a material property, a force value, or any other entity that you want to investigate its impact on the design.

Analysis Background: Linear Static Analysis Frequency Analysis Linearized Buckling Analysis Thermal Analysis Optimization Studies, Material property, Material Models, Linear Elastic Isotropic.
Plotting Results - Describes how to generate a result plot and result tools.
Listing Results - Overview of the results that can be listed.
Graphing Results - Shows you how to graph results.
Results of Structural Studies - Lists results available from structural studies.
Results of Thermal Studies - Lists results available from thermal studies.
Reports - Explains the study report utility.
Stress Check - Lists the basics of checking stress results and different criteria used in the checking.

5. Impact analysis in COSMOS Steel (45 kmph)

5. A. Imported model

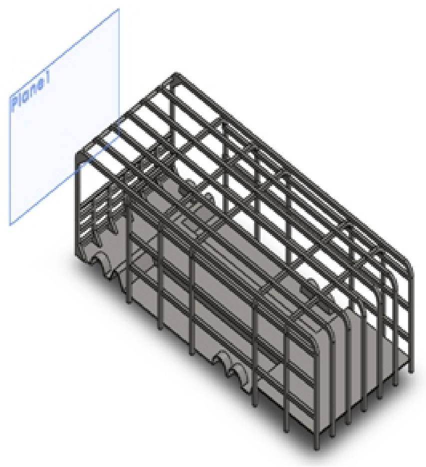

Figure. 3. Imported model from PRO/E.

5. B.Meshed model

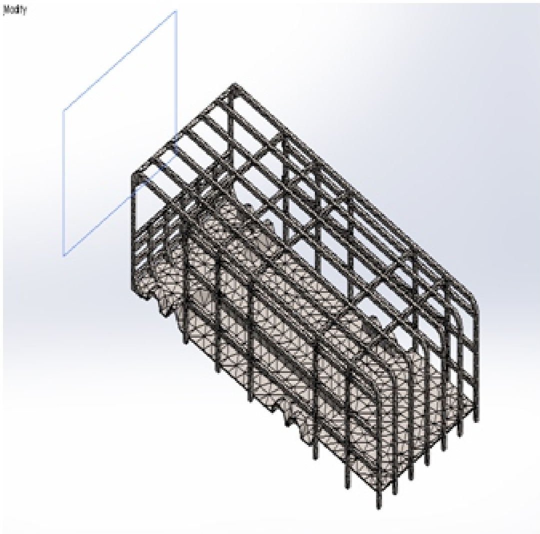

Figure. 4. Meshed model in COSMOS.

5. C.Stress = 1544.4 N/mm2 (MPa)

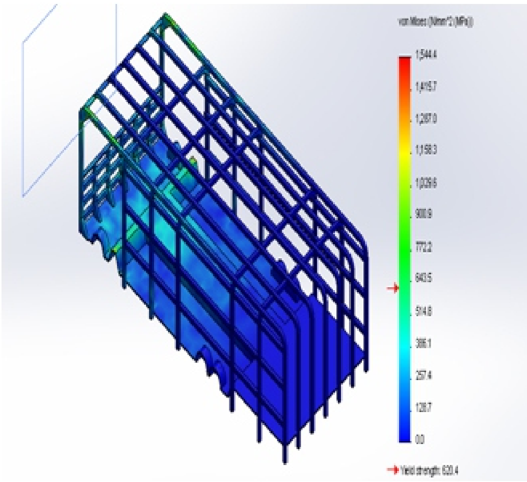

Figure. 5. Stress result in COSMOS.

5. D.Displacement = 12.2619 mm

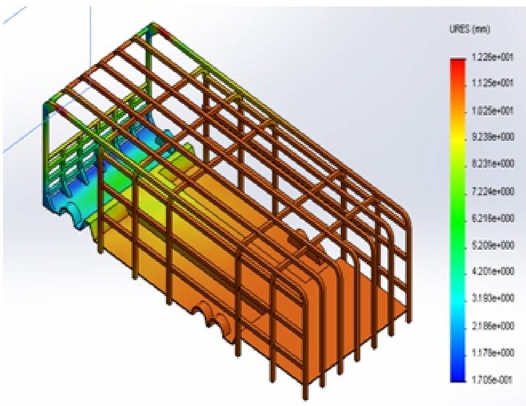

Figure. 5. Displacement result in COSMOS.

5. E. Strain = 0.00374276

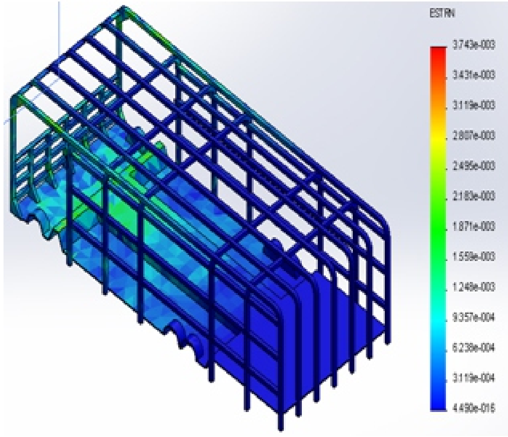

Figure. 6. Strain result in COSMOS.

6. Material Properties

6. A. Steel

Young's Modulus(MPa)	210000
Poisson's ratio	0.313
Density (g/cc)	7.7

Table.1.Material properties of Steel.

6. B. E-Glass Epoxy

Young's Modulus(MPa)	72400
Poisson's ratio	0.21
Density (g/cc)	2.62

Table.2.Material properties of E-Glass Epoxy.

6. C. S-Glass Epoxy

Young's Modulus(MPa)	86900
Poisson's ratio	0.23
Density (g/cc)	2.48

Table.3.Material properties of S-Glass Epoxy.

7. Results

Speed in kmph	Stress in N/mm^2	Displacement in mm	Strain
40	1320.69	9.13851	0.003441
60	1972.25	13.5533	0.005180
80	2598.41	18.0696	0.006938
100	3350.66	22.5851	0.008723

Figure.7. Results of steel for different speeds.

Material: S-Glass Epoxy

Speed in kmph	Stress in N/mm^2	Displacement in mm	Strain
40	546.02	9.07363	0.003034
60	816.14	13.5633	0.004483
80	1099.77	18.0873	0.006053
100	1372.14	22.6123	0.007474

Figure.8. Results of S-Glass Epoxy for different speeds.

Material: E-Glass Epoxy

Speed in kmph	Stress in N/mm^2	Displacement in mm	Strain
40	456.613	9.1107	0.003318
60	681.361	13.5625	0.004941
80	896.353	18.0794	0.007754
100	1516.380	22.5979	0.009416

Figure.9. Results of E-Glass Epoxy for different speeds.

8. Conclusion

Impact analysis is done on the frameless chassis construction for different speed of 40km/hr, 60km/hr, 80km/hr & 100km/hr. The analysis done on the frameless chassis for different materials steel, S-Glass epoxy & E –Glass epoxy. Present used materials for construction of frameless chassis are steel. We are replacing with S-Glass epoxy and E-Glass epoxy by observing the impact analysis results the stress values of the E-Glass epoxy is better than S-Glass epoxy and steel so it can conclude that using material E-Glass epoxy material is better. In future this material can be used for construction of frame less chassis of a bus body. By using epoxies we can reduce the weight of the frameless chassis of a Volvo bus.

9. References

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