DESIGN AND STRUCTURAL ANALYSIS OF BUS CHASSIS

PremKumar.D[1], Dr.V.Balaji[2],Naresh Kumar.S[3], Sheik Mohammad Tameem[4] & Venkatesh.P.D[5]
[1]Assistant Professor,[2]Associate Professor
Department of Mechanical Engineering, Prathyusha Engineering College, Thiruvallur.

Abstract: Conventional Design of bus chassis have more weight and due the heavy weight of the bus body components.The load carrying capacity and the performance characteristics of the bus is highly reduced. This paper deals with the improvisation of the convectional design, by altering the thickness properties of the frame as well as reducing the weight of the chassis by providing suitable material. In order to analyze the vehicle under its loading conditions, the working boundary constrains are utilized. A complete feature based chassis model of the vehicle has been designed and assembled as per the regulations using CATIA V5 Software. The analysis part has been carried out using ANSYS Software.

Index Terms- Chassis, Finite element Analysis, Structure, Ladder Frame, Static structural analysis, Side Member, Cross Member.

1. INTRODUCTION

The necessary condition to obtain complete safety of a vehicle is by balancing it during its motion and simultaneously capable to withstand loads and stresses induced during accidents. Another phenomenon to be considered is the weight of the vehicle, as the fuel consumption of the vehicle majorly depends upon its weight. The bus body comprises of some important components namely, the left side structure, the right side structure, the top structure, the floor, rear and front portion and finally the Frame which supports all the above mentioned components. This paper is ultimately focused to reduce the weight of the vehicle and thereby improve the performance of the vehicle. The cross sections that are majorly used in making the bus body frames are the tubular sections (Square and rectangular). The materials which were utilized earlier for these frames were GI tubular sections.. The behavior of the Chassis under static loading condition is analyzed. The shear stress acting on the frame has also been evaluated.

1.1. Chassis

Fig-1: Pictorial view of Chassis

Chassis is a French term and it is now utilized to denote the frame or the structure of the vehicle. The chassis consists of an internal vehicle frame that supports an artificial object in its construction and use. The automotive chassis is tasked with holding all the components together while driving and transferring the vertical and lateral loads, caused by the acceleration, on the chassis through the suspension as well as the wheels.

2. Design of Bus Chassis

2.1. Design Parameters

The design parameters were selected from reference papers and OEM's. Some modifications are carried out by varying the thickness and geometrical dimensions. All these dimensions are made with respect to the bus body regulations by Automotive Industry Standards AIS052. The existing convectional frame is modified by increasing the thickness of the sections used and also evaluating the model using three materials namely ASTM A216 Steel, Annealed 4130 Cr-Mo and ASTM A602 Grade M8501, thus reducing the material usage and also the weight of the vehicle. The material Composition of all the three materials are represented in the Table-2

Table-1 Specification of materials

Property	ASTM A216 Steel	Annealed 4130 Cr-Mo	ASTM A602 Grade M8501
Modulus of Elasticity (GPa)	190	190	180
Poisson's Ratio	0.29	0.28	0.29
Tensile Yield Strength(MPa)	310	460	590
Tensile Ultimate Strength(MPa)	570	560	720
Mass Density(g/cm^3)	7.85	7.80	7.6

2.2. Design of Chassis Frame using CATIA

The geometric model of the bus chassis (Ladder Frame) is done using CATIA Software. The Three Dimensional model of the Ladder Frame is shown in Fig. 2.

Fig-2: CATIA Model of Bus Chassis

The side members are made from 260 x 176 x 6 mm C- Section while the cross members are made from 200 x 220 x 10 mm I- Section.

Table-3 Force acting on the Chassis

S. No	Location	Load (Kg)	Load (N)
1	Front	355	3483
2	Centre	1790	17560
3	Rear	445	4366

3. Analysis of Bus Chassis

After the creation of the model using the design software, the geometric model is converted into STEP format in order to avoid data losses occurring due to importation of the geometric design file. There are three main steps involved in the analysis software, namely: pre-processing, solution and post processing. In the pre-processing stage, the geometric domain of the model is imported along with its material properties and boundary constraints. Further the geometric is meshed in several nodes and elements for accurate evaluation of the problem.

3.1. Finite Element Analysis of Bus Chassis using ANSYS Workbench

The model of the chassis is saved in STEP format which is imported into ANSYS Workbench. The imported model is shown in Fig-4.

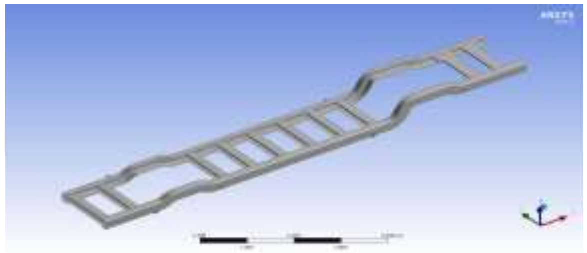

Fig-3 Imported model in ANSYS Workbench

3.2. Meshing and Boundary Conditions

The model is meshed initially with 41568 nodes and 21122 tetrahedral elements. The meshed model is represented in the Fig-5. The bus chassis is provided with necessary working loading which is considered to be uniformly distributed throughout the chassis. The maximum weight of the structure carried by the chassis is considered to be 1700 kg and the passengers sum up to a load of 4000 kg. The finite element model of the chassis provided with necessary boundary constraints are shown in the Fig 6 and 7respectively.

Fig-4 Meshed model of Chassis

Fig-5 Load applied on chassis

3.3.Static Structural Analysis of Bus Chassis

The Finite element static structural analysis of bus chassis model is experimented using three different materials – ASTM A216 Steel, Annealed 4130 Cr-Mo, and ASTM A602 Grade M8501. The contour plots of all the three materials comprising the Von Mises stress distribution, Deformation and Normal Stress are shown in Fig-8 to Fig 16.On comparison of these images the results of the paper is identified.

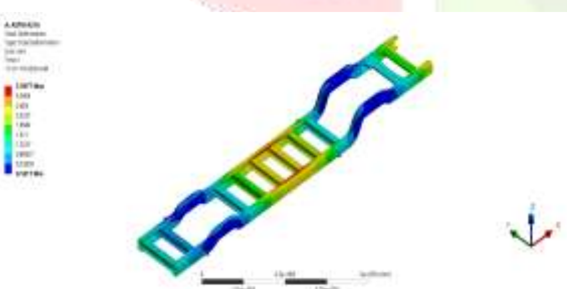

Fig-6 Total Deformation of ASTM A216 Steel

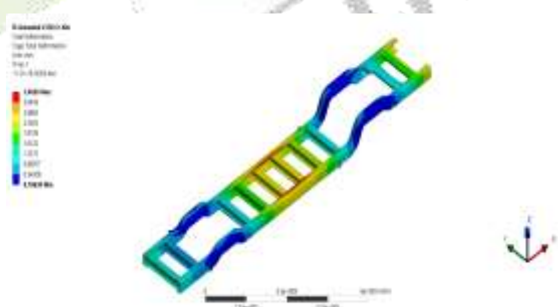

Fig-7 Total Deformation of Annealed 4130 Cr-Mo

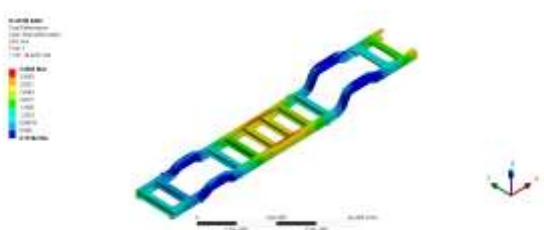

Fig-8 Total Deformation of ASTM A602 Steel

4. Results

The problem given is a complex structure, the theoretical method cannot be used to determine the most accurate values and hence FEA results are taken into consideration. By using ANSYS, the problem is evaluated and the results obtained are tabulated in the Table-4.

Table-4 Results

Material	ASTM A216 Steel	Annealed 4130 Cr-Mo	ASTM A602 Grade 8501
Von Mises Stress (MPa)	123.01	123.08	123
Deformation(mm)	3.3977	3.4036	3.5865
Max. Stress Intensity (MPa)	139.36	154.31	136.55
Max. Shear Stress (MPa)	23.8	24.086	23.8
Equivalent Strain (mm/mm)	0.001125	0.001133	0.001188

5. Conclusion

This paper focuses on improving the strength of bus chassis. After the analysis of the Bus chassis, it is found that the Equivalent Stress value is Highest for Annealed 4130 Cr-Mo and Lowest for ASTM A602 Grade 8501 and the deformation is highest for ASTM A602 Grade 8051 and lowest for ASTM A216 steel. All the three materials have the working stress value less than their Tensile Yield Strength and hence the design is safe for all the three materials.

6. References

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