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# Design And Weight Optimization Of YJ3128 Type Dump Truck's Frame

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**Abstract** — *The thesis consist of an introduction, design of chassis, model, analysis, specific characteristics, a comparison between the results with in obtain by optimization. The mainly studies the YJ3128-type dump truck's frames, for the fatigue crack occurred on frame in worked in bad condition for 3 to 5 months, the truck's working conditions and the load of 16tonne features are researched, and ANSYS is used to analyses the stress of the frame. The weight reduction is achieved by changing section of the side bar and changing materials. Then FEA is performed on that model. After complete FEA, comparing them and get the best solution.*

***Keywords***- *FEA, Truck Chassis, Structural Analysis, ANSYS, CREO.*

## I. INTRODUCTION

The dump truck used for transporting loose materials in mining and construction. A typical dump truck is equipped with a hydraulically – operated suspension with closed box structure chassis, a body which is located at the top of the chassis. The chassis supported at the front and rear side suspension of the truck. The purpose of the body is lifted rear side of the vehicle, which is to deposit the materials on the ground. Chassis is an important part of the load carrying member of a rear dump truck over which the entire equipment is structured. Chassis acting as a structural support for power train elements and also enables the dump body carrying full payload. The chassis is neither a serviceable nor a replaceable component as far as the life span of the vehicle is concerned. The life span of a chassis must be equal to or more than 30,000 running hours under normal operating condition of the vehicle.

To increase the fatigue life and its propagation across the chassis and to avoid crack, it is absolutely necessary to have an optional design to withstand the complete load under normal conditions. For this purpose, it is necessary to strengthen the frame and to increase the safety factor of the chassis for an increased fatigue life.

The chassis development processes in the automotive and transport equipment industries are subject to ever higher demands in terms of improved reliability, safety and performance, as well as reduced weight; production cost and development lead time. Due to the demand of huge truck for building and testing prototypes and manufacturing, there is increased emphasis on analytical durability assessment methods.

## II. LITERATURE REVIEW

The experts and researchers who have already worked in the field of selected study is the most valuable resource of the information and inspiring to this work; this literature study is made. Hirak Patel, Khushbu C. Panchal, Chetan S. Jadav did research about the truck chassis design is done analytically and the weight optimization is done by sensitivity analysis. In sensitivity analysis different cross section are used for stress analysis and we find a 17% weight reduction in the truck chassis. The stress and deformation are also compared for the different cross section [1]. Hemant B.Patil1, Sharad D.Kachave, Eknath R.Deore, Stress analysis of a ladder type low loader truck chassis structure consisting of C-beams design for application of 7.5 tonne was performed by using FEM. To reduce the expenses of the chassis of the trucks, the chassis structure design should be changed or the thickness should be decreased. Also determination of the stresses of a truck chassis before manufacturing is important due to the design improvement [2]. Chen Yanhong, Zhu Feng, the dump trucks working conditions and the load features are researched, and ANSYS is used to analyze the stress of the sub-frame. According the deferent stress, the reason of the fatigue cracks occurring is researched too. At last an improvement and optimization to the structures of the frame is provided. The turning point of the left stringer is also reduced greatly, therefore, there is no big turning transform in the improved frames, and the torsional stiffness is enhanced. No excessive stress concentration exists, and the bearing capacity is greatly improved. Thus it meet the design and use requirements [3]. Sandip Godse, Prof. D.A.Patel, The static load analysis of the chassis of TATA ace exusing ANSYS workbench and stress optimizationusing reinforcement technique of optimization. This has been carried out with limited modifications by adding stiffeners. The necessary design changes required to enhance the load carrying capacity of the vehicle has been recommended successfully [4]. Sairam Kotari , V.Gopinath, The existing TATRA chassis was analyzed by the finite element analysis for installation of the Antenna and Electronic components and the stress levels are found to be 737.3 N/mm2.After modifications, the TATRA Chassis with suitable reinforcement, increase in thickness, addition of stiffeners, the finite element analysis was carried out, and the stress levels of chassis are found as 173.38 N/mm2, which is less than yield stress 410 N/mm2.From the Results, it can be concluded that the modified TATRA chassis is capable to carry the loads beyond the previous payload up to 14 tones [5]. Tushar M. Patel, Dr. M. G. Bhatt and Harshad K. Patel, Truck chassis is the structural backbone of any vehicle. The main function of the truck chassis is to support the components and payload placed upon it. The chassis frame has to withstand the stresses developed as well as deformation occurs in it and that should be within a limit. This paper presents the study of the stress developed in chassis and deformation of chassis frame of EICHER 11.10. The stress and deformation has been calculated for the chassis frame and the FE analysis has been done for the validation on the chassis frame model [6]. Mohd Azizi Muhammad Nora, Helmi Rashida, Aims to prepare model, simulate and perform the stress analysis of an actual low loader structure consisting of I-beams design application of 35 tons trailer designed in-house by Sumai Engineering Sdn. Bhd, (SESB). The material of structure is Low Alloy Steel a 710 C (Class 3) with 552 MPa of yield strength and 620 MPa of tensile strength. The results of analysis revealed that the location maximum deflection and maximum stress agrees well with theoretical maximum location of simple beam under uniform loading distribution [7].

## III. FINITE ELEMENT ANALYSIS

### 3.1 BASIC CONCEPT OF FEM

Finite element analysis is getting a bigger role in development of projects. One of the reasons is that it helps slash expensive prototype testing. FEA consists of a computer model of a material or design that is loaded and analyzed for specific results.

In finite element analysis, the design is discretize or subdivided into a series of elements that are connected by nodes. Material properties and element properties are specified to represent the physical properties of the model. Boundary conditions and applied loads are then define to represent the operating environment for which the design is to be subjected and its simulation tool that enables engineers to simulate the behavior of an entire structure.

For carrying out the FE analysis of truck chassis as per standard procedure first it requires to create assembly to achieve the connectivity and loading and constraining is required to be applied also idealization of parts is done on structure this will lead to faster analysis since the connected structure will be mechanical properties of mechanical structure. Procedure is followed in this section.

## IV. MODELING OF EXISTING CHASSIS FRAME

The model of existing as per the dimension is created in CREO and this model is saving in IGES format which can be directly imported into ANSYS workbench. So fig. 1 shows the imported model in ANSYS workbench.

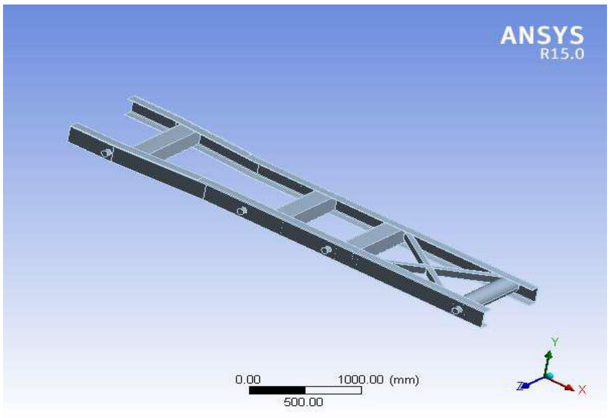



*Fig. 1 geometry of chassis in ANSYS*

### 4.1 MATERIAL OF CHASSIS

For the geometry of chassis, generally use variety of material, composite material and different of alloys. In the present, 16Mnl is used and its properties are as below.

Table 1 Material property of chassis [3]

| | |
|---|---|
| Type | Isotropic Elasticity |
| Young's Modulus (E) | 2.e+005 MPa |
| Poisson ratio μ | 0.3 |
| Bulk Modulus | 1.75e+005 MPa |
| Yield Strength | 510 MPa |
| Ultimate Strength | 610 MPa |
| Density | 7.85e-006 kg mm^-3 |
| Shear Modulus | 80769 |

### 4.2 MESHING OF CHASSIS FRAME

The meshing is done on the model with 59960 No. of nodes and 30120 No. of elements show in fig.

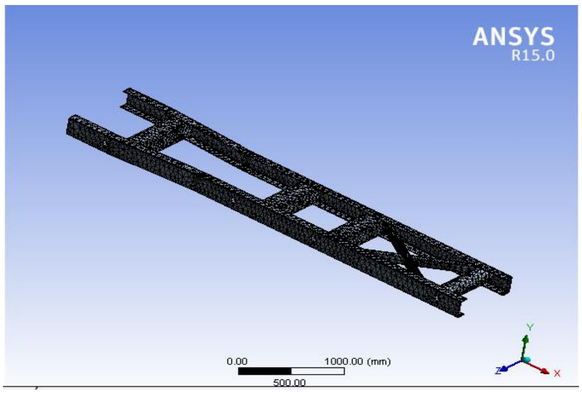



***Fig. 2 meshing of chassis***

### 4.3 LOADING OF CHASSIS

All parts of the chassis are made from "C" Channels with 210mm x 95mm x 8mm and cross member 190mm x 190mm and circular member with 40mm radius. Each Truck chassis has two beams. So load acting on each beam is half of the Total load acting on the chassis is 121266.3 N/Beam. Chassis is simply clamp with shock absorber and leaf spring. So chassis is a simply supported beam with uniformly distributed load. Load acting on entire span of beam is 121266.3N. Length of the beam is 4700 mm.

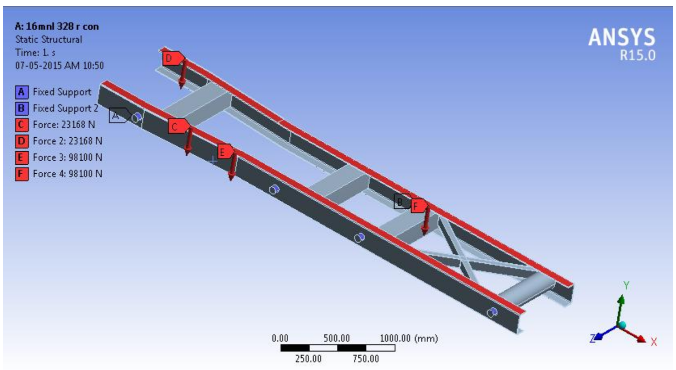



Fig. 3 Loading of Chassis

### 4.4 RESULT OF ANALYSIS

In a generated Max. Stress, Max. Displacement, Max. Shear stress are as under:

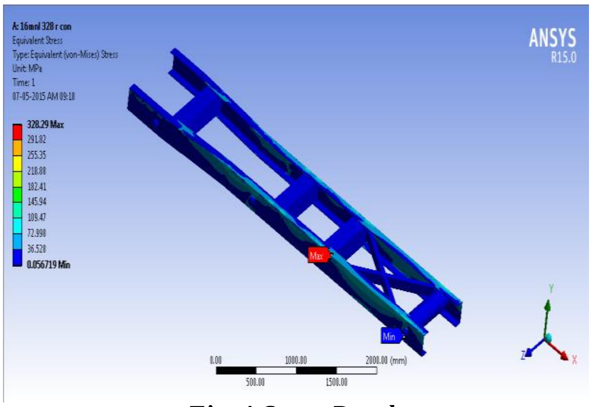



*Fig. 4 Stress Result*

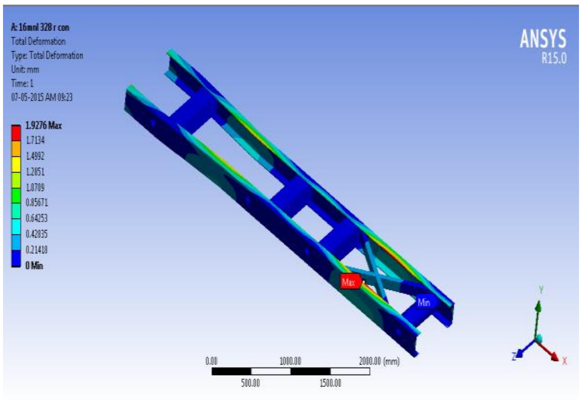



*Fig. 5 Displacement Result*

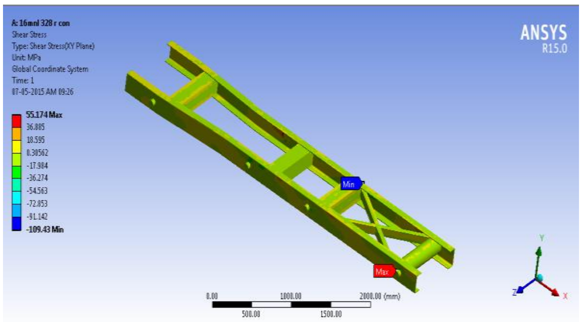



*Fig. 6 Shear Stress*

As shown in above fig. generated Max. Stress, Max. Displacement, Max. Shear stress is within limit so Design is Safe.

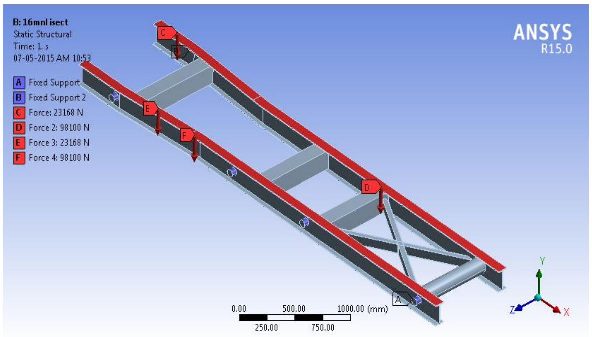
## V. WEIGHT REDUCTION OF CHASSIS

"Optimization is define as a maximization of wanted properties and minimization of unwanted properties" In case of structural optimization the chassis wanted properties are strength, stiffness, life etc. and unwanted properties are material, cost, weight etc.

In this phase of work we are changing the cross section of the frame member (size/shape) such a way that weight should be reduce and then check all the properties with FEM. Here we are considering diff. sections and materials. After creating models of frame we are going for the FEA of the same. By comparing all results with the result of the existing design we can choose the chassis with least weight.

### 5.1 Case 1: FEA OF I – SECTION

All parts of the chassis are made from "I" Channels with 210mm x 95mm x 8mm and cross member 190mm x 190mm and circular member with 40mm radius. In a material is 16Mnl used.



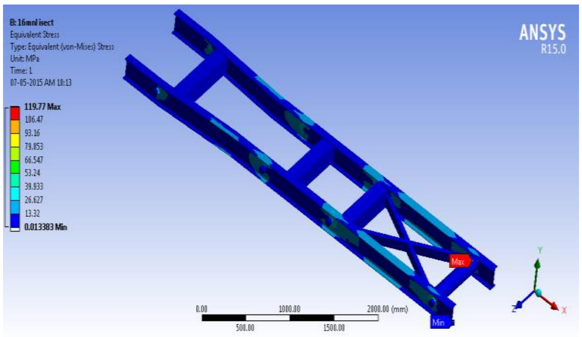



*Fig. 6 Loading of Chassis with I section*

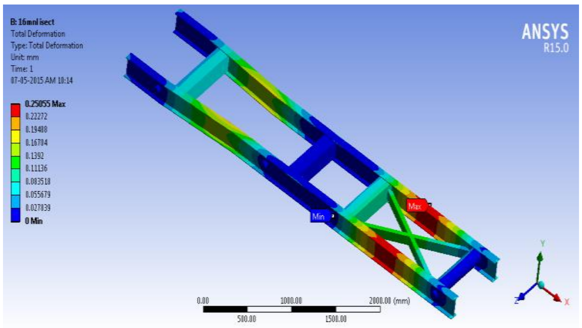



*Fig. 8 Displacement Result of I – section*

*Fig. 7 Stress Result of I – Section*

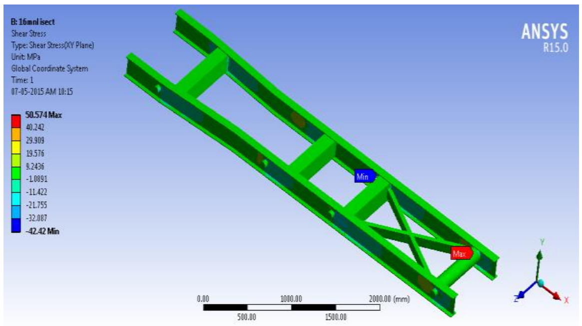



*Fig. 8 Shear Stress of I – section*

### 5.2 Case 2: FEA OF SECTION WITH MODIFIED MATERIALS

In modified materials, SAE-AISI-1080 is used and its properties are as below.

Table 2 SAE-AISI-1080 material properties

| Type | Isotropic Elasticity |
|---|---|
| Young's Modulus (E) | 2.1e+005 MPa |
| Poisson ratio μ | 0.3 |
| Bulk Modulus | 1.75e+005 MPa |
| Yield Strength | 550 MPa |
| Ultimate Strength | 830 MPa |
| Density | 7.6e-006 kg mm^-3 |
| Shear Modulus | 80769 |

In a generated, Max. Stress, Max. Displacement, Max. Shear stress is as under:

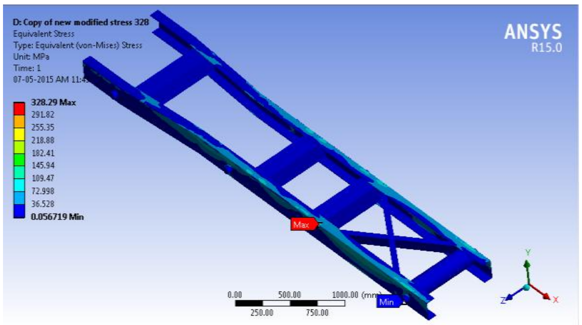



*Fig. 9 Stress Result of C – Section*

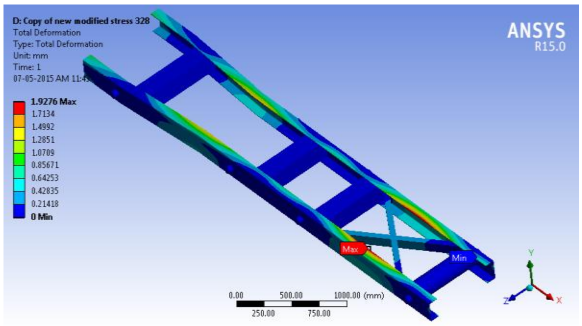



*Fig. 10 Displacement Result of C – Section*

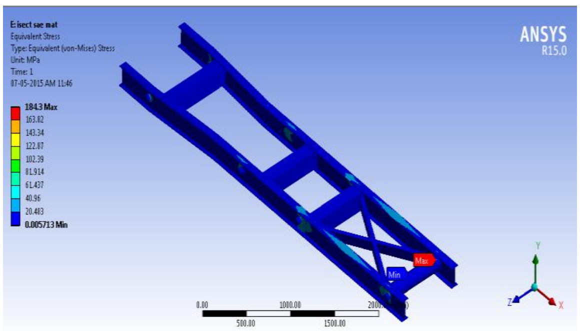



*Fig. 11 Stress Result of I – Section*

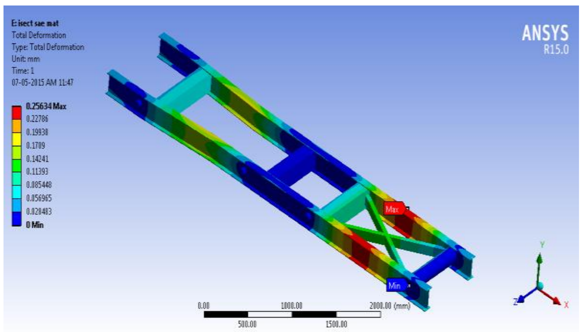



*Fig. 12 Displacement Result of I – Section*

As shown in above fig. generated Max. Stress, Max. Displacement, Max. Shear stress is within limit so Design is Safe.

## VI. RESULT

**Comparison Table of Existing Model with Modified Models:**

| Sr. No. | Parameters | Existing "C" Section | "I" Section | Modified "C" Section | Modified "I" Section |
|---|---|---|---|---|---|
| 1 | Materials | 16Mnl | 16Mnl | SAE-AISI-1080 | SAE-AISI-1080 |
| 2 | Assembly Weight (kg.) | 393.13 | 410.95 | 383.05 | 400.59 |
| 3 | Stress (MPa) | 328.29 | 119.77 | 328.29 | 184.3 |
| 4 | Displacement (mm) | 1.927 | 0.250 | 1.927 | 0.256 |
| 5 | Shear Stress (MPa) | 55.174 | 50.574 | 55.174 | 67.872 |
| 6 | Life | 4979.8 cycles | 16718 x $10^5$ cycles | 17912 cycles | 34600 cycles |

## VII. CONCLUSION

In the "I" section, value of stress is minimum and life time is higher than C section. In the modified "I" section has higher weight than C section. But due to clamping reason "I" section is not used for the practical use. So the modified "C" section has lowest weight 383.05 Kg than I section and life is more than existing "C" section. Also stress and displacement are within limit. So, modified "C" sections are satisfying the criterion of project title "Design and Weight Optimization of Yj3128 Type Dump Truck's Frame".

## VIII. SCOPE OF FUTURE WORK

In a future, to work is done on effect of dynamic load like vibration and load due to external factors such as air resistance, suspension effect, cornering, brake dip etc. By considering all and some above loads, the analysis of chassis can be made to meet actual life situation. Also to use of other analysis software like catia etc., the comparative study of capabilities of above mentioned software can be made. In a future, work is carried out on optimization of chassis by changing material and their properties.

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