# Depreciating the effect of vibration by substituting vibration absorbing pads

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***Abstract*** – Development oriented train department are introducing newly developed train systems which are more attracted towards luxury, speed and performance. This leaves a big focus on the running trains which running on old systems. There are various parameters that can be changed to make the ongoing train systems work in a much better way. The ground borne vibrations that are produced due to rail vibrations creates harmful effects on the nearby areas. Though there is a progressing development in new upcoming track systems, there should be improvements in the running track systems as well. This research tries to introduce and solve the vibration related issues by replacing a new rail pad material called sorbothane which is very well known for reducing vibrations. This will be a comparison study of vibration transfer through different absorbing pads in 1:√5 prototype as well as on field which will directly aim towards the reduction to further borne vibrational effects. Thus this study will clarify the most suitable vibration absorbing material.

***Keywords-*** **vibration absorbing pads, ground borne vibrations, rail track, rubber pads, sorbothane.**

## I. INTRODUCTION

Railway safety is one of the important issue that needs to be taken into consideration. Recently there are many tain accidents occurring in which rail slipping is also observed. Due to train movements the absorbing pads get pressed out under heavy load in which they lose their dimensions. This occurs when there is a change in climate from hot to cold, in between which the material starts becoming hard and losses its elasticity. These conditions shear the pads and tend to crack which further leads to in balancing and not sufficient gripping for tracks. The European Railway Traffic Management System (ERTMS) aims at replacing the many different national train control and command systems in Europe and make a standardized system. A very important and ongoing issue is the consequences that are being faced due to ground borne vibrations. Thus due to many faced accidents on the stations in India this research is been carried out and which will aim in transferring minimum amount of vibrations as compared with the ongoing. Shopping malls, apartments, hotels, office buildings and other public facilities are close to the track as well as there are buildings which are connected to stations directly. There are also many direct impacts to the infrastructures nearby track which has caused many accidental situations. Thus it is essential to study the influence of the vibrations and find an efficient method to reduce the effect. This research tries to explain the importance of vibration absorbing pads on rail vibrations. The aim is to reduce the train borne vibrations passing to the ground through the rails. This can be achieved by using an alternative absorbing bad over the traditionally used.

## II. MAIN SOURCE OF VIBRATION

The stations are the main areas from where all the train passes as well as the infra structures are built very much close to the tracks. Thus when train passes the vibrations are passed easily through the platform. This causes an unwanted loosening of the structures due to repeated vibrations and may lead to various accidents [1]. In addition to that all the tracks gather near each other near the stations creating a throttled area making it more suitable for transfer of vibrations. The vibration characteristics are associated with many factors, such as speed, rail types, absorbing pads, sleepers, ballast, subgrade, building foundation and structure [2]. The vibration of the train power system and rail structure, the dynamic interaction of wheel/rail and wheel/rail irregularity are the main vibration sources for rail structure. Thus our main focus is on the rail and sleeper interaction as they both are separated by the vibration absorbing pads.

Figure 1: Areas where more vibrations are been observed [1]

## III. RAIL TRACKS

The track on a railway or railroad, also known as the permanent way it is the structure consisting of the rails, fasteners, railroad ties (sleepers) and ballast or slab track, plus the underlying subgrade. It enables trains to move by providing a dependable surface for their wheels to roll upon as well maintain the balance of the rails[4].

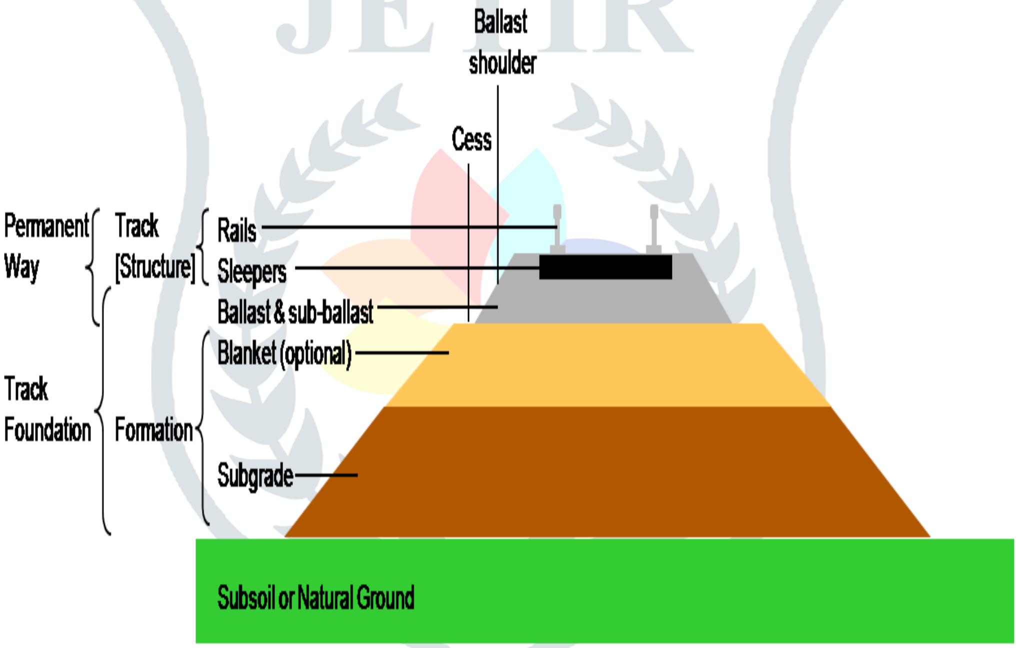



Figure 2: Foundation of rail tracks [4]

### A. Rails

Modern track typically uses hot-rolled steel with a profile of an asymmetrical rounded I-beam. While some others use iron and steel, railway rails are subjected to very high stresses and have to be made of very high-quality steel alloy. It took many decades to improve the quality of the materials, including the change from iron to steel. The stronger the rails, the heavier and faster the trains the track can carry. These rails are placed over the sleepers. The two types of rails shown below in the fig3 are mostly used.

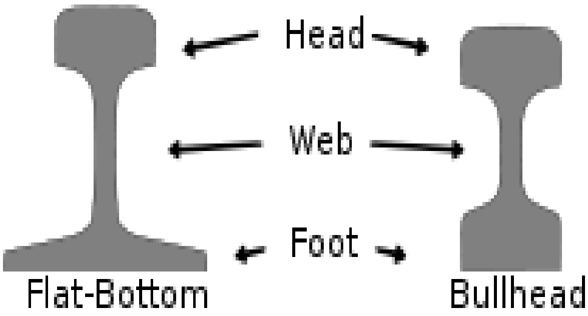



**Figure 3: Profile of rails [12]**

*B. Sleepers*

A sleeper is a rectangular object on which the rails are supported and fixed. The sleeper has two main roles i.e. to transfer the loads from the rails to the track ballast and the ground underneath, and to hold the rails to the correct width apart to maintain the rail gauge. They are generally laid transversely to the rails. There are basically five types of sleepers made from i.e. wood, concrete, steel, plastic and stone block.


**Figure 4: Different types of sleepers [1]**

*C. Vibration absorbing pads*

Generally absorbing pads are used to reduce the vibrational transfer through the system. The same is been used in rail track system. There are rubber pads placed between the rails and the sleeper to reduce the vibration transfer from train to the ground i.e. it works as vibration absorbing pad [5]. The rubber pads are a traditional material used since past many years. Thus in spite of using a vibration absorbing material the effects faced are still worse. As there are revolutionary changes ongoing form the bullet trains, there should be betterment and inventions for the existing running trains. Thus this review is trying to find the better absorbing pad which could reduce the vibration effects.


**Figure 5: Construction of rail pads [11]**

Traditionally used material for vibration absorbing pads is rubber in India. The resistance of rubber to water and to the action of most fluid chemicals has led to its use in wet conditions. Because of their electrical resistance, soft rubber is used as insulation and for protective purposes. The coefficient of friction of rubber, which is high on dry surfaces and low on wet surfaces, leads to its use for power-transmission and for water-lubrication. Thus as followed by the properties it is a well suitable material for absorbing pads, still the effects caused due to vibrations are more. Thus a very famous material invented in 1982 has an enormous vibration absorbing capacity and that can fulfill all the requirements [8]. Sorbothane is a visco-elastic material i.e. it exhibits properties of both liquids (viscous solutions) and solids (elastic materials). The material combines some of the properties of rubber, silicone, and other elastic polymers. It is considered to be a good vibration damping material, an acoustic insulator, and highly durable [11]. In addition to that it can reduce upto 97% of vibrations. Sorbothane has many industrial applications, from acoustic shielding to machine mounts. It has been used to quiet personal computers by being packed around the hard drive and other noisy spinning components. Sorbothane dampens vibration transmission from vibrating hardware. It has been used to isolate subwoofers from turntables. In addition, Sorbothane has been used by NASA to isolate vibration, in the Air Force Memorial, and to transport the Liberty Bell. Thus from all above properties with their applications is quiet assuring that the material can be an alternative material for the rubber in vibration absorbing pads.

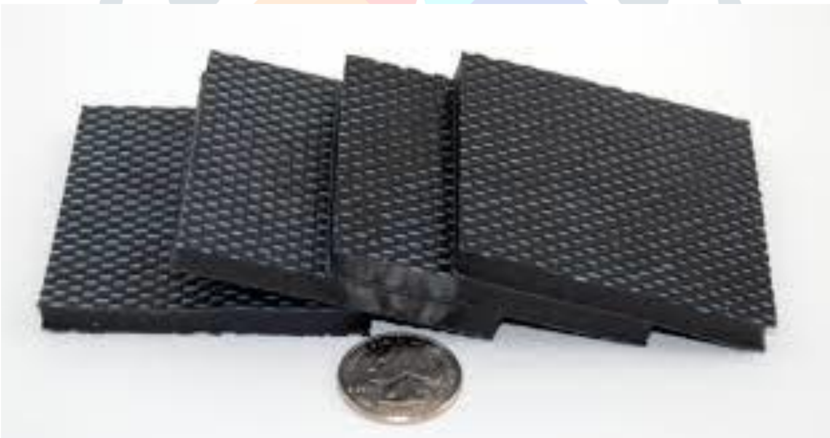


**Figure 6: Sorbothane pads[11]**

## IV. EXPERIMENTATION

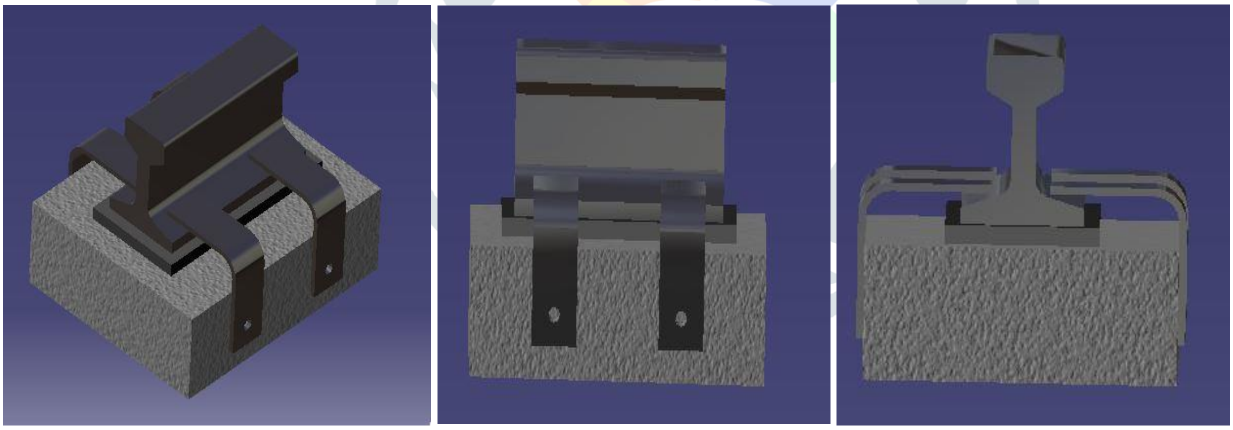
To find the better absorbing pad there was a need to test them in similar conditions with the necessary components required. Thus the system of 1:√5 ratio was been built to carry the testing[13]. The components used where as follows:-

| Sr. no. | Components | Quantity |
|---|---|---|
| 1 | Rail | 1 |
| 2 | Rubber Pad | 1 |
| 3 | Sorbothane Pad | 1 |
| 4 | Concrete Sleeper Block | 1 |
| 5 | Lever | 1 |
| 6 | Clamps | 1 |
| 7 | Bolt | 1 |
| 8 | Nut | 1 |

**Table 1: List of components used in Rail System**

### *A. Design*

The properties of the sorbothane pads are also selected as per 1:√5 ratio viz. DURO70. The material is been imported from The Vibration Solution, LLC/ Isolate IT, Burlington, North Caroline, USA. The dimensions of both the pads where taken as per required area below the rails. Catia V5 was used to model the the components as per ratio, thus it helped to design and manufacture more precisely.

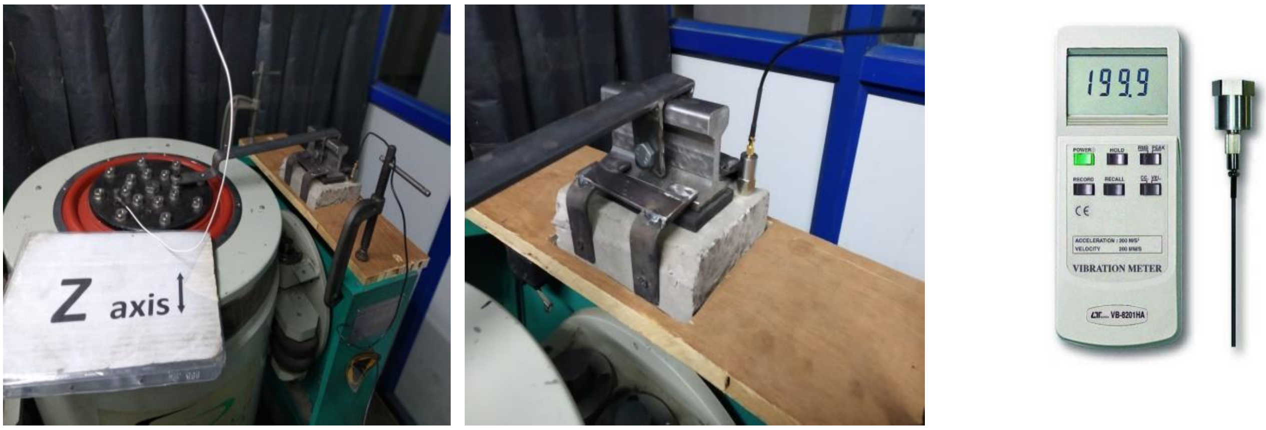


a b c

**Figure 7: CAT model a) Isometric view b) Front view c) Side view**

### *B. Setup*

The experimentation was carried out in Nashik Engineering Cluster (NEC). The setup was observed under forced vibrations created by vibration creating machine. The vibration meter was used to measure the acceleration on the sleepers. The rail system was fixed with the help of a wooden fixture and C-clamps were used to hold the wooden fixture. The probe of the meter was rested on the horizontal surface of the sleeper. One side of the lever was fixed on the upper surface of the machine and the other end on the rail upper face with the help of the bolt and nut.




a b c

**Figure 8: Setup a) steup arrangement b) Meter probe rested on sleeper c) Vibration meter**

*C. Procedure*

With the fixed lever on the machine and rail the vibrations from the machine were passed on to the rail system. With the help of the computer system the frequency was controlled which were given to the system. At ten different intervals the readings were taken by the vibration meter in $m/s^2$. The range was kept from 100Hz to 1000Hz and the gravitation acceleration was kept 5 times. This procedure was carried out for both rubber pad and sorbothane pad. The probe was circulated once at every corner i.e. 4 corners of the sleeper block at the same frequency. The readings were noted in acceleration for both the pads. The procedure was carried once for each pad.

*D. Results*

After experimentation it was observed that the sorbathane pad absorbed much more vibration transfer as compared to the traditionally used rubber pad. The properties taken for rubber were 1:1 while for sorbothane it was selected as per 1:√5. This gives an advantage for selecting sorbothane pads as an alternative absorbing pad. Thus the below graph clearly shows the acceleration reduction of sorbothane pad.

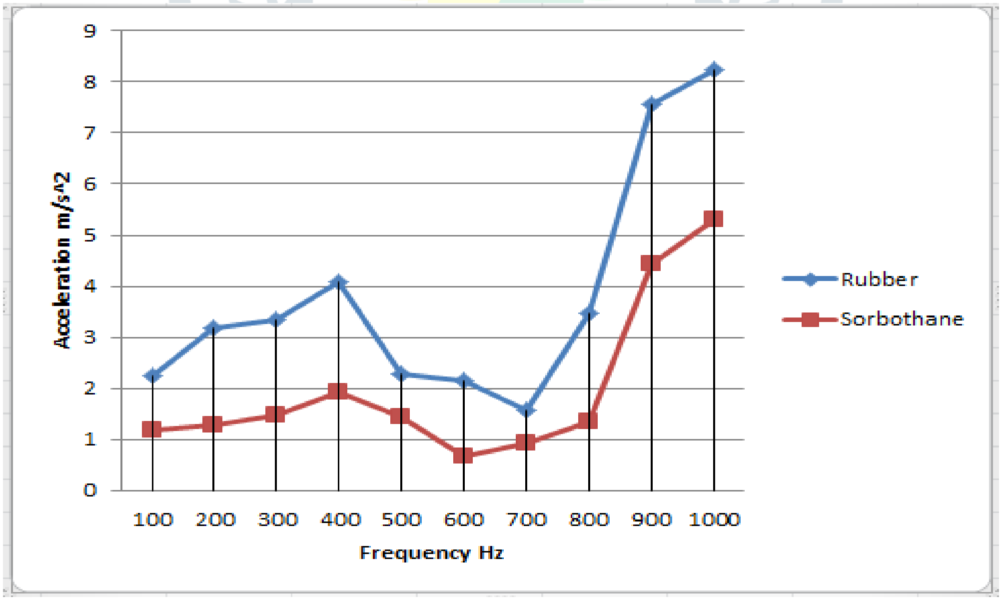



**Figure 9: Comparison graph of Rubber vs. Sorbothane**

## V. ON FIELD TESTING

The above results were satisfying to test the material under actually running conditions. Therefore the testing permission was granted by Railway Engineer on Nashik Road Railway station. Thus at distance of 100m from the station the rubber pads were replaced by sorbothane pads. Three trains were allowed to pass from the testing area and the instrument used was vibration meter.

a

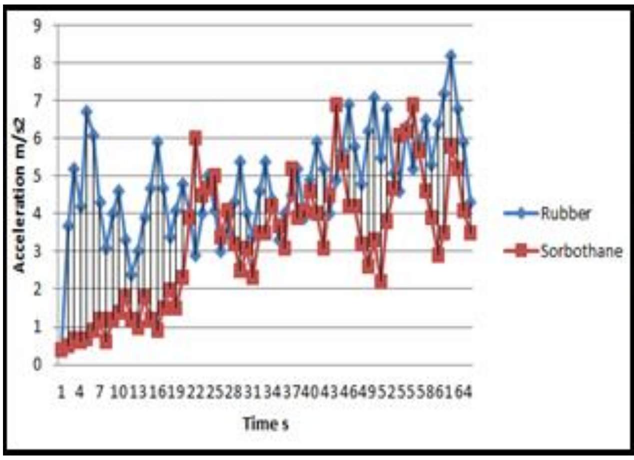
b

c

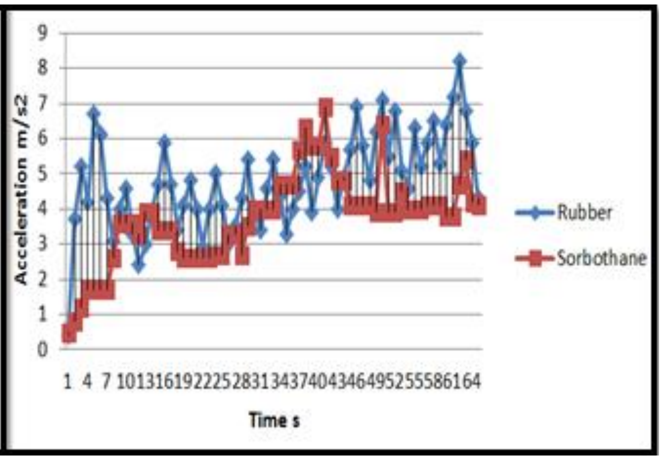
**Figure 10: On Field testing a) Probe rested on sleeper b) meter setup prepared c) Sorbothane pads replaced**

The probe was fixed on the sleeper so that the vibration transfer could be noted. Twice the readings of sorbathane was taken and once for rubber. It was observed that the rubber pads where given U-shaped notches to create air gap to sustain heavy load and for griping. But in spite of not having notches the solid sorbothane sustained the load of the running trains without breaking as well as giving less vibration transfer.

The material itself holds the rails and sleeper tightly that it does not need extra griping methods. Even by giving air gaps it could easily give exceptional performance as compared to traditionally used rubber. The material is also very elastic that it can maintain its elasticity and maintain its dimensions in any sudden climatic changes. The below are the Graphs which were generated after taking readings shows the comparison of both the readings at different interval of time. This will clarify the difference between the traditionally used material and newly introduced material.




a




b

**Figure 11: On field results a) Rubber vs. Sorbothane1 b) Rubber vs. Sorbothane2**

## VI. CONCLUSION

- As due to train borne vibrations there are many intolerable effects that need to be solved. The vibration transfer from train to the ground passes through rails, absorbing pads and sleepers, thus the aim of cancelling the vibration transfer can be obtained by changing the vibration absorbing pads as it lies between the rails and sleepers.
- Thus after comparing the traditionally used material and the foreign material we can conclude that the foreign material i.e. sorbothane is more suitable for the vibration absorbing activity as absorbing pad.
- Inspite of been selected according to 1:√5 ratio it withstands and beats actual used rubber pads in every parameter.
- Hence by implementation of such material as absorbing pad can definitely help in reducing the vibration effects, also there are many various applications of sorbothane that satisfies the required need.

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