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A Review on "Finite Element Analysis of Chassis using ANSYS"

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Abstract

At present review paper an effort is made to study the previous investigations that have been made on the different analysis techniques of automobile frames. That analysis may be fatigue analysis, static analysis or dynamic analysis. A number of analytical and experimental techniques are available for the analysis of the automobile frames. Determination of the different analysis around different condition through the various methods lie FEA, in an automobile frames has been reported in literature.

Keywords: FEA; ANSYS, Chasis.

1. Introduction

In reading tests of and articles about new cars in newspapers and magazines and on The Auto Channel, we have seen much attention paid to increased chassis rigidity in new vehicles. We on the writing-about-it side certainly hear much on the subject, at press conferences and new car introductions and in the informational material given to us by the auto manufacturers. "The all-new 1998 Bloxfire GT is 75% more rigid than the 1997 model" is a typical sort of statement. "Whatever does that mean and is it important?"

It certainly is important. The chassis of a car (or truck, or any other sort of wheeled vehicle) is the most important structural part. The more rigid it is, the better chance that all of the wheels will point in the desired direction. This is a Good thing for control, safety, and comfort.

Consider control, primarily steering response and cornering ability. If the vehicle's frame flexes too much, the wheels, and therefore the vehicle itself, will move in directions other than the one which the driver intended. Not a Good Thing.

This movement doesn't have to be large to be noticeable. The need for constant steering corrections while driving may be due to frame flex (among many other possible causes.) This can be tiring at best (a definite safety factor), and can make a car's cornering abilities less than optimum - another very negative safety factor. In the "good olde days" when automobile frames were less rigid than today, sports cars often had very stiff suspensions. This reduced unwanted wheel movement. It also reduced comfort, and, seemingly paradoxically, sometimes reduced handling abilities as well. No paradox, really. The tires must be in contact with the ground in order to transmit acceleration, braking, or cornering forces. A too-stiff suspension will have wheels rebounding into the air, where the tires do nothing.

Another noticeable effect of flex is noise. As different parts of a vehicle move with respect to each other, noise results. With time, things loosen and get even more annoying noisy. Squeaks and rattles are the most noticeable effects, but constant flex or vibration can break things, too. Not good, for cosmetic, comfort, or possibly (depending on what breaks) safety reasons.

So the modern, more rigid car is quieter, more comfortable, handles better, and is safer than its flaxy forebear. The automobile as we know it is barely over 100 years old, and depends on quite a few other technologies as well. There has been a certain amount of mechanical natural selection over the past century, with plenty of evolutionary dead ends and side tracks along the way. Many modern materials, construction techniques, and auxiliary technologies used in automobile manufacture today are considerably newer than that century, too. Karl Benz and Henry Ford didn't have the fruits of modern metallurgy, heavy-duty machine tools, space-age composite materials, or computers. They barely had electricity. Industry pioneers adapted horse-drawn wagon and bicycle technology to the automobile, but the automobile is a different sort of machine than either of those. It took time to learn, and they're still learning.

Chassis Frame: Chassis is a French term and was initially usedto denote the frame parts or Basic Structure of the vehicle. It is the back bone of the vehicle. A vehicle with-out 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.

The following main components of the Chassis are

1. Frame: it is made up of long two members called side membersriveted 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 flywheel to the transmission system.

4. Gear Box

5. U Joint

6. Propeller Shaft

7. Differential

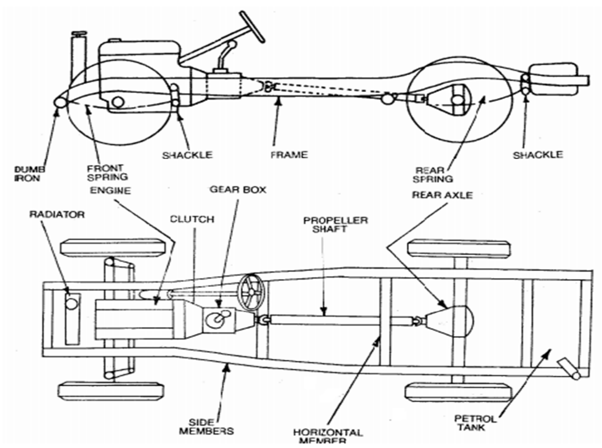

Fig 1.1 a general Layout of Chassis and its main Components

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

1. Conventional frame: It has two long side members and 5 to 6 cross members joined together with the help of rivets and bolts. The frame sections are used generally.

a. Channel Section - Good resistance to bending

b. Tabular Section - Good resistance to Torsion

c. Box Section - Good resistance to both bending and Torsion

2. Integral Frame:

This frame is used now a day in most of the cars. There isno frame and all the assembly units are 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.

3. Semi - Integral Frame:

In somevehicles half frame is fixed in the front endon which engine gear box and front suspension is mounted. It has the advantage when the vehicle is met with accident the front frame can betaken easily to replace the damaged chassis frame. This type of frame is used in FIAT cars and some of the European and American cars.

Various loads acting on the frame:

Various loads acting on the frame are

1. Short duration Load - While crossing a broken patch.

2. Momentary duration Load - While taking a curve.
3. Impact Loads - Due to the collision of the vehicle.
4. Inertia Load - While applying brakes.
5. Static Loads - Loads due to chassis parts.
6. Over Loads - Beyond Design capacity.

Fatigue, static & Dynamic Analysis

Fatigue damage concepts:

Stress-Life Diagram (S-N Diagram): The basis of the Stress-Life method is the Wohler S-N diagram, shown schematically for two materials in Figure 2.The S-N diagram plots nominal stress amplitude S versus cycles toFailure N. There are numerous testing procedures to generate the required data for a proper S-N diagram. S-N testdata are usually displayed on a log-log plot, with the actual S-N line representing the mean of the data from several tests.

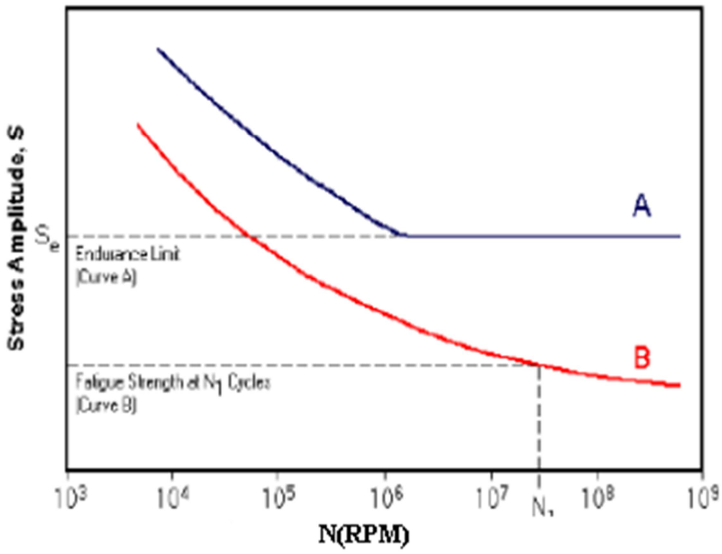

Fig 2 S-N Curve

Review on previous investigations

CicekKaraoglu and ***N.SefaKuralay*** did the finite element analysis of a truck chassis. The analysis showed thatincreasing the side member thickness can reduce stresses on the joint areas, but it is important to realize that the overall weight of the chassis frame increases. Using local plates only in the joint area can also increase side member thickness. Therefore, excessive weight of the chassis frame is prevented.

In November 2008 ***MohamadTarmizi Bin Arbain*** Mechanical Engineering department Universiti Malaysia Pahang he use 3D model for finite element analysis issues regarding the experimental analysis of car chassis is addressed. The modeling approach is investigated extensively using both of computational and compared it to experimental modal analysis.

A comparison of the modal parameters from both experiment and simulation shows the validity of the proposed approach. Then perform the computational stress analysis with linear material type analysis to find the stress concentration point in thecar chassis.

Karaoglu and ***Kuralay*** investigated stress analysis of a truck chassis with riveted joints using Fem. Numerical results showed that stresses on the side member can be reduced by increasing the side member thickness locally. ***Fermer et al***investigated the fatigue life of Volvo S80 Bi-Fuel using MSC/Fatigue Conle and Chu did research about fatigue analysis andthe local stress –strain approach in complex vehicular structures. Structural optimization of automotive components applied to durability problems has been investigated by Ferreira et al

FilhoEt. al. have investigated and optimized a chassis design for an off road vehicle with the appropriate dynamic and structural behavior.In1837, Wilhelm Albert publishes the first article on fatigue.

***Manpreetsinghbajwa* et.al.(2013)** reported onthe effect of static load and give an analysis (excluding damping and inertia effects) of the chassis of TATA super ace using ANSYSworkbench and itsverification using solid mechanics. The chassis of TATA super ace is of ladder frame type which has two side members or longitudinal members of C- cross section and five transverse members called as cross members of box cross section. The chassishas been modelled in CATIA V5R18 using the most of the actual dimensions. FEM analysis was done using ANSYS 14 workbench. Dimensions used for analysis

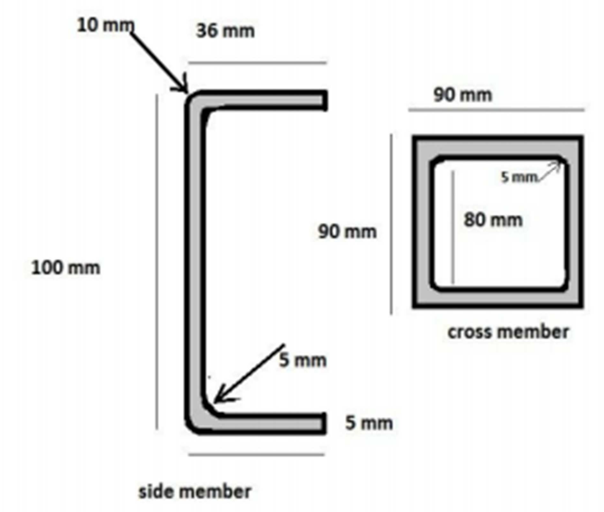

Fig 3 Dimensions of chassis using by *Manpreetsinghbajwa* et.al.(2013)

Finally the design, static analysis and its verificationusing solid mechanics has been successfully accomplished. The work not only provides an insight into the design and analysis of the chassis but alsopinpoints the critically stressed points where the design can be modified for improving the chassis.

Swami K.I. et.al.(2014) related his work to perform towards the static structural analysis of the truck chassis. Structural systems like the chassis can be easily analyzed using the finite element techniques. Thus proper finite element model of the chassis has been developed. The chassis is modeled in ANSYS. Analysis is done using thesame software.

SanikaOturkaret. al.(2013)to give an introduction to this staticstress analysis method using ANSYS APDL 12.0, covering topics such as impact force determination, loading points, convergence of nodes, and the mesh size dependence of generated stress.The analysis highlights the areas of high stress concentration, which need a change in design. This preliminary analysis consumes little time and approves of a reasonable design, which can form the basis for a detailed

Modeled.

Andrew Salzano et.al.(2009)focused on the design, analysis, and fabrication of a steel tube space frame chassis for use in Formula SAE. A guideline for the construction of this frame will be based upon the Wolfpack Motorsports 2009 car (WMF09).

Dr.R.Rajappan et.al.(2013)focused onstatic and dynamic load characteristics of chassis which are analysed using FE models from this work. It is found that some location of high stress area, analyzing vibration, natural frequency and mode shape by using finite element method. Modal updating of truck chassis model will be done by adjusting the selective properties such as mass density and Poisson's ratio. Predicted natural frequency and mode shape has been validated against previously published result. Finally, the modifications of the updated FE truck chassis model has been proposed to reduce the vibration, improve the strength, and optimize the weight of the truck chassis.

4. Conclusion

In this paper an effort is made to review the previousinvestigations that have been made on the analysis of variousautomobile frames structure. An attempt has been made in the present article to give an overview of various techniques developed for the analysis of automobile frames and results of that analysis due to which further study on the chassis will become easy. An information of assessment of a suspension arm, vehiclesuspension components, analysis of truck chassis, for the fatigue analysis of a truck chassis with riveted joints are considered.

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