# Analysis of Chassis in 3 Wheeler E-Rickshaw for Weight Reduction

Dhvani Pandya[i]
[i]P.G. Student,
Dept of Mechanical Engineering,
Indus University, Ahmadabad, Gujarat, India

Dr. A.M. Bisen[ii]
[ii]Professor,
Dept of Mechanical Engineering,
Indus University, Ahmadabad, Gujarat, India

***Abstract* - Chassis is the most important structural member in the On-Road vehicles. All the loads generated by other components of the vehicle are transferred to chassis only. So the chassis structure has to be strong enough to with stand the loads in static and dynamic conditions. In most of the On-Road vehicles the cross section of the chassis structure is uniform in spite of the variable loads. In order to overcome more failure in the chassis structure and ensure the safety, the variable section chassis structure has to be designed based on the variable loads along the length of the vehicle.**
**In this paper an analysis is done on current running E-rickshaw chassis.**

***Key words - E-rickshaw; Chassis***

## I. INTRODUCTION

Most of the cities in developing countries are highly polluted. The main reasons are the air and noise pollution caused by transport vehicles, especially petrol-powered two and three wheelers and about 1.5 million petrol and diesel powered three wheeler and their population is growing at a healthy rate of about 15% per annum [1]. Besides being a major hazard to people's health, these machines are guzzling huge amounts of petrol and diesel for which the country has to pay dearly in foreign exchange outflow.
Electric drive vehicles are becoming an attractive alternative to combustion engine auto rickshaw with global gradual fossil fuel prices rise. In addition, increasing energy prices also have led to an increase interest in the development of electric vehicles. An electric rickshaw can provide a non-polluting and a very silent transport system for urban and rural areas of India [6]. Besides it is a very energy efficient and cost effective vehicle.
In electric vehicles, efficiency of energy usage is very important. In order for an electric auto rickshaw to perform at its best it must have adequate structure, this means it must have a stiff frame.
The chassis is the "skeleton" of the rickshaw which provides the structural strength and the mounting points for other components. The chassis provides necessary support to the vehicle components placed on it such as suspension components and the weight of the driver. Electric auto rickshaw chassis designing and fabrication involves tradeoffs [4]. There is no one ideal design. One obvious consideration is that the rickshaw must not be too heavy. This will make it easier for the motor to push a lighter rickshaw than a big, heavy one [5].

## II. SURVEY OF E-RICKSHAW

Among all other products e.g. Yo bykes, E-cars, E-taxi, E-loaders of Electrotherm we have selected an E-taxi to modify the design. Electrotherm India Pvt. Ltd. Is one of the most reputed companies manufacturing E-rickshaw. In 2006, ET was the first to introduce Electrical Scooters in an organized manner in India. Today with more than one lakh satisfied users ET has emerged as the largest selling and the most trusted Electrical Vehicles manufacturers in India. Electrotherm is a truly global company taking social responsibility in its stride as 'No engines means no pollution'.
The following are the design criteria of the chassis which we have considered for modification.

Table 1: Approximate masses of main components

| S. No. | Components | Mass (kg) |
|---|---|---|
| 1 | Body | 123 |
| 2 | Chassis | 52 |
| 3 | Driver | 100 |
| 4 | Passengers | 400 (No. Of passenger = 4) |
| 5 | Battery | 250 |
| | **Total** | 925 |

Table 2: Mechanical Properties of Chassis Material

| **STEEL GRADE: IS 3074** | | |
|---|---|---|
| **S. No.** | **Properties** | **Values** |
| 1 | Young's modulus | 2e+011 $N/m^2$ |
| 2 | Poisson ratio | 0.266 |
| 3 | Density | 7860 $kg/m^3$ |
| 4 | Yield Strength | 3.73e+008 $N/m^2$ |

## III. SOLID MODELLING

After load approximation and material selection, preparing CAD model of chassis from past design. Creo software tool was used for designing and Ansys software tool was used for Finite Element analyses (FEA).

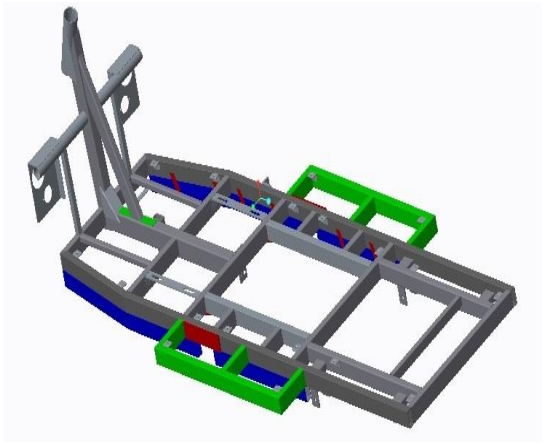

Figure 1: 3D Chassis Structure

## IV. ANALYSIS OF DATA

Structure designing was followed by its testing and consequent validity. To analyze the chassis design before construction, finite element analysis could serve the purpose. While the process of solving Finite Element problems is a science, creating the models is quite an art [2]. Conventionally in FEA, the frame is subdivided into elements. The number, orientation and size of elements as well as loads and boundary conditions are all critical to analyze the chassis [3].

*Finite Element Analysis:*

- *Bending loads:*
  Bending loads are caused by the weight of the components on the chassis. Bending loads are loads applied normal to an axis that produce a bending moment. To simulate these loads, forces will be applied in the vertical plane to simulate the bending force cause by the weights of the various components, the driver and passenger [3].

To analyze this load, boundary conditions are considered in ANSYS software as

- The wheels are in fixed condition
- The chassis and passenger loads are under loading condition.

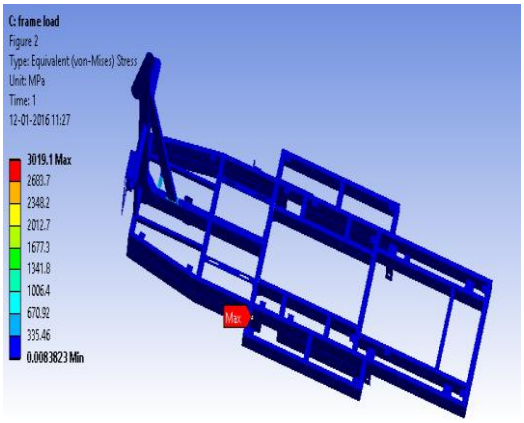


Figure 2: Von Misses stresses during static load

- *Breaking loads:*
  Braking loads are those experienced by the car during deceleration. The loads originate at the surface of the road where the tyres are in contact with the tarmac. The forces are transferred through the suspension struts onto the chassis of the vehicle through the mounting points [3].

1. The situation while thrust acting on front wheel of the rickshaw, the boundary conditions are as:
   - Rear wheels are under fixed condition
   - Loads acting at front wheel

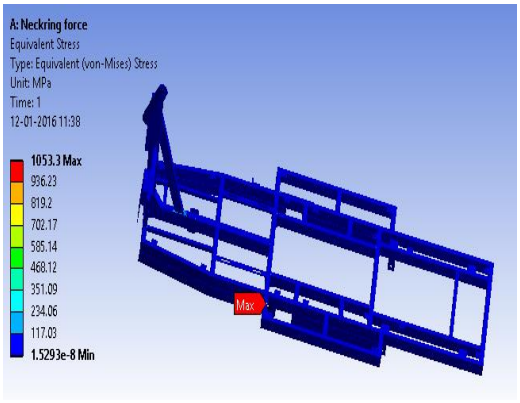


Figure 3: Von Misses stresses during deceleration

2. The condition while thrust acting at rear wheel of the rickshaw, the boundary conditions are as:
   - front wheel is under fixed condition
   - Loads acting at rear wheels

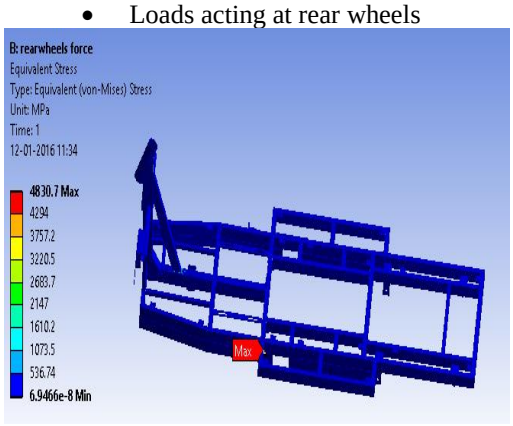


Figure 4: Von Misses stresses during deceleration

## V. OBSERVATIONS

From above analysis, following are the observations

1. The failure in chassis observed while in bump testing are on to the welding joints as shown in figure 5.
2. In case of overloading on the chassis, there are certain welding joints which show the failure of the part.
3. Depending on the type and place load, material shows the weakness and failure tendency.

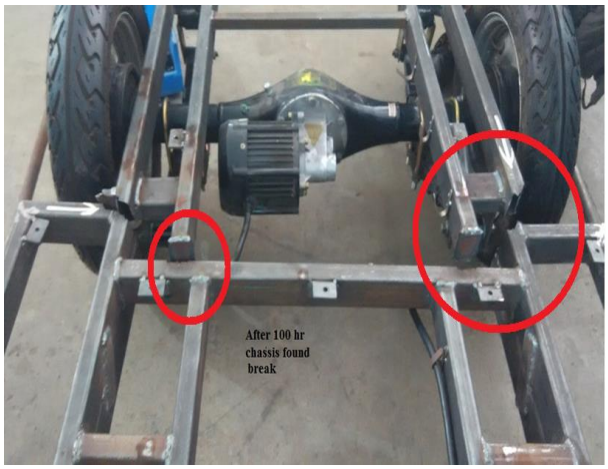

Figure 5: Actual breakage while bump test

## VI. DISCUSSION

As per the observation made, it has been observed that failure generally occurs at welding joints and at the neck ring. So, by making some modification in the welding process or by redesign the components, failure can be avoided. The stress concentration at some points is observed which again leads to failure of the parts which can be taken care to reduce it. The change in the material at certain parts may be one of solution for avoiding the failure of the part. Complete design of every part is required by considering the load factor. There are certain parts which are in very safe portion where we can modify the material and reduce the cost of chassis.

## VII. CONCLUTION

Following are the conclusions of the work

1. Stress concentration can be minimised by providing the rib at neck ring.
2. Quality of welding and welding joints should be designed to reduce the failure at the joint.
3. Stress distribution should be uniform.
4. As per analysis, some parts need to redesign for safe side.
5. Overload factors is to be consider in order to provide extra strength to the chassis.

## VIII. FUTURE WORK

More design of Chassis are to be analysed in order to reduce the cost of chassis and to suggest alternative design for higher strength.

## REFERENCES

1. Anil K.Rajvanshi, “Electric and improved cycle rickshaw as a sustainable transport system or India” in Current Science, VOL. 83, NO. 6, 25 SEPTEMBER 2002.
2. Riley, W.B., George, A.R., 2002. Design, Analysis and Testing of Formula SAE Race Car Chassis, SAE paper 2002-01-3300, Motorsports Engineering Conference and proceedings.
3. Ravinder Pal Singh, “STRUCTURAL PERFORMANCE ANALYSIS OF FORMULA SAE CAR” Jurnal Mekanikal December 2010, No. 31, 46 – 61
4. Ahmad Zainal Taufik, Nur Rashid[1], Mazlan, Mohd Faruq, Muhammad Zahir, ‘Electric car chassis design and analysis by using CATIA V5 R19”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 4 Ver. III (Jul- Aug. 2014), PP 56-59.
5. K.Rajasekar, Dr.R.Saravanan, “Literature Review on Chassis Design of On-Road vehicles”, IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 7, September 2014.
6. Izhar Hifnie Bin Mohd, Amin, “Design and analyze the chassis of an electric vehicle for use in campus condition”, Universiti Teknikal Malaysia Melaka, APRIL 2009.