Design and Development for Three Wheeler Chassis

Manish M. Patil
Asstt. Professor, Department of Mechanical Engineering,
Dr. Sau. Kamaltai Gawai Institute of Engineering and Technology, Darapur Dist – Amravati Pin-444814(M.S)

Abstract: This project focuses on development of three wheeler chassis as objective function, while not compromising with required strength, frequency and stiffness. Chassis is one of the important components of vehicle which links suspension, steering system, wheel hub, Sit, body parts and Engine.

This project report presented about the design and development of chassis of three wheeler vehicle chassis. For this, analysis of chassis has to be performed. The parameters checked in the analysis are the displacement of the chassis structure and stresses under static condition. The modeling of new chassis is done by using Creo Parametric 3.0 and FEA by using ANSYS. Specifications of materials selection become a priority in order to construct the new chassis, based on the results of FEA, we selected Mild steel. The best design with minimum self-weight,maximum load capacity and minimum deflection under static loading was then identified based on the results obtained through FEA. The primary unknowns in this structural analysis are displacements and other quantities such as strains, stresses, and reaction forces are then derived from the nodal displacements.

Keywords*: Thee wheeler Vehicle, Ergonomic consideration, Von Moisses stresses, Chassis*

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I. INTRODUCTION

The frame is a skeleton upon which parts like gearbox and engine are mounted. So it is very important that the frame should not buckle on uneven road surface. Also it should not be transmitted distortion to the body. Two wheeler frames can be made of steel, aluminum or an alloy. Mostly the frame is consisting of hollow tube. If the natural frequency of two wheeler frame is coincides with excitation frequency then the resonance will occur. Due to resonance the frame will undergo dangerously large oscillation, which may lead excessive deflection and failure.A chassis consists of an internal framework that supports a man-made object. It is analogous to an animal's skeleton. An example of a chassis is the under part of a motor vehicle. That mass or weight reduction is an important issue in automotive industry. Chassis is a prominent structure for a moped body,which takes the loads during serious accidents, costly recalls; chassis also has an impact on product image. There is a great potential for optimizing weight of chassis by using alternate material without affecting its structuralbehavior. A chassis serves as the basic foundation on which all the parts of a machine rest. In any two wheelers, the chassis acts as a skeleton on which the engine, gearbox, driveshaft, transmission, driveshaft, differential, andsuspension are mounted.The chassis should be structurally sound in every way and support the body over the expected life of the two wheeler and may be beyond expected.

II. LITERATURE

The text books give the basic design of various chassis's of automobiles. The literature shows that the design of three wheeler chassis is different than the design of four wheeler chassis..In this paper a new chassis model is proposed. It will help both passenger three wheeler and Three wheeler load carrier , thus during manufacturing of three wheelervehicles the productivity drastically increases.

We go through following National/International Journal/Papers which are to be studied during project According to that they have various results & conclusions which are as follows-**Neeraja, C. H., C. R. Sireesha, and D. Jawaharlal**,have published in International Journal of Engineering.Research and Technology "Structural Analysis of Two Wheeler Suspension Frame.".

S. Agostoni, A. Barbera, E. Leo, M. Pezzola, M. Vanali,"investigation on motorvehicle structural vibrations Caused by engine unbalances"

Neeraja, C. H., C. R. Sireesha, and D. Jawaharlal, Dec 2013 "Structural Analysis of Two Wheeler Suspension Frame."

Bhunte and Deshmukh, studied the investigations made on the analysis techniques of the frame of the automobile, including both static and dynamic analysis.

Kumar et al., 2013 designed a three wheeler vehicle for physically handicapped people.

Carfagni, Monica, Dec 2012 "Virtual Scooter Prototype in The Design For Comfort."

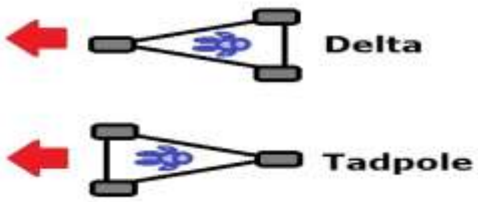
III. Design Considerations

Design considerations refer to some characteristics, which in-flounce the design of the element or, perhaps the entire system. The strength of each element, its dimension and geometry are important design consideration from the mechanical point of view. As a transport for the physically disabled people the overall safety, stability, reliability, control, comforts etc are a very much important and taken in to consideration while de-signing it. However, the general points of consideration during the designing of the three-wheeler are: simplicity, strength, stability, safety, corrosion and wear, weight, size, flexibility, ease of control, and all terrain tires for all terrain traffic ability/mobility, increased suspensions, biomechanics and comforts and cost.

- Chassis Frame

  In chassis design we increase the width from 260mm to 350mm to increase width our main aim is to fix two wheels in rear , 350mm is minimum distance require to fix two wheels because our three wheeler is narrow track vehicle.

Basically three wheelers are of two types-



3.1 Figure- Types of three wheelers

As we are developing chassis for three wheelers from two wheeler chassis so we are using delta design.

IV. CAD Modeling

The commercial designsoftware package, CREO 3.0 isused for the design of the chassis. The chassis frame is modeled with 3Ddimensional. The chassis was modeled as beam elements with circular hollow sections. The circular hollow section has a diameter of 25 mm and thickness of 5 mm. About 10 linear beam elements were used for the chassis. Material properties were assigned to the model. Load value was varied from 981 N.

Overall road condition including bumps, pot-holes etc. around the country is duly considered while choosing the wheel as well as its size. All the three wheels are of equal size having the diameter of 380 mm each. All terrain tires are used for better traffic ability. The body of the s three-wheeler is made of pipes, steel sheets of minimum possible thickness and fiber for lighter weight. One leaf springs are added to the rear axle for better suspension. An adjustable waterproof cushioned seat is attached with the chassis. While modeling; sharp edges, bends, nails are avoided to avoid accidents.

4.1 Figure- Isometric view of 3 wheeler chassis

The Chassis/Frame of the presently available three-wheeler is heavy and wheels are of big sizes. So while designing, unnecessary weight is reduced to meet the requirement. Comparatively smaller wheels are selected; keeping in mind that the weight of the narrow track three-wheeler should be as low as possible and must have required strength. The three-wheeler chassis is designed by using mild steel pipes reinforced with angle bars where necessary. The chassis can withstand necessary loads as well as absorbs shocks. The overall length and width are also reduced to some extent. Finally, the chassis is made by steel pipes having 30 mm diameter with 5 mm thickness.

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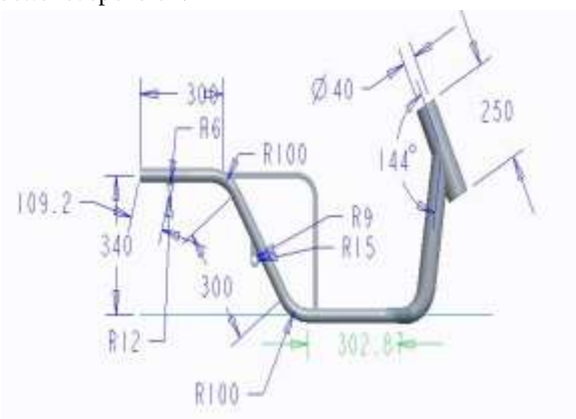
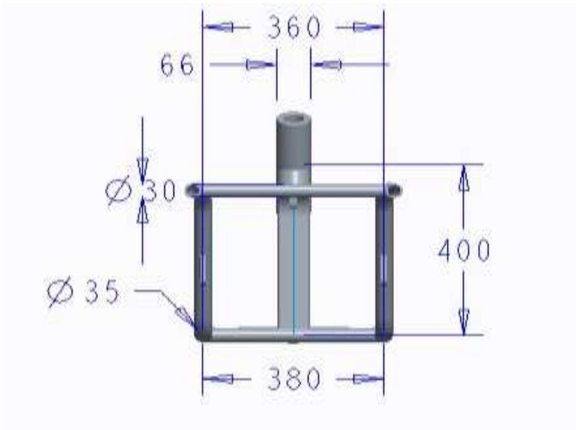
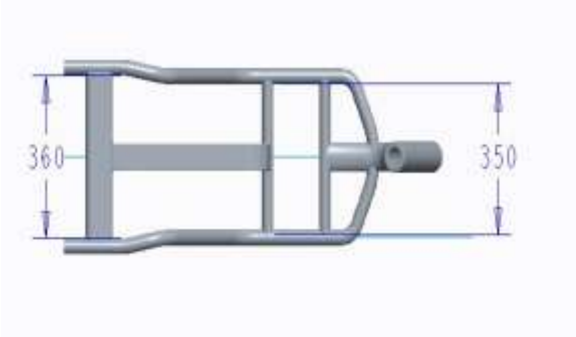


4.2 Figure- Side view of chassis developed



4.3 Figure-Front view of chassis



4.4 Figure-Top view of chassis

Table – Chassis specifications

Specification	Dimensions in mm
Chassis length	1200
Chassis width Front	350
Chassis width Rear	360
Chassis height	350
Pipe Thickness	5
Steering tunnel diameter	40
Pipe diameter	25
Riser member	300
Rear long member	300
Front Long member	300
Horizontal tunnel	100
Material	M.S

Table 3.2.1 Chassis specifications

Material used for chassis

An important type of automotive chassis, motorcycle chassis comprise of different auto parts and components like auto frame, wheels, two wheeler brakes and suspension. It's basically the frame for motorbikes that holds these components together. A motorbike chassis can be manufactured from different materials. But the commonly used materials are steel, aluminum, or magnesium. We used mild steel as our reference material.

Chemical composition (Ideal analysis to meet the majority of grades listed above)	
Carbon	0.16-0.18%
Silicon	0.40% max
Manganese	0.70-0.90%
Sulphur	0.040% Max
Phosphorus	0.040% Max

Table 4.2 chemical composition of mild steel

Max Stress	700-960 n/mm^2	dependent on ruling section
Yield Stress	300-440 n/mm^2 Min	dependent on ruling section
0.2% Proof Stress	280-420 n/mm^2 Min	dependent on ruling section
Elongation	10-14% Min	dependent on ruling section

Table 4.3 Mechanical properties in cold drawn condition

V. Static analysis

Static analysis deals with the conditions of equilibrium of the bodies acted upon by forces. A static analysis can be either linear or non-linear. All types of non-linearity's are allowed such as large deformations, plasticity, creep, stress stiffening, contact elements etc. this chapter focuses on static analysis. A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those carried by time varying loads. A static analysis is used to determine the displacements, stresses, strains and forces in structures or components caused by loads that do not induce significant inertia and damping effects. A static analysis can however include steady inertia loads such as gravity, spinning and time varying loads.

In static analysis loading and response conditions are assumed, that is the loads and the structure responses are assumed to vary slowly with respect to time. The kinds of loading that can be applied in static analysis includes,

1. Externally applied forces, moments and pressures
2. Steady state inertial forces such as gravity and spinning
3. Imposed non-zero displacements.

A static analysis result of structural displacements, stresses and strains and forces in structures for components caused by loads will give a clear idea about whether the structure or components will withstand for the applied maximum forces. If the stress values obtained in this analysis crosses the allowable values it will result in the failure of the structure in the static condition itself. To avoid such a failure, this analysis is necessary.

Analysis setting

To start with any analysis there is certain analysis settings have to be done in ANSYS. First we have to covert part file to IGS file which is supported format of ANSYS software.

In this project finite element analysis was carried out using the FEA software ANSYS. The primary unknowns in this structural analysis are displacements and other quantities, such as strains, stresses, and reaction forces, are then derived from the nodal displacements.

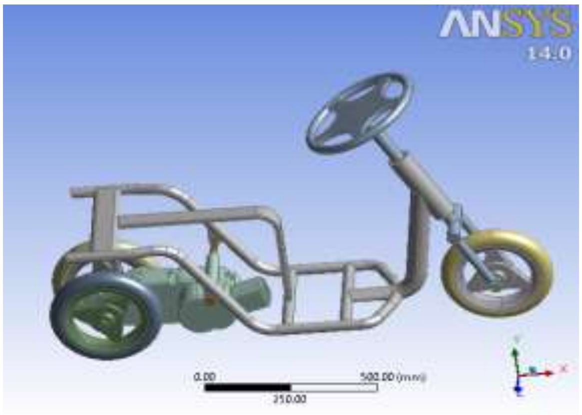
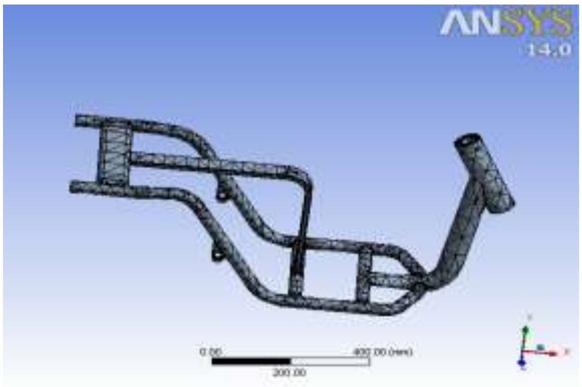


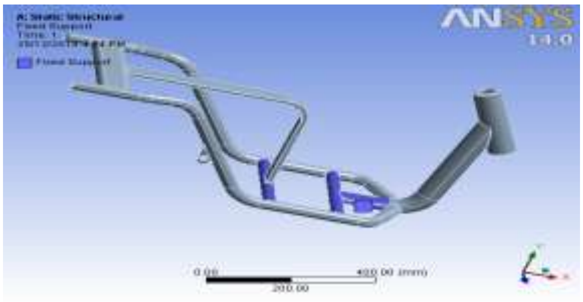
Figure 5.1 Conversion of part file to IGSformat (Ansys support format)

These settings are related to boundary condition, meshing and connection between meeting parts. This meshing can generate very fine mesh on the selected geometry which is shown in figure 4.1. Analysis setting of the chassis frame is done by, fixing support and applying the load and displacement in y axis direction



5.2 Figure- Chassis meshing in ANSYS

We fixed the supports as shown in Fig.-5.3 for ansys calculations.



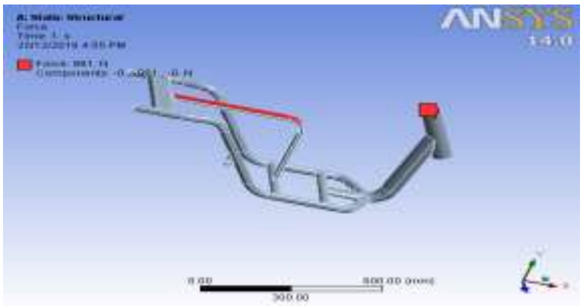
5.3 Figure- Fixing of chassis parts

Under Normal working conditions, the parts in blue shade are fixed parts and a load of 100 kg applied at front part and at rear 100 kg is applied andsimulation studies made. The obtained contour plots of deflection and stresses developed in the chassis areshown in Fig.4.3, Fig. 4.4 and Fig.4.5.

Setting of fixed support is same for both cases as mentioned below cases-

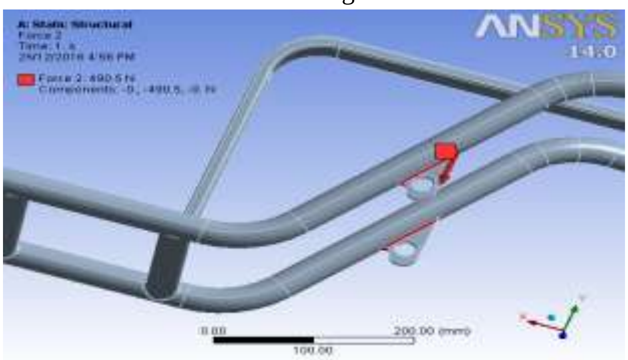
CASE-I

we applied load of 981 N self-weight on chassis frame and also add engine weight of 490.5 N on chassis



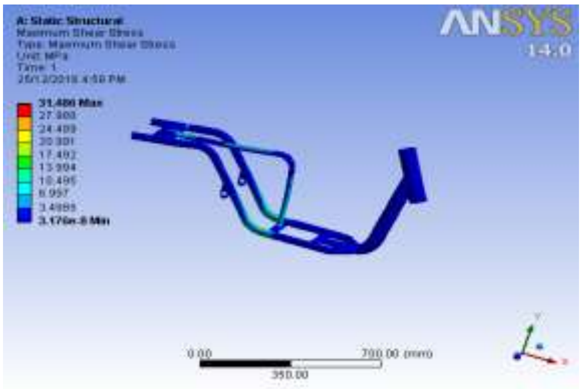
5.4 Figure-Body weight, Force acting on chassis

Also the engine is attached at rise member of chassis by giving clamps on either side and we consider maximum load of chassis is 50kg i.e 490.5 N.



5.5 Figure- Engine load acting on clamps of chassis

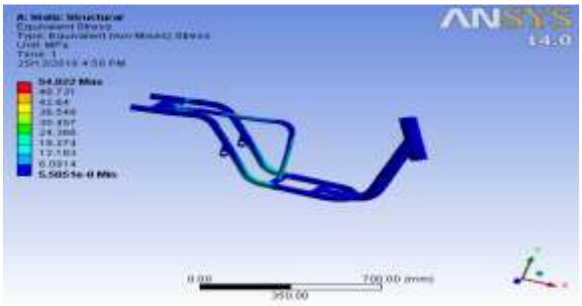
Maximum deflection for the normal load condition is: 1.14mm and Maximum stress for the normal load condition is: 31.486 N/mm2.



5.6 Figure – Maximum shear stress applied to chassis

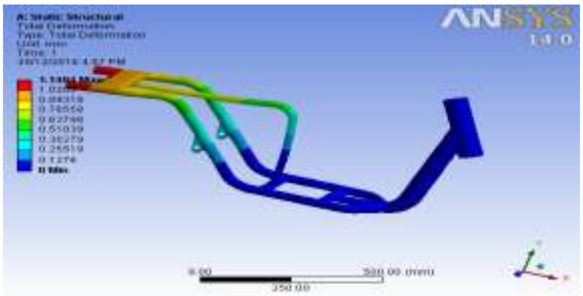
In this case, a material is said to start yielding when its **von Mises stress** reaches a critical value known as the yield strength.. The **von Mises stress** is used to predict yielding of materials under any loading condition from results of simple uniaxial tensile tests.

As we found von mises stress by applying 981 N on front and rear side ,we get maximum stress 54.822 mpa.



5.7 Figure- Von- mises Stress

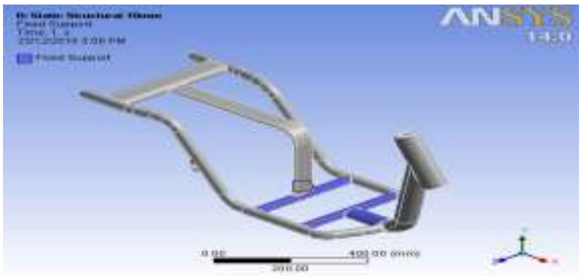
Total deformation of chassis frame after applying the 981 N load is 1.14 mm and which is desirable and safe.



5.8 Figure- Total Deformation

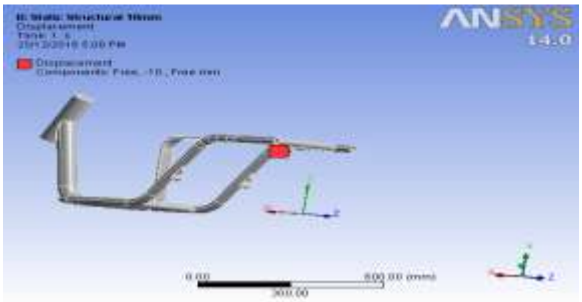
CASE- II

Asthe design is safe for applied load we have to test the body for maximum displacement after application of maximum load , so we now take 10mm displacement of chassis and following results were found-

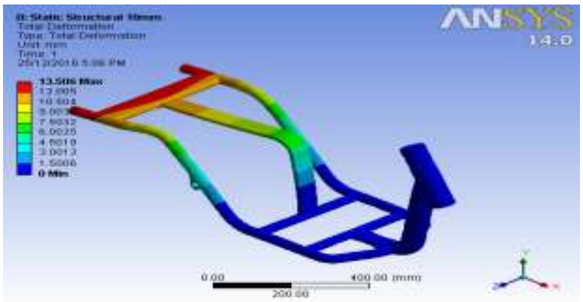


5.9 Figure- support points fixing

As we are checking for maximum deflection, we apply 12 mm deflection of chassis by applying displacement at suspension rest point where whose weight of body is applied.

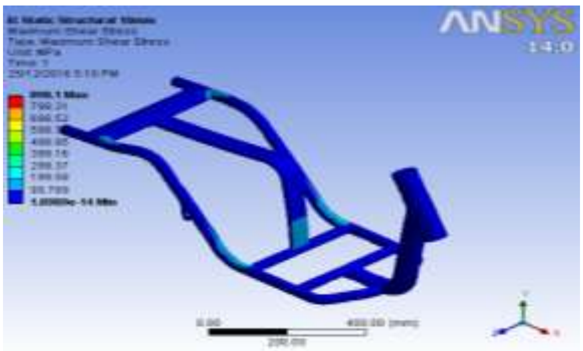


5.10 Figure- Point Allocation for force Displacement



5.11 Figure-Total deformation after 12 mm displacement

The total deflection of 12 mm results to produce maximum shear stress of 898.1 MPa while that stress is still safe



5.12 Figure- Maximum shear stress for 12 mm displacement

5.13 Figure- Von- mises Stress

VI. RESULT AND DISCUSSION

Results and methods presented illustrate how static structural analysis can be used to determine the chassis safety majors. This approach can be a expanded to analyze more complex chassis three wheeler design in products and assist with optimization with prior fabrication. Results indicate that the most significant factor influencing the chassis failure is compared with the fatigue strength of the material which has been studied and analyzed with the Ansys software.

Technologies like static structural analysis and fast personal computers plays a vital role in allowing engineers to optimize three wheeler chassis components. Utilize robust design for future scope.

Static analysis has been performed on chassisvehicle under both normal and overload conditions. The loading was calculated by assuming its capacity as1 person and also its engine weight as 50 kg. It was constrained at three wheels and the loading was uniformlydistributed load.Under normal loading conditions the vehicle has undergone a static deflection of 1.14 mm. vertically downwards and the stresses developed were 54.822 N/mm2. Whereas with 10 mmdeflection,898.1 N/mm2 stress were developed

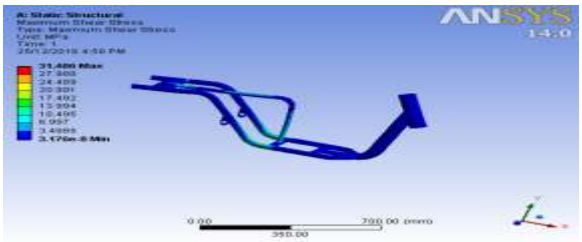
Grade of strength 910 N/mm2, we can say that the body can withstand these stresses. Hence the vehicle is said tobe safe under these conditions.

As we are using two wheeler moped chassis as our reference chassis, we first modeled two wheeler chassis and then made changes in that to develop THREE WHEELER CHASSIS. The newly designed three wheeler chassis is perfect to add one wheel in rear side and develop three wheelers.

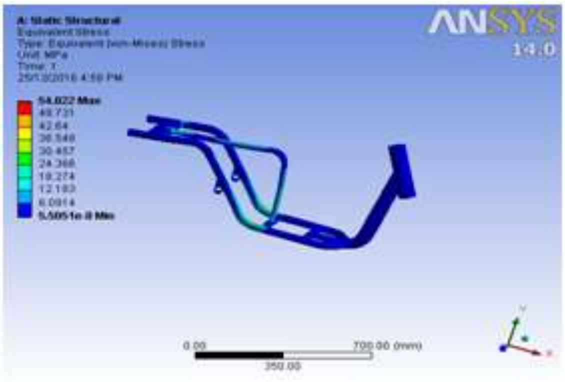
As per theoretical calculations and FEA result our chassis is safe for 100 kg load which applied at chassis frame and also we apply engine load 50kg at engine attachment point of chassis that seems to be safe.

We also checked our chassis for maximum 10mm deflection and in that case chassis is also safe so according to our result our chassis is suitable for manufacturing of small three wheeler car.

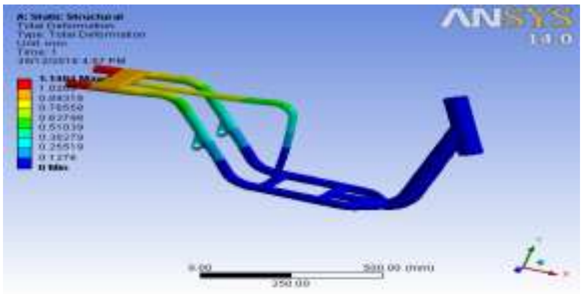
Results of Case I



6.1 Figure- Maximum shear stress developed for case I



6.2 Figure- Von mises stressfor case I



6.3 Figure- Total deformation for case

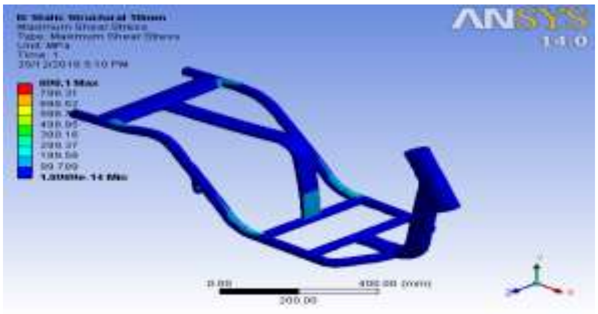
IModel (A4) > Static Structural (A5) > Solution (A6) > Results

Object Name	*Total Deformation*	*Shear Stress*	*Maximum Shear Stress*	*Equivalent Stress*
State	Solved			
Scope				
Scoping Method	Geometry Selection			
Geometry	All Bodies			
Definition				
Type	Total Deformation	Shear Stress	Maximum Shear Stress	Equivalent (von-Mises) Stress
By	Time			
Display Time	Last			
Calculate Time History	Yes			
Identifier				
Suppressed	No			

Orientation		XY Plane		
Coordinate System		Global Coordinate System		
Results				
Minimum	0. mm	-15.531 MPa	3.176e-008 MPa	5.5051e-008 MPa
Maximum	1.1484 mm	18.777 MPa	31.486 MPa	54.822 MPa
Information				
Time	1. s			
Load Step	1			
Substep	1			
Iteration Number	1			
Integration Point Results				
Display Option		Averaged		

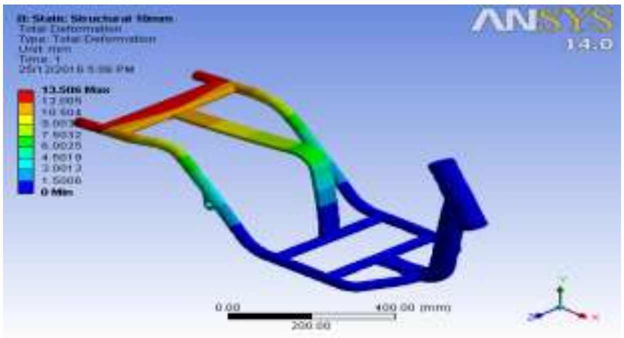
Table 6.1 Result generated for CASE 1 in ANSYS software

Result of case II



6.4

Figure- Maximum stress for case II



6.5 Total deformation for case II

Model (B4) > Static Structural (B5) > Solution (B6) > Results

Object Name	*Total Deformation*	*Maximum Shear Stress*	*Shear Stress*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Maximum Shear Stress	Shear Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Orientation			XY Plane
Coordinate System			Global Coordinate System
Results			
Minimum	0. mm	1.8989e-014 MPa	-334.73 MPa
Maximum	13.506 mm	898.1 MPa	427.32 MPa
Information			
Time	1. s		
Load Step	1		
Substep	1		
Iteration Number	1		
Integration Point Results			
Display Option		Averaged	

Table 6.2 Result generated for CASE 2 in ANSYS software

VII. CONCLUSIONS

The concept model of chassis is successfully designed and analyzed. The design is done by Creo 3.0 software; analysis is done by using ANSYS. The design is developed after the study of the existing two wheeler chassisdesign and analysis is performed. Basic load calculations have beenperformed by using the concepts strength of materials and these results have been compared with the resultsobtained through ANSYS. The FEA results and theoretical results are in closed agreement, and the design stressesare within the limits of strength of material. Based on these results the TWO WHEELER chassis is modified into the THREE WHEELER chassis which increases comfort and stability.

Also some of conclusions at which we reach are as-

- The three wheeler developed is found helpful for handicapped person also which gives more comfort to them.
- This model is unique in Indian market in narrow track three wheeler car.
- This model of three wheeler is derived from two wheeler so its cost is slightly more than two wheeler but less than other three wheelers.
- In Indian market no one three wheeler car is still launched by any automobile manufacturers so this could be the successful one.
- The chassis we developed can able to withstand more load and does not fail even after 10mm deflection as we saw in ANSYS results.

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Author's Profile –

Prof. Manish M. Patil

Currently serves as the Workshop Faculty Department of Mechanical Engineering at the Dr. Sau. Kamaltai Gawai Institute of Engineeringand

Technology, Darapur.Dist – Amravati India. His research is at the Manufacturing science and Production Technology. He studies firms' knowledge management strategies by employing TPM and TQC. He has more than 8 years Industrial Experience and 12 Years Teaching Experience in engineering colleges. He also Complected MBA from SantGadge Baba Amravati University, Amravati.and pursing Ph. D. in Master of Business Management and administration from RTM University Nagpur.