Modeling and Design Analysis of Automotive Chassis frame for the effect of various stresses Distribution

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Abstract

For a heavy vehicle, the chassis frame is a strong member responsible for carrying the utmost lead in a safe manner when considering all the designed working situations. This paper elaborates on the static structural examination concerning the heavy duty truck chassis frame to determine the response of a truck chassis under the influence of three different load considerations such as bending, torsion and combined bending and torsion load cases acting on the horizontal C-Channel. In this paper, the dimensions of a heavy vehicle chassis of a FAW dump truck vehicle is obtained from Bishoftu Automobile Industry to model and examine an heavy vehicle chassis and the conventional materials are substituted with composite materials made up of carbon-epoxy couple with E-glass epoxy with same geometry under similar pressure or load with a steel chassis. The software employed in this work is the CATIA V5 R19 to model and the ANSYS 14.5 for the finite element analysis. The result shows that composite materials mainly carbon epoxy have high load carrying capacity and higher factor of safety than to e-glass epoxy and mild steel, and the weight of the chassis is reduced by 4.8 times for carbon epoxy and 3 times for glass epoxy. Generally using composite materials for chassis frame is safe. Material substitution is the best way to reduce weight of the vehicle so as to reduce fuel consumption and atmospheric emission which is the global issue.

Keywords**:** Chassis, composite materials, stress, deformation

1. Introduction

Basically chassis is taken into consideration as a framework to assist the body, engine and other components which make up the automobile. Chassis lends the entire car aid and pressure. Chassis generally consists of a pair of longitudinally extending channels and more than one transverse go contributors that intersect the channels. The transverse members have a discounted cross phase that allows you to allow for a longitudinally extending storage area. The chassis has to include the diverse additives.

1.1 Terminology

The endorse of vehicle chassis is to keep the shape of the automobile and to support the various masses carried out to it. The structure commonly debts for a massive proportion of the development and production cost in new car programmer and lots of distinctive structural principles are available to the designer. It is essential that the satisfactory one is chosen to make sure appropriate structural performance within other layout constraints together with price, extent and method of production, product utility and plenty of more. Assessments of the overall performance of a automobile structure are related to its power and stiffness. A design goal is to reap sufficient stage.

1.2 Strength

The power requirement means that no part of the shape will lose its feature whilst it is subjected to avenue loads. Loss of characteristic can be because of instant overloads due to intense load cases, or by cloth fatigue. Instantaneous failure can be caused by both overstressing of additives beyond the elastic restrict, or by using buckling of gadgets in compression or shear strain, or by failure of the joints. The existence to initiation of fatigue cracks is fairly dependent on layout element, and might only be assessed while a detailed information of the element is to be had. For this purpose assessment of fatigue electricity is commonly deferred till after the conceptual layout stage. The energy may be as a substitute described as the most force which the structure can face up to. Different load cases extraordinary nearby aspect hundreds, however the shape needs to have sufficient strength for all load cases.

1.3 Stiffness

The stiffness of the structure relates the deflection produced when load is applied. It applies only to structures in the elastic range and is the slope of the load versus deflection graph. The stiffness of a vehicle structure has important influence on its handling and vibrational behavior. It is important to ensure that deflection due to extreme loads is not so large to impair the function of the vehicle, for an example so that the doors will not close, or suspension geometry is altered. Low stiffness are lead to unacceptable The two cases apply completely different local loads to individual components within the vehicle. It is usually found that the torsion case is the most difficult to

design for, so that the torsion stiffness is often used as a benchmark to indicate the effectiveness of the vehicle structure.

2. Vibration behavior

The global vibration characteristics of a vehicle are related to both its stiffness and mass distribution. The frequencies of the global bending and torsional vibration modes are commonly used as benchmarks for vehicle structural performance.

2.1 Selection of vehicle type and concept

In order to achieve a satisfactory structure, the following must be selected

a) The most appropriate structural type for the intended application.

b) The correct layout of structural elements to ensure satisfactory load paths, without discontinuities, through the vehicle structure.

c) Appropriate sizing of panels and sections, and good detail design of joints.

An assumption made in this book is that is satisfactory load path (i.e. if the equilibrium of edge forces between simple structural surfaces) are achieved, then the vehicle is likely to have the foundation for sufficient structural (and especially torsion) stiffness. Estimate of interface loads between major body components calculated by the simplified methods described are assumed to be sufficiently accurate for conceptual design although the structural members comprising load paths must still be sized appropriately for satisfactory results. Early estimates of stiffness can be obtained using the finite element method, but the results should be treated with caution because of simplifications in the idealization of the structure at this stage.

3. Literature Review

Many researchers completed take a look at on truck chassis as follows:

Patel et al [1] have investigated and optimized a chassis design for Weight discount of TATA 2516TC chassis body using Pro-Mechanic. Thy first discover the meeting weight, most strain, strain and displacement for the prevailing segment of chassis by using the usage of ANSYS Software after then they changed the dimensions of current C-sections and once more discover all and concluded that the present "C" sections is better than all of the sections with admire to the Stress, Displacement, Strain and Shear stress besides the burden. For the burden attention modified "C" phase has less weight than the all sections which are studying on this paper. Finally By the usage of changed "C" phase, 105.50 Kg (eleven %) weight is saved in step with chassis assembly and in identical way price will also be decreased approximately eleven%. From the consequences, modified "C" sections are used as an optimized phase.

Murali et al [2] have investigated the crucial point which has the very best stress using Finite Element Method (FEM). This essential factor is one of the elements that may motive the fatigue failure. For the changes and analysis, the present truck chassis were introduced with stiffeners. Initially the thickness of the model, where the most deflection takes place in bending analysis became expanded to positive value with suited restriction. And one more pass beam was introduced at the center of the wheel base to feature stiffness to the version. Series of modifications and tests have been conducted through adding the stiffener which will fortify and stepped forward the chassis stiffness as well as the general chassis performances.

S. Prabakaran and K. Gunasekar [3] have research the Structural Analysis of EICHER E2 (or 11.10) Chassis Frame for the existing C-phase. They first discover the meeting weight, maximum shear pressure, maximum equal strain and displacement for the prevailing C-section of chassis by using SOLID WORKS and ANSYS Software and then they modified the present C-section taking 3 exclusive cases and discover the parameters for all cases. They have investigated that the load, maximum shear stress, maximum equal pressure and displacement for the 0.33 case are reduced respectively 6.Sixty eight%, 12.14 %, 8.Fifty five % and 11.20 %. So they concluded that by the use of FEM software program we can optimize the burden of the chassis body and it's miles viable to research modified chassis body earlier than production.

4. Methodology

Methodology can well discuss with the theoretical analysis of the strategies appropriate to the sector of take a look at or to the frame of methods and additionally principles particular to the department of information. In this experience, one may additionally talk of objections to the technique of a geographic survey (that is, objections dealing with the appropriateness of the methods used) or of the method of cutting-edge cognitive psychology (the concepts and practices that underlie studies in the subject). Ladder body more inflexible to different chassis type, that is the reason race automobile typically use ladder body chassis. The chassis now not really only a ladder chassis. As the end result, driver and engine compartment, the aggregate reduces the load of the auto.Theoretically, the chassis layout concept kingdom that the chassis designed must have the triangulated format of hole pipes with the intention to growth the torsional stress of the chassis. But for the designing of the prototype automobile the use of ladder chassis for car, it is not crucial to follow this idea due to the fact the goals

of the design is to have a lightweight automobile that could cruise further via using much less quantity of strength. It's mean that, the auto will now not cross quicker and no longer going through the twisting force or torque. The dressmaker will ignore approximately the precept which is to region the body members in a triangulated layout as stated earlier than.

5. The Design Process

The engineering design manner is the stairs of chassis design production procedure. In this chapter explain how chassis was designed and the way stimulation of the chassis become carried out. In this element, defined how chassis is executed. Before the final chassis design were given, there are several steps need to be taken into consideration to make the closing end result deliver the quality layout. In this component, begin from the sketching manner, the n use AUTOCAD INVENTOR VER 2016 is used which will create the version of the chassis. The analysis degree used ANSYS 14.0 to research the, version of chassis.

5.1 Conceptual Design

By the use of previous sketches in Figure as a guideline, the conceptual chassis layout may be the usage of AutoCAD Inventor veers 2016. In this step, the exceptional dimensions want to make the layout to be draw symmetry and feature good judgment idea. Shown in Figure 3.1. Consist pass form be am underneath the motive force compartment to guide weight of driving force and the chassis designed with tow beams at left and right aspect.

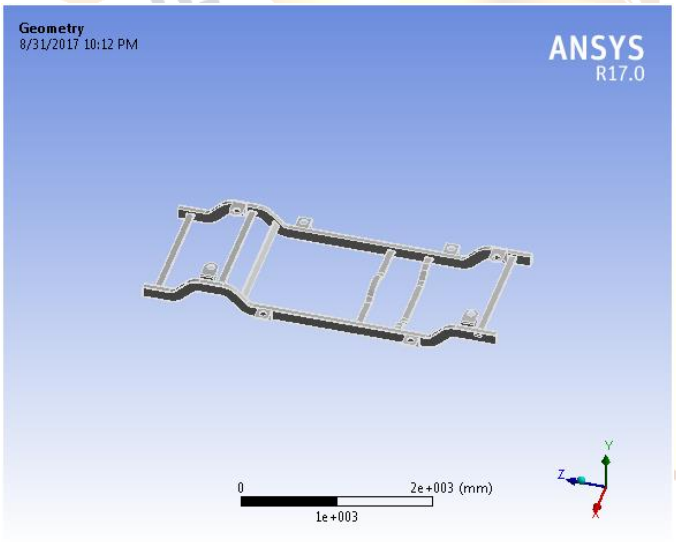

Fig. 1: Conceptual design of Chassis

6. Modeling & Simulation

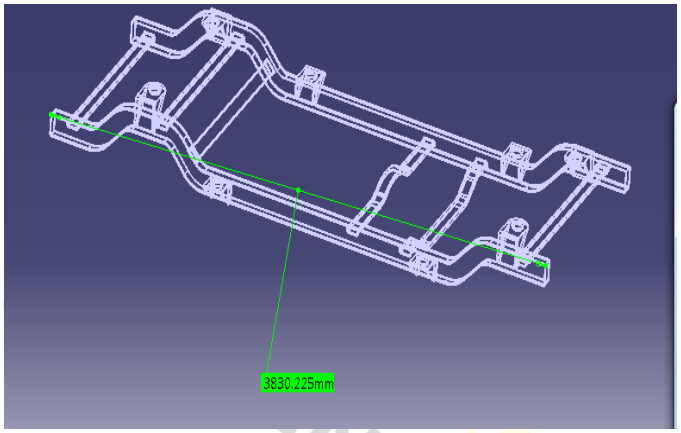

Fig. 2: Modeling & Simulation

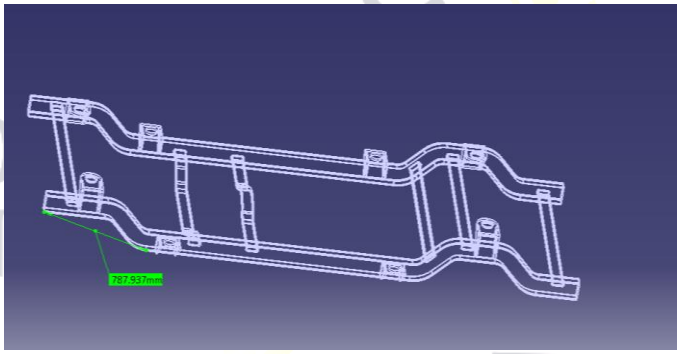

Fig. 3: BY ANYSIS

6.1 Geometry

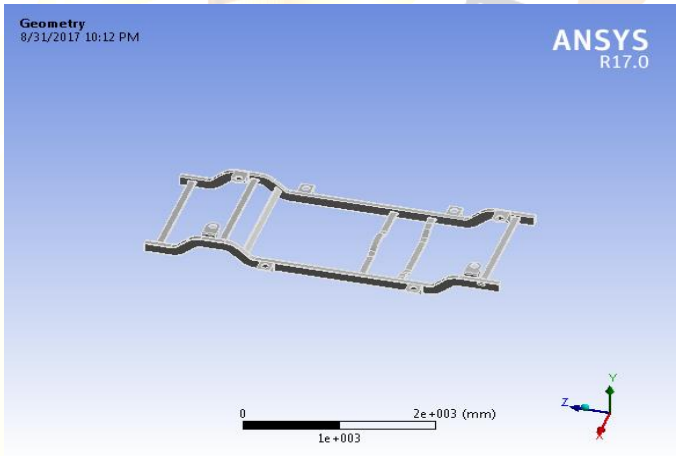

Fig. 4: BY ANYSIS

6.2 Meshing

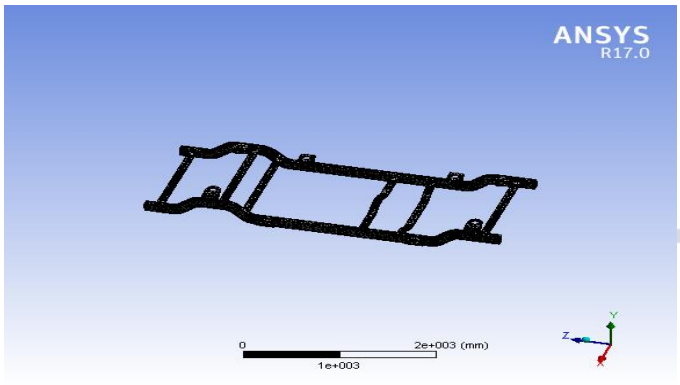

Fig. 5: BY ANYSIS

7 Result & Discussion

In our observe we are reduced weight of different substances like that Epoxy E Glass 162 kg, aluminum Alloy 202 kg and Structural Steel 270 kg. In exiting design we become used metal substances and aluminum materials chassis body however now we're the usage of composite substances Epoxy E Glass then we are lowering 40% weight loss with assessment metal shape substances chassis body and while we are able to be as compared with composite materials Epoxy E Glass weight reduction with aluminum alloy fabric then we are reduced weight 25% But composite cloth value is better than Steel and aluminum materials and We can say that once we will be used composite materials then it's far greater long lasting and vehicle performance may be stepped forward. So that is our goal of research paintings.

The most deformations prompted in EPOXY S GLASS UD Glasses 10.97mm, Hence primarily based on rigidity the layout is secure however if we examine deformations induced in Structural Steel , aluminum, EPOXYCARBON UD, EPOXY E GLASS UD Glass, EPOXY S GLASS UD Glass 0.Forty five mm,1.29 mm, 10.96 mm, 9.38mm and 10.97 mm.If we compare corresponding deformations in structure steel (S 460) it's miles zero.45mm which has much less deformation. The equivalent pressure induced for 5 substances is sort of identical i.E. Structural Steel , Aluminium, EPOXYCARBON UD, EPOXY E GLASS UD Glass, EPOXY S GLASS, sixty nine.5Mpa, sixty eight.07Mpa, 68.Sixty six Mpa, seventy three.2 Mpa and 77.23 Mpa that's much less than the allowable strain (460Mpa).Hence the design is secure based on strength. On optimization it's far clear that , EPOXY E GLASS UD Glass composite material suggests exact consequences as compared to different five substances and its mild weight material compare to 5 materials consequently its cloth is usually recommended for manufacturing to stated enterprise.

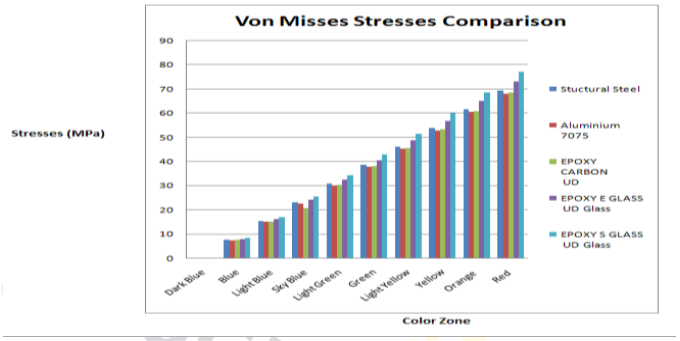

Fig. 6: Comparison of Vonmisses Stress Charts

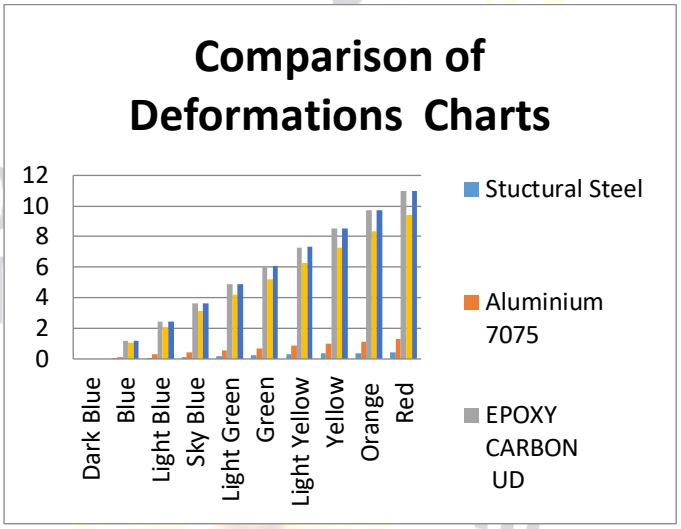

Fig.7: Deformation Comparison

Conclusion

Stress analysis using finite detail technique became efficaciously achieved to decide excessive stress price, maximum deflection and its place on a low loader chassis structure. The corresponding technical drawing and records of the low loader chassis acquired became utilized to develop the finite detail model. The effects of analysis discovered that the place maximum deflection and most stress consents nicely with theoretical maximum vicinity of easy beam under uniform loading distribution. This study discovered out that there's discrepancy among the theoretical (2-D) and numerical (three-D FEA) results. Therefore further analysis can be achieved to enhance the present day FE version. Apart from that, destiny examine will consist of experimental research to determine real deflection of a comparable beam. Structural evaluation to optimize the wide variety of Box-beams that result in weight and fee discount could be pronounced imminently.

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