Optimum Design of a Trailer Chassis to Overcome Failures of Welded Joints to Improve Maintenance Actions

Tangella Teenage Vara Prasad[1], Dr. P.K.Soni[2]

[1]M.Tech Scholar, Mechanical Engineering Department, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh
[2]Assistant Professor, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh

---***---

Abstract-*This project is centered on an ongoing trailer chassis component and its failure of welded joints in this research the problem has been systematically approached using ANSYS finite element analysis software. The conditions are simulated in ANSYS which involve model designed in SolidWorks and imported into it and analyzed using finite element modeling. The finite element model subjected to static structural analysis and finally, this research concludes with a proposal for further analysis on the trailer*.

***Key Words* —Trailer, Ansys, Solid Works, Analysis, weld.**

I. INTRODUCTION

Welding is widely used in automotive industries to assemble various products. The chassis is considered to be one of the significant structures of an automobile. It is the frame which holds both the car body and the power train. Vehicles have to withstand dynamical loads and their components have lots of arc welds, spot joints, and notches. Several technological treatments with positive or negative influence on the lifetime usually are applied. Thus, it is important to evaluate the deformation due to welding. FEA is the most dominant method for calculation and simulation of computer made models. The name FEA comes from the way a complicated model is divided into a model that is built by small elements. The welding simulations simulate an actual welding process based on science and physics and the tests can be performed inside the computer without wastage of resources and hazardous environmental impact. Design of a component by overcoming failures in welded joints and improving Maintenance activity yields better results by considering the factors and steps to be taken to overcome it. In order to improve its functionality, one should need a better maintenance approach so as to maintain its health for a prolonged time. But the cost of maintenance also even higher depending upon the techniques that we apply and frequency of failures that may happen because of payload conditions which further increases the overall cost. These loads include the weight of each component and the forces which occur during acceleration, deceleration, and cornering. Chassis should be rigid enough to absorb the shock, twist, vibration and other stresses.

2. LITERATURE REVIEW

Akshay Nighot, Anurag A. Nema , Anantharma A [1] Welding distortion, a result of the non-uniform expansion and contraction of weld metal and adjacent base metal during the heating and cooling cycle of the welding process, is a major concern during the fabrication of a welded structure. Helmut Dannbauer, Christian Gaier and Klaus Hofwimmer[2] Assessment of welding seams and spot joints and self-piercing rivets. It shows, how the influence of the mesh quality and the element size can be minimized. For spot welds, stress based concepts deliver better results and can be applied for self-piercing rivets too. T. Marin, G. Nicoletto[3] work presented a structural stress approach to fatigue assessment of welded joints that integrates well with finite element modeling. The mesh-insensitivity was confirmed: even coarse meshes provide adequate structural stress estimates so the method can be used in modeling complex structures. Wolfgang Fricke and Olaf Doerk[4] fatigue behavior of fillet welds around stiffener and bracket toes, where frequently a high-stress concentration is present. Two different types of cracks are possible, starting from the weld toe and from the non-welded root Gap. Rohan Y Garud[5] Optimisation of chassis by improving its strength and reducing its weight by choosing various types of materials with different cross-sections. Anurag,Amrendra Kumar Singh, Akash Tripathi[6] In this chassis made of steel is analyzed by using FEA software along with High strength low alloy steel (HSLA)materials. various parameters such as Nodal displacement, stress distribution are analyzed. Mr.Yadav, Rahul Shivaji[7] Light Commercial Vehicles (LCV) chassis are manufactured by welding to reduce the weight of the chassis. e there is a more stress concentration occurs at a welded joint region. develop a model of the welded joint to sustain various loads of LCV trailer chassis. Pravin A Renuke[8] Bending and torsion stiffness influences the vibrational behavior of the structure. Modal analysis using Finite Element

Method (FEM) can be used to determine natural frequencies and mode shapes. K.Rajasekar Dr.R.Saravanan[9] Chassis design should be cost-effective, lesser weight, maximum payload, ensure vehicle safety by withstanding the worst loading conditions and to satisfy fuel economy requirements. Hemant B.Patil, Sharad D.Kachave, Eknath R.Deore[10] Stress analysis of a ladder type low loader truck chassis structure consisting of C-beams was performed by using FEM. The magnitude of the stress can be used to predict the life span of the chassis. Jadav Chetan S.Panchal Khushbu C., Patel Fajalhusen[11] Fatigue failures occur due to the application of fluctuating stresses. It has been estimated that fatigue contributes to approximately 90% of all mechanical service failures. Grzegorz Szczęśniak, Paulina Nogowczyk, Rafał Burdzik[12] Dynamic properties and geometric parameters of the vehicle depends on chassis. It was described as an interesting method IPPD adopt to the automotive industry. Slivinskii E. V.Korchagin, Radin S. Yu., Rizayeva Yu. N.[13] Relating to the development of advanced designs of devices aimed at improving safety in the maintenance and repair of trailers. Calculations of loading elements will prove rational geometrical parameters of such structures.

3.OBJECTIVE

Trailers are commercial vehicles for carrying oils, milk, water, sand, iron, etc. The design of these trailers typically varies based on the application, environmental conditions, payload capacity. So to meet those requirements and to maintain functional aspects for a long time one should need an optimum design approach for chassis as it is one of the critical components of the vehicle.

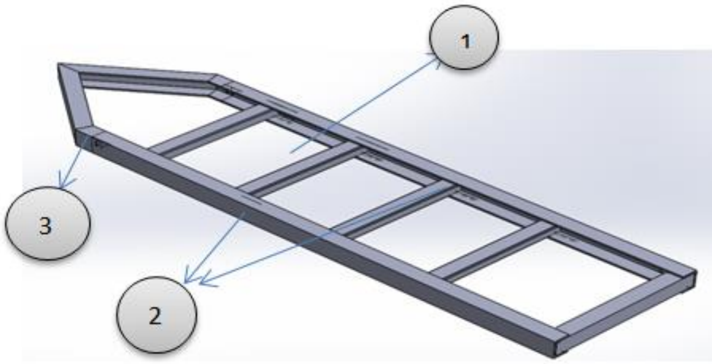

Fig1.Geometric Model of Trailer Chassis

1. cross member 2. side member(c-section) 3. weld bead

Welding of the cross members with the side members so as to provide rigidity of the chassis and to improve its mechanical properties.

In this, a weld bead of the 5mm radius is used to combine joints of T-section and channel section members.

This research is intended for analysis of tipping trailer chassis so as to overcome failures in welded joint structural members with improved maintenance activity.

To simulate and analyze chassis using software packages like Ansys with Finite Element Methods as the base.

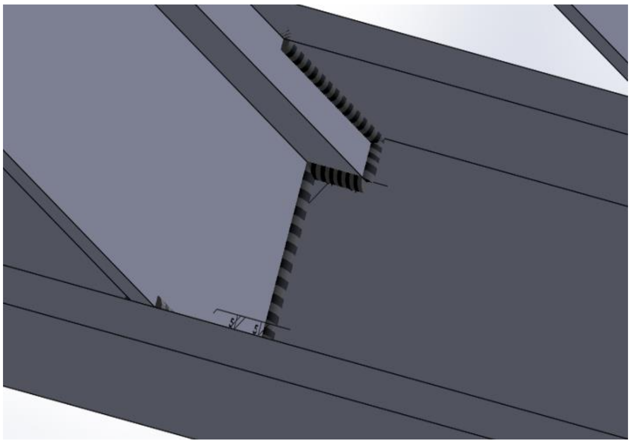

Fig2.Geometric Model of fillet weld at the juncture of T-cross member and C-section main member

4. METHODOLOGY

The proposed work involves the following steps:

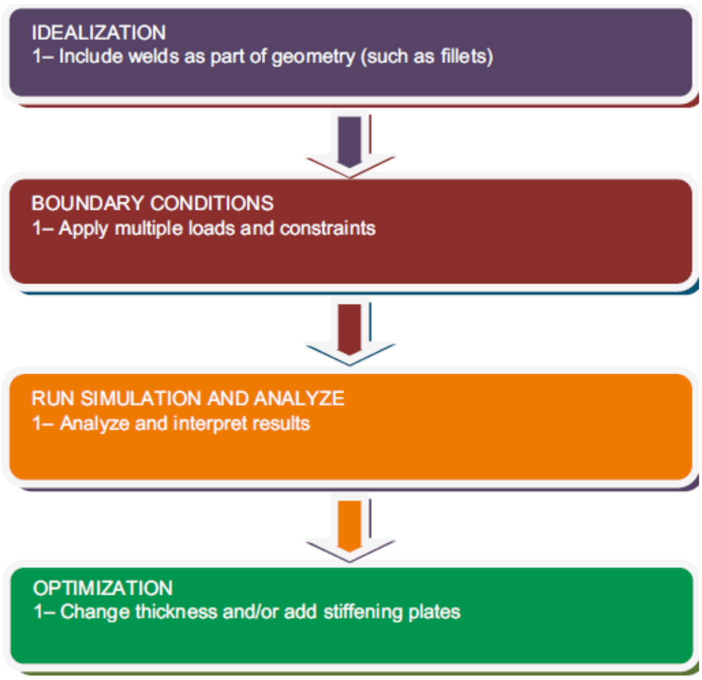

Fig.3 Flow chart for Analysis and optimization of Chassis

This study has been dealt with two parts. The first part of this study involves modeling of chassis frame and analysis of stresses and displacement under actual load conditions. CAD models of chassis frame were developed in 3D modeling software, such as Solid Works. The stress analysis and stiffness of the models are then obtained in Ansys workbench.

a) **Idealization**:

As the initial model of the chassis has been designed along with fillet welds of the required radius at the juncture of members and subsequently, it can be tested for further analysis.

b) **Boundary Conditions:**

Table1: Boundary conditions and Loads

Type	Fixed Support
Define	By Vector
Force Magnitude	98100 N
Direction	Defined

MESHING OF MODEL:

Table -2: Meshing of Model

Bodies	11
Active Bodies	11
Nodes	9411
Elements	1602

Table-3: Static Structural Analysis

Object Name	Static Structural
State Solved	Definition
Physics Type	Structural
Analysis Type	Static Structural
Solver Target	Mechanical APDL Options
Environment Temperature	22. °C

Given input geometry, various loads, boundary conditions and material selection for trailer chassis come out a solid design base with mechanical properties as follows:

Table-4: Mechanical properties of Chassis according to data given

Length X.	3.0485 m
Length Y	0.1 m
Length Z	0.76997 m
Volume	2.5071e-002 m^3
Mass	196.81 kg
Scale Factor Value	1

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

c) **Run the simulation and interpret results:**

In Finite element model shell elements have been used for the longitudinal members & cross members of the chassis. The advantage of using shell element is that the stress details can be obtained over the subsections of the chassis as well as over the complete section of the chassis. The vehicle model is fixed at the wheels.

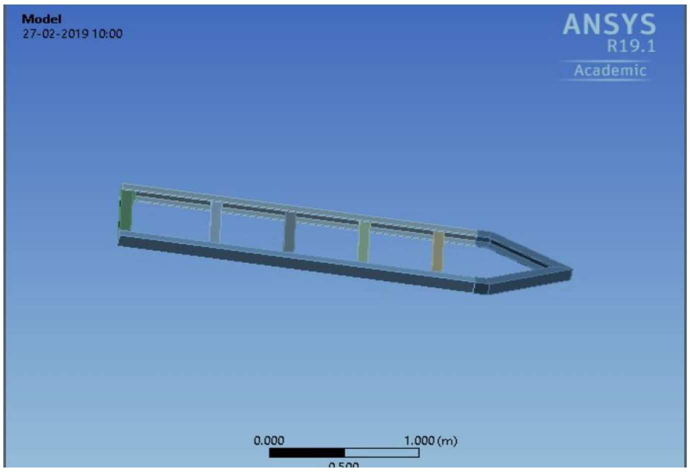

fig.4 Model of chassis

Equivalent Stress

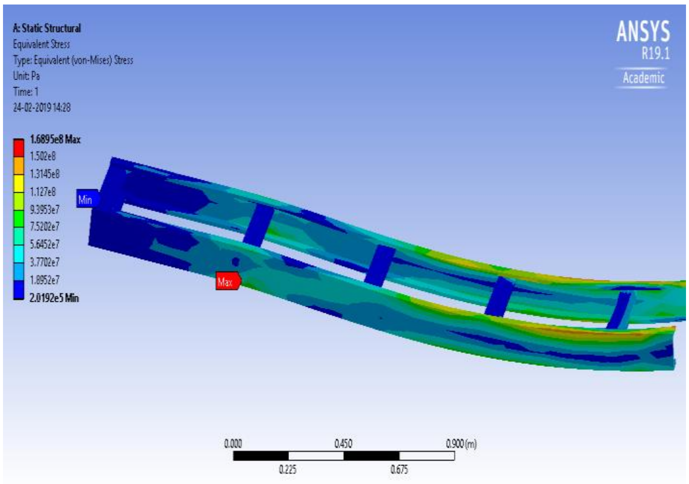

Fig.5: Equivalent stress in chassis

Table-5 Equivalent stress results

Time(s)	Maximum(Pa)	Minimum(Pa)	Average(Pa)
1.	1.6895e+008	2.0192e+005	3.1444e+007

Total Deformation:

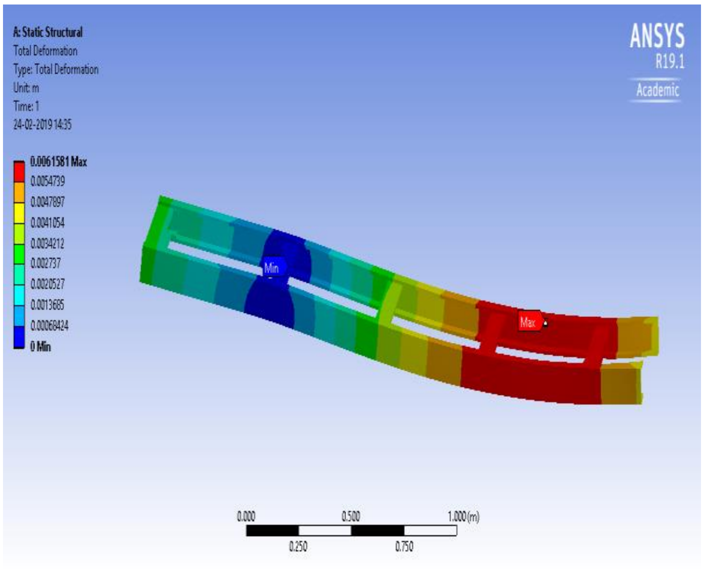

Fig.6: Total Deformation

Table 6: Total deformation values

Time(s)	Minimum(m)	Maximum(m)	Average(m)
1.	0	6.1581e-003	3.5466e-003

Life of component:

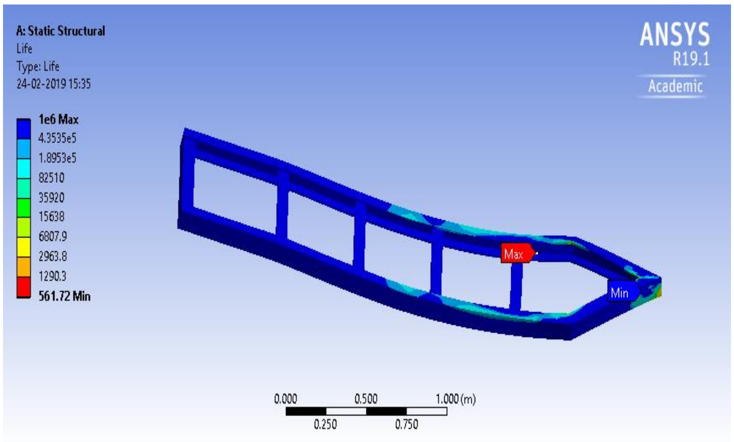

Fig.7: Life of component

Table 7: Life of component chassis results

Time(s)	Minimum (cycles)	Maximum (cycles)	Average(cycles)
1.	561.72	1.e+006	9.4271e+005

Graphical Variation of various failure theories:

The chassis subjected to necessary conditions and loads generate the following amplitude and correction theories.

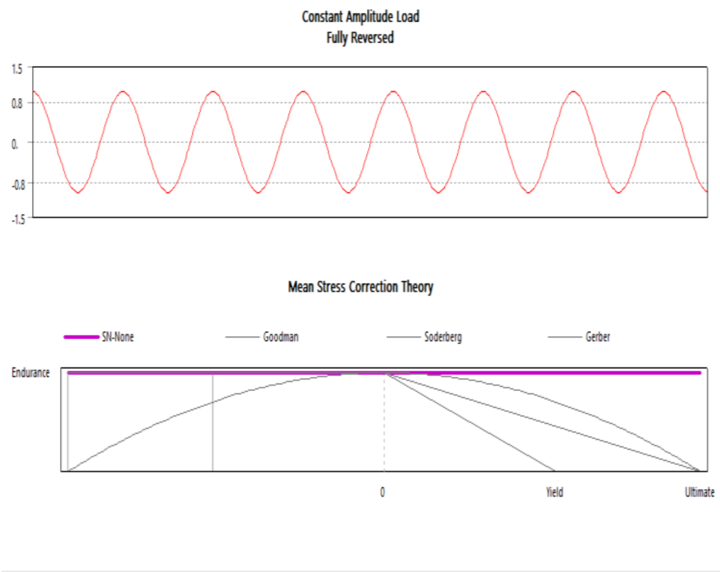

Fig.8: Various Graphs of Failure theories

Equivalent Alternating Stress:

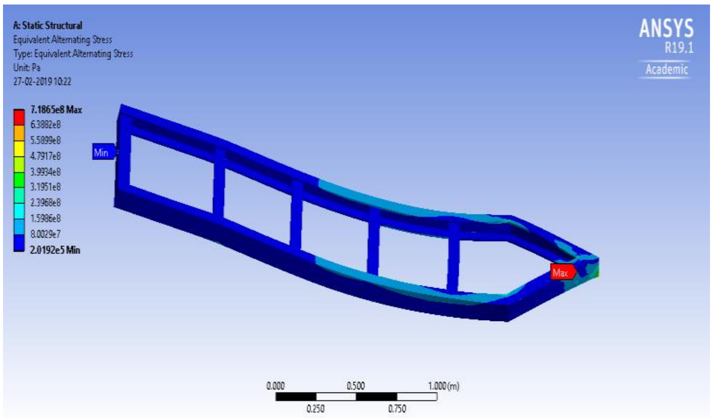

Fig.9: Equivalent Alternating Stress

Table 8: Results of Equivalent Alternating Stress

Time(s)	Maximum(Pa)	Minimum(Pa)	Average(Pa)
1.	2.0192e+005	7.1865e+008	3.4367e+007

Structural Steel > S-N Curve:

Table 9: S-N curve results data

Alternating Stress(Pa)	Cycles(1/s)	Mean Stress (Pa)
3.999e+009	10	0
2.827e+009	20	0
1.896e+009	50	0
3.999e+009	100	0
1.413e+009	200	0
1.069e+009	2000	0
4.41e+008	10000	0
2.62e+008	20000	0
2.14e+008	1.e+005	0
1.38e+008	2.e+005	0
1.14e+008	1.e+006	0
8.62e+007	10	0

RESULTS AND CONCLUSIONS:

The analysis may yield to stress levels are within the permissible limits and considered C-cross section welded to T-section members produces excellent resistance to bending and torsional stiffness with maximum equivalent stress of 1.6895e+008 Pa with total deformation of 6.1581e-003m. The life of this trailer with respect to the materials, load, and weldments exhibit a maximum of 1.e+006 cycles Stress based concepts usually deliver better results in case of welds by local mesh refinement. Hence, during the welding of carbon steels, low alloy high strength or stainless steels, adequate data on the weldability of the material including carbon equivalent, hydrogen induced, etc. should be established. Several testing methods are available to evaluate the cracking susceptibility.

REFERENCES:

[1]Akshay Nighot, Anurag A. Nema, Anant Sharma A International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 p-ISSN: 2395-0072

[2]Helmut Dannbauer, Christian Gaier and Klaus Hofwimmer, Fatigue Analysis of Welding Seams and Spot Joints in Automotive Structures, SAE International, ISSN 0148-7191-2005

[3]T. Marin, G. Nicoletto et alii, Frattura ed Integrità Strutturale, 9 (2009) 76 - 84; DOI: 10.3221/IGF-ESIS.09.08

[4]Wolfgang Fricke and Olaf DoerkFatigue Analysis of Fillet Welds around Stiffener and Bracket Toes May 2004.

[5]Rohan Y Garud, Structural Analysis of Automotive Chassis, Design Modification and Optimization International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 11 (2018) pp. 9887-9892

[6]Anurag, Amrendra Kumar Singh, Akash Tripathi,
DESIGN AND ANALYSIS OF CHASSIS FRAME, IJRE | Vol. 03 No. 04 | April 2016

[7]FEA Based Validation of Weld Joint Used In Chassis of Light Commercial Vehicles (LCV) In Tensile and Shear Conditions, INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT] ISSN: 2394-3696 VOLUME 2, ISSUE 3

[8]Pravin A Renuka, Dynamic Analysis Of A Car Chassis, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 6, November- December 2012, pp.955-959.

[9]K.Rajasekar Dr.R.Saravanan, Literature Review on Chassis Design of On-Road Heavy Vehicles, International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 7, September 2014.

[10]Hemant B.Patil, Sharad D.Kachave, Eknath R.Deore, Stress Analysis of Automotive Chassis with Various Thicknesses, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 6, Issue 1 (Mar. - Apr. 2013), PP 44-49

[11]Jadav Chetan S.Panchal Khushbu C., Patel Fajalhusen, A Review of the Fatigue Analysis of Automobile Frames, International Journal of Advanced Computer Research (ISSN (print): 2249-7277.

[12]Grzegorz Szczęśniak, Paulina Nogowczyk, Rafał Burdzik, Some basic tips in vehicle chassis and frame design, JOURNAL OF MEASUREMENTS IN ENGINEERING. DECEMBER 2014, VOLUME 2, ISSUE 4.

[13]Slivinskii E. V.Korchagin, Radin S. Yu., Rizayeva Yu. N Modernization of Bodies Tipper Trailers to Improve the Working Conditions of Maintenance, International Journal of Traffic and Transportation Engineering 2015, 4(2): 35-44 DOI: 10.5923/j.ijtte.20150402.01.