ANALYSIS OF VIBRATION REDUCTION IN RAILS BY USING ETHYLENE PROPYLENE DIENE MONOMER (EPDM) RUBBER MATERIAL

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Abstract

From few decades, the fracture of rail has found a peculiar issue in railways and the reason is due to the high dynamic frequency propagation in rail joints. Reducing the dynamic vibrations in rails is one of the solutions to overcome the mentioned problem. This article try to study the influence of design parameters on dynamic response of the railway track structure by implementing Finite Element Method (FEM). Two types of rail absorbers have been considered and compared i.e EPDM and DVA It is found that , EPDM with different layers at rail joints exhibits more efficiently in reducing vibrations and also have very good damping coefficient, excellent abrasion resistance and good tear resistance when compared DVA.

Key words: Railway track, Rail absorber, Finite element method, Vibrations, Ethylene Propylene Diene Monomer (EPDM), Dynamic Vibration Absorber (DVA)

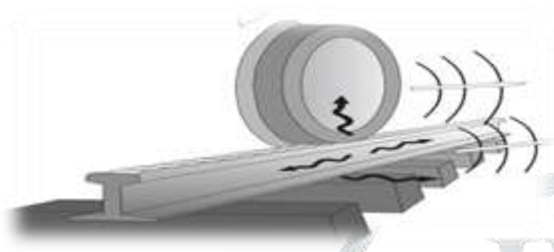
1. Introduction

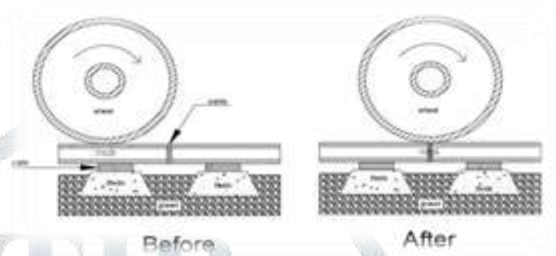
Railway is seen as a means of environmental friendly transportation by providing efficient mass transit. However, noise and vibration problems due to railway operation become public, technical and administrative concern. The predominant source of noise from railway is associated with the rolling of the wheel on the rail. The roughness on the wheel and rail tread forms excitation and causes vibration of the track. When vibration propagates in the wheel and rail, the structure radiates noise. The main sources of vibration in a train are track defects in welding or rolling defects, rail joints, etc. The nature of vibration itself is random and covers a wide frequency range.

The ballast is crushed granular material, of uniform size, placed as the top layer of the substructure in which the sleepers are embedded. The most important functions are resisting vertical, lateral, and longitudinal forces applied to the sleepers to maintain track in its desired position, provision of resiliency and energy absorption for the track, provision of drainage, and reduction of traffic induced stresses in the underlying layers, and facilitating maintenance operations. Rail Fastenings are components which together form the structural connection between rail and sleeper. The fastening system is used to hold the rail onto the sleepers, to ensure fixing of the rails. The choice of fastening greatly depends on the type of sleeper and geometry of the rail.

Fig 1 :Vibration and noise on Rail track due to absence of absorbers

Fig 2:Dynamic rotation of the wheel on track



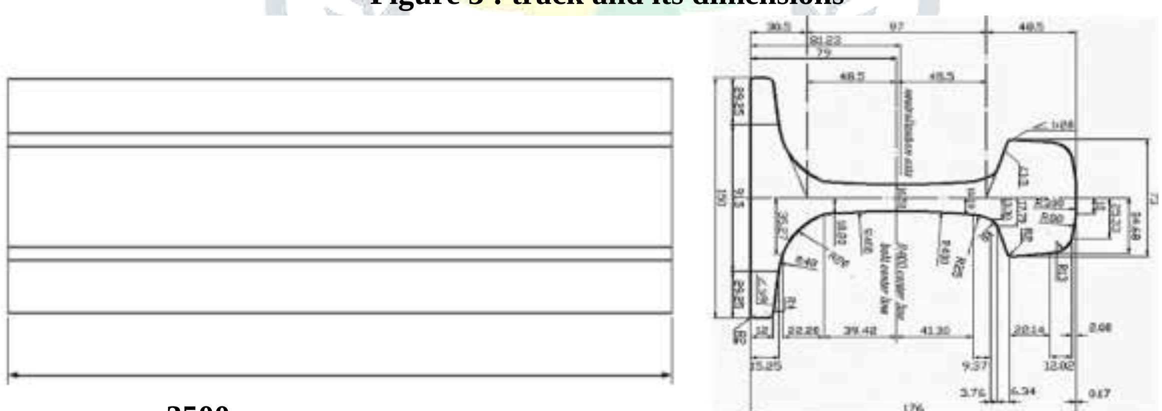


2. Design

Model 1 : Design of the Base rail track with out absorber

The design we have proposed gives a confidential result in the analysis part which shows that the vibration will be considerably reduced. The design part is given below figure 3 , the 52kg broad gauge rail track was chosen which is mostly used all over India. The dimensions are standard according to the Indian Railways.

Figure 3 : track and its dimensions



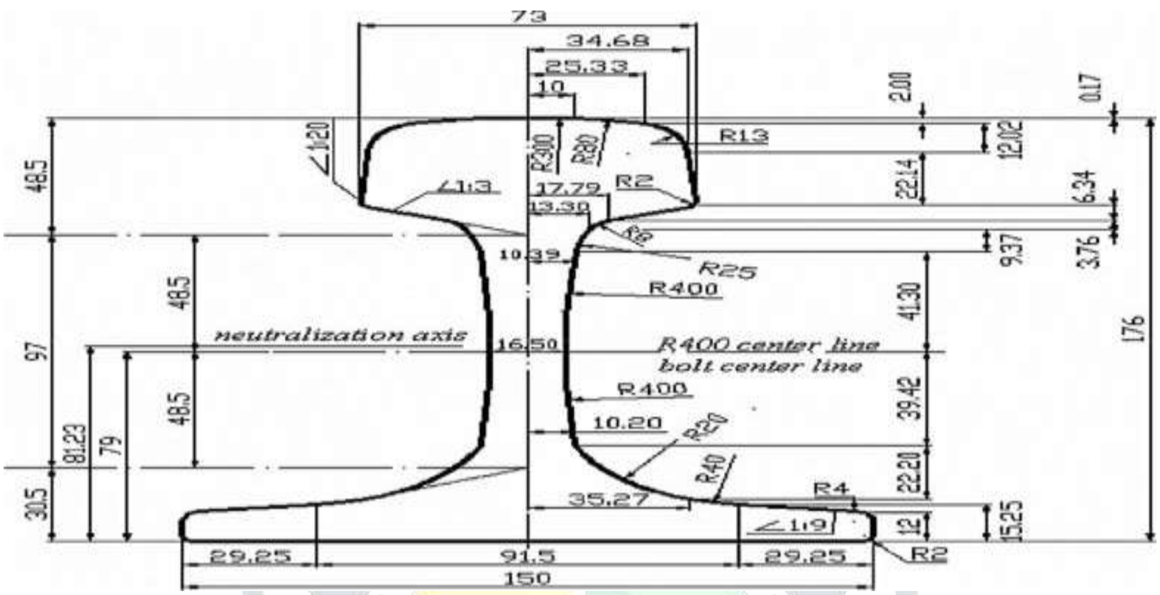
All dimensions are in mm (not to scale)

The analysis is carried out for typical data obtained from Indian Railways. The analysis is carried out for only one side of the railway track. The rail cross-section is shown in figure 4 and parameters are shown in table 1.

Table 1: Major dimensions of rail track and its dimensions

S.NO	Technical terms	Dimensions in mm
1.	Length	3500
2.	Flange	150
3.	Web	97
4.	Flange thickness	22
5.	Web thickness	16.5

Figure 4 : Rail cross section



All dimensions are in mm

Fig 5: Cross-section of the rail with absorber(single layer)

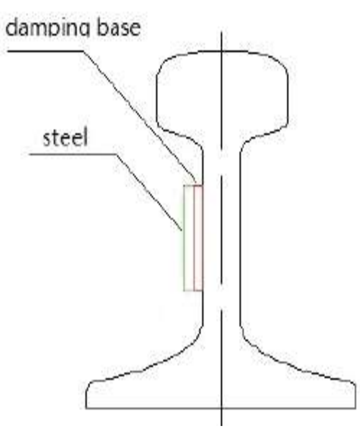


Table 2 properties of rail cross-section

Cross section area of rail	66.15×10^{-4}	m2
Moment of inertia	2158×10^{-8}	m^4
Distance between two-sleeper pads	0.6	m
Young modulus of rail	2.0678×10^{11}	N/m^2
Density of rail	7600	Kg/m^3

3. Model analysis On Rail

Model analysis is used to determine the natural frequencies and mode shapes of a structure. The natural frequencies and mode shapes are important parameters in the design of a structure for dynamic loading conditions. Meshing is applied to assemble using tetrahedron and brick Mesh 200 elements, the model having 21539 nodes and 9818 elements. Fixed Boundary conditions are applied at bottom of rail and rigid connection is arranged between rail and absorber plates. Model and harmonic analysis is performed. Here natural frequency and resonance frequencies are noted to find out optimum model to arrange the absorbers.

Fig 6 :Base Rail track cross section

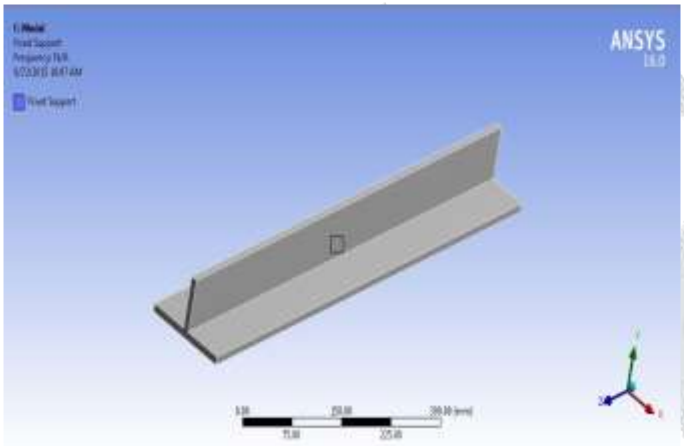


Fig 7: Rail track cross section without absorber

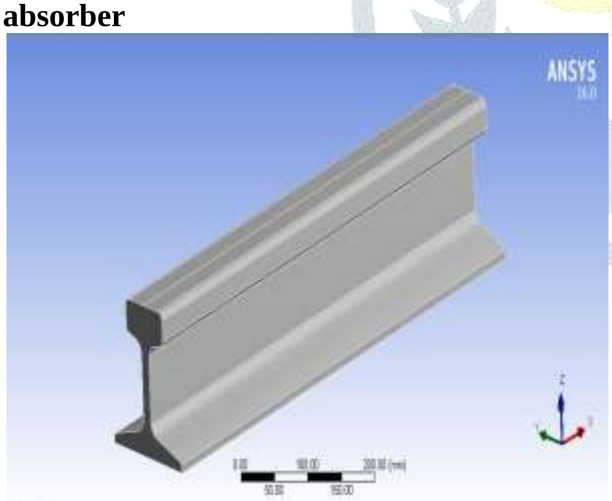
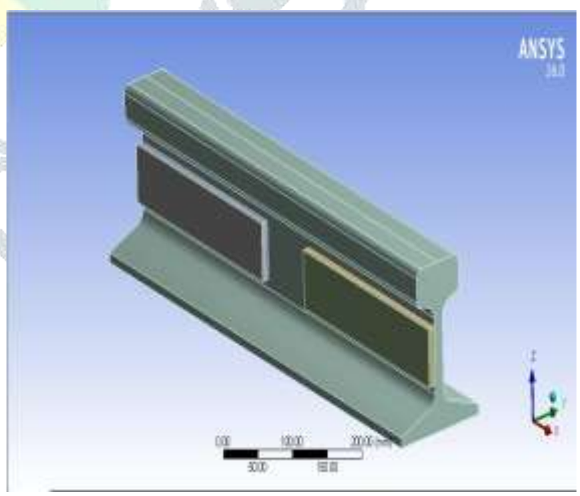
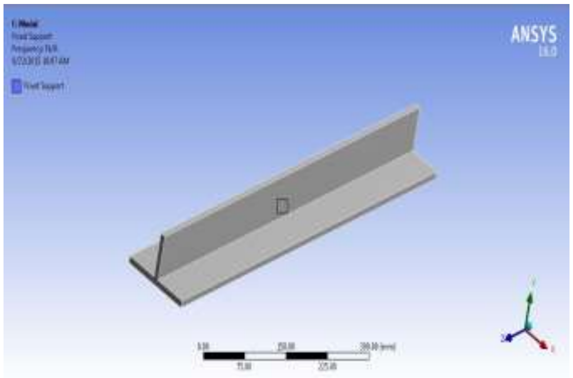
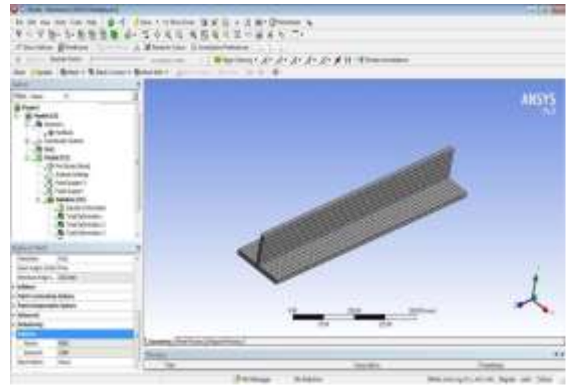
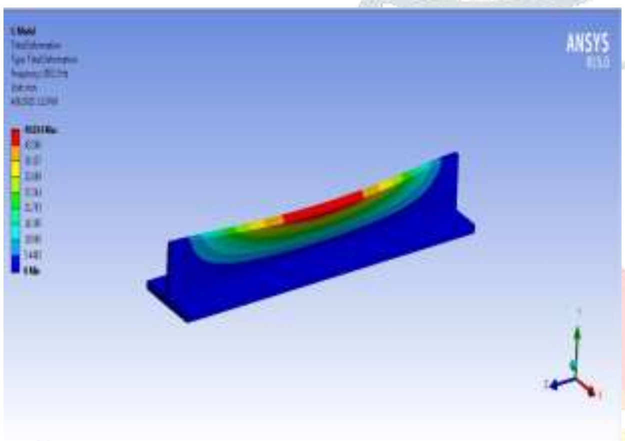
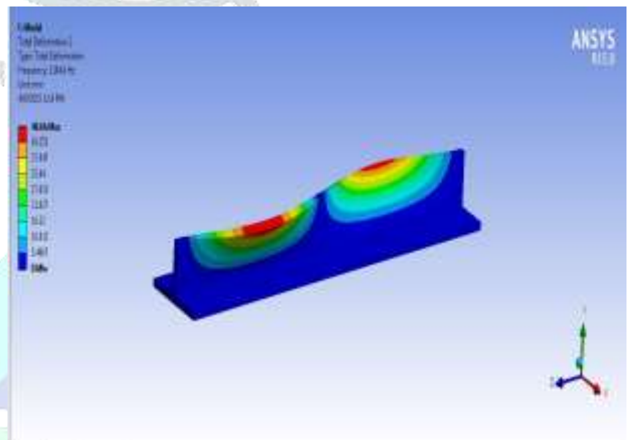


Fig 7: Rail track cross section with absorber

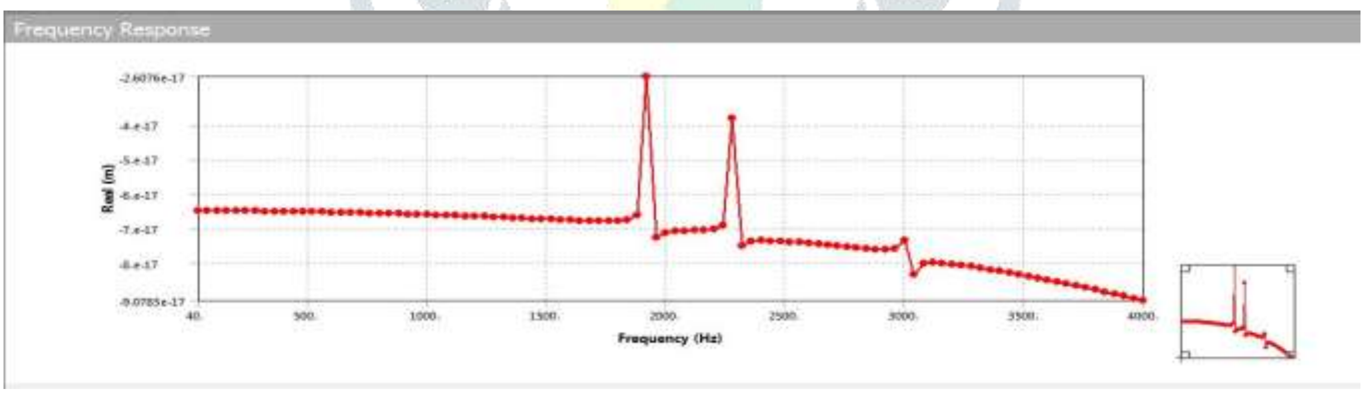


4. RESULTS AND DISCUSSION

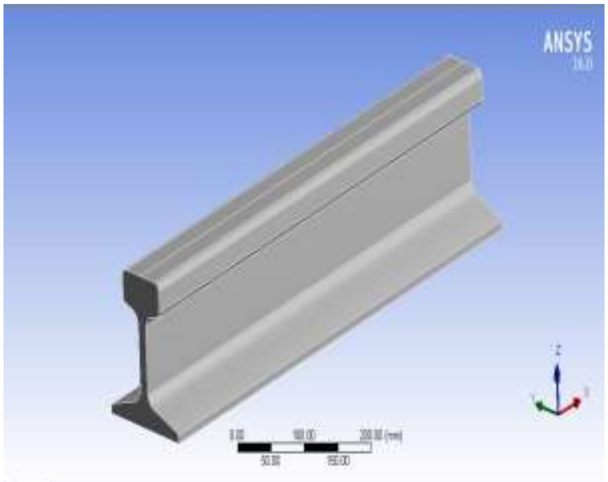
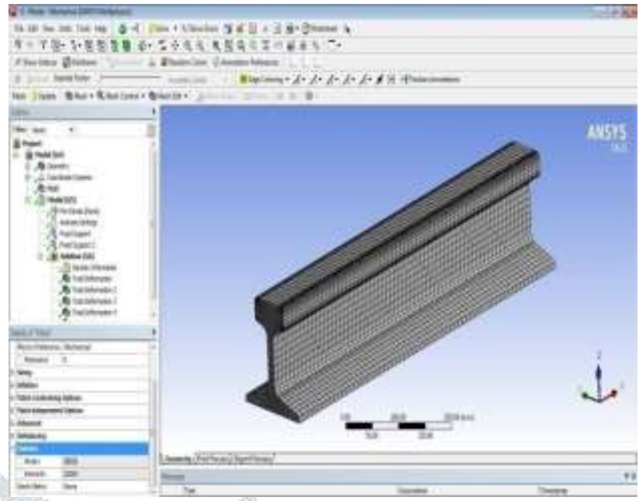
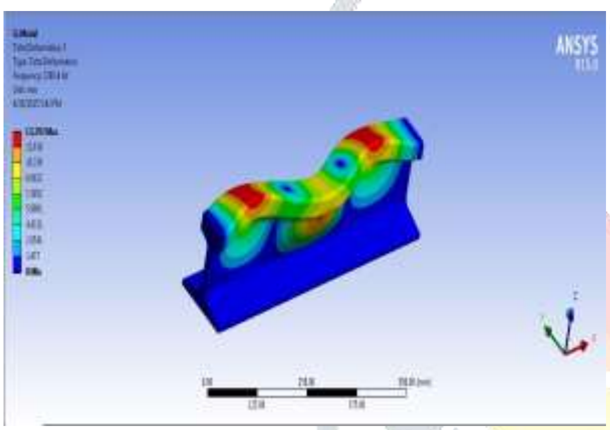
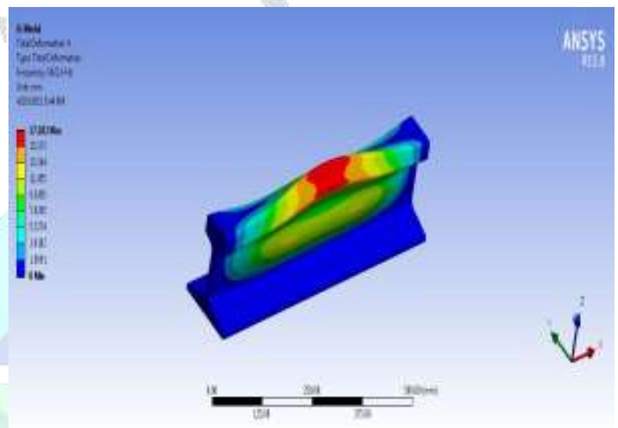
FIRST MODEL NATURAL FREQUENCIES RESULTS

3D MODEL IMPORTED IN TO ANSYS	FINITE ELEMENT MODEL
	
MODE-1	MODE-2
	

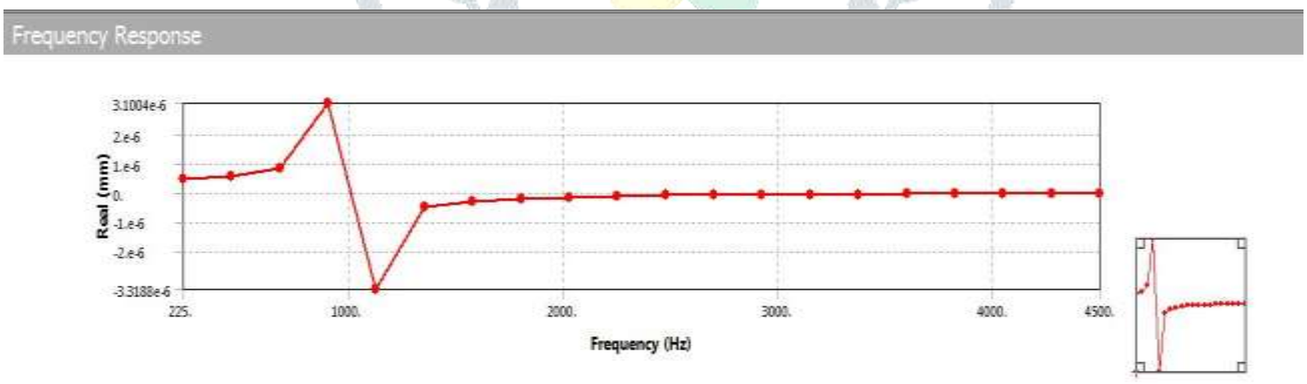
1 ST MODEL , FREQUENCIES RESPONCE RESULTS



SECOND MODEL NATURAL FREQUENCIES RESULTS

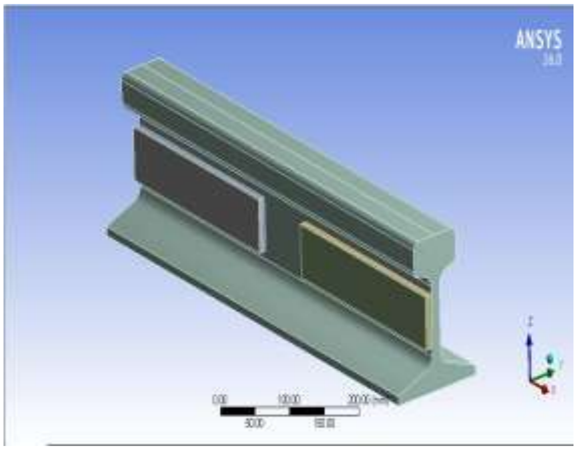
3D MODEL IMPORTED IN TO ANSYS	FINITE ELEMENT MODEL
	
MODE-1	MODE-2
	

2 nd MODEL , FREQUENCIES RESPONCE RESULTS

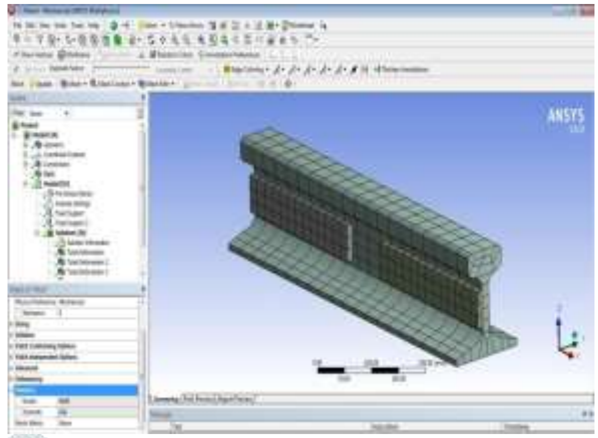


THIRD MODEL (Single Layer Pad), NATURAL FREQUENCIES RESULTS

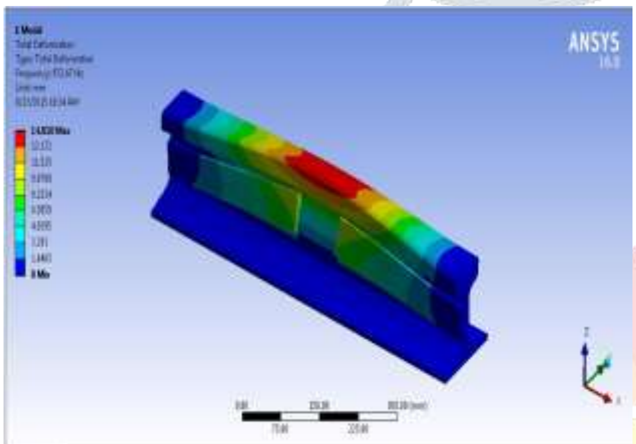
3D MODEL IMPORTED IN TO ANSYS



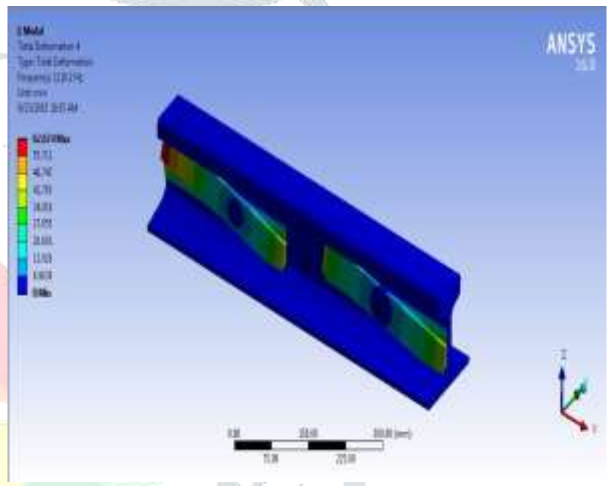
FINITE ELEMENT MODEL



MODE-1



MODE-2



3 rd MODEL , FREQUENCIES RESPONCE RESULTS

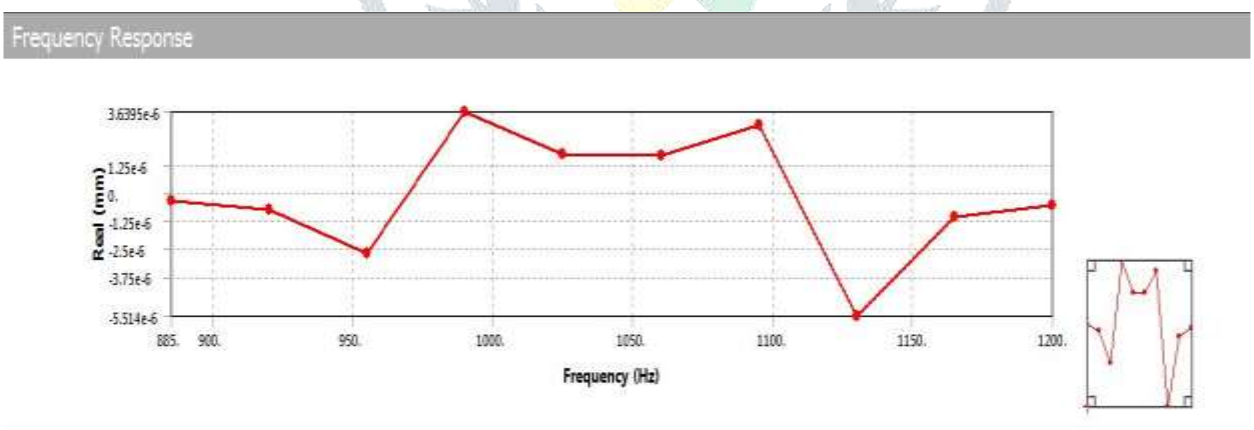


Table 3 : Natural frequencies comparison for three models.

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MODE.NO	1st MODEL (Base rail track)	2nd MODEL Without absorber)	3rd Model (Single layer)
1	1912	2053	367
2	2068	2184	369
3	2333	2406	388
4	2709	2721	389
5	3197	3131	472
6	3797	3635	493

Three type of models are created in CATIA V5 R20 and saved as IES format and imported in to ANSYS workbench. Model analysis is performed to find out natural frequencies and frequencies response analysis also performed to find out resonance frequency. The present analysis results are compared with single layer absorber It is resulted as shown in the above table 3 ,that natural frequencies are starting from above 1000 Hz while Without absorbers are having 2053 Hz minimum natural frequency and has showed 367Hz minimum natural frequency for with absorber.

5. CONCLUSION

The EPDM rubber has high property to withstand high heat dissipated due to friction and high water resistance..The high frequency vibrations are reduced to their maximum extent using absorbers arrangement. Here 3 rd model (single layered absorber arrangement) having minimum natural frequencies and frequencies response analysis has performed as 367 Hz compared to 1 st model and 2 nd model. Thus, the EPDM rubber is designed in such a way that it reduces the vibration comparatively high rate than others DVA and suggested that single layered absorber arrangement is an optimum model to reduce the vibrations.

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