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VIBRATION REDUCTION IN CONVENTIONAL VEHICLES BY INCREASING THE STIFFNESS ON THE CHASSIS FRAME

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ABSTRACT
The major hazard overcoming by the heavy vehicle transport corporation in our country is generation of noises and it is due to loosening of components mounted over the chassis frame. For this reason transport corporations are spending lot of money at reconditioning centres. Ladder type chassis is the most commonly used because of its better bending and torsion strength. The source for the failures of fasteners in the road excitation frequency lying between 0 to 100 Hz. The natural frequency of the vehicle chassis frame for bending and torsion lies at the same range resulting in resonance causing the frame to vibrate. It is highly impossible to replace the chassis and suspension system with latest ones for the huge number of heavy vehicles under operation across the country. In our project we had shifted the natural frequency of bending and torsion above the road excitation frequency by the use of reinforcement plates placed at different geometries at the side rails of the frame. The modal analysis were conducted for various thickness of reinforcement plates like 5, 7 and 9mm. Software used in this work is CATIA V5 R20 for modeling, ANSYS for Analysis.

Keywords: chassis frame, reinforcement plates, modal analysis.

INTRODUCTION
Automotive chassis is the supporting frame like backbone of any automobile to which various mechanical parts like engine, axle assemblies, tires, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It gives strength and stability to the vehicle under different conditions. Frames provide strength as well as flexibility to the automobile. Chassis frames are generally manufactured from steel alloys. Frame that holds the body and motor of an vehicle. The vibration of the chassis will also cause high stress concentration at certain location loosening of mechanical joints cause noise and vehicle discomfort. To solve this problem reinforcement plates are placed. There are different types of chassis include they are, Ladder chassis, Backbone chassis, Monocoque chassis etc. Ladder type chassis is most commonly used chassis for heavy vehicles.

LITERATURE REVIEW
[1] *Abhishek Singh** *et al*. determined the structural analysis of ladder chasses for higher strength by finite element package hypermesh. Four different vehicle chassis have been modeled by considering four different cross-sections. Namely C, I, Rectangular Box (Hollow) and Rectangular Box (Intermediate) type cross sections. For validation the design is done by applying the vertical loads acting on the horizontal different cross sections. He observed that the Rectangular Box (Intermediate) section is more strength full than the conventional steel alloy chassis. [2] *Roslan Abd Rahman:* does stress analysis on heavy duty truck chassis by finite element package ABAQUS. To improve the fatigue life of components at critical point by design modifications the stresses can be reduces. He uses ASTM low alloy steel a 710 C (Class 3) with 552 MPa of yield strength and 620 MPa of tensile strength for chassis founds the maximum stress 386.9MPa at critical point occurred at opening of chassis. This critical point is located at element 6104 and node 3045, which was in contacted with the bolt from it, he concludes, that this critical point is an initial to probable failure. [3] *Romulo Rossi Pinto Filho*, who analyzed on the Automotive Frame Optimization. The objective of his study was basically to obtain an optimized chassis design for an off-road vehicle with the appropriate dynamic and structural behaviour. The studies were consisted of three main steps. Firstly, the modelling of the chassis used in a commercial off- road vehicle using commercial software based on the finite elements method (FEM). Secondly, a series of testing were conducted to obtain information for modelling and validation. In the finite element model, the author has developed the chassis by using steel with closed rectangular profile longitudinal rails and tubular section cross-member. Then, a modal analys is procedure was accomplished on the real chassis and finite element model structure in order to establish the real structure to the chassis structures. Based on the result, the analys is and experimental procedure applied had significantly improved the overall structural stiffness by 75% by maintaining the centre of gravity and the total weight was increased by 6%. [4] *Guo and chen* (2008), research into dynamic and modal analysis of a space chassis (complex 3-dimensional chassis) and analyse transient response using the principal of superposition. *Cicek Karaoglu*: does stress analysis of heavy duty truck chassis with riveted joints by using a finite element package ANSYS version 5.3. He examine the effect of the side member thickness and connection plate thickness with length change, the thickness of the side member is varied from 8 to 12 mm, and the thickness of the connection plate is also varied by local plate from 8 to 12 mm, the connection plate thickness is varied from

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7 to 10 mm, and the length of the connection plate (L) is varied from 390 to 430 mm during his study. From it he concluded that if it is not possible to change the side member thickness using local plates, because of increase in weight of chassis then choosing an optimum connection plate length (L) seems to be best practical solutions for decreasing the stress values

OBJECTIVES

Excitation frequencies generated during different working conditions regularly meets the natural frequency of the chassis frame resulting in resonance condition. Because of the vibrations produced with maximum amplitude mechanical joints gets loosened, causing misalignment and noise generation. The natural frequency of the conventional vehicles lies within the range of road excitation frequency. In order to overcome this problem, we going to Increase the stiffness of the frame by shifting the natural frequency by placing reinforcement plate at frame rail and cross member.

LADDER CHASSIS

Ladder chassis is considered to be one of the oldest forms of automotive chassis or automobile chassis that is still used by most of the SUVs till today. As its name connotes, ladder chassis resembles a shape of a ladder having two longitudinal rails inter linked by several lateral and cross braces.

MATERIAL PROPERTIES

For this analysis Bharath Stage-II chassis has been chosen.

Material	Structural steel
Chassis Type	Ladder
Volume	$8.1902e^7$ cubic metres
Mass	652.93 kg
Young's Modulus	$2e^5$ MPa
Poisson's Ratio	0.3
Density	7850 kg/m^3
Tensile Yield Strength	250 MPa
Compressive Yield Strength	250 MPa

FINITE ELEMENT

Bus chassis has been modeled with CATIA V5 R20. Chassis model have been shown in Figure-1.

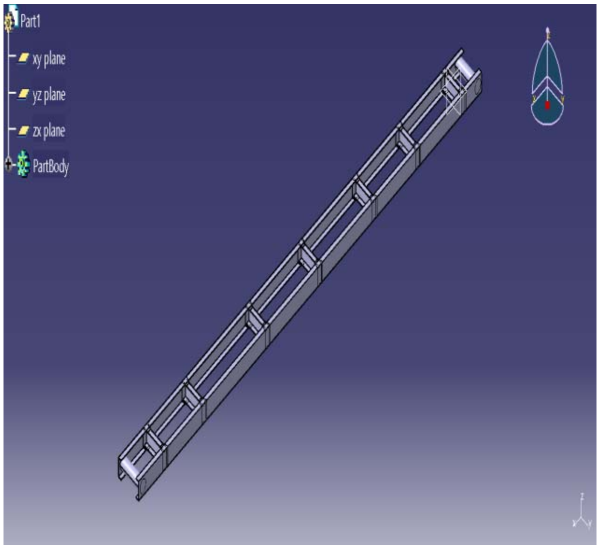

Figure-1. Modelling of chassis frame in CATIA.

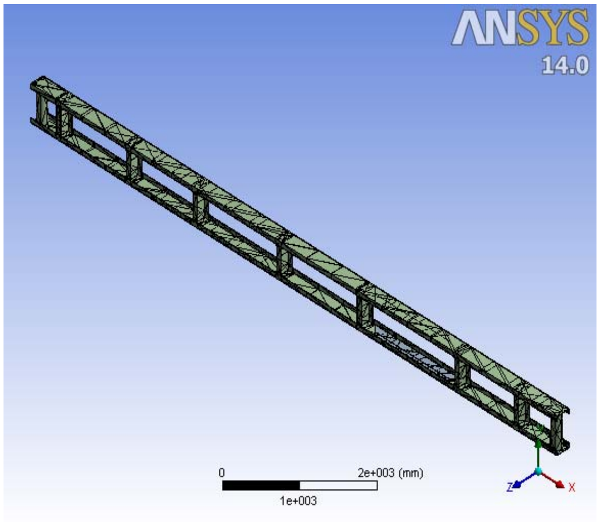

Figure-2. Meshing of chassis frame in ANSYS 14.0.

There are approximately 5485 nodes and 2635 elements. And free-free boundary condition has been chosen.

MODEL ANALYSIS AND RESULTS

Model analysis was calculated for chassis frame and its natural frequency is 49.666Hz.

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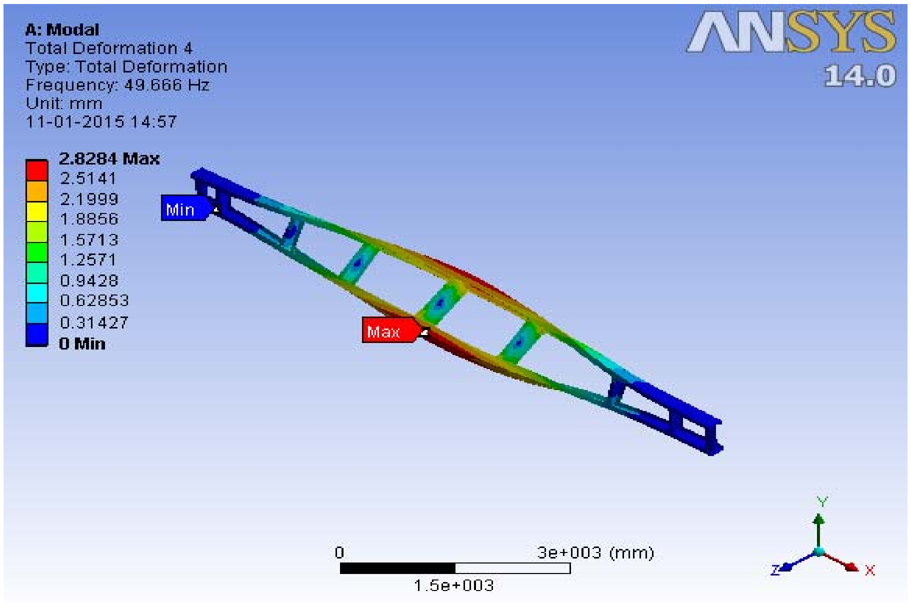

Figure-3. Natural frequency of chassis frame without reinforcement plates.

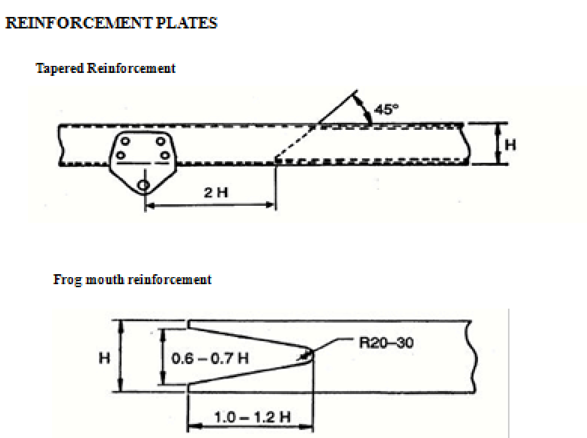

Figure-4. Tapered and Frog mouth reinforcement.

REINFORCEMENT PLATES

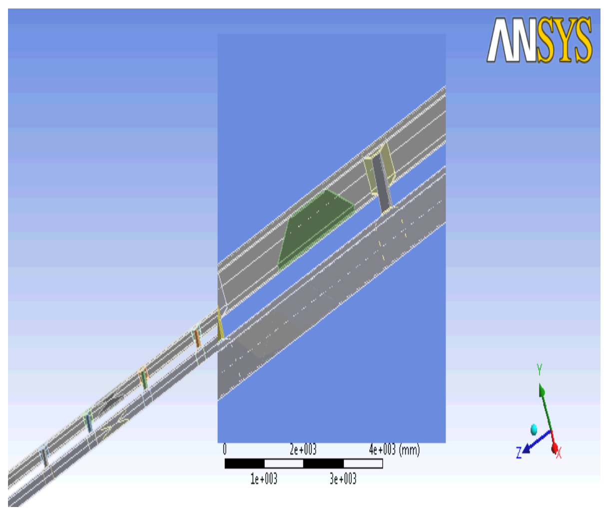

Figure-5. Modelling of tapered reinforcement.

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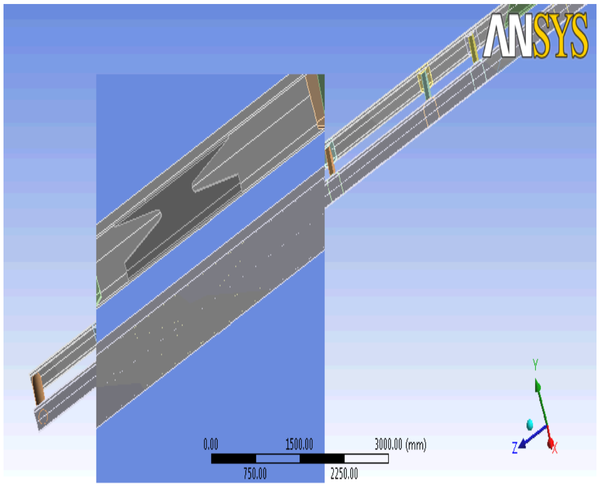

Figure-6. Modelling of frog mouth reinforcement.

After modelling of tapered and froug mouth reinforcememt plates should be placed in side rails of the chassis. In th Figures 5 and 6 shown in above.

MODEL ANALYSIS OF TAPERED AND FROG MOUTH REINFORCEMENT

After placing the reinforcement plate's natural frequency of chassis frame increases shown below:

Tapered reinforcement

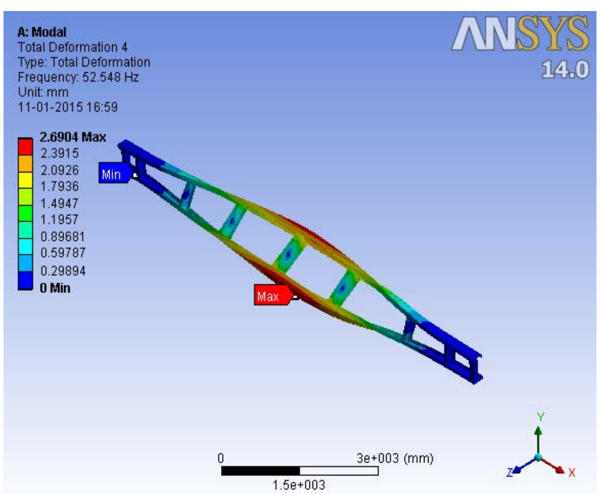

Figure-7. First mode of frequency.

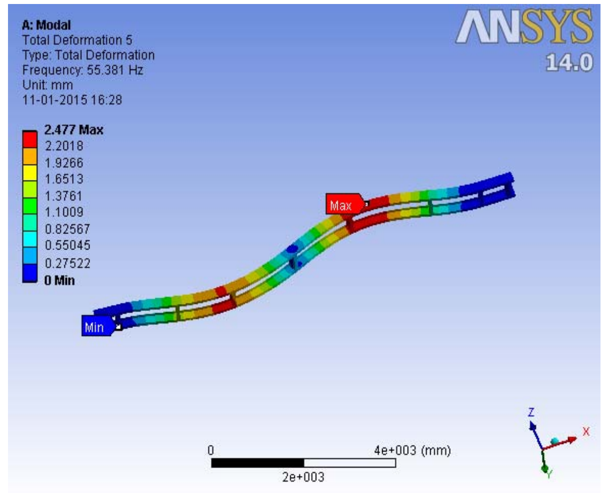

Figure-8. Second mode of frequency.

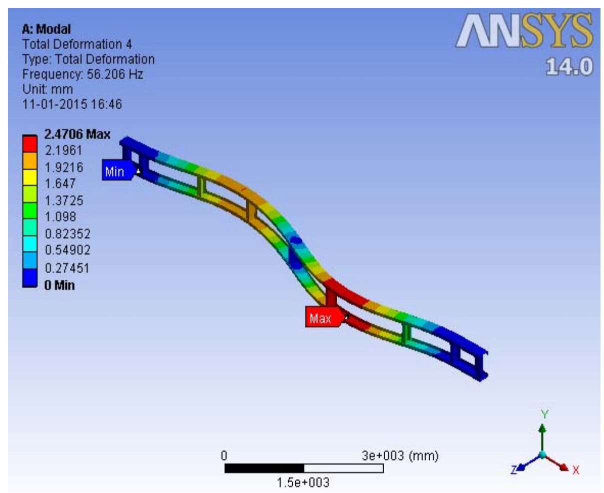

Figure-9. Third mode of frequency.

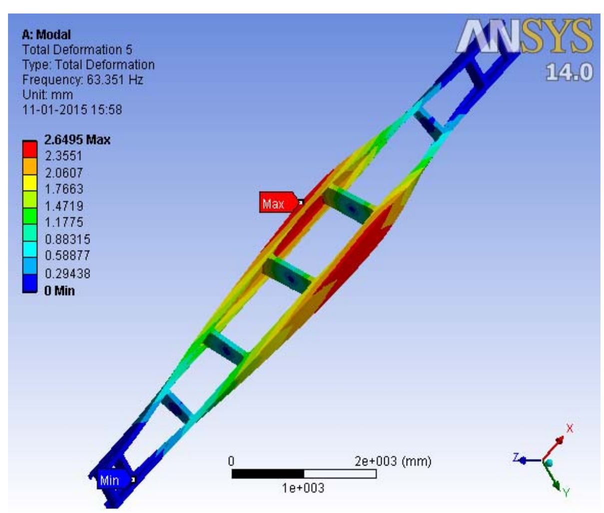

Figure-10. Fourth mode of frequency.

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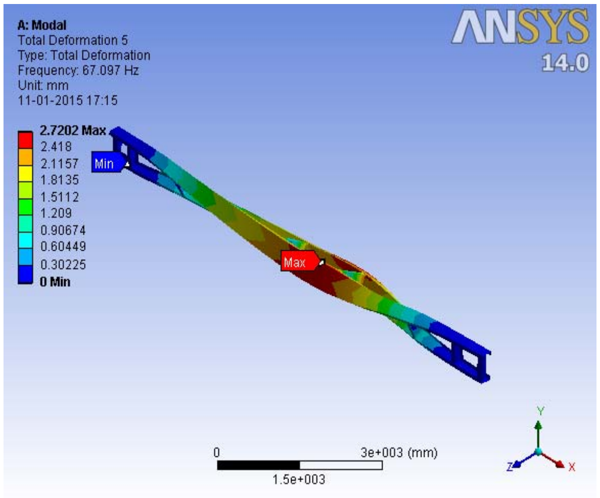

Figure-11. Fifth mode of frequency.

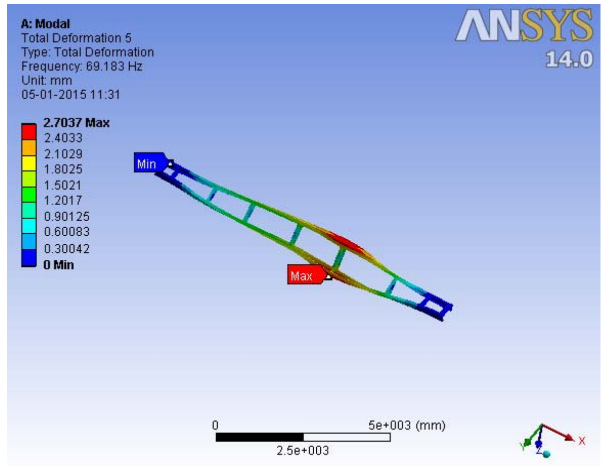

Figure-12. Sixth mode of frequency.

Table-1. Natural frequency shift in Hz for different length.

9mm thickness plate			
Reinforcement plate length in mm	Mass	Natural frequency	Deflection
657	11.935	52.548	2.4575
766	14.892	55.381	2.4775
876	17.849	56.316	2.4678
1095	23.764	63.350	2.6495
1314	29.678	67.097	2.6682
1533	35.592	69.183	2.6983

Model analysis was done different set of thickness like 5, 7 and 9mm. Finally 9mm thickness plate has been for further analysis. Because natural frequency variation is better than remaining and the length of plate is chosen by height of the side rail of the frame. After fixing of tapered reinforcement plates the natural frequency increases up to 69.183Hz.

Frog mouth reinforcement

Table-2. Natural frequency shift in Hz for different length.

9mm thickness plate			
Reinforcement plate length	Mass	Natural frequency	Deflection
657	11.325	55.107	2.4575
766	14.082	55.618	2.4889
876	17.239	56.206	2.4706
1095	23.152	64.849	2.6221
1314	29.066	67.097	2.7202
1533	34.080	70.87	2.6010

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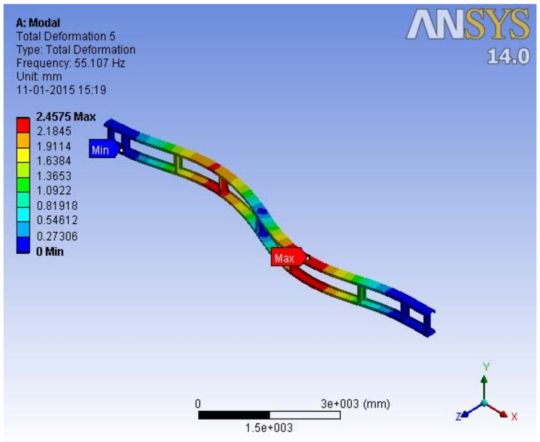

Figure-13. First mode of frequency.

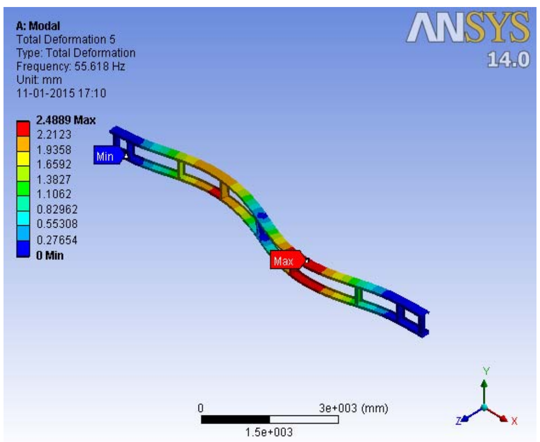

Figure-14. Second mode of frequency.

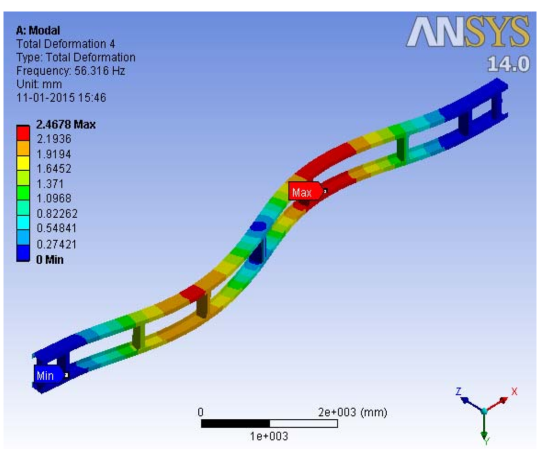

Figure-15. Third mode of frequency.

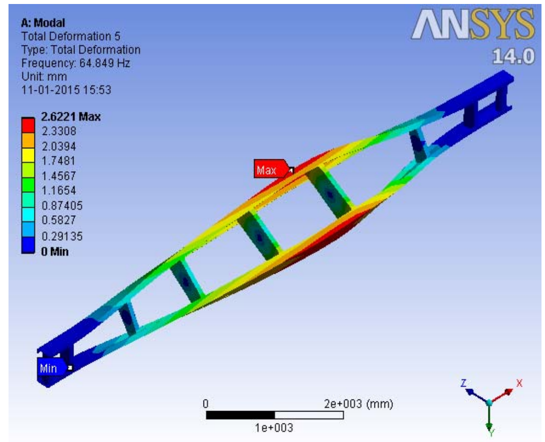

Figure-16. Fourth mode of frequency.

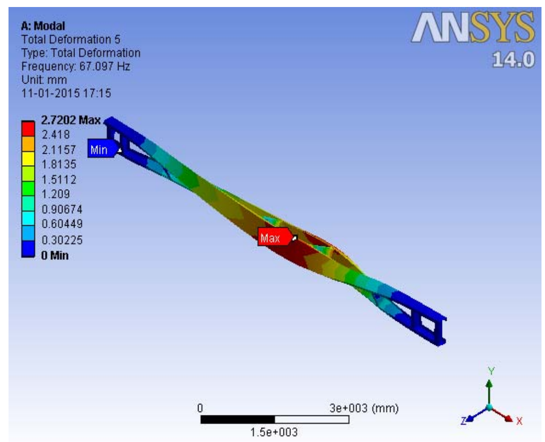

Figure-17. Fifth mode of frequency.

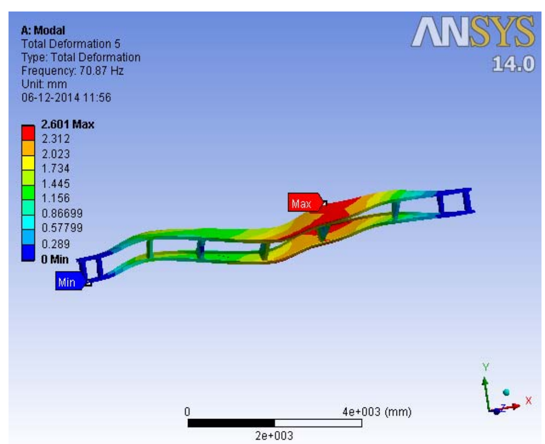

Figure-18. Sixth mode of frequency.

After placing of frog mouth reinforcement plate first mode shape with natural frequency of bus chassis is 55.107HZ. In above Table-2 it can be show clearly. After increasing of plate length and thickness natural frequency of chassis increases and the deflection of chassis is

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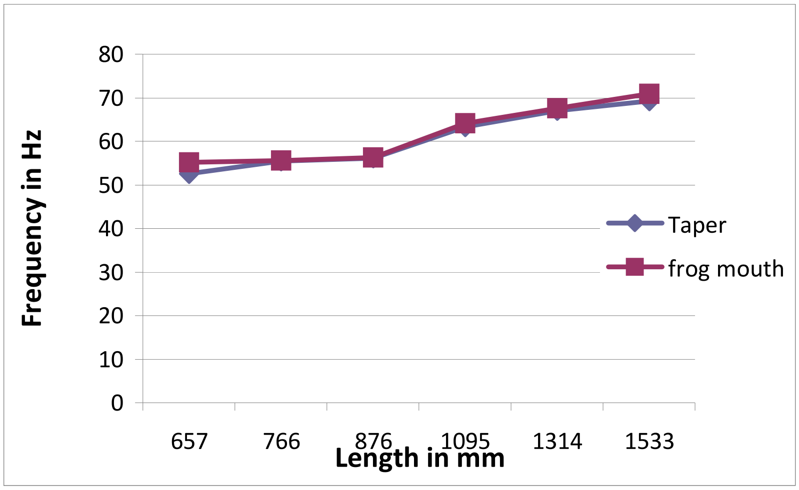
decreased. The thickness of the plate length has been chosen on bases of height of the side rail. Finally natural frequency shifted to 70.87 Hz for Fog mouth reinforcement and its deflection is 2.6010.

TAPERED Vs FROG MOUTH REINFORCEMENT

After the calculation of model Analysis results were compared to obtain better result. The natural frequency of chassis increases slightly by increasing chassis length and thickness and it can be shown below on the flow chart.

a) Tapered reinforcement plate
Max natural frequency =69.183Hz

b) Frog mouth reinforcement
Max natural frequency =70.87Hz



Comparison with natural frequency of tapered and Frog mouth reinforcement

The flow shows that while increasing the length of the plate natural frequency of chassis also increased.

CONCLUSIONS

After modelling the heavy vehicle chassis in CATIA V5 R20, it is analysed in ANSYS workbench 14.0, we conclude that, an updated Bus chassis FE model to evaluate the critical characteristics like vibration, strength. Natural frequency of the chassis is 49.666 Hz. After increasing the chassis thickness by placing of reinforcement plates, natural frequency of chassis slightly increases.

- Natural frequency of chassis is shifted from 49.66 Hz to 69.183Hz in tapered and 70.87 Hz in frog-mouth reinforcement plate.
- Natural frequency of the Bharath Stage -II chassis increases considerably more in frog mouth reinforcement than in tapered one.
- Finally we conclude that natural frequency slightly increases to 70.87Hz by placing of suitable plates and also reduced in total deflection.

REFERENCES

[1] Pravin A Renuke. 2013. Dynamic analysis of car chassis using Finite Element method in. Vol. 2.

[2] Dr. R. Rajappan. 2013. Static and modal analysis of chassis by using fea in. Vol. 2.

[3] Haval Kamal Asker, Thaker Salih Dawood and Arkan Fawzi Said. 2012. Stress analysis of standard truck chassis during gramping on block using finite element method. 7(6).

[4] Kutay yilmazçoban, yaşar kahraman tojsat. 2011. Truck chassis structural thickness optimization with the help of finite element technique. 1(3).

[5] Fui T. H., Rahman R. A. 2007. Statistics and Dynamic Structural analysis of a car chassis, in.

[6] Fahi F. and Walker J. 2004. Advanced Applications in Acoustics, Noise and Vibration, 1st Ed, spon press, London.