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Design and Impact Analysis on a Frameless Chassis Construction of Volvo Bus for Different Speeds

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Abstract: In this project we are reducing the impact by modifying the existing design. Data is collected from the Body construction work shop in Hyderabad. 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 Software used for modeling CREO and for analysis COSMOS.

Key words: CREO parametric software, solid works, composite materials, speeds.

I. INTRODUCTION

The chassis forms the main structure of the modern automobile. A large number of designs in pressed-steel frame form a skeleton on which the engine, wheels, axle assemblies, transmission, steering mechanism, brakes, and suspension members are mounted. During the manufacturing process the body is flexibly bolted to the chassis.

This combination of the body and frame performs a variety of functions. It absorbs the reactions from the movements of the engine and axle, receives the reaction forces of the wheels in acceleration and braking, absorbs aerodynamic wind forces and road shocks through the suspension, and absorbs the major energy of impact in the event of an accident.

There has been a gradual shift in modern small car designs. There has been a trend toward combining the chassis frame and the body into a single structural element. In this grouping, the steel body shell is reinforced with braces that make it rigid enough to resist the forces that are applied to it. To achieve better noise-isolation characteristics, separate frames are used for other cars. The presence of heavier-gauge steel components in modern separate frame designs also tends to limit intrusion in accidents.**INTRODUCTION OF CHASSIS FRAME**: Chassis is a French term and was initially used to denote the frame parts or Basic Structure of the vehicle. It is the back bone of the vehicle. A vehicle without body is called Chassis. The components of the vehicle like Power plant, Transmission System, Axles, Wheels and Tyres, Suspension, Controlling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame. It is the main mounting for all the components including the body. So it is also called as Carrying Unit.

LAYOUT OF CHASSIS AND ITS MAIN COMPONENTS: The following main components of the Chassis are

1. Frame: it is made up of long two members called side members riveted together with the help of number of cross members.

2. Engine or Power plant: It provides the source of power

3. Clutch: It connects and disconnects the power from the engine fly wheel to the transmission system.

4. Gear Box

5. U Joint

6. Propeller Shaft

7. Differential

FUNCTIONS OF THE CHASSIS FRAME:

1. To carry load of the passengers or goods carried in the body.

2. To support the load of the body, engine, gear box etc.,

3. To withstand the forces caused due to the sudden braking or acceleration

4. To withstand the stresses caused due to the bad road condition.

5. To withstand centrifugal force while cornering

TYPES OF CHASSIS FRAMES:

There are three types of frames

1. Conventional frame

2. Integral frame

3. Semi-integral frame

BUS STRUCTURE

Only in the first years of bus body design, a flexible truck chassis was used together with non- structural body elements of wood and canvas resulting in the true chassis design as a contrary to the integral body design. Today, even if a channel beam chassis is used together with properly designed floor cross members, side wall and roof structure, a fully' integral structure is achieved.

Advantages of a channel beam bus chassis are simplicity of design, fully equipped drive able vehicle, heavy duty suspension and sturdy load introduction members. The bus body as a whole is a light weight, stiff structure, however significant distortion of the overall stiffness occurs at the doors and other large openings Shear deformation at the doors is up to 10 times greater than for comparable sidewall sections. Most of the bus bodies on the European continent are fully welded tubular steel structures having similar stiffness properties. However, there are differences in the local design of welded joints with respect to dimensions, shape and application of additional stiffeners. Therefore different fatigue life performance is achieved.

TYPES OF AUTOMOBILE CHASSIS

Motorcycle Chassis:

An important type of automotive chassis, motorcycle chassis comprise of different auto parts and components like auto frame, wheels, two wheeler brakes and suspension. Its basically the frame for motorbikes that holds these components together. A motorbike chassis can be manufactured from different materials. But the commonly used materials are steel, aluminum, or magnesium.

Car Chassis:

The main structure of a car is known as chassis. Car chassis functions as a support for the different car parts. Automotive parts like engine, suspension & steering mechanism, braking system, auto wheels, axle assemblies and transmission are mounted on the car chassis.

Bus Chassis:

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.

II. LITERATURE REVIEW

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

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.

III. INTRODUCTION TO CAD

Computer-aided design (**CAD**) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term **CADD** (for Computer Aided Design and Drafting) is also used.

Its use in designing electronic systems is known as electronic design automation, or **EDA**. In mechanical design it is known as mechanical design automation (**MDA**) or **computer-aided drafting** (**CAD**), which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

INTRODUCTION TO CREO

PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule-based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself.

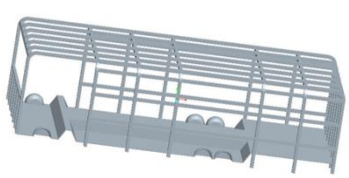
The name was changed in 2010 from Pro/ENGINEER Wildfire to CREO. It was announced by the company who developed it, Parametric Technology Company (PTC), during the launch of its suite of design products that includes applications such as assembly modeling, 2D orthographic views for technical drawing, finite element analysis and more.

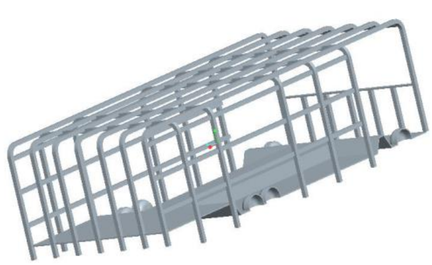
Introduction to solidworks : Solidworks is a 3d mechanical cad (computer-aided design) program that runs on microsoft windows and is being developed by dassault systèmes solidworks corp., a subsidiary of dassault systèmes, s. A. (vélizy, france). Solidworks is currently used by over 1.3 million engineers and designers at more than 130,000 companies worldwide. Fy2009 revenue for solidworks, was 366 million dollars. Solidworks is a parasolid-based solid modeler, and utilizes a parametric feature-based approach to create models and assemblies. Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allows them to capture design intent. Design intent is how the creator of the part wants it to respond to changes and updates. For example, you would want the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can. Solidworks allows you to specify that the hole is a feature on the top surface, and will then honor your design intent no matter what the height you later gave to the can.

Features refer to the building blocks of the part. They are the shapes and operations that construct the part. Shape-based features typically begin with a 2d or 3d sketch of shapes such as bosses, holes, slots, etc. This shape is then extruded or cut to add or remove material from the part. Operation-based features are not sketch-based, and include features such as fillets, chamfers, shells, applying draft to the faces of a part, etc.

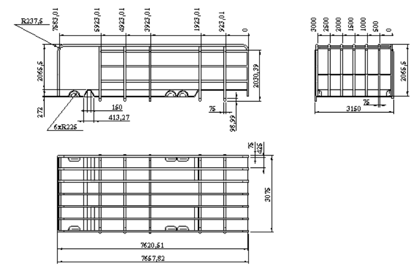
IV RESULTS AND DISCUSSION

PRESENT MODEL

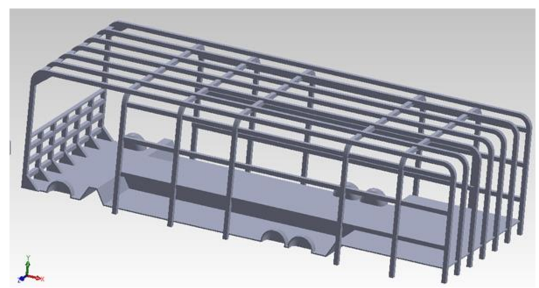


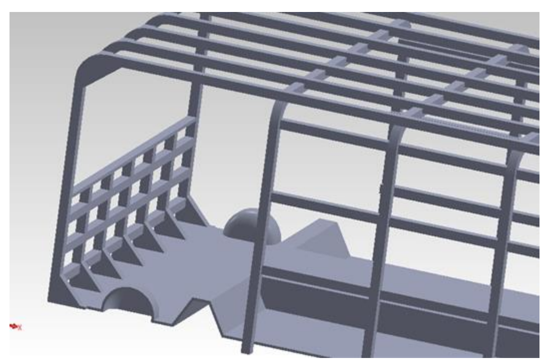


2D DRAWING

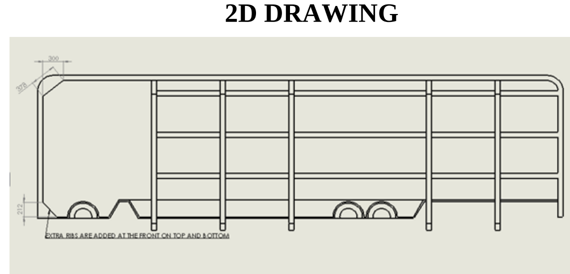


MODIFIED MODEL





2D DRAWING



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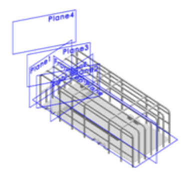
IMPACT ANALYSIS OF FRAME LESS CHASSIS PRESENT DESIG SPEED – 75km/hr ALLOY STEEL



Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	
Imported1	Solid Body	Mass:4977.26 lb Volume:86106.4 in^3 Density:0.2781 lb/in^3 Weight:4973.89 lbf	

Study Properties

Study name	impact_75_STEEL
Analysis type	Drop Test
Mesh type	Solid Mesh
Large displacement	On
Result folder	SolidWorks document (

6.3.3 Setup Information

Type	Velocity at impact
Velocity Magnitude	20.83 m/sec
Impact Velocity Reference	Plane1
Gravity	9.81 m/s^2
Gravity Reference	Top Plane
Parallel to reference plane	Right Plane
Friction Coefficient	0
Target Stiffness	Rigid target

6.3.4 Result Options

Solution Time After Impact	20 microsec
Save Results Starting From	0 microsec
No. of Plots	25
No. of Graph Steps Per Plot	20
Number of vertex	0

Units

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Material Properties

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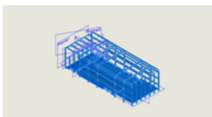
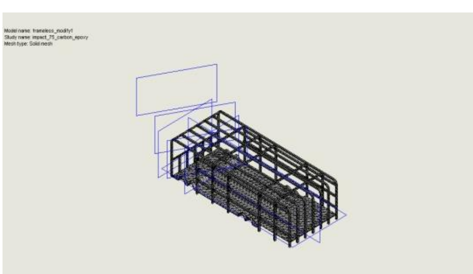
Model Reference	Properties
	Name: **Alloy Steel** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **6.20422e+008 N/m^2** Tensile strength: **7.23826e+008 N/m^2** Elastic modulus: **2.1e+011 N/m^2** Poisson's ratio: **0.28** Mass density: **7700 kg/m^3** Shear modulus: **7.9e+010 N/m^2** Thermal expansion coefficient: **1.3e-005 /Kelvin**

MESH INFORMATION

Mesh type	Solid Mesh
Mesher Used:	Curvature based mesh
Jacobian points	4 Points
Maximum element size	0 mm
Minimum element size	0 mm
Mesh Quality	High

Mesh Information - Details

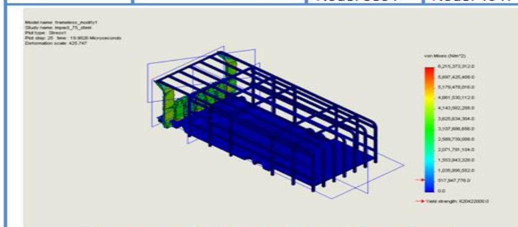
Total Nodes	29770
Total Elements	34921
Maximum Aspect Ratio	27.204
% of elements with Aspect Ratio < 3	28.1
% of elements with Aspect Ratio > 10	9.88
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:34
Computer name:	W



Study Results

STRESS

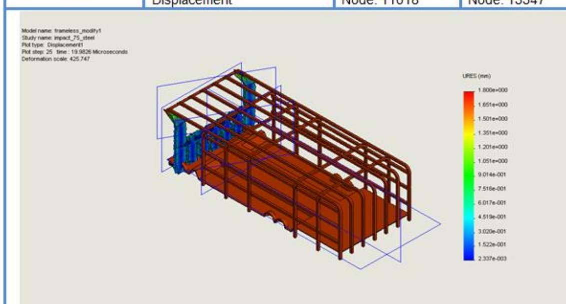
Name	Type	Min	Max
Stress1	VON: von Mises Stress	4.76583e-008 N/m^2 Node: 5891	6.21537e+009 N/m^2 Node: 4047



frameless_modify1-impact_75_steel-Stress-Stress1

DEFORMATION

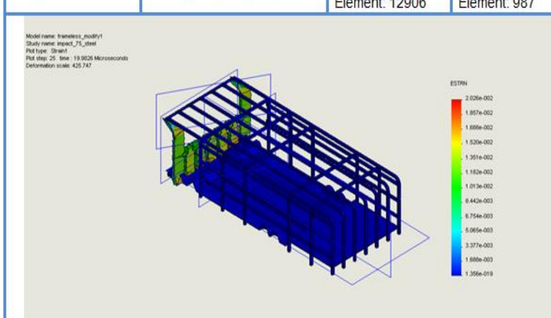
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.00233694 mm Node: 11018	1.80046 mm Node: 15547



frameless_modify1-impact_75_steel-Displacement-Displacement1

STRAIN

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0 Element: 12906	0.0202619 Element: 987



frameless_modify1-impact_75_steel-Strain-Strain1

CARBON EPOXY

STUDY RESULT

STRESS

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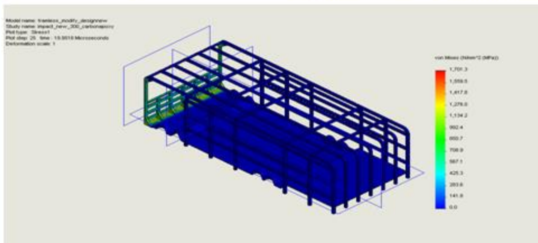
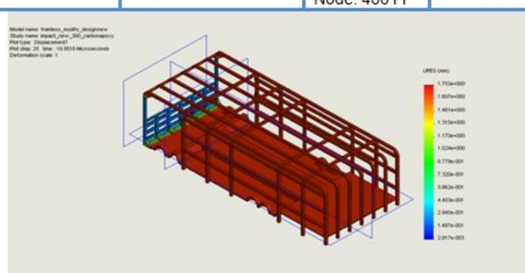
Name	Type	Min	Max
Stress1	VON: von Mises Stress	1.29944e-014 N/mm^2 (MPa) Node: 26138	1701.3 N/mm^2 (MPa) Node: 40145



framless_modify_designnew-impact_new_300_carbonapoxy-Stress-Stress1

DEFORMATION

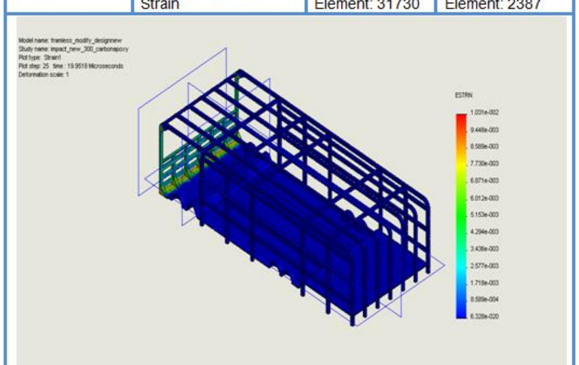
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.00281669 mm Node: 40011	1.75293 mm Node: 3735



framless_modify_designnew-impact_new_300_carbonapoxy-Displacement-Displacement1

STRAIN

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0 Element: 31730	0.0103067 Element: 2387



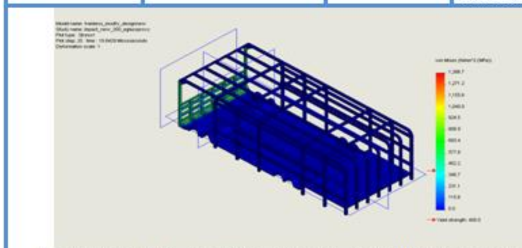
framless_modify_designnew-impact_new_300_carbonapoxy-Strain-Strain1

GLASS EPOXY

STUDY RESULT

STRESS

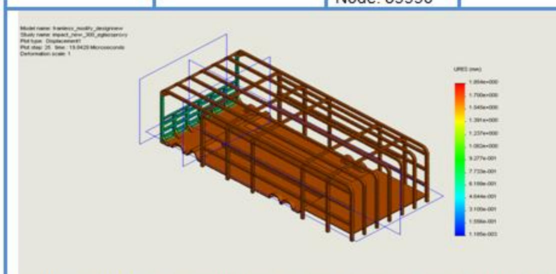
Name	Type	Min	Max
Stress1	VON: von Mises Stress	3.53276e-015 N/mm^2 (MPa) Node: 47402	1386.71 N/mm^2 (MPa) Node: 68188



framless_modify_designnew-impact_new_300_eglassproxy-Stress-Stress1

DEFORMATION

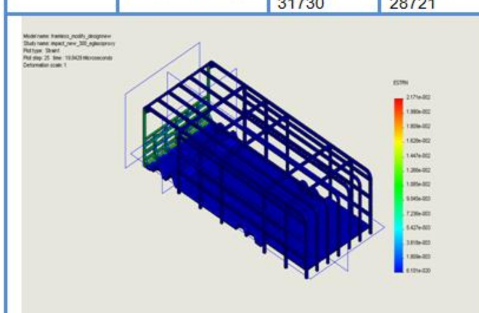
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.00118548 mm Node: 39990	1.85419 mm Node: 1230



framless_modify_designnew-impact_new_300_eglassproxy-Displacement-Displacement1

STRAIN

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0 Element: 31730	0.0217082 Element: 28721



framless_modify_designnew-impact_new_300_eglassproxy-Strain-Strain1

RESULTS

PRESENT MODEL

	ALLOY STEEL			CARBON EPOXY			E – GLASS EPOXY		
	STRESS N/mm^2	DISP mm	STRAIN	STRESS N/mm^2	DISPLACEMENT mm	STRAIN	STRESS N/mm^2	DISPLACEMENT mm	STRAIN
75 Km/hr	6210	1.80046	0.020261	678	0.459936	0.00279	361.913	0.44251	0.00543
150 Km/hr	3251.74	0.950993	0.010666	1357.07	0.920092	0.00560	725.164	0.885161	0.01087
300 Km/hr	6214.61	1.80024	0.020259	2710	1.84126	0.01123	1455.94	1.77189	0.02182
WEIGHT (Kg)	10864			2257.65			2822		

MODIFIED MODEL

	ALLOY STEEL			CARBON EPOXY			E – GLASS EPOXY		
	STRESS N/mm^2	DISP mm	STRAIN	STRESS N/mm^2	DISP mm	STRAIN	STRESS N/mm^2	DISP mm	STRAIN
75 Km/hr	1359.51	0.462389	0.00482	426.164	0.437768	0.002574	347.026	0.463127	0.0054199
150 Km/hr	2720.15	0.925276	0.00965	851.737	0.875923	0.005151	693.928	0.926536	0.0108466
300 Km/hr	5440.78	1.85143	0.01933	1701.3	1.75293	0.010306	1386.71	1.85419	0.0217082S

CONCLUSION

In our project we have designed a frameless chassis used in a Volvo bus collecting data from Body construction work shop in Vijayawada. Present used material for frameless chassis is Steel. We are replacing the steel with composite materials Carbon Epoxy and E – Glass Epoxy. By replacing with composites, the weight of the frameless chassis is reduced by almost 4 times. Impact analysis is done on the chassis at different speeds 75km/hr, 150 km/hr and 300 km/hr. By observing the results, the displacement and stress values are less for E – Glass epoxy than Steel and Carbon Epoxy. We have also modified the design of frameless chassis by adding ribs at the top and bottom at the front side of the chassis. By observing the impact analysis on modified design the displacement and stress values are reduced than the present design. So we can conclude that E – Glass epoxy is better material for frameless chassis and by modifying the design some advantages can be found (i.e) decrease of stress and displacement values.

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1. **Material Optimization and Analysis on a frameless chassis construction of Volvo bus** Mr. K. Eswararao M. Tech-MACHINE DESIGN pursuing Student, SISTAM College of Engineering, Srikakulam, Mr. S. Chandrasekhar Reddy Associate Professor & HOD, SISTAM College of Engineering, Srikakulam,
2. Impact analysis on a frame less chassis construction of mini bus for variable loads mr. A.naresh, assistant professor in the department of mechanical engineering, guru nanak institutions and technical campus (gnitc) , ibrahimpatnam, r. R. Dist ,hyderabad,telangana, india mr. E. Naveen kumar, application engineer , mech engg, amberpet, hyderabad , telangana, india.
3. Design and analysis of a bus body side frame 1 sreenath s, 2k kamalakkannan 1m.tech, 2associate professor department of automobile engineering hindustan university, chennai
4. **Stabilization of city bus chassis to reduce tilt effect using ansys work bench** Murari Nagendra Babu1, S N S Maruthi Vijay2, Vinjamuri Venkata Kamesh3.
5. Computer Aided Bus Skeleton Design (BUS-CAD) H. M. A. Hussein and Alexander Harrich
6. TRIZ method for light weight bus body structure design S. Butdee a,*, F. Vignat b a Department of Production Engineering, Faculty of Engineering, Thai-French Innovation Center (TFIC) & Integrated Manufacturing System Research Center, King Mongkut's University of Technology, North Bangkok, Thailand