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TRACKELAST UNDERSLEEPER PADS - A COST-EFFECTIVE ANSWER FOR VIBRATION REDUCTION

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SUMMARY

This paper discusses the advantages of using an elastomeric element situated underneath the railway sleeper for the reduction of ground borne vibration transmitted from railway tracks. Not only is the Undersleeper Pad a very cost-effective means of reducing vibration, it can be retrofitted and also has advantages in reducing track maintenance.

INTRODUCTION

In recent years a great deal of attention has been given to the environmental impact of railway systems. The expansion of rapid transit and urban railways in many countries, coupled with the scarcity of building land, has forced city developers to build adjacent to and above surface and underground rail routes. The noise and vibration created by railway systems affect people, and once the noise and vibration generated exceed a certain level, they can annoy and disturb those living and working in the vicinity of the railway track.

During the passage of a train, the irregularities of rail and wheel contact and other excitation mechanisms generate a wide spectrum of vibration in the track. The most energetic frequencies are those between 30 and 250Hz, and it is these frequencies which can travel significant distances from the track, causing low frequency vibration and noise in nearby buildings. This low frequency is heard as a rumbling noise each time a train passes and can be very disturbing in apartment blocks, hospitals, concert halls and convention centres, and also the vibration itself can be unacceptable in printing works and other buildings where sensitive equipment is used.

The normal means of reducing vibration from railway track is to insert an elastic element between the source and the building to be isolated. The elastic element must be chosen with great care to ensure that its durability, dynamic stiffness and loss factor are those required for the application and that these properties do not deteriorate with age or within the operating environment.

Tiflex Limited make, under the brand names TICO and Trackelast, a wide variety of these elastic elements ranging from structural bearings to isolate complete buildings, ballast mats to isolate ballasted track and resilient baseplate pads and floating slab track bearings for the reduction of vibration transmitted from concrete track structures.

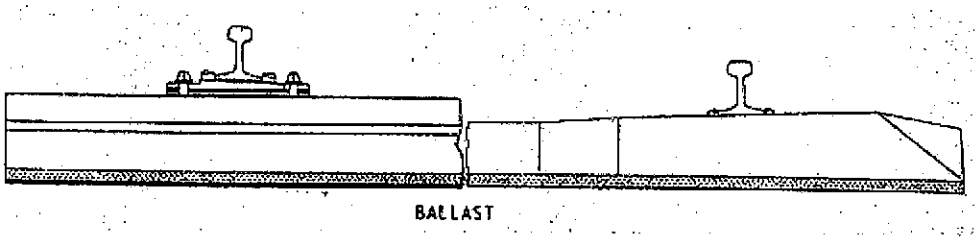
This paper concerns the effectiveness of Trackelast Undersleeper Pads in reducing ground borne vibration from railway tracks.

TRACKELAST UNDERSLEEPER PADS

Construction

In this construction, soft, resilient natural rubber pads are fixed to the base of either timber or concrete sleepers. The pads can allow track deflections of up to 6mm because the high aspect ratio of the sleepers means that this soft and resilient material can be installed under the sleepers without having an adverse effect on track stability.

The material chosen for this application is cellular natural rubber which must be protected from damage by a very tough and durable ballast protection layer. The construction is shown in the sketch below: -



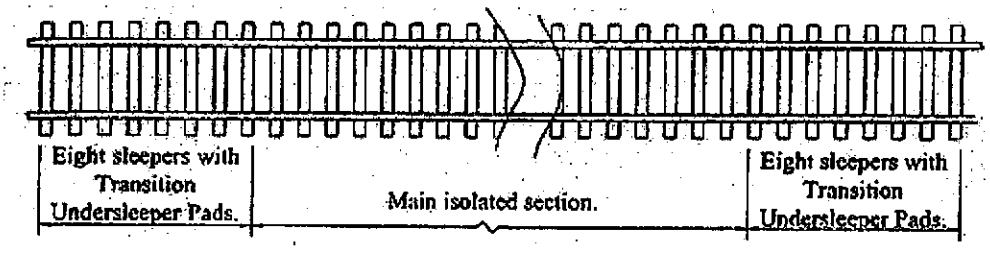
The Trackelast Undersleeper Pads are attached to concrete sleepers by means of a glue which can adhere well to rigid concrete and also to cellular natural rubber. For timber sleepers, the Undersleeper Pads are mechanically fixed on by means of staples or nails driven into the sides of the sleepers. Concrete sleepers have Undersleeper Pads extending over the entire base area of the sleeper to prevent cracking due to centre binding of the sleeper on the ballast. For timber sleepers, which are more flexible, Undersleeper Pads either cover the entire area or an area 1000mm in from each end of the sleeper.

Trackelast Undersleeper Pads can also be installed under switches and crossings

Installation in the track

Standard concrete and timber sleepers may be used. No special precautions are needed when installing Trackelast Undersleeper Pads other than some care when dragging the sleepers to ensure that the pad is not damaged in the process, and no special arrangements need to be made for water drainage.

Furthermore, it is possible to retrofit Trackelast Undersleeper Pads into existing ballasted track by removing the old sleepers and inserting sleepers with Trackelast Undersleeper Pads attached to them. This can reduce greatly the cost of isolating a track compared with a ballast mat system, where all of the ballast would need to be removed prior to installation.

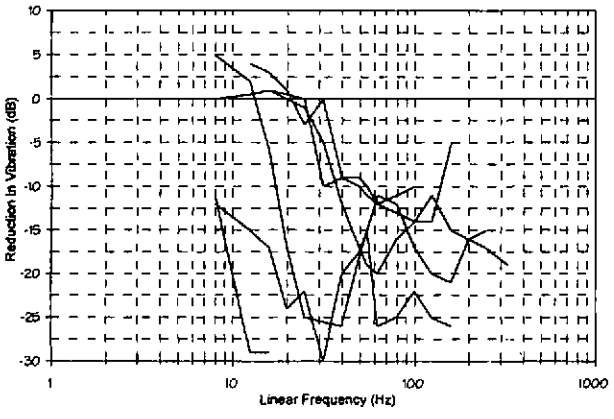


At either end of the main vibration isolated area, a length of eight sleepers should be installed with transition Undersleeper Pads. These pads have a stiffness of twice that of the main Undersleeper Pads and therefore provide a stiffness gradient at either end of the main isolated track for a smooth transition.

Performance

The performance of the Trackelast Undersleeper Pads in reducing the transmission of vibration depends upon the stiffness of the natural rubber cellular layer. The softer the cellular layer (the greater the track deflection), the greater the reduction in vibration transmission (insertion loss).

The figure below shows a number of graphs of insertion loss against frequency for different types of sleeper and trains using Trackelast Undersleeper Pads. Some of the sleepers are timber, some are concrete monoblock and some concrete duo-block. The measurements of vibration reduction were made by the railways concerned at various track locations.



The results split into two categories: those with track deflections of approximately 3mm giving an insertion loss on average of 12dB at the 63Hz band and those with track deflections of approximately 6mm giving an insertion loss if 20dB at the 63Hz band.

Tiflex have developed a computer simulation which can predict with reasonable accuracy the performance of undersleeper pads in reducing vibration.

Cost

The performance of Trackelast Undersleeper Pads is comparable to that of ballast mats, but in terms of cost, Trackelast Undersleeper Pads are very much less expensive to install. Ballast mats must be laid carefully over the entire sub-structure of the ballast, and special arrangements have to be made for ground preparation, drainage, gluing the mats together and so on.

Trackelast Undersleeper Pads typically use about one quarter of the area of resilient material compared to ballast mats, and installation time is very rapid for the pads themselves. Generally, a team of four men can complete the gluing or nailing operation at a rate of 90 seconds per sleeper.

No special precautions have to be taken when tipping ballast onto the concrete or substrate, as would be the case when ballast mats were used.

Tamping

No special steps have to be taken when the track is tamped as the Undersleeper Pads are sited under the sleeper and are thus protected from damage.

A test four years ago following a retrofit of Undersleeper Pads showed that in 12 tamping passes over concrete sleepers, no damage was done to the pads.

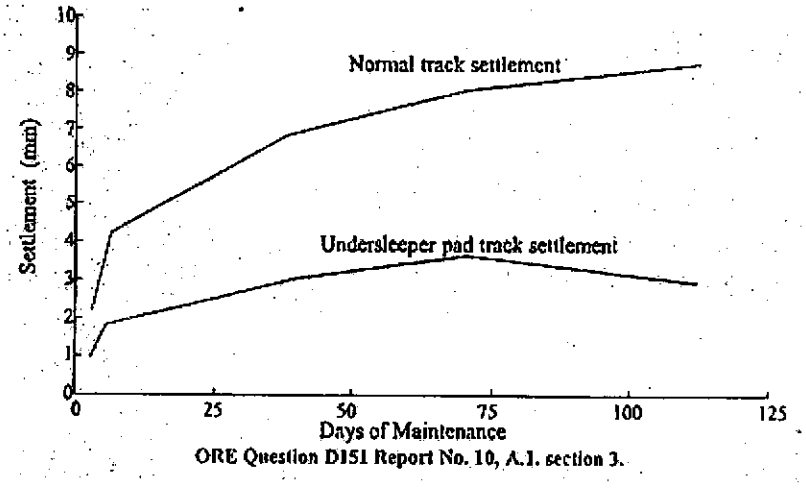
Track maintenance benefits

When the train runs over a concrete sleeper fitted with Trackelast Undersleeper Pads, the impact loading from the train and the sleeper vibration is cushioned from the ballast by soft, resilient material.

The peak forces transmitted into the ballast are therefore reduced and the sleeper is supported evenly on the resilient layer, with the result that there is less ballast attrition, and less maintenance is required.

This result was demonstrated in a test carried out to compare ballast mats and undersleeper pads with conventional ballasted track on British Rail in 1986. The graph below is taken from the ORE report concerned with this test, which is referred to in the list of references.

Selection of materials for Undersleeper Pads.



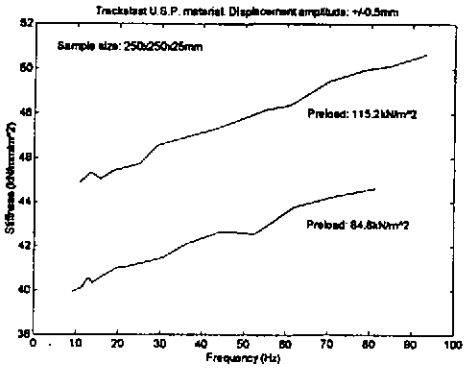
ORE Question D151 Report No. 10, A.1. section 3.

It is very important that each application for Trackelast Undersleeper Pads is examined carefully and that calculations are carried out to ensure that the track deflections meet the requirements of the railway authority.

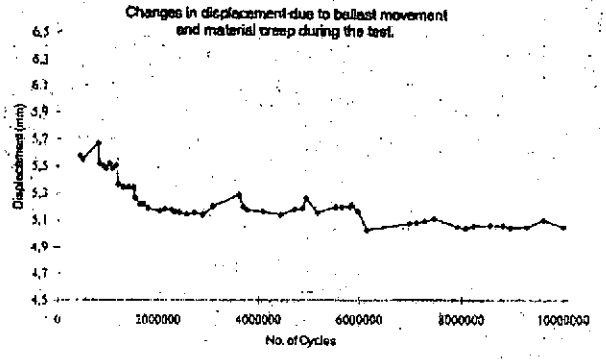
The cellular layer is the important component in determining the vibration reduction of the undersleeper pads. Natural rubber is the preferred choice of material for any anti-vibration mounting. This is because it is the most versatile and adaptable elastomer with excellent strength, durability and dynamic properties. Furthermore, natural rubber has been in use as a resilient mounting material for over 100 years, so its performance is well documented. The charts below show typical performance of Trackelast Undersleeper Pads. Graph 1 shows the increase in dynamic stiffness of Trackelast Undersleeper Pads with frequency, using a 250mm square

sample with a deflection of ±0.5mm: the kind of deflection which the Undersleeper Pad experiences in the track. The Trackelast material stiffness increases by only 11% over the frequency range of 10 to 80Hz.

Graph 1



Graph 2



Graph 2 shows the settlement and change in deflection of Trackelast Undersleeper Pads during the course of 10 million cycles of loading with an amplitude of ±2mm at 3Hz in a ballast box on a servo-hydraulic testing machine. The ballast has settled by about 0.5mm during the first 200,000 cycles, and thereafter there is very little ballast settlement or change in stiffness of the Trackelast Undersleeper Pad on test.

Since Trackelast Undersleeper Pads were first installed on the Barcelona Metro in 1976, there have been no complaints of any loss of efficiency in reducing vibration from this or any of the many other installations where Trackelast Undersleeper Pads have been installed.

Trackelast products are manufactured and sold by:

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References.

ORE Question D151.1: "Anti-vibration measures for ballasted track in the open." Report No. 10 Vibration isolation measures on open line: Effect of added track resilience. Utrecht 1986.

Noise and vibration from Ludgate Railway Works. C.J. Manning, Arup Acoustics, 1991.

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