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DYNAMIC ANALYSIS OF A COMMERCIAL 3-WHEELAR PASSENGER VEHICLE CHASSIS BY USING ANSYS

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Abstract:
The chassis is backbone of any commercial passenger vehicles. The chassis of 3 wheeler light vehicle chassis easily subjected to the vibration mainly from the weight of the passengers and road irregulaties. The work involved in this paper is to determine static and dynamics analysis and key characteristics of a commercial three wheeler passenger vehicle chassis. The study of static characteristics include identifying location of high stressed area by applying maximum load, and also determine the dynamic characteristics of chassis such as the natural frequencies and mode shapes by using finite element method. The 3D model of the chassis was formed by means of CREO 3.0 and converted into parasolid file exported in into ANSYS for static and dynamic analysis.

Key Words: Chassis Frame, ANSYS Work Bench & Model Analysis

1. Introduction:

Passenger vehicles are used for the transportations in different organizations. In case any of the excitation frequencies matches with the normal frequencies of the chassis, then resonation will happens. The undercarriage will encounter hazardously gigantic movements, which may incite extreme shirking and frustration. The vibration of the suspension will likewise cause high anxiety focuses at specific areas, weariness of the structure, slackening of mechanical joints, and making of commotion and vehicle uneasiness. To take care of these issues, consider dynamic attributes on the vehicle case as fundamental. The torsion firmness and modular parameters were resolved tentatively. Then results are used to approve the limited component demonstration. Finally the skeleton was enhanced to build the basic solidness. It was noticed that the torsion mode commanded the characteristic recurrence.

A. Chassis: Chassis is the basic spine of a business vehicle. In future all voyager automobiles have gotten unibody improvement, which implies their undercarriage and bodywork have been composed into each other. The segments of the vehicle like engines, transmission system including handle gearbox, propeller shaft, wheels and tires, suspension, controlling systems and electrical structures are mounted on the Chassis plot. So it is similarly called as carrying unit. As a vehicle comes the road, the vehicle chassis is empowered by one of a kind forces affected by the road obnoxiousness, engine, transmission. Under such unique dynamic excitations, the vehicle outline tends to vibrate. In case any of the excitation frequencies agrees with the trademark frequencies of the vehicle outline, then resonation ponder will happen, the skeleton will encounter dangerously huge movements, which may incite over the best redirection and frustration. The vibration of the body creates high nervousness centers at particular regions, shortcoming of the structure, discharging of mechanical joints, and development of commotion. The body structure is the more noteworthy section in auto vehicle. The vehicle shape subject to this skeleton gives techniques for immersing imperativeness from frontal, side and rollover impacts. It is noticed the influence of the lower imperativeness levels transmitted to vehicle occupants and condition, will reduce the chances of harm. Consequently the skeleton should be arranged with the end goal that could bear the different static and dynamic stacking experienced while working at different working condition. The scrutinizing of the present paper is to convey happens which may correct the issues related with the structures of a business vehicle.

B. Functions of the Chassis Frame:

- ✓ To carry the passengers load with baggage.
- ✓ It has to support the weight of the body, various mountings weight, etc.,
- ✓ To withstand under the impact loads caused due to the sudden change in moment of the vehicle.
- ✓ To withstand the stresses caused because of the terrible street condition.
- ✓ To withstand radiating power while cornering

C. Objectives:

- ✓ Create a 3d Model of the existing Chassis assembly
- ✓ Perform Finite Element analysis on the existing Chassis assembly and identify the maximum stressed locations.
- ✓ Identify the root cause of the failure of the chassis through Finite element analysis.
- ✓ Optimize the Chassis to withstand worst loading through FEM.
- ✓ To study the dynamic behavior of chassis through model analysis

2. Literature Review:

Dr. R. Rajappan, et. al, [1] Vehicle case is a noteworthy part in a vehicle. In vehicle frame diverse kind of disappointments are happen because of static and dynamic stacking condition. In this present work static and dynamic load qualities are investigated utilizing FE models from this work. The paper has investigated the regular frequencies and the mode shapes of the vehicle skeleton, exploring the mounting areas of parts on the vehicle case and watching the reaction of the vehicle under static stacking conditions.

Monika S. Agrawal, et. al, [2] An exertion is made to survey the examinations that have been made on the distinctive investigation strategies of vehicle outlines. That examination might be exhaustion investigation, static investigation or dynamic investigation. Various expository and test systems are accessible for the examination of the car outlines. An endeavor has been

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made in the article to introduce a review of different procedures created for the examination of car edges and consequences of that investigation because of which additionally think about on the frame will turn out to be simple A data of evaluation of a suspension arm, vehicle suspension parts, examination of vehicle skeleton, for the exhaustion investigation of a vehicle undercarriage with bolted joints are considered.

Ahmad O. Moaaz1, et. al, [3] The real concentration in the vehicle fabricating businesses is plan of vehicle body with more pay stack limit and conceivable less weight. An essential part of case's outline and examination is the anxiety circulation and exhaustion life of expectation process. Weariness is a standout amongst the most vital parameters to consider when planning vehicle segments. Weariness investigation of the track frame has been the concentration of various past works. It is discovered that the case investigation essentially comprises of stress examination to foresee the powerless indicates and weakness examination anticipate the life of the case

P. Meghana, et. al, [4] In a vehicle industry while outlining the parts, the most basic perspective considered was the conservativeness and the heaviness of the segment. The mounting sections are implied for supporting the auxiliary part and electronic segments. Furthermore it should bolster the outer load, i.e. traveler's weight. Analysis was performed for existing and altered outlines. However the wellbeing of streamlined plan was expanded. Weight of the both the optimized outline and existing design was same but the distortion and stresses were superior to the existing design and thus the optimized configuration ought to be utilized as a part of training.

3. Methodology:

A 3D model of the commercial passenger 3-wheeler vehicle chassis was modelled using CREO software as shown in fig 1, to carry out static structral analysis by using Ansys Software. While exporting 3D modelled chassis file to ansys, converted to parasolied file. The following material properties and loading parameter were defined for static structural analysis

Mechanical Properties of Structural Steel:

- ✓ Young's modulus: 210GPa,
- ✓ Poisson's extent: 0.30 and
- ✓ Density = 7850 kg/m3.
- ✓ Yield Strength = 250 MPa

Table 1: The load details of commercial passenger 3-wheeler vehicle chassis

Total Weight acting on the Chassis in Kgs		
S.No	**Components of loads**	**Weight in Kgs**
1	Chassis Self weight	108
2	Gear Box and Engine weight	63
3	Passenger Cabin Weight	85
4	10 Passengers (10X80) + Luggage (20Kgs)	820
5	Vehicle Weight	400
Net Load		1476

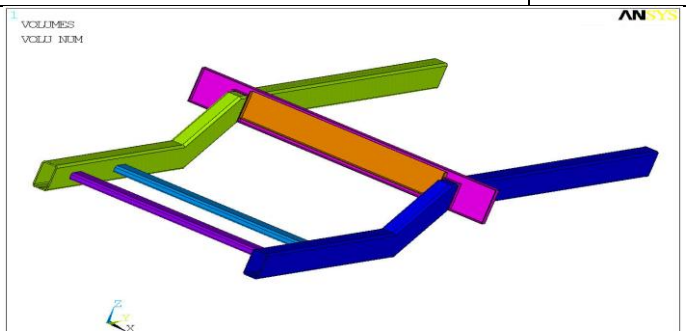

Figure 1: 3D Model of 3 wheeler passenger vehicle

The 10 Node 3D solid 92 element has taken for the meshing the chassis. The 10 Node 3D solid 92 element as shown in fig.2.

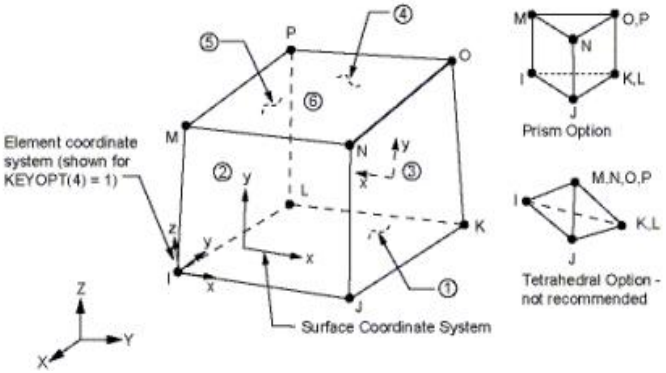

Figure 2: SOLID92 Geometry

The figure 3 shows the finite element model of commercial passenger 3-wheeler vehicle chassis.

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Figure 3: FE Model of 3 wheeler passenger vehicle chassis

A Finite Element analysis was carried out on the commercial passenger 3-wheeler vehicle chassis by using ANSYS for maximum loading conditions according to the components as shown in table. 1. The applied boundary conditions for the static structural analysis on chassis of the vehicle were labeled in the fig 4.

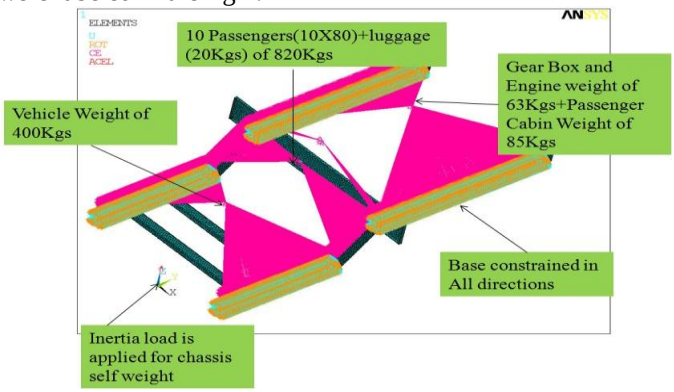

Figure 4: Boundary conditions and loading of the passenger vehicle Chassis

4. Results and Discussions:

A. Static Structural Analysis Results and Discussions: It is observed from the static structural analysis that the existing commercial 3-wheeler passenger vehicle chassis subjected to the maximum Von Mises stress 338 Mpa as revealed in the figure 5 which is greater than the yield strength of the material.

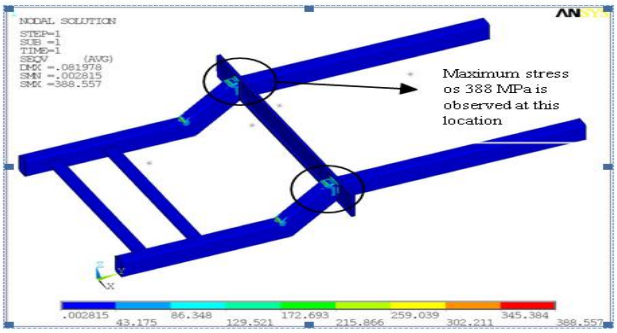

Figure 5: Von-Mises Stress on 3 wheeler passenger vehicle Chassis

The results the existing vehicle chassis is not safe for the loading conditions as mentioned in table no1. It is recommended the high stressed area has to strengthen by adding additional sheet of 4mm thickness. Based on the recommendation the modified model of existing chassis as shown in figure 6.

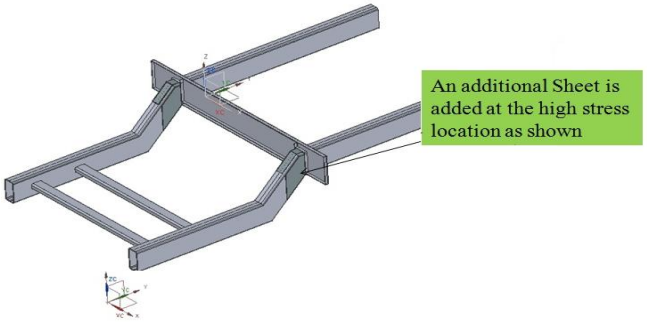

Figure 6: Modified model of the chassis

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The static structural analysis was performed in ANSYS on the modified 3-wheeler passenger vehicle chassis under the maximum load condition. The figure 7 shows Von-Misess stress distribution over 3-wheeler passenger vehicle chassis.

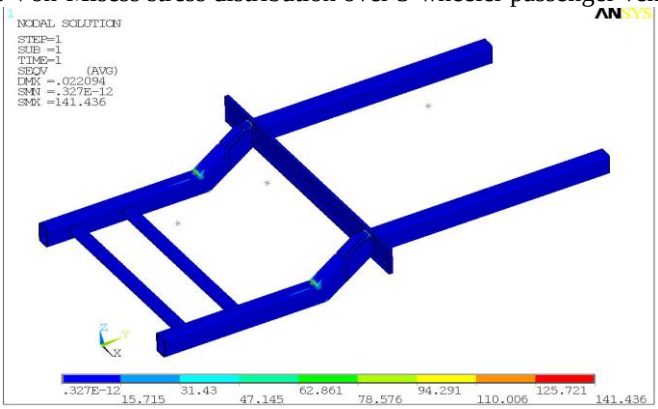

Figure 7: Von-Mises Stress on 3 wheeler passenger vehicle Chassis

B. Dynamic Analysis of Modified Chassis Results and Discussions: The dynamic analysis was carried out on the modified chassis to investigate the structural behavior at different frequencies. From this analysis the initial six natural frequencies of mode shapes and respective deformations were analyzed. The 1st frequency was obtained at 33.438 Hz and the maximum deflection is 8.18mm as shown in figure 8

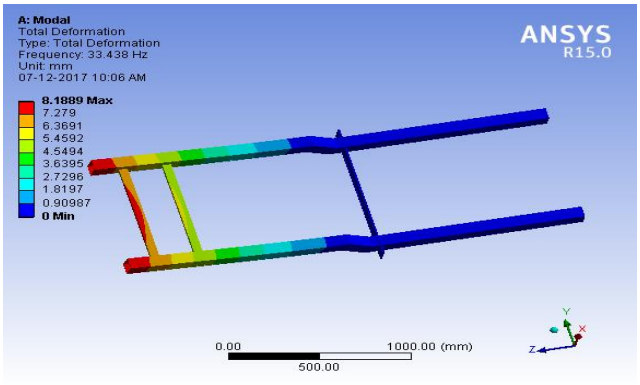

Figure 8: The total deformation of 1st Mode @33.438

The 2nd frequency was obtained at 45.488 Hz and the maximum deflection is 7.32 mm as shown in fig.9

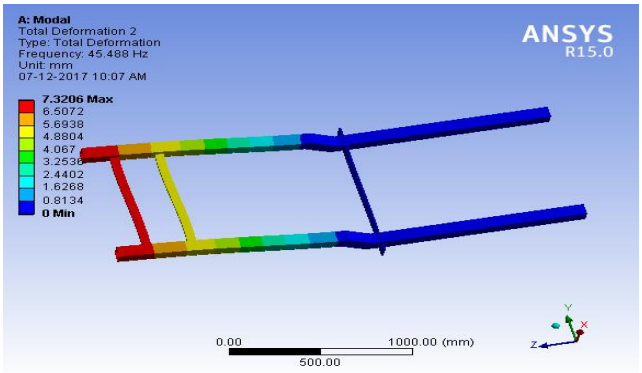

Figure 9: The total deformation of 2nd Mode @45.488

The 3rd frequency was obtained at 55.618 Hz and the maximum deflection is 9.78 mm as shown in fig.10

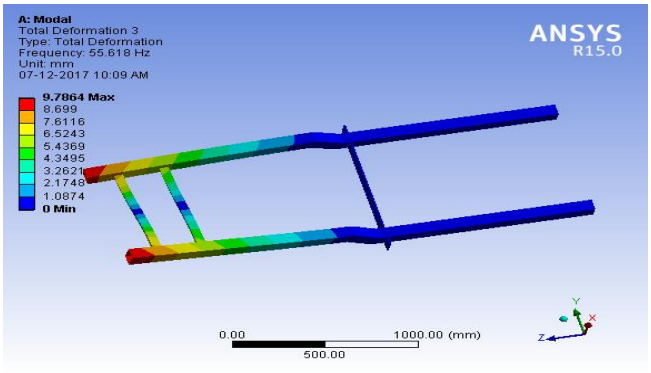

Figure 10: The total deformation of 3nd Mode @55.618

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The 4th frequency was obtained at 103.87 Hz and the maximum deflection is 22.71 mm as shown in figure 11

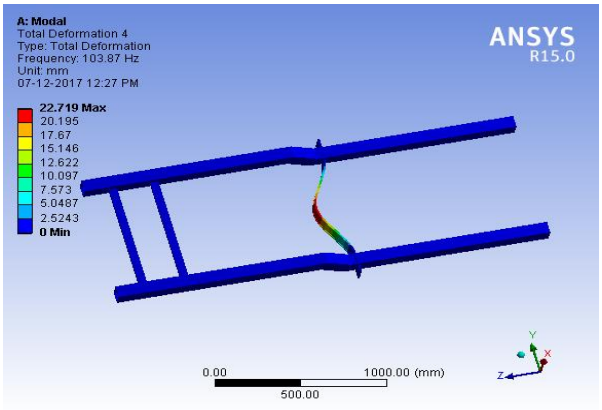

Figure 11: The total deformation of 4th Mode @103.87

The 5th frequency was obtained at 173.65 Hz and the maximum deflection is 13.32 mm as shown in fig.12

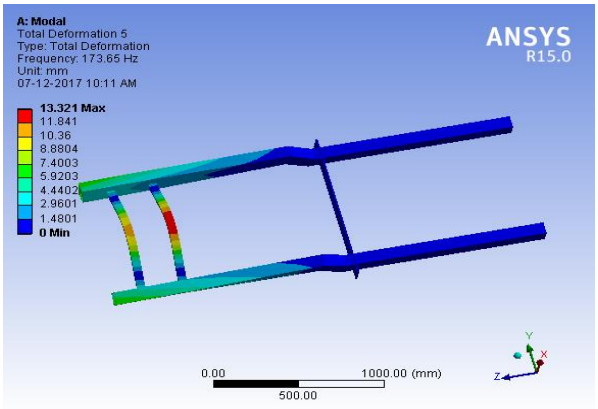

Figure 12: The total deformation of 5th Mode @173.65

The 6th frequency was obtained at 187.37 Hz and the maximum deflection is 13.32 mm as shown in fig.13

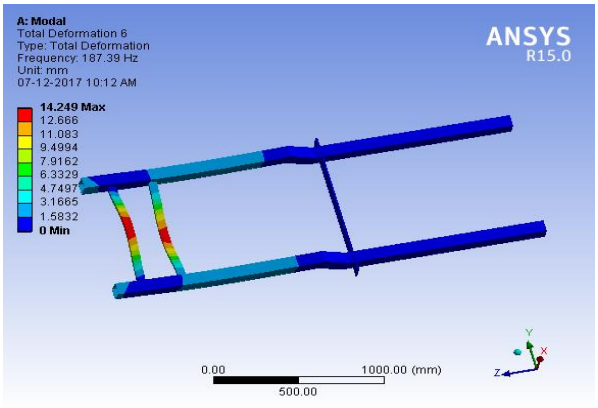

Figure 13: The total deformation of 6th Mode @187.37

5. Conclusion:

The paper has investigated the crack propagation area of the existing vehicle chassis under the extreme loading conditions. It is recommended that to strengthen the area of crack propagation adding additional sheet with 4mm thickness. Based on the recommendation the modified model was investigated under the same loading conditions. The investigation results revealed the stresses induced values in the modified chassis of the vehicle was below the designed limits of the chassis material.

Table 2: Results of existing and modified chassis

S.No	Items	Existing Chassis	Modified Chassis
1	UX	0.08	0.02
2	UY	0.04	0.007
3	UZ	0.024	0.002
4	USUM	0.011	0.022
5	Von Mises Stress	388MPa	141MPa
6	Tensile Stress	290MPa	98MPa
7	Compressive Stress	116MPa	35MPa

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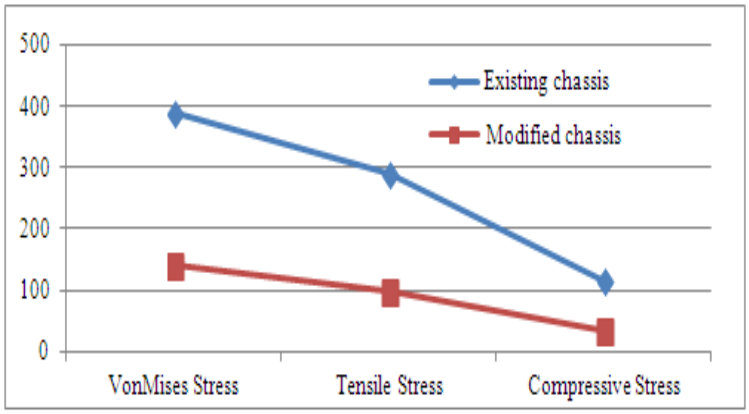

Figure 14: Comparison of stress values of modified and existing chassis.

It is observed from the fig.14 that the various stress values of modified chassis were under the design limits of the material. Hence it concluded that the modified chassis model was safe under considered static loading condition. The dynamic model analysis was performed on the modified chassis obtain the initial six natural frequencies and the mode states of the vehicle chassis under static stacking conditions. Out of six modes of frequency fourth mode having frequency 103.87 Hz and it is having total deformation of 22.719mm which seems critical in observation as shown in fig.13.

Table 3: Results of model analysis of modified chassis

Mode No	Frequency, Hz	Deflection, mm
1	33.438	8.18
2	45.488	7.32
3	55.618	9.78
4	103.87	22.719
5	173.65	13.321
6	187.37	14.249

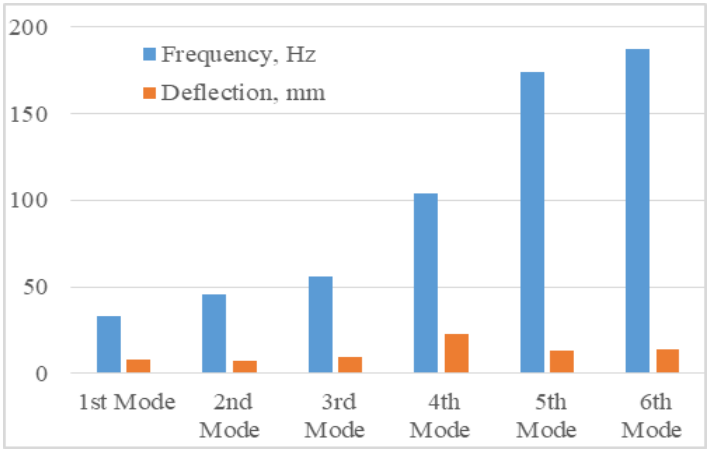

Figure 15: Total deformation at different Modes of frequency

The detailed investigation under static and dynamic was proved that the modified commercial 3-wheeler passenger vehicle chassis is safe under static and dynamic loading conditions.

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