THEORITICAL COMPARISON OF LIGHT COMMERCIAL VEHICLE FRAMES

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ABSTRACT

The purpose of this project is to determination of the best frame by comparing characteristics, merits and demerits among the two frames. The values of frame properties will calculate by using theoretical calculations. By found values of properties such as moment of inertia, section modulus, bending stress, yield stress and safety factor, to determine, which frame is to be selected as a best frame among these two frames. Then margin of safety factor (FOS) is to be assumed and check whether the value of safety factor is satisfy for finding sustain condition of frame. By considering and comparing the overall values of properties, the best frame was selected.

I. INTRODUCTION

Vehicle is a machine used to transport people and cargo. Since from the development of vehicle in 1700's the need for vehicle increased day by day. Vehicle stability is one of the important areas of concern for safe design and to ensure passenger safety. This is achieved through the application of various inbuilt and standalone units such as suspension system, frame, engine system .etc.

Chassis:

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. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. Tie bars, that are essential parts of automotive frames, are fasteners that bind different auto parts together.Automotive chassis is considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. More precisely, automotive chassis or automobile chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc are bolted. At the time of manufacturing, the body of a vehicle is flexibly moulded according to the structure of chassis. Automobile chassis is usually made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis or automobile chassis helps keep an automobile rigid, stiff and unbending. Auto chassis ensures low levels of noise, vibrations and harshness throughout the automobile.

Frame:

A frame is the main structure of the chassis of a motor vehicle. All other components fasten to it; a term for this is design

Is body-on-frame construction. In 1920, every motor vehicle other than a few cars based on motorcycles had a frame. Since then, nearly all cars have shifted to unit-body construction, while nearly all trucks and buses still use frames.

The below diagram is a structural example of a simple frame.

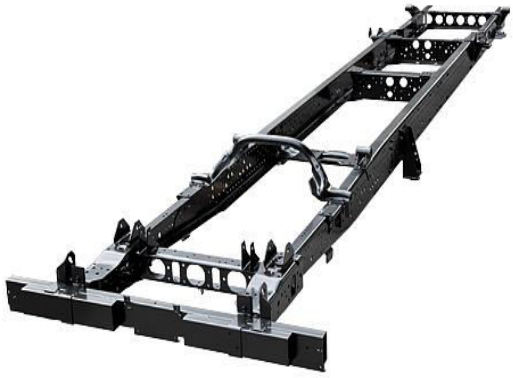


Fig .1 Frame structure

II.DATA COLLECTION

Data collection is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes.

Measurement of Frame Dimensions:

The required dimensions of the frames such as length, width, thickness and starting and ending points of bends are measured by using the instruments are rolling tap, vernier calliper and ruler. It includes the process of measuring dimensions of long member and cross members.

Measurement of Distance:

It concerned to measure the displacement of the various loads acting on the frame. The distances are measured from the front edge of the frame. And the measurement of displacements from placement of wheel locations.

III.CALCULATIONS

In this stage, the following steps are used to determine the sustain condition of the frame.

STEP – 1: Vehicle Input

Frame is a skeletal part of a vehicle which holds together all the other components. Each and every component mounted on the frame will induce a stress in it. To start with the design process, a knowledge on various mounting parts is necessary in order to calculate the stress induced by each of the components. The load and positioning of the load of various mounting parts is taken as input. Cabinet, engine, spring load, steering, radiator, air intake, transmission system, load body, exhaust, fuel tank, battery, wheels, suspension system, axle, brakes are the different mounts on the frame whose loads and moments are considered, using which the strength and load bearing requirements of the frame are determined.

STEP – 2: Line Diagram

After the collection of the various load data required for design of a frame, a line diagram is drawn considering the frame as a beam and representing all the loads with their centre of gravity positioning.

STEP – 3: Axle Reaction Calculation

According to Newton's Second Law, "Every action has equal and opposite reaction". Therefore, for all the loads acting on the frame there will be a reaction force from the ground, corresponding to the weight of the vehicle. The reaction forces are exerted on the front and rear wheels of the vehicle which are in direct contact with the ground. These reaction forces travel through the suspension and spring system and are ultimately exerted on the frame of the vehicle. The forces on the front wheels are taken as Front Axle Reaction or Front Axle Weight (FAW) and the forces on rear wheels are taken as Rear Axle Reaction or Rear Axle Weight (RAW). The point of action of the Front Axle Weight is taken as the reference point or origin point in the frame from which all other positions are measured and indicated. The distance between the FAW and RAW is a direct measure of the wheel base of the vehicle. [7] discussed about a disclosure which is made regarding a driving alert system which is designed in the form of a neck cushion which has the capability to sense the posture of the drivers neck position so as to identify whether the driver is alert and if he is dozing of. The system is made intelligent to obtain data from the movement so as to produce triggers to alert the user and to keep him/her awake to avoid accidents. The system is also linked to a mobile computing device so as to provide a report of the analysis done. The drivers location can also be tracked using the same.

The Rear Axle Weight is calculated by taking moment about the reference point where the Front Axle Weight is acting.

RAW * Wheel Base = Sum of the moments of the loads acting on the frame about the reference point.

Since the load points, positioning and the wheel base are known, RAW is calculated from the above formula. The difference between the vehicle weight and RAW gives the FAW of the vehicle.

FAW = Vehicle Weight – RAW

STEP – 4: Calculation of Bending Moment

The different loads on the frame and its positioning are determined from the line diagram. Using this data the moment about each load point is calculated by summing up the moment of different loads responsible for the moment at the selected load point. The Bending Moment is calculated using the formula taking anticlockwise moment as negative and clockwise moment as positive.

M = P * D (Nmm)

Where,

M = Bending moment.

D = Perpendicular distance of the load from the selected load point.

P = Load.

The bending moment varies throughout the length depending on the magnitude and nature of load acting on it. It is found that the bending moment curve starts and ends with zero for any defined structure.

STEP – 5: Section of Cross Section of Frame

Automobile frames are mainly made of three sections,

- Channel section or C – Section.
- Box section.
- Tubular section.

Channel sections are good at resisting bending. For this reason they are preferred for long frames.

Box section are used is frames where both bending and torsional stresses are acting, as they offer both bending as well as torsional resistance. [13] discussed about a disclosure which is made regarding a gear blocking gear cover for the four wheeler vehicle where the protective cover has been with touch sensors and biometric sensors. Here in case of theft even if the car is started without a key the gear system is locked using biometric locks which can read the palm of the user to unlock the gear system thus protecting the vehicle against any form of theft. This device can be attached to any type of four wheeler vehicle.

Tubular sections offer better torsional resistance and hence they are generally used in frames of shorter length.

Depending upon the requirement of the frame and the various stresses acting in it, the cross section of the frame is selected.

STEP – 6: Calculation of Moment of Inertia

The next step of design procedure is the calculation of moment of inertia of the frame section. This is done based on the cross section of the frame and its dimensional specification. The moment of inertia is calculated by using different formulae for different cross section. For channel section frame the moment of inertia is calculated using the formula:

For C–section,

$$\mathbf{I = [(bf*d^3)-((bf-tw)*h^3)]/12}$$

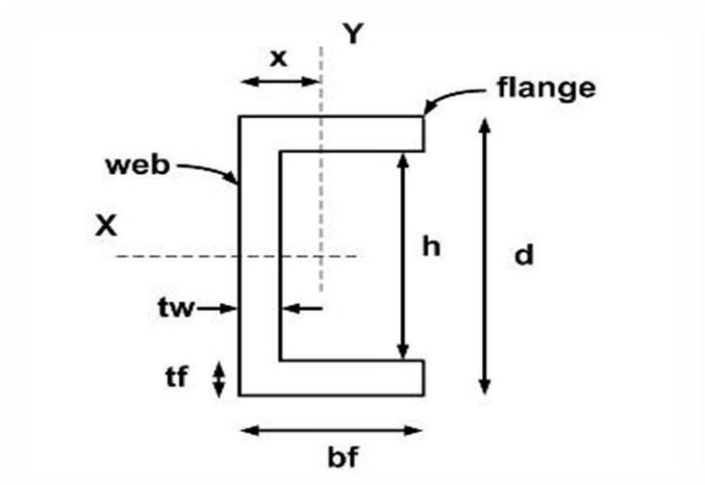


Fig 2.C section

STEP – 7: Calculation of Section Modulus

Section modulus is determined using moment of inertia and the maximum axial displacement of the frame section from its neutral axis. It is calculated by the formula.

Section modulus, $\mathbf{Z = I / y}$

Where,

I – Moment of Inertia

y – Axial displacement

STEP – 8: Calculation of Applied Stress

Applied stress is the stress applied on the frame as a result of external forces or loads acting on it. The magnitude of stress applied in the frame is determined by the Moment of Inertia, Bending moment and the maximum axial displacement of the section from the neutral axis. This is calculated by bending moment equation:

$$M/I = \sigma/y$$

STEP – 9: Material Selection

Depending on the magnitude of applied stress, the strength of the material to be used for the frame is determined. It is found that the applied stress must be less than the yield strength of the material which is the maximum permissible stress that the material can withstand without deformation or change in properties of the material. The material selection is carried out based on standards and its availability or ease of access. Cost factor is another major area of concern for the selection of material since a more economical material is highly preferred.

STEP – 10: Calculation of Factor of Safety

Factor of safety is a term describing the structural capacity of the frame beyond the expected loads or actual loads. It is a measure of how strong the frame is, than it usually needs to be for an intended load. Factor of safety is the ratio between the yield strength or maximum permissible stress of the material to the applied or working stress.

Factor of Safety = Yield Strength / Design Stress

Factor of Safety or Safety Factor (FOS) can be determined for each loads acting on a point. If 3 ton of the load acting on the truck the factor of safety calculated and the values Safety Factors are tabulated as shown in table

Factor of safety is calculated by the formula

Factor of safety = Yield stress / Design stress

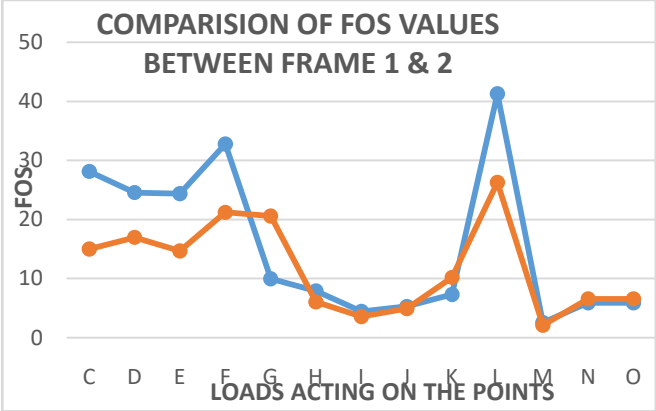
Example:

FOS at point C = 340 / 12.07202067 = 28.1643.

LOADS ACTING POINTS	FACTOR OF SAFETY FRAME 1	FACTOR OF SAFETY FRAME 2
A	-	-
B	68.3494	21.1748
C	28.1643	15.0327
D	24.583	16.9958
E	24.4112	14.7106
F	32.7964	21.23656
G	9.982612	20.61811
H	7.935647	6.050644

I	4.481134	3.563583
J	5.323565	4.94063
K	7.345759	10.21016
L	41.3022	26.3111
M	2.57461	2.1012
N	5.9566	6.5777
O	5.9566	6.5777
P	-	-

Table: FOS of frame1 and 2



IV. CONCLUSION

This project concludes with the Frame No1 is selected as a best frame by means of theoretically. By comparing the two type values of factor of safety on both frames, the best frame was selected. The two type values are obtained by condition of with and without applying of payload to the load body unit. This project concluded with the level of theoretical calculations. After the method of Theoretical method, the value of properties are determined from the Analysis methods. Then Theoretical values are compared with software analysed method and the variations between these values are also calculated. . When comparing with frame 2, frame 1 will be sustainable and Carry high load with efficiently by considering the factor of safety values.

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