iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IV **Month of publication:** April 2023

DOI: https://doi.org/10.22214/ijraset.2023.50172

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

Analysis of Coir Composite In-filled Trench in Mitigating Ground Vibration

Malavika V[1], Revathy V S[2]
[1]PG Scholar, [2]Assistant Professor, Marian Engineering College, Trivandrum

Abstract: Ground vibration is a significant geo hazard that might detrimentally affect civil engineering designs and constructions. Vibrations caused by heavy vehicles, mining railway, traffic and other construction activities have become the major reason for ground vibrations. These destructive vibrations can be isolated by providing open or in filled trench barriers as it creates material discontinuity. In this study the performance of coir composite in filled trenches in mitigating ground vibration experimentally as well as numerically by using PLAXIS 2D software is carried out by varying different parameters such as geometrical parameters, source distance, load intensities etc. It was observed that the proposed trench having coir and latex components in equal proportions can efficiently isolate the ground vibrations.
Keywords: Ground vibration, Trench barrier, Coir composite

I. INTRODUCTION

Ground vibration is a significant geo hazard and has always been an aspect of consideration in civil engineering construction. These vibrations caused by heavy vehicles, mining railway, traffic and other construction activities can annoy people and detrimentally effect structures and sensitive devices.

Ground vibrations are concerned to types of elastic waves propagating through the ground. These can be surface waves, mostly Rayleigh waves, bulk longitudinal waves and transverse waves propagating into the ground depth. Environmental ground vibrations generated by rail and road traffic may cause annoyance to residents of nearby buildings both directly and via generated structure-borne interior noise. Very strong ground vibrations like those generated by heavy lorries on bumped roads, may even cause structural damage to very close buildings. Magnitudes of ground vibrations are usually described in terms of particle vibration velocity (in mm/s or m/s). Sometimes they are also described in decibels.

The stresses generated in the ground during vibration are proportional to the particle velocity of the ground, the intensity of ground vibrations may be easily quantified using the peak particle velocity (PPV) of the ground. Adjusting the excitation frequency, changing the location and direction of the vibration source, modifying the attenuation characteristics of the soil, interrupting the propagation of waves with wave barriers, or isolating the target structure using a base-isolation method are all options for reducing the structural response of an adjacent building to ground vibrations. A well-placed wave barrier can lower the strength of propagating waves while also isolating the buildings in question. Wave barriers with open trenches are thought to be the most effective. However, infilled wave barriers are utilised in many practical applications due to difficulties in maintaining open trenches due to soil instability and water table height inside the trench

Vibration isolation using open or in filled trenches as wave barriers, where the wave of vibration is blocked from reaching the structure, proves to be a simple, quick economic method. Many materials have been incorporated into the trenches for filling purpose. Most of them were costly and inaccessible. Coir latex is an easily available material that has sufficient properties to be used as a filling material in trenches during vibration mitigation.

According to the study of Liu et al. (2020), width should be 0.23 times the Rayleigh wavelength for effective vibration isolation. Increasing the central angle of the trench reduces diffraction of Rayleigh wave. Increasing the depth to width ratio of the trench, the area of effective vibration isolation also increases. Bose et al. (2020), suggests that infill density and shear wave velocity has inverse relation with vibration isolation. Also increasing depth of the trench results in reducing Amplitude Reduction Ratio (Ar) and increasing width from 0.15 to 0.35, Ar decreased by 40%.

Herbut (2020) suggests that vibration reduction efficiency of an inclined, curved, open trench is more than 5 times better than that of a classic rectangular open trench. Vibration attenuation efficiency is more, if the trench is near the vibration source. Gao et al. (2019) conducted a numerical analysis based on boundary element method by varying length, width and thickness. It was obtained that vibration screening effectiveness increases with increase in width, thickness, and depth. Amplitude attenuation ratios at a distance far from the vibration source are relatively lower than that near the vibration source.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

While the amplitude attenuation ratios of WIB near the vibration source are relatively lower than that at a distance far from the vibration source.

Yao et al. (2019) through his numerical analysis found that increase of trench width decreases the acceleration and amplitude ratio of the transmitted wave. Difference in density and elastic modulus between in-filled material and soil properties results in larger reflection coefficient and better vibration isolation. Jayawardana et al. (2018) claims that the vertical ground vibration was more influential with the distance from the source. For trenches of width 30 cm and depths of 50 and 75cm, the transverse vibration was most damped. For trench depth of 100 cm, the longitudinal vibration seemed to be the most damped. The study conducted by Jaya et al. (2016), it can be observed that when the length of trench was halved, efficiency reduced by 20%. Also when the depth was doubled, efficiency increased by 33%. Coir latex composite of ratio 50:50 has better vibration isolation than that of other compositions. Saikia et al. (2016) found that the in-filled trenches can isolate vertical vibration component more effectively than horizontal components. The effect of barrier location on screening effectiveness depends on barrier depth and width and also on the component of vibration. In the study conducted by Duzgun et al. (2015), it was said that open trenches provides better isolation than in-filled trench but its practical application is limited to relatively shallow depths. Also the efficiency of vibration isolation increases with height of trench. Maximum decrease in the displacements occurs when the trench is located closest distance to the vibration source.

II. EXPERIMENTAL STUDY

For the purpose of conducting the experimental study, a glass tank of dimension 1m x 0.5m x 0.5m was filled with uniformly dense sand as shown in fig.1. The sand was collected at a depth of 1m below the ground surface from Menamkulam, near Kazhakootam and the properties of the same was shown in table 1.

Fig. 1 Experimental Set up used for the Analysis

Table 1 Geotechnical Properties of Collected Sand

Property	Measured Value
Uniformity Coefficient, Cu	1.55
Coefficient of Curvature, Cc	0.87
Percentage of Gravel	0 %
Percentage of Coarse Sand	0 %
Percentage of Medium Sand	13 %
Percentage of Fine Sand	87 %
Percentage of Silt	0 %
IS Classification	SP
Specific Gravity, G	2.66
Angle of Internal Friction (Ø)	31^{o}
Cohesion (C)	$0.1 kg/cm^2$
$\gamma_{d\ max}$	2.038 g/cc
$\gamma_{d\ min}$	1.784 g/cc
$\gamma_{d\ 30}$	1.835 g/cc

As shown in the schematic diagram (fig. 2), a load of mass 0.5 kg was subjected to fall at a constant height. Inorder to isolate the vibration arises due to the impact load trenches are made on the sand bed. It was difficult to construct open trenches due to lateral caving or local collapse since there is limited practical application of the same. In-filled trenches seem to overcome this limitation.

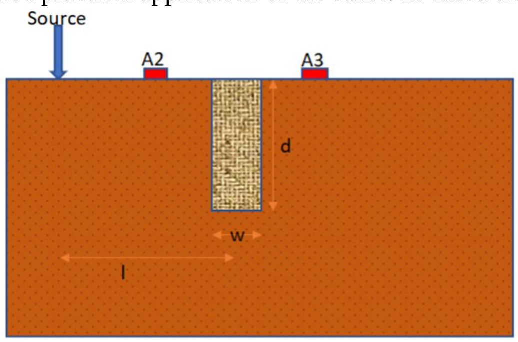


Fig. 2 Schematic Representation of Experimental Set up

Coir-latex in-filled trenches of different dimensions were constructed in the sand bed for conducting the experiment. Amplitudes resulting in each trail were recorded with the help of two accelerometers placed on the surface of the sand bed. YMC series high sensitivity accelerometers were used for the same, which was specifically designed to detect low vibrations of low frequencies. Along with the accelerometer, a data logger T-DAQ IEPE with portable USB was used.

III. RESULTS AND DISCUSSIONS

The efficiency of vibration isolation can be determined by analyzing the screening efficiency of different trenches under consideration. For the same, trenches of different geometric parameters (length, breadth and depth) were constructed in the soil tank. For each trial displacement, velocity and accelerations was recorded. The screening efficiency of the system can be calculated as:

Screening efficiency = (1-ARR) x 100

$$ARR=\frac{\text{Amplitude of Ground Surface with Trench}}{\text{Amplitude of Ground Surface without Trench}}$$

The efficiency of the system is expressed in terms of Amplitude Reduction Ratio (ARR). It is the measure of decrease in amplitude after the trench to that of before the trench. As the ARR value decreases better vibration isolation happens.

A. *Influence of Length*

In the experimental parameters, trenches of different lengths were considered as 10 cm, 20 cm and 30 cm. Coir:latex of proportion 50:50 was in-filled in the trenches considered to analyse the variation in vibration isolation efficiency due to change in length of the trench as shown in fig. 3. It was observed that with the increase in length from 10 cm to 30 cm, the ARR value decreases from 0.982 to 0.858. It results in an increase of 13% in screening efficiency as the area of active vibration isolation increases with increase in length.

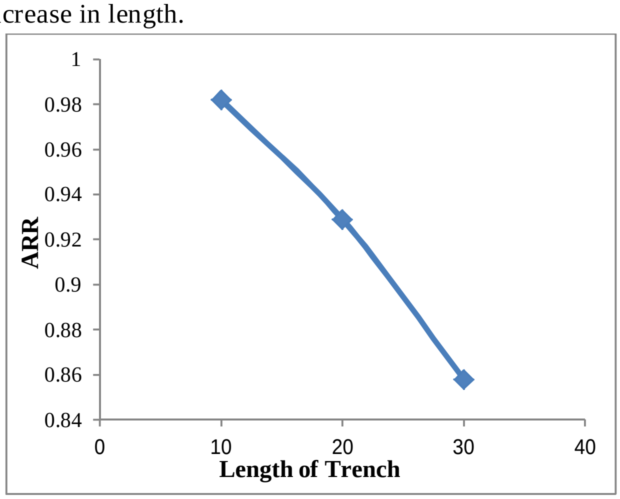


Fig. 3 Variation of ARR with Length of Trench

B. Influence of Breadth

Trenches of different breadths were considered for the experimental analysis as 2 cm, 3 cm and 5 cm. Coir:latex of proportion 50:50 was in-filled in the trenches considered to analyse the variation in vibration isolation efficiency due to change in breadth of the trench as shown in fig. 4. It was observed that with the increase in breadth from 2cm to 5cm, the ARR value decreases from 0.982 to 0.897. This results in an increase of 9% in screening efficiency as the area of active vibration isolation increases with increase in breadth.

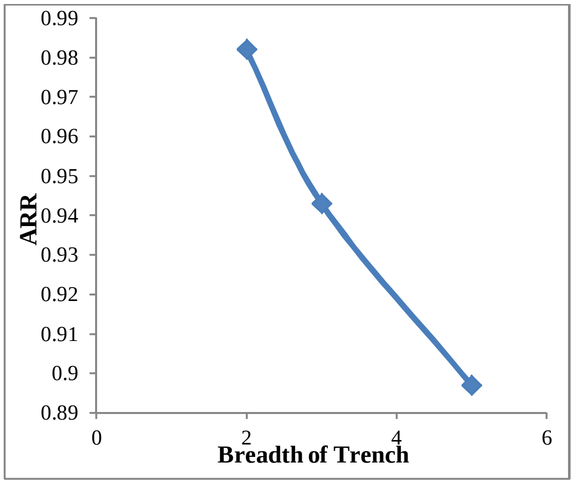
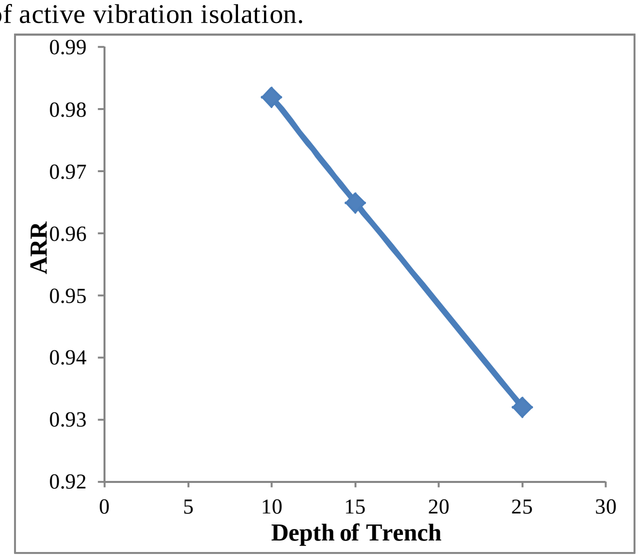


Fig. 4 Variation of ARR with Breadth of Trench

C. Influence of Depth

Trenches of different depths were considered for the experimental analysis as 10 cm, 15 cm and 25 cm. Coir:latex of proportion 50:50 was in-filled in the trenches considered to analyse the variation in vibration isolation efficiency due to change in depth of the trench as shown in fig. 5. It was observed that with the increase in depth from 10cm to 25cm, the ARR value decreases from 0.982 to 0.932. This results in an increase of 5% in screening efficiency. Larger increase in depth does not increases the screening efficiency in larger magnitude as the depths higher than the vertical components of the propagated waves doesn't increases the area of active vibration isolation.



IV. CONCLUSIONS

From the study conducted, it can be observed that the geometric parameters of the trench have significant influence in ground vibration isolation and its screening efficiency. As the dimensions of the trench increases the area of active vibration isolation also increases thus resulting in better screening efficiencies. Among the different parameters considered length of the trench has highest influence and depth of the trench has the least influence.

REFERENCES

[1] Bose, T., Choudhury, D., Sprengel, J. and Zieglar, M. (2018), "Efficiency of Open and Infill Trenches in Mitigating Ground-Borne Vibrations", Journal of Geotechnical and Geo-Environmental Engineering, 144(18), pp. 1-11.

[2] Jayawardana, P. (2018), "Use of Infilled Trenches to Screen Ground Vibration due to Impact Pile Driving: Experimental and Numerical Study", Soil Dynamics and Earthquake Engineering, 20(1), pp. 1-18.

[3] Jaya, V., Lekshmi, C. M. and Nandan, L. (2016), "Evaluation of Ground Vibration Isolation using In-filled Coir- Latex Composite Trenches", Indian Geotechnical Conference December 2016.

[4] Saikia, A. (2016), "Active Vibration Isolation by Open and In-filled Trenches: A Comparative Study", Journal of Engineering Technology, 4(1), pp. 146-148.