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Influence of Geometric Dimensions in Screening Efficiency of Geofoam Crumb Rubber Infilled Trench

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Abstract: This study evaluates the influence of geometric dimensions in screening efficiency of styrene butadiene crumb rubber and expanded polystyrene geofoam infilled trench (GRFT). Since used rubber is a waste product, its proper disposal is matter of concern.Experimental analysis was conducted in the laboratory conditions. Intermittent arrangement or alternate arrangement in particular composition ratio (C_R) was used to arrange infill material. Impact loading condition used for the analysis and efficiency of the system evaluated based on the amplitude reduction ratio (A_{RR}).The results show that geometric dimensions like length, breadth and depth have significant effect on the efficiency of GRFT wave barrier system.
Keywords: Wave barrier, Harmonic loading, EPS Geofoam, Amplitude reduction ratio

I. INTRODUCTION

India is a developing country that depends widely on sectors like construction, mining,large-scale public and private transportation, etc. The rapid rate of urbanization and population boom caused an increase in the usage of these sectors, which unfortunately are the major contributors to underground vibrations.Stopping or minimizing the transmission ofground vibration is one of the major issues in field soil dynamics. Researchers from allover the world are interested in controlling the energy of vibration to reduce the damage caused to surrounding sensitive instruments or existing structures. As a result, vibration screening is required to limit the transfer of vibrational energy through the propagation of surface waves. The most common solution to this issue is to construct a screen or barrier to isolate vibrations along the surface wave transmission line. Active isolation refers toplacing this wave barrier around the vibration source, and passive isolationrefers to placing it around a building or the structure for protection.

In geotechnical engineering, wave barriers are widely employed to minimize the ground vibrations produced by propagating surface waves with relatively short wavelengths. For the surface wave to be effectively screened, it is essential to control the wave velocity in the medium. The acoustic impedance ratio (Ar), which evaluates how quickly waves may pass through a material, is defined as the productof the material's density and the Rayleigh wave's velocity. Installing an open trench (OT) is found to be most effective since theA_r value of the air is low, but it is also quitedangerous because the fragility of the wallsposes a serious difficulty for building. As aresult, an in-filled trench (IFT) is recommended as a superior option. Efficiency of infill trench depends on infill material.

In previous studies [1] [2] [4] results shows that geofoam can be used as an efficient infill material because of its low density. Intermittent refers to the occurrence of anything at irregular or discontinuous intervals in space. In the current work, EPS geofoam and crumb rubber is arranged alternately to improve overall screening effectiveness. Poorly graded sand taken from a depth of 1m is used for the study. Geofoam is selected based on the density 11.2 Kg/m^3 ,EPS12 is used for the analysis.

Since crumb rubber is a waste product made from used car tyres and has very little A_r. The use of crumb rubber as filler material in the geofoam crumb rubberinfilled trench (GRFT) will be advantageous from a design and environmental perspective. Recycling of used tyres is a major concern today, so it will also be beneficial for our environment.The purpose of the current study is to examine the variation of screening efficiency by varying the geometric dimensions of the trench.

II. FIELD STUDY

As seen in Fig 1, a test tank with dimensions of 1m x .5m x .5m was filled with uniformly dense sand. On the locationdepicted as the source in Fig 2, an impact load with variable energy was applied to thesand bed's surface by decreasing the heightof fall while keeping the weight constant. Figure 2 displays a schematic representation of a test setup. Sand made it challenging to build an open trench. Therefore, the necessary-sized hollow casing is initially placed in the sand bed.

After removing the soil from within thehollow container, the composites were put inside. The casing was taken off after installation. The experiment involvedexciting the ground again and measuring theground motion at the same pre-selected places as stage one. Two accelerometers were positioned on the surface of the sand bed to measure the vibrations. In the presentanalysis YMC Series High SensitivityAccelerometers is specifically designed to detect ultra–low vibration, low frequency vibration is used along with T-DAQ IEPE USB based portable FFT analyzer. T Vib software is used for the data interpretation and analysis.

The effectiveness of the trench was assessed by varying parameters such as thegeometric dimensions of trench which include the length of trench, depth of trench, and breadth of trench.

Fig1: Test setup used for the analysis

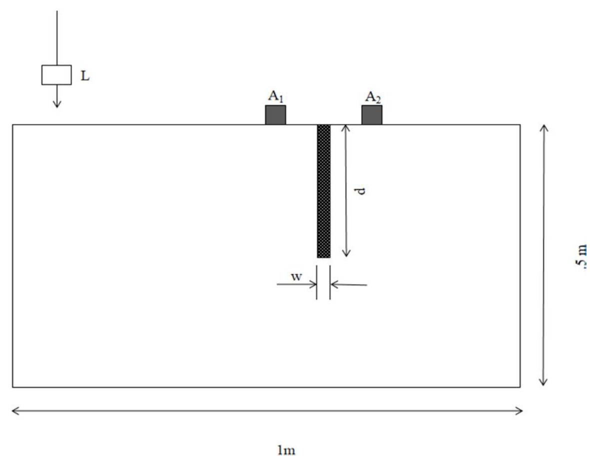

Fig2: Schematic representation of test set up

III. RESULTS AND DISCUSSION

The performance of the GRFT was analyzed based on screening efficiency. Theefficiency of the system may be assessed using the measured displacement, velocity, or acceleration with the vibration barrier,As soil particle acceleration was measured using acceleration pickups, the efficiency of the system may be expressed as a decrease in soil particle acceleration.The results are presented in the form of amplitude reduction ratio, ARR, which is calculated as the post-trench installation peak acceleration amplitude by the peak acceleration amplitude before trench installation.

Screening efficiency = 1-ARR (in %)

So lower value of ARR higher will be screening efficiency.

A. *Influence of Trench Length*

The test was conducted by varying lengthsof trenches keeping all other parameters constant that include breadth and depth of trench. Real time acceleration plot obtained for EPS12 geofoam and crumb rubber composite layer with a composition ratio 1.Breadth of trench was taken as 3cm,depth of trench was taken as 15cm,Three lengths 10cm, 20cm and 30cm were taken for the analysis. It was observed that there was an increase of 22% in screening efficiency when the length of trench changed from 10 cm to 30 cm.

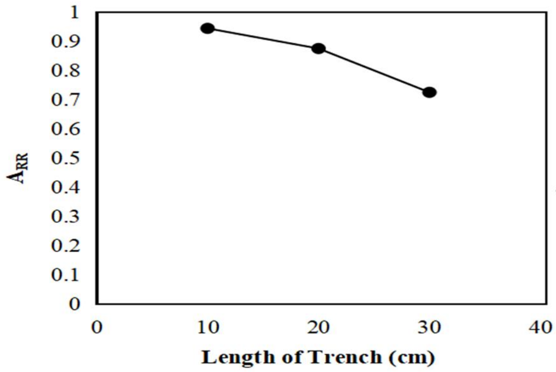

Fig 3 : Influence of length of trench on the screening efficiency

B. *Influence of Trench Breadth*

The test was conducted by varying breadthof trenches keeping all other parameters constant that include length and depth of trench. Real time acceleration plot obtained for EPS12 geofoam and crumb rubber composite layer with a composition ratio 1.Length of trench was taken as 20cm,depth of trench was taken as 15cm,Three breadth 2cm, 3cm and 5cm were taken for the analysis. It was observed that there was an increase of 19.4% in screening efficiency when the breadth of trench changed from 2 cm to 5 cm.

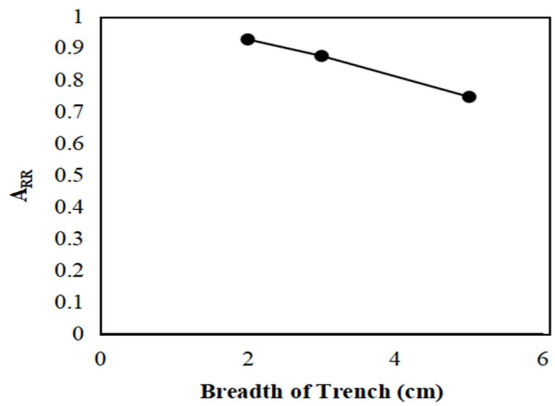

Fig 4 : Influence of breadth of trench on the screening efficiency

C. *Influence of Trench Depth*

The test was conducted by varying depth of trenches keeping all other parameters constant that include length and breadth of trench. Real time acceleration plot obtained for EPS12 geofoam and crumb rubber composite layer with a composition ratio 1.Length of trench was taken as 20cm,breadth of trench was taken as 3cm,Three depth 10cm, 15cm and 30cm were taken for the analysis. It was observed that there was an increase of 5.1% in screening efficiency when the breadth of trench changed from 10 cm to 30 cm.

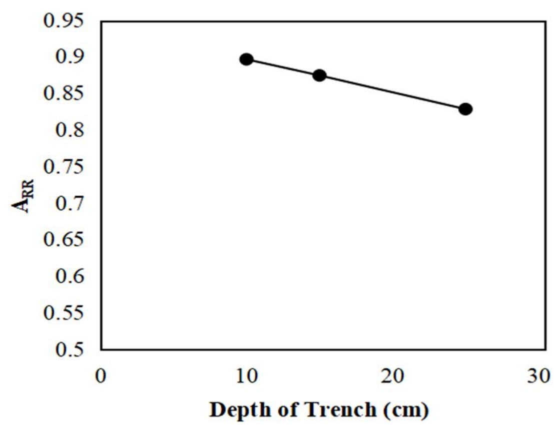

Fig 6 : Influence of depth of trench on the screening efficiency

IV. CONCLUSIONS

The findings from the study shows geometric dimensions length, breadth, depth have significant effect in the screening efficiency of trench. It was observed that in GRFT significant increase in screening efficiency when length and breadth of trench increased.The quantity of wave scattering increases as length and breadth increases, leading to a large improvement in screening efficiency.

Since the geometric dimensions affects the vibration screening system's cost in addition to other factors, geometric dimensions should be chosen taking into account actual field conditions.

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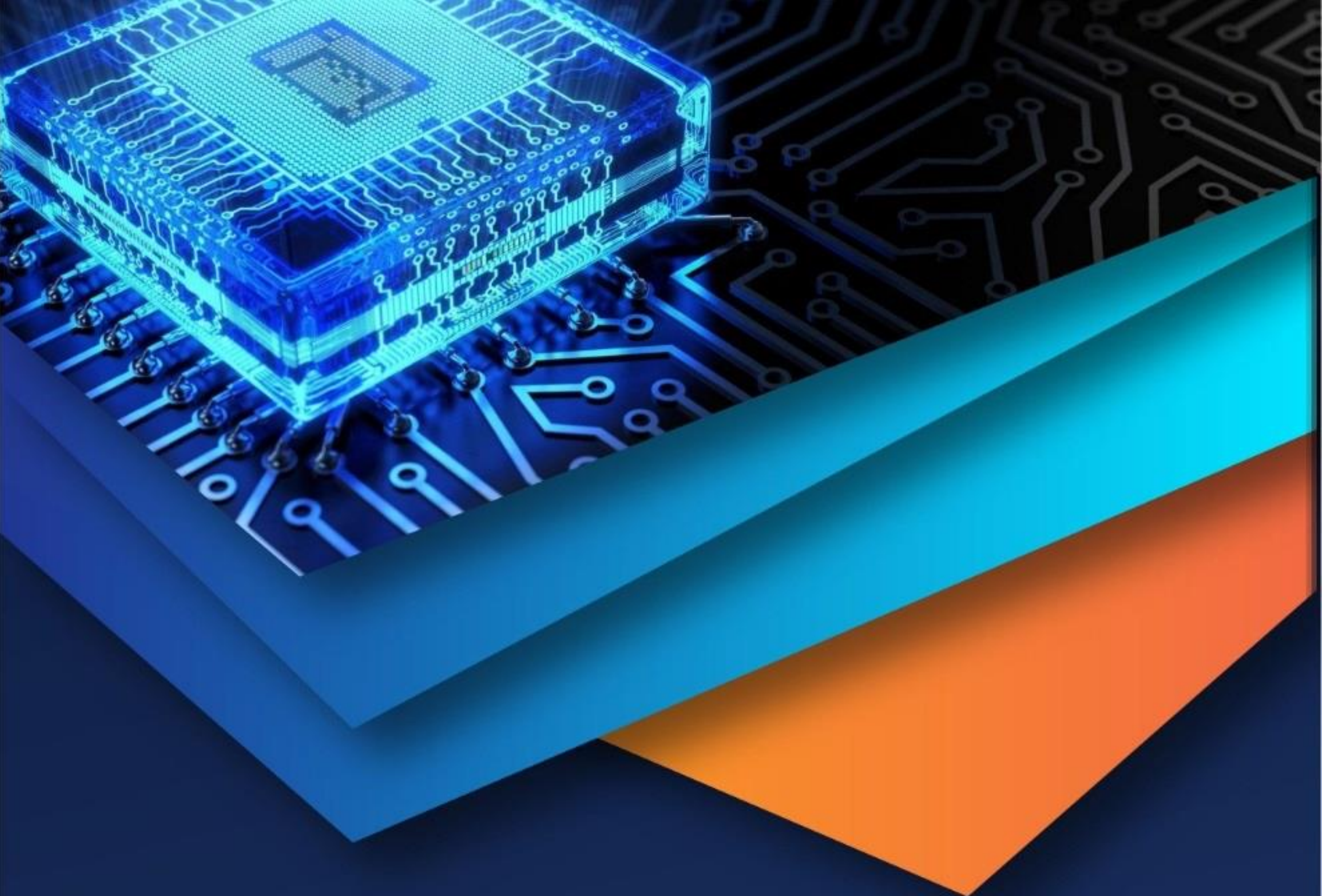

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