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DESIGN AND ANALYSIS OF DYNAMIC VIBRATION ABSORBER (DVA) TO REDUCE VIBRATION IN RAILS

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ABSTRACT

Railway induced vibration are a growing matter of environmental concern. The rapid development of transportation leads to the increase of vehicle speeds and vehicle weight have resulted higher vibration level. This effect leads damage to the buildings nearby and sound waves are considered a nuisance. In this case it is necessary to find an alternate way to reduce vibration. This is taken into account and methods like changing the construction lines and placing beds under the ballast are done which is a tedious process. In this project dynamic vibration absorber(DVA) is introduced which have high property for absorbing vibration compared to the other. The work includes simple clamping technique with the rail along the line. By the use of this technique, one can achieve reduction in vibration in an easier and economical way. The advantage in this project is replacement can be done easily if failure occurs. In this project EPDM is used which plays a vital role in economical concern of the cause.

Keywords: Vibration, Ballast, Ethylene Propylene Diene Monomer (EPDM), Dynamic Vibration Absorber (DVA).

1. INTRODUCTION

In Indian railways, the type of ballast arrangement is very economical and effective. But this failed in the current scenario were the speeds and loads are considerably increased. Especially in the railway bridges absence of these ballast affect the constructional parts by fatigue failure. In the mean time vibrations that were tolerated in the past are now considered to be a nuisance. Numerous solutions have been proposed to solve these problem. But the majority only acts on a specific part of the dynamic behaviour of the track.

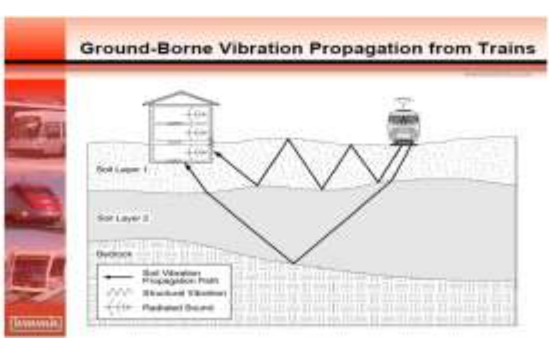

Figure 1.Vibrations from rail tracks affecting constructional parts

A railway track structure forms the physical mean, which is necessary for the support and the guidance of a railway vehicle. The use of a railway track structure by a vehicle initiates dynamic loading, which gives vibrations of the interacting systems of the train and the track. The vibration behaviour of the railway track structure in the mid- and high-frequency range can act as an indicator for the performance of the track structure with respect to vibration sensitivity and wheel-rail interaction forces. The main aspect of vibration transfer is due to the dynamic behaviour of rail.

2. LITERATURE REVIEW

J.Maes, H.Sol [11] presents a possible solution to reduce vibration by providing a dynamic vibration absorber. Rail pads are a standard part of the track, sub-ballast mats are a growing feature and under-sleeper mats are in use on ballast less track. However, all of these measures only influence the dynamic behavior of the rail when the

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rail transmits vibrations through the sleeper. In this paper the placement of the damper is also given. The model of damper and its behavior is also presented.

International Journal of Steel Structures is the official journal of the Korean Society of Steel Construction (KSSC). This provides the necessary information about the usage of the steel material in the required area of application. This says the reason to use the material for the specific purpose of application

Improvement of Damping Performance of Electric Railway Pole with Viscoelastic Damper Aboshi, Mitsuo; Tsunemoto, Mizuki; Sunakoda, Katsuaki; Matsuoka, Taichi; Ikahata, Naobumi; Shibata, Kazuhiko Journal of System Design and Dynamics, Volume 4, Issue 6, pp. 928-940 (2010).Improvement of Damping Performance of Electric Railway Pole with Viscoelastic Damper.

3.DESIGN

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 2.Track and its dimensions

The 52kg broad gauge rail track was chosen which is mostly used all over India . The dimensions are standard according to the Indian Railways.

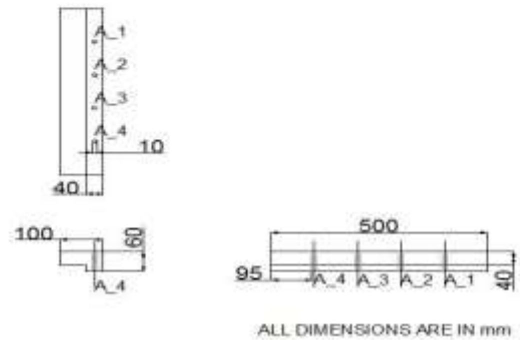

Figure 3.Rubber block (DVA) and its dimensions

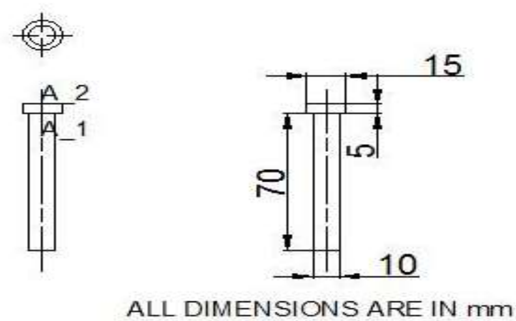

Figure 4.Bolt and its dimensions

Figure 5.3D Model (Project Idea)- DVA fixed on a single cross sectioned track

4.HARMONIC ANALYSIS

Testing for the designed project is to be done for justifications and for arriving results. This is done with the help of ANSYS 11 analysis software in which Harmonic analysis is done for the whole model.

Primarily, the track without Dynamic Vibration Absorber is analyzed to find out how much unwanted vibrations are produced which affects and causes fatigue failure to the constructional parts around the track. The Natural frequency of the track material is found within which the load should be given to avoid failure of

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the material. The natural frequency found is

Table 1.Frequency Ranges

Mode	Frequency [Hz]
1	1912.4
2	2068.7
3	2333.3
4	2709.4
5	3197.7
6	3797.9

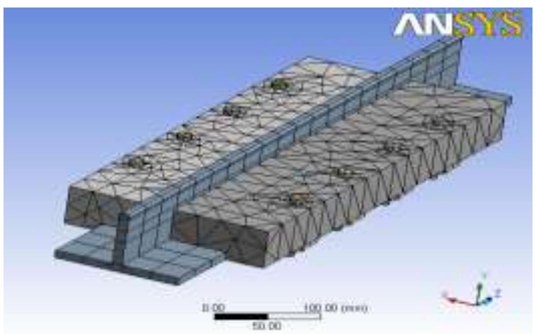

Figure 6.Mesh Top View

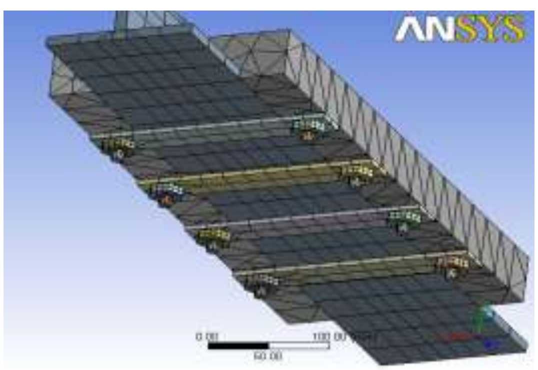

Figure 7.Mesh Bottom View

Then the load of 5000N is given which is below the natural frequency. The total deformation of the track without Dynamic Vibration Absorber for the given load produces 2340 Hz of frequency. The track with Dynamic Vibration Absorber of our design for the same load produces 840 Hz. The difference is 1500Hz which is drastic reduction. Thus a large amount of frequency is reduced which will be definitely absorbed by the DVA without transmitting it to the surroundings. Thus this reduces the fatigue failure in an easier way.

5. PROPERTIES OF EPDM

EPDM – Ethylene Propylene Diene Monomer rubber exhibits satisfactory compatibility with fireproof hydraulic fluids, ketones, hot and cold water, and alkalis, and unsatisfactory compatibility with most oils, gasoline, kerosene, aromatic and aliphatic hydrocarbons, halogenated solvents, and concentrated acids.

The main properties of EPDM are its outstanding heat, ozone and weather resistance. The resistance to polar substances and steam are also good. It has excellent electrical insulating properties.

Typical properties of EPDM vulcanisates are given below. EPDM can be compounded to meet specific properties to a limit depending first on the EPDM polymers available, then the processing and curing method(s) employed. EPDMs are available in a range of molecular weights (indicated in terms of Mooney viscosity ML(1+4) at 125 °C), varying levels of ethylene, third monomer and oil content.

5.1.Mechanical Properties

Hardness, Shore A	40-90 unit
Tensile failure stress	25MPa
Density	Can be compounded from 0.9-2.00 g/cm^3

5.2.Thermal properties

Coefficient of thermal expansion, linear	160 µm/Mk
Maximum service temperature	150 ^{o}C
Minimum service temperature	-50 ^{o}C
Glass temperature	-54 ^{o}C

6. RESULTS AND DISCUSSION

The following figure and graph shows the total deformation with the reduced values.

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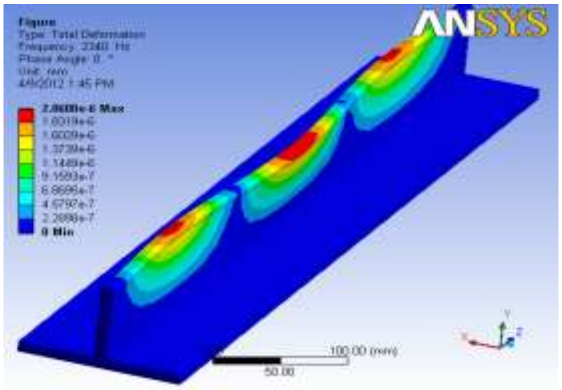

Figure 8.Without DVA

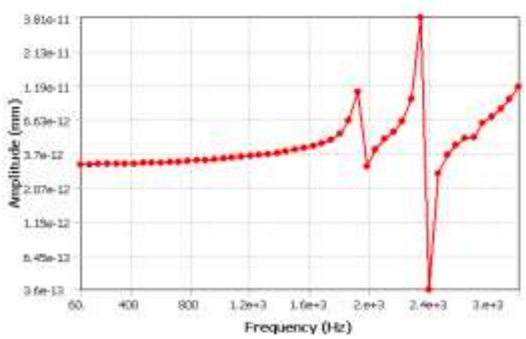

Figure 9.Frequency graph

Table 2. Vibration analysis without DVA

Object Name	*Total Deformation*	*Equivalent Stress*
State	**Solved**	
Scope		
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
Frequency	2340. Hz	
Phase Angle	0. °	
Results		
Minimum	0. mm	4.6197e-007 MPa
Maximum	2.0608e-006 mm	1.4011e-003 MPa
Information		
Reported Frequency	**2340. Hz**	

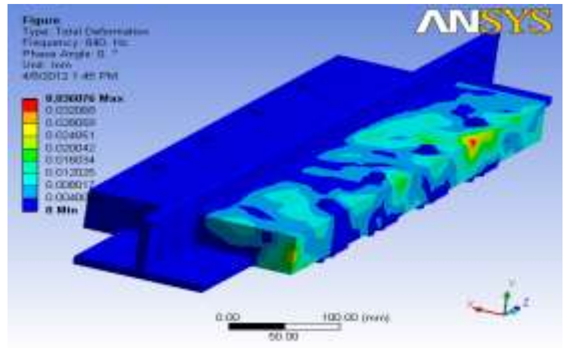

Figure 10.With DVA

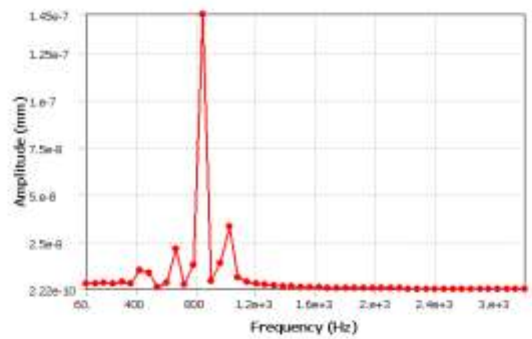

Figure 11.Reduced frequency graph

Table 3. Vibration analysis with DVA

Object Name	*Frequency Response*
State	**Solved**
Scope	
Geometry	1 Face
Spatial Resolution	Use Average
Definition	
Type	Directional Deformation
Orientation	Y Axis
Options	
Frequency Range	Use Parent
Minimum Frequency	0. Hz
Maximum Frequency	3000. Hz
Display	Body
Results	
Maximum Amplitude	1.454e-007 mm
Frequency	**840. Hz**
Phase Angle	0. °
Real	1.454e-007 mm
Imaginary	0. mm

As per harmonic analysis
Vibration produced without DVA = 2340 Hz
Vibration produced with DVA = 840 Hz.
Thus the reduction of vibration is achieved by our design.

7. CONCLUSION

The rubber chosen has high property to withstand high heat dissipated due to friction and high water resistance. It also deals with the fatigue testing which will be analyzed by the software.

Thus the dynamic vibration absorber is designed in such a way that it reduces the vibration comparatively high rate than others by the collected details. The details consist of various properties of the parameters of the materials used in this project concluded from the literature survey. The high frequency vibrations are reduced to their maximum extent that they occur below the noise level which is clearly shown in the graph.

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