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Original Article

Laboratory Study of Vibration Isolation Performance of Needle Felt Coir Latex Composite (NFCLC) Trench Type Wave Barriers

M. Lekshmi Chandran[1,2], V. Jaya[3], K. Balan[4]

[1,3]*Department of Civil Engineering, College of Engineering Trivandrum, Kerala, India.*
[2]*Department of Civil Engineering, Mar Baselios College of Engineering and Technology, Kerala, India.*
[4]*Department of Civil Engineering, Rajadhani Institute of Engineering and Technology, Kerala, India.*

[1]*Corresponding Author : lekshmi.chandran@mbcet.ac.in*

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Abstract - *Ground vibrations can be caused by various sources such as traffic, construction activities, and industrial machinery. These vibrations can propagate through the ground and into adjacent structures or the environment. Predicting and controlling ground vibrations are essential in various fields, such as transportation, construction, and industrial activities. Regulations and guidelines have been developed in many countries to manage the impact of ground vibrations on people and structures. Open and In-filled trenches are practiced as barriers for mitigating ground vibrations in engineering practices. Coir latex wave barriers are highly sustainable barrier that combines the natural strength of coir fibers with the durability and weather-resistant properties of natural latex. The vibration isolation performance of in-filled trenches using Coir Latex composite was evaluated through laboratory model studies. The study assessed the impact of various factors, such as the trench geometry, latex content, and composite material properties, on the in-filled trenches' isolation performance. The composite with an equal latex and coir fiber content ratio demonstrated over 75% wave isolation efficiency, indicating its effectiveness as a vibration isolation solution.*

Keywords - *Ground vibrations, Coir-Latex composite, Wave barriers, Wave isolation efficiency, Amplitude reduction ratio.*

1. Introduction

The Ground vibrations resulting from construction activities, operation of machinery, traffic, blasting and other human activities have become a significant environmental concern. These vibrations generate waves that travel through the ground and are subject to various changes depending on the properties of the ground, the source of the vibrations, and the distance they travel. As the waves propagate through the soil, they can either attenuate or magnify in amplitude.

Vibration from nearby sources can damage buildings, disturbance to living organisms and sensitive equipment. Various vibration isolation methods and wave barriers exist designed to restrict the propagation of waves, attenuate their amplitude and minimize their energy impact. Wave barriers can either reflect wave energy towards the source or absorb energy to prevent further propagation beyond the barrier. Active wave barriers are typically placed close to the source of vibration, while passive wave barriers are situated near buildings or equipment that requires protection.

A wave barrier can be considered a geometric or material discontinuity in the soil or half-space medium, interrupting the propagation of vibrations and reducing their amplitude. This can be achieved by introducing a change in the properties of the soil medium or by adding a layer of a different material that can absorb or reflect the waves. By creating this discontinuity, the energy of the waves can be dissipated, resulting in reduced ground vibrations in the area behind the barrier. Open trenches are more effective than in-filled trenches in mitigating ground vibrations, but their use is limited to relatively shallow depths due to practical considerations.

In-filled trenches are generally more convenient for construction purposes, so they are commonly used in practical applications. Tulika et al. [1] stated that it is essential to evaluate the sensitivity of trench efficiency to different geomaterial parameters. The authors conducted numerical finite element modelling studies in 2D and 3D using PLAXIS software to accomplish this. The study's findings indicated that the trench's normalized depth and width did not significantly affect its efficiency. However, the relative stiffness of the trench material and in-situ soil proved to be a critical factor in determining its performance. Dhanya et al. [2] found that sand-rubber tire mixture (SRM) in-fill trench with 50% rubber content demonstrated similar effectiveness to open trenches in reducing vertical vibration amplitude. The researchers conducted a 2D finite element analysis to evaluate the potential of using a sand-rubber tire mixture (SRM) in-fill trench barrier for screening ground-borne vibrations caused by vertical ground movement.

Jazebi et al. [3] used FLAC software to perform a numerical investigation of the efficiency and behaviour of open and geofoam in-filled trenches in reducing vibrations caused by machine impact loading. The authors observed that the impact of the normalized width of the geofoam trench on its effectiveness was more significant for a Rayleigh wavelength of $\lambda_R = 2.00$ m compared to $\lambda_R = 8.00$ m. Adding admixtures and proper treatment can lead to an advanced vibration isolation material. Sumesh et al. [4] developed and determined the properties of Coir Fibre Latex composite and its effectiveness as a separator in pavement layers. Jaya et al. [5] conducted laboratory studies for ground vibration isolation using Coir Latex composites (CLC). The study evaluated the performance of CLC with different percentages of latex content and concluded that latex coating improves the vibration isolation efficiency of coir fibre.

Woods [6] conducted an experimental study on open trenches and concluded that a trench or wave barrier should achieve at least 75% attenuation for protecting waves. Naghizadehrokni et al. [8] and Ashref Alzawi et al. [7] conducted a full-scale experimental study and numerical analyses to evaluate the efficiency of the Geofoam-filled barrier. Different isolation trenches, such as single, double and triangular wall systems, were studied in active and passive cases [8]. Massarch [9] introduced the gas cushion method and assessed wave isolation in different soil conditions from full-scale projects in field application. Celebi et al. [10] conducted field tests to determine the effectiveness of barriers filled with water, bentonite and concrete. The authors concluded that a higher attenuation level was obtained in passive isolation compared to active isolation.

Beskos et al. [1], Al-Hussaini [11], Kattis et al. [12], Wang et al. [13], and Saikia and Das [14] employed numerical methods in order to evaluate the effect of both geometrical properties and type of wave barriers on screening performance. They inferred that those open trenches provided better vibration isolation than in-filled trenches. However, trench barriers are usually preferred in practice due to a lack of stability in open trenches. Hamdan et al. [15] investigated the effectiveness of different shapes of wave barriers using the finite element method. Their results showed that the wave reduction level was around 50% for rectangular, triangular and L-shaped wave barriers. Field experiments conducted by Woods [6] and numerical analysis performed by Al-Hussaini [11] showed that the trench width did not affect the vibration isolation performance. The authors concluded that the shear wave velocity ratio between the in-fill material and the surrounding ground considerably influenced vibration isolation performance. Çelebi et al. [10] and Massarsch [9] reported that the isolation performance of the wave barrier was strongly dependent on the relative stiffness between in-filled material and the surrounding soil (impedance ratio). These studies emphasized that the trench depth and Rayleigh wavelength had a noteworthy influence on vibration screening.

Natural fibres can be used as in-filled materials in trenches to create wave barriers [17, 18]. These fibres can be derived from plant or animal sources and have been found to possess good acoustic absorption properties. The fibres can be used in different forms, such as mats, panels, or screens, to create barriers that absorb or reflect waves. One of the commonly used natural fibres is coconut coir, obtained from the outer shell of the coconut. It has been found to have excellent sound absorption and thermal insulation properties. Natural fibres used as wave barriers include jute, hemp, sisal, and bamboo. These fibres can be processed into different forms, such as composites, mats, and boards, and can be combined with other materials, such as plastics or resins, to improve their performance. Using coir-latex composite as wave barriers offers a sustainable and eco-friendly alternative to traditional materials while effectively reducing vibration and noise.

This study investigated the performance of the Needle Felt Coir Latex Composite (NFCLC) in-filled trenches as wave barriers through experimental studies. The study aimed to determine the influence of various parameters on the performance of NFCLC trenches, including trench geometry and material properties. Laboratory model tests were carried out in an active case to evaluate the performance of the NFCLC trenches.

The study found that the NFCLC trenches' geometry significantly impacted their performance as wave barriers. Trench depth and length, the different percentages of latex with needle-felt coir, and the source's frequency influenced the barrier's performance. The study provides an understanding of the factors that affect the performance of these barriers, which can be used to improve their effectiveness in mitigating ground vibrations.

2. Experimental Study

The experimental program was carried out at the geotechnical laboratory of the College of Engineering Trivandrum. A sand bed was prepared in a test tank measuring 2m x 2m x 1m for the ground vibration isolation study. A sine wave generator was used as the vibration source, and the waves were transferred to the sand bed through a stinger kit. The vibration levels were measured using accelerometers connected to a data acquisition system.

2.1. Materials

Coir fibres and latex were combined to form the Coir-Latex composite, which was used along with sand in the model study. The material properties of the Coir-Latex composite were determined at the Geotextile testing laboratory of the College of Engineering Trivandrum and are presented in Table 1.

The Coir Fibres used in the study were collected and prepared by sun drying. The fibres were cut into uniform lengths of 100mm and spread evenly in a bed. Chemically treated natural rubber latex was then sprayed onto the fibres manually to create a mat-shaped composite. The composite was then oven dried at a temperature of 120ºC. The fibre content was kept constant to create five different composites while the latex content was varied, and coir geotextile material was also used for the study.

Five different latex contents were used, which corresponded to 70%, 60%, 50%, 40%, and 30% of the total composite. The resulting composites were designated as NFCLC70, NFCLC60, NFCLC50, NFCLC40, and NFCLC30, respectively. The composites were then compressed using a hydraulic compressor to achieve a uniform thickness. Figure 1 shows the Coir-Latex composites that were developed. The required physical properties of Coir Latex composites, including density and thickness, were in the laboratory. Table 2 shows these properties.

2.2. Test Equipments

This study used an electro dynamic shaker with a force rating 200N as the vibration source. Three single-axis accelerometers (model number 4600-010-060) were inserted at different locations in the sand bed to measure the amplitude of the vibrations. These accelerometers were connected to a data logger, and the amplitude of accelerations was recorded using the DEWESoftX software, as shown in Figure 2.

2.3. Test Procedure

An absorbing boundary condition was created in the geotechnical laboratory of the College of Engineering Trivandrum to simulate the elastic half-space. The simulation facility consisted of a test tank measuring 2.0m x 2.0m x 1.0m, with hollow concrete blocks of approximately 250mm thickness used for the tank wall.

The boundary element comprised spiral-shaped thermocol pieces, and sawdust was tightly packed between the masonry wall and the boundary element. The tank was filled with dry sand using a sand raining technique, with a uniform density of 16 kN/m3 maintained. The modulus of elasticity of the sand was determined using a triaxial test, and the Poisson's ratio was taken as 0.30 following IS: 5429-1995. The properties of the sand filled in the tank are presented in Table 1, and the experimental setup is depicted in Figure 2.

A sinusoidal harmonic waveform was generated using a waveform generator and transferred to the sand bed using a vibration exciter with a capacity of 200N. The force amplitude was set to 100N, and the distance between the wave barrier and the excitation source was kept constant at 0.90m in the sand bed. A hollow casing was inserted into the sand bed, and the Coir Latex composite barrier was placed inside it.

The casing was then slowly removed. The depth of the wave barriers selected for the study was 0.30m, 0.60m, and 0.90m. The parameters selected for the experimental study are presented in Table 4. Single axis accelerometers (model number 4600-010-060) were placed in the sand bed at three locations to measure the accelerations - near the source (A1), before the wave barrier (A2), and after the wave barrier (A3) as presented in Figure 3.

The accelerometers were connected to the data logger. The amplitude of accelerations was recorded using the software DEWESoftX. The test arrangement is shown in Figure 4. The acceleration amplitudes observed in the accelerometers were compared to obtain the efficiency of the wave barriers. The amplitude reduction ratio, ARR, is the ratio of peak acceleration amplitude of vibration with and without barriers.

The lesser value of ARR indicates better efficiency of the wave barrier. All test parameters and the test program results are introduced in dimensionless format. All geometrical parameters of the experiments are normalized by the Rayleigh wavelength, which is a function of the excitation frequency. Table 3 represents experimental parameters, including the geometrical dimensions of the barrier, its distance from the source of disturbance and the loading frequencies considered.

Fig. 1 Developed needle felt coir latex composite (NFCLC)

Table 1. Soil properties

Properties	**Unit**	**Value**
Dry density of soil	kN/m^3	16
Poissons ratio	-	0.3
Modulus of Elasticity	MPa	20
Shear modulus	MPa	7.69
Shear wave velocity of soil	m/s	68.66
Rayleigh wave velocity	m/s	63.69

(a) **(b)** **(c)**

Fig. 2 Model study equipment (a) Accelerometers model 4600-010-060 unit (b) Data acquisition system with cables (c) Power amplifier and shaker unit

Table 2. NFCLC material properties

Representation of Specimen	**Thickness of Coir-Latex Composite (mm)**	**Density of Coir-Latex Composite (kg/m^3)**
Coir Geotextile	29.54±0.43	145±2.76
NFCLC30	19.31±0.65	119.062±10.00
NFCLC40	18.97±0.57	133.2±4.34
NFCLC50	20.11±0.73	146.169±7.11
NFCLC60	19.40±1.05	194.808±6.56
NFCLC70	19.59±0.67	216.658±3.26

Table 3. Experimental parametric study

Parameters	Symbol	Unit	Values
Barrier width	w	m	0.03
Barrier depth	d	m	0.3, 0.6, 0.9
Barrier length	l	m	0.5,1.0
Distance between source of disturbance and barrier	x	m	0.9
Geometry	Rectangular		
Needle Felt Coir-Latex Composite (NFCLC)	NFCLC30, NFCLC40, NFCLC50, NFCLC60, NFCLC70.		
Source of vibration	Electro dynamic shaker		

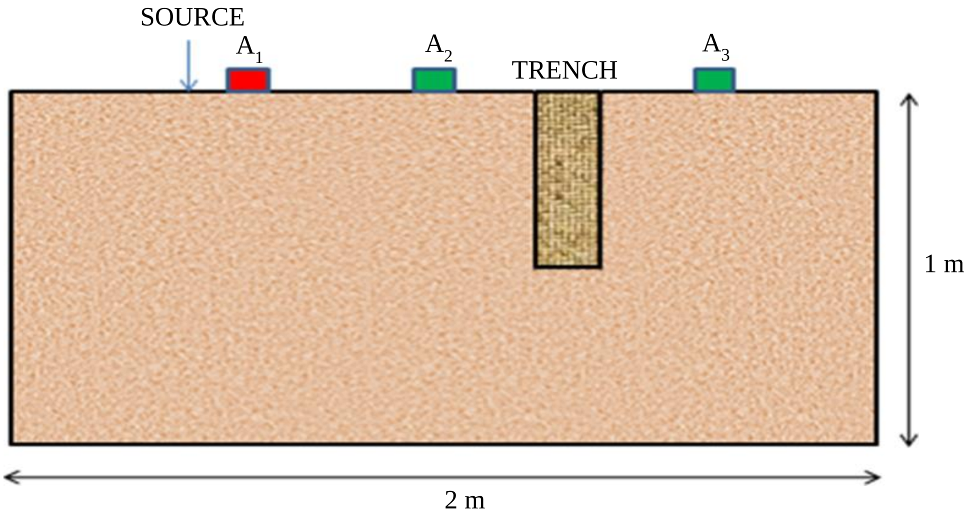

Fig. 3 Schematic representation of test setup

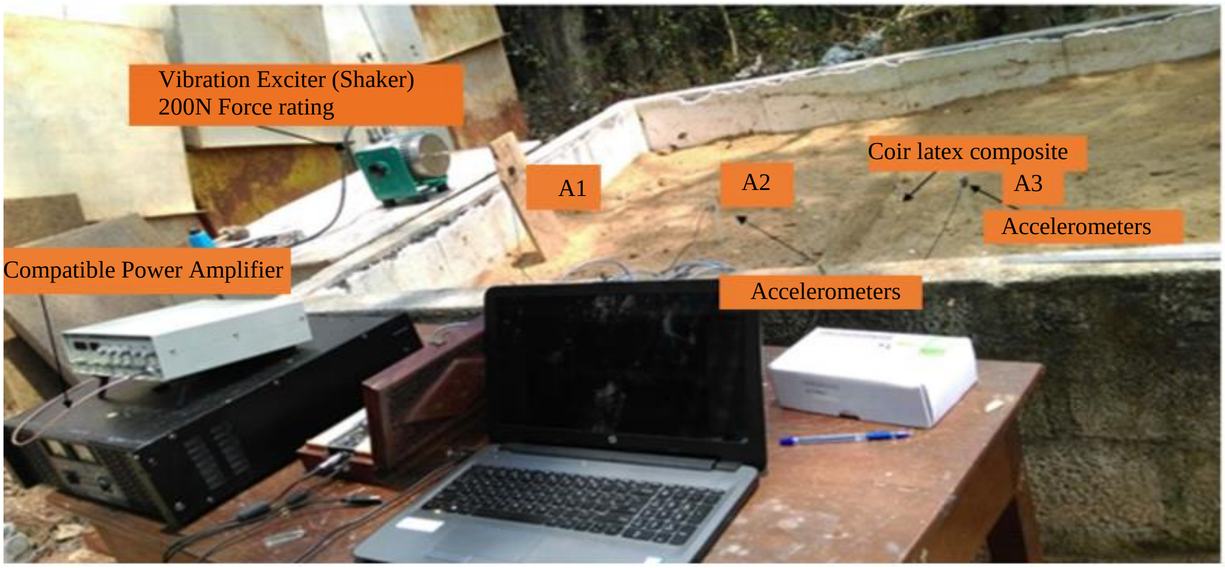

Fig. 4 Experiment test configuration with the source of vibration using an electro dynamic shaker

3. Results and Discussion

The influence of Coir Geotextile and NFCLC with five different latex percentages on the performance of ground vibration isolation was studied in this section. Additionally, we investigated the effect of NFCLC material on the effectiveness of the barrier, the length and depth of the NFCLC when used as a barrier, and the frequency of the vibration source. These topics are discussed in detail in subsequent results and discussion sections.

3.1. Influence of NFCLC Barrier

Figure 5 illustrates the variation of the amplitude reduction ratio (ARR) at various frequencies, ranging from 20Hz to 80Hz. The study included all barriers with different latex percentages, ranging from 0% to 70%. The results indicated that the NFCLC50 barrier with 50% latex content provided the most effective isolation, with an average ARR value of 0.076 (92.35% efficiency) across all frequencies.

Interestingly, a similar trend was observed in the absence of latex, with an average ARR value of 0.128 (87.20% efficiency). Other barriers with 30% and 40% latex content achieved sufficient ARR values of 0.170 (82.97%) and 0.148 (85.17%), respectively. However, the barriers with 60% and 70% latex content failed to achieve adequate ARR values, with ARR values of 0.328 (67.15%) and 0.396 (60.33%), respectively. The absence of latex results in high pores, which absorb more vibration energy instead of transmitting waves. Nonetheless, using non-latex coir material for ground vibration isolation has several drawbacks, including low durability, high water absorption, and quick degradation. Hence, NFCLC can be used as an effective ground vibration material with 50% optimal latex content. This material has a latex coating, which makes it more durable and less permeable than non-latex coir. Compared to non-latex coir, the latex-coated sample has coir fibres firmly bound together with the latex, allowing the nonwoven coir needled felt to be handled easily without the risk of tearing the sample.

3.2. Influence of Normalized Distance of the NFCLC Barrier

Rayleigh waves predominantly carry ground vibrations, accounting for 67% of the energy. To express the geometric parameters of the trench in a dimensionless manner, it is normalized by the Rayleigh wavelength, as presented in Table 4.

The normalized distances (L) used in the previous studies vary from 0.2 to 4 (Woods [6], Dolling [16], Haupt [14], Beskos et al. [1]., and Al-Hussaini[11]). The present study utilised a normalized distance of 0.283 to 1.131. Therefore, as described in the subsequent section, the amplitude reduction ratios were plotted concerning Normalized Depth (D) for all NFCLC materials in this study.

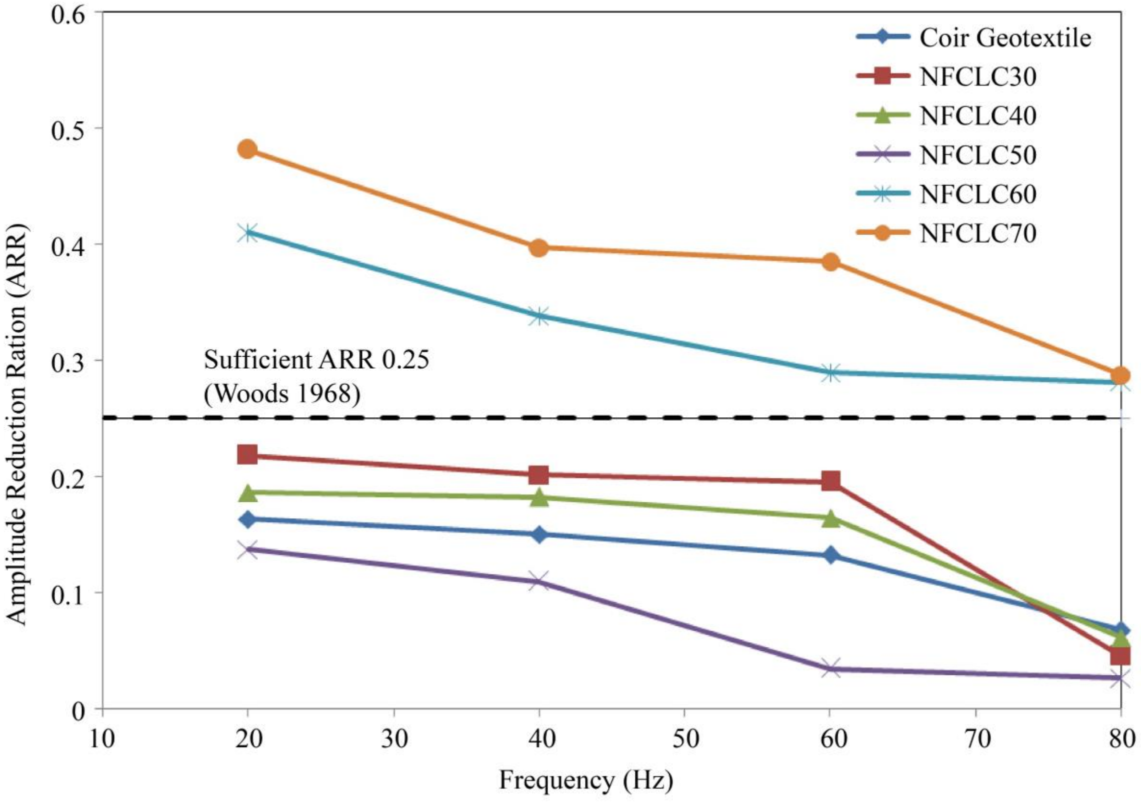

Fig. 5 Variation of ARR with frequency (l x w x d =1.00m x 0.03m x 0.90 m)

Table 4. Experimental test configurations with dimensional geometric properties

Frequency f (Hz)	Rayleigh wavelength (m) $\lambda_R = \frac{V_R}{f}$	Normalized Depth $D = \frac{d}{\lambda_R}$			Normalized Width $W = \frac{w}{\lambda_R}$	Normalized Distance $L = \frac{l}{\lambda_R}$
		d=0.3m	d=0.6m	d=0.9m	w=0.03m	l=0.9m
20	3.185	0.094	0.188	0.283	0.009	0.283
40	1.592	0.188	0.377	0.565	0.019	0.565
60	1.062	0.283	0.565	0.848	0.028	0.847
80	0.796	0.377	0.754	1.130	0.038	1.131

3.3. Influence of Normalized Depth of the NFCLC Barrier

The variation of ARR with normalized depth (D) is depicted in Figures 6 to 11. The present study utilised a normalized depth of 0.094 to 1.131. A consistent trend is observed across all NFCLC barriers, where an increase in the normalized depth of the barrier results in a decrease in the ARR value and an increase in efficiency. The appropriate barrier depth can vary depending on soil conditions, in-fill material and the vibration source. To achieve a screened zone with an amplitude reduction ratio (ARR) of 0.25, Woods [6] proposed a minimum normalized depth of 0.6 for active isolation.

The results showed that the nonwoven Coir Geotextile in-filled trenches with depths of 0.30 m and 0.60 m had average ARR values of 0.461 and 0.348, respectively, both of which exceeded the required ARR value of 0.250. However, when the trench depth was increased to 0.90 m, the average ARR value dropped to 0.128, below the required ARR value of 0.250.

These findings are depicted in Figure 6. For a particular frequency of 60Hz, the normalized depth (D) increases with trench depth (d) increase. The ARR values decreased from 0.450 to 0.132 when the normalized depth increased from 0.283 to 0.848. The results showed that the ARR value decreased as the normalized depth increased, indicating that depth and frequency significantly influence the ARR value. A similar trend was observed for NFCLC in-filled trenches, as shown in Figures 6 to 9.

Figure 7 shows that for a specific frequency of 60Hz, the amplitude reduction ratio (ARR) values for NFCLC30 decreased from 0.267 to 0.195 as the normalized depth increased from 0.283 to 0.848. When using NFCLC30, a trench depth of 0.60m showed sufficient ARR values for normalized depths above 0.565. With a further increase in trench depth to 0.9m, sufficient ARR values were attained for normalized depths ranging from 0.283 to 1.130.

According to the data presented in Figure 8, it is observed that at a frequency of 60Hz, the amplitude reduction ratio (ARR) values for NFCLC40 exhibit a decreasing trend as the normalized depth increases from 0.283 to 0.848, dropping from 0.246 to 0.164. When using NFCLC40, a 0.3m and 0.6m trench depth provided satisfactory ARR values for normalized depths greater than 0.283 and 0.377, respectively. Moreover, by increasing the trench depth to 0.9m, sufficient ARR values were achieved for normalized depths ranging from 0.283 to 1.130.

According to the data presented in Figure 9, it is observed that at a specific frequency of 60Hz, the amplitude reduction ratio (ARR) values for NFCLC50 decreased significantly as the normalized depth increased from 0.283 to 0.848, dropping from 0.206 to 0.034. When using NFCLC50, a 0.3m and 0.6m trench depth provided satisfactory ARR values for normalized depths greater than 0.283 and 0.377, respectively. Moreover, increasing the trench depth to 0.9m resulted in sufficient ARR values for normalized depths ranging from 0.283 to 1.130. Additionally, the barrier's efficiency improved from 79.4% to 96.6% when the depth of the barrier was increased from 0.3m to 0.9m.

In contrast to the previous materials, NFCLC60 and NFCLC70 show an increase in ARR values as the depth increases, as presented in Figures 10 and 11. For NFCLC60, the ARR values for depths of 0.3m, 0.6m, and 0.9m are 0.473, 0.350, and 0.330, respectively. Similarly, for NFCLC70, the ARR values are 0.561, 0.438, and 0.388 for the same depths. However, despite the increase in ARR values, the efficiency of both materials is lower than that of the other materials tested. NFCLC60's average efficiency ranges from 52.70% to 67.05%, while NFCLC70's average efficiency ranges from 43.95% to 61.25%. However, despite the increase in ARR values, the efficiency of both materials is lower than that of the other materials tested. NFCLC60's average efficiency ranges from 52.70% to 67.05%, while NFCLC70's average efficiency ranges from 43.95% to 61.25%. Furthermore, it is worth noting that when considering the effect of depth, an increase in latex content up to 50% positively influences the material's efficiency with increasing depth. However, the efficiency decreases with increasing depth for materials with 60% and 70% latex content. The ARR values obtained in these tests indicate that a higher frequency results in better isolation for the same normalized depth. Therefore, a detailed study on the effect of frequency will be presented in the subsequent section. Similar trends were observed for NFCLC30, NFCLC40, and NFCLC50 for all depths of 0.3m, 0.6m, and 0.9m. However, for NFCLC60 and NFCLC70, the ARR value did not reach the required threshold of 0.25, indicating that the depth did not significantly impact these two materials, as illustrated in Figures 10 and 11.

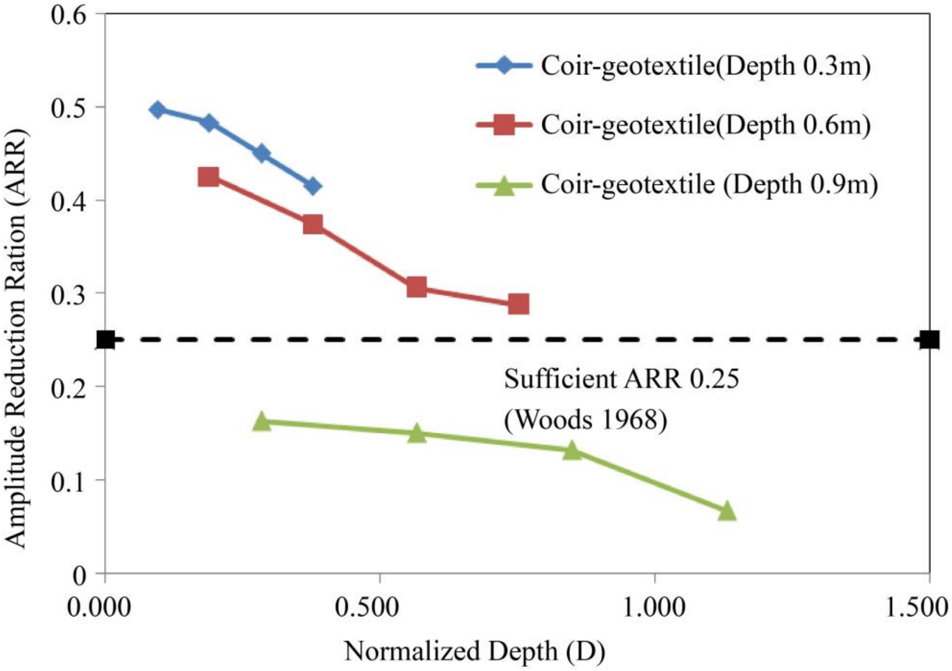

Fig. 6 Variation of ARR with normalized depth (d) for coir geotextile (l x w =1.0mx0.03m)

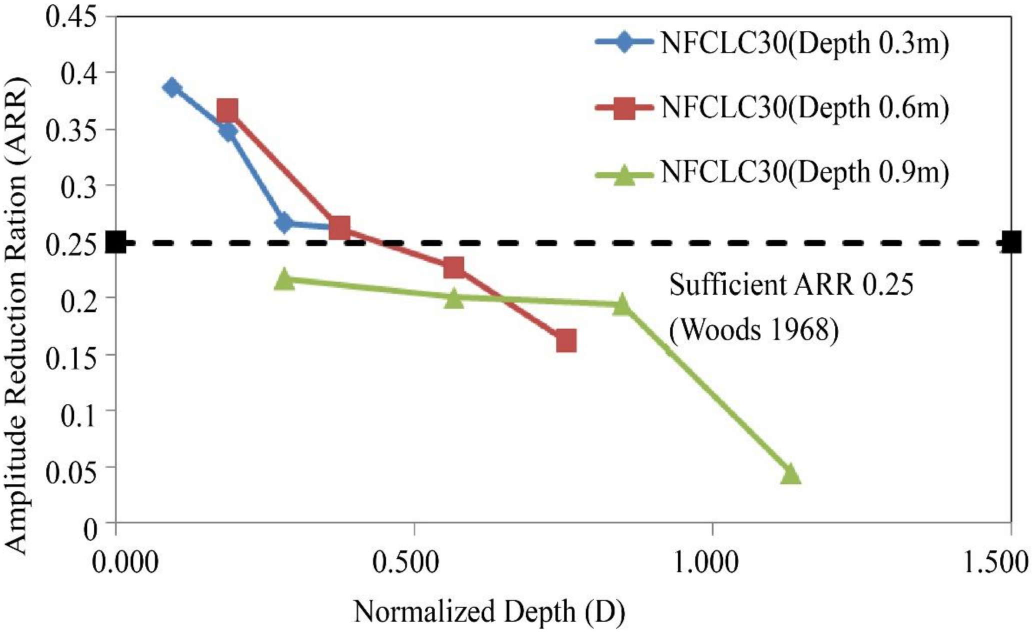

Fig. 7 Variation of ARR with normalized depth (D) for NFCLC30 (l x w =1.0mx0.03m)

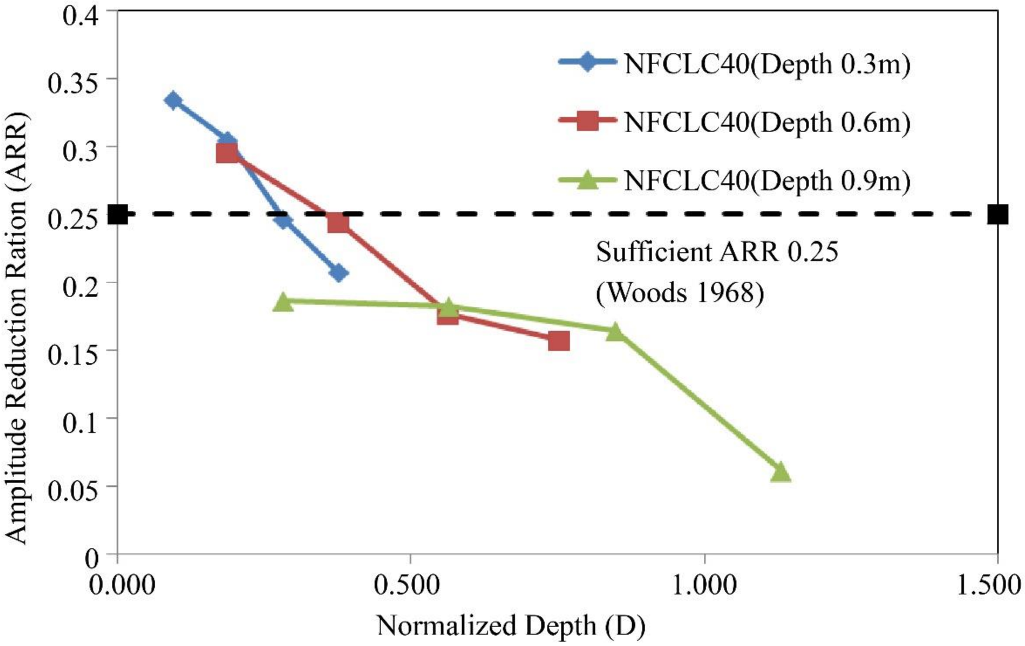

Fig. 8 Variation of ARR with normalized depth (D) for NFCLC40 (l x w =1.0mx0.03m)

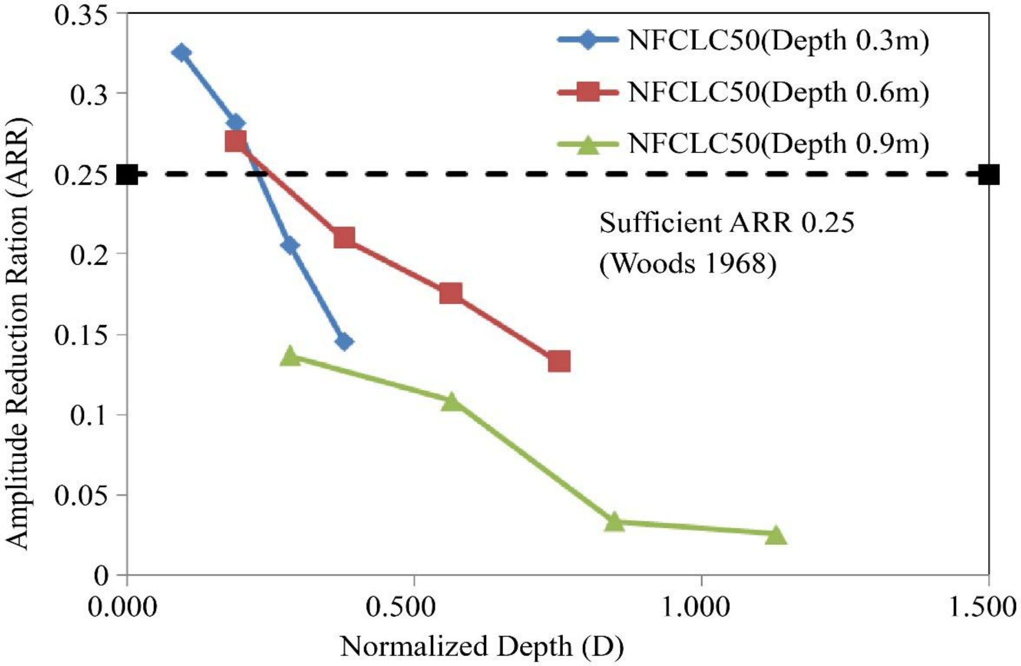

Fig. 9 Variation of ARR with normalized depth (D) for NFCLC50 (l x w =1.0mx0.03m)

3.4. Influence of Frequency of the NFCLC Barrier

The efficiency of various latex percentage materials, including Coir Geotextile, was studied for a sample size of 1m in length, 0.03m in width, and 0.9m in depth. The results are presented in Figure 12, which shows the variation of efficiency with frequency. The findings suggest that the efficiency of the materials is lower at low frequencies and increases with increasing high frequencies. Woods has recommended that for effective ground vibration isolation, the efficiency of the materials should be at least 75%. For a trench depth of 0.9m, the vibration isolation efficiency of Coir Geotextile and NFCLC materials was evaluated at a frequency of 20 Hz. The results showed that materials with up to 50% latex content achieved efficiency above 75%, with NFCLC50 showing the highest efficiency of 86.3%. This value is nearly the same as that achieved with Coir Geotextile (83.7%). However, NFCLC60 (59%) and NFCLC70 (51.9%) showed less than 75% efficiency values.

Furthermore, it was observed that the efficiency of all NFCLC materials increased with the frequency of the vibration source. At a frequency of 80Hz, Coir geotextile and NFCLC materials with up to 50% latex content achieved an efficiency of 75%, with NFCLC50 showing the highest efficiency of 97.4%. However, an increase in the latex content above 50% decreased the vibration isolation performance of NFCLC. Upon comparing the efficiencies at all frequencies, it was found that NFCLC50 had the highest efficiencies. Therefore, it can be concluded that NFCLC50 is suitable for ground vibration isolation applications at high frequencies.NFCLC50 has proven to be an effective solution for reducing ground vibrations while also providing an eco-friendly option for ground vibration isolation. Its use is sustainable due to coir and latex's natural and renewable properties. Additionally, it offers an alternative to synthetic materials that can have harmful environmental effects. However, the effectiveness of NFCLC50 may be limited by the percentage of latex used and its susceptibility to degradation or moisture absorption over time. Despite these limitations, NFCLC50 can be a more stable option than an open trench and can serve as an efficient barrier for isolating ground-s.

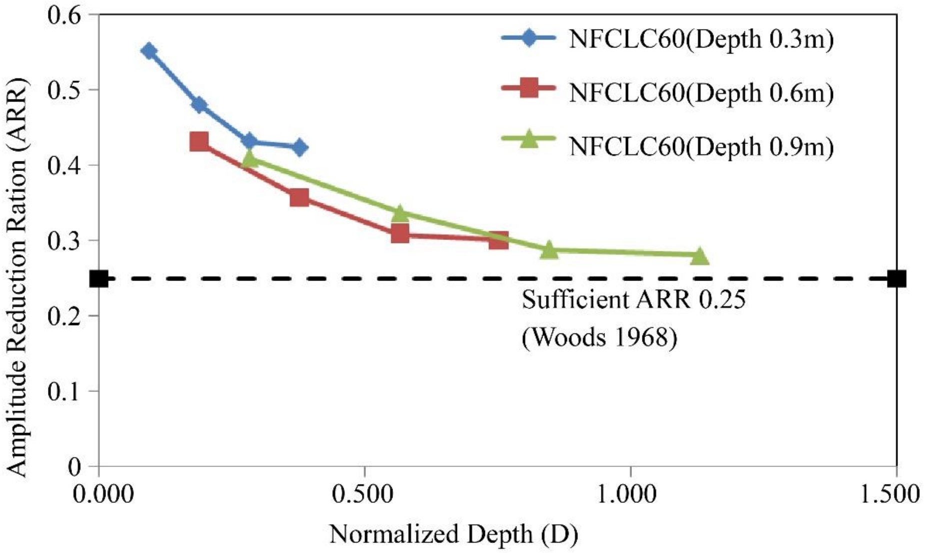

Fig. 10 Variation of ARR with normalized depth (D) for NFCLC60 (l x w =1.0mx0.03m)

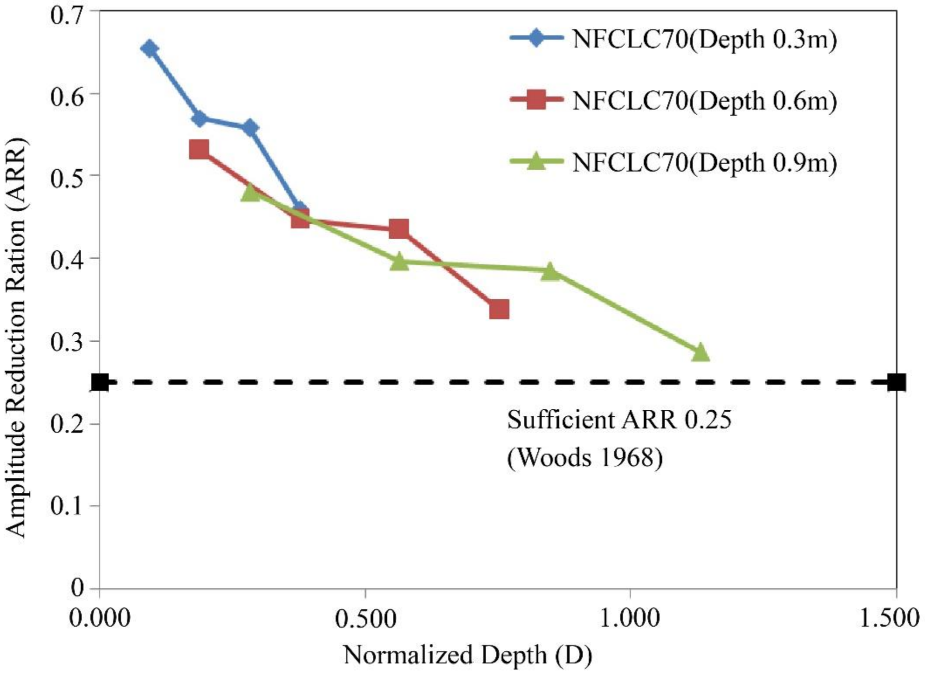

Fig. 11 Variation of ARR with normalized depth (D) for NFCLC70 (l x w =1.0mx0.03m)

4. Comparison of Findings with Literature.

In this study, Woods [6] minimum normalized depth recommendation of 0.6 for active isolation was mentioned, but different suggestions can be found in the literature regarding the minimum or optimum trench depth. For the specific experimental conditions and site, normalized depths ranging from 0.094 to 1.130 were obtained, sufficient for the isolation required in this study. It is important to note that these results do not apply to other locations or scenarios.

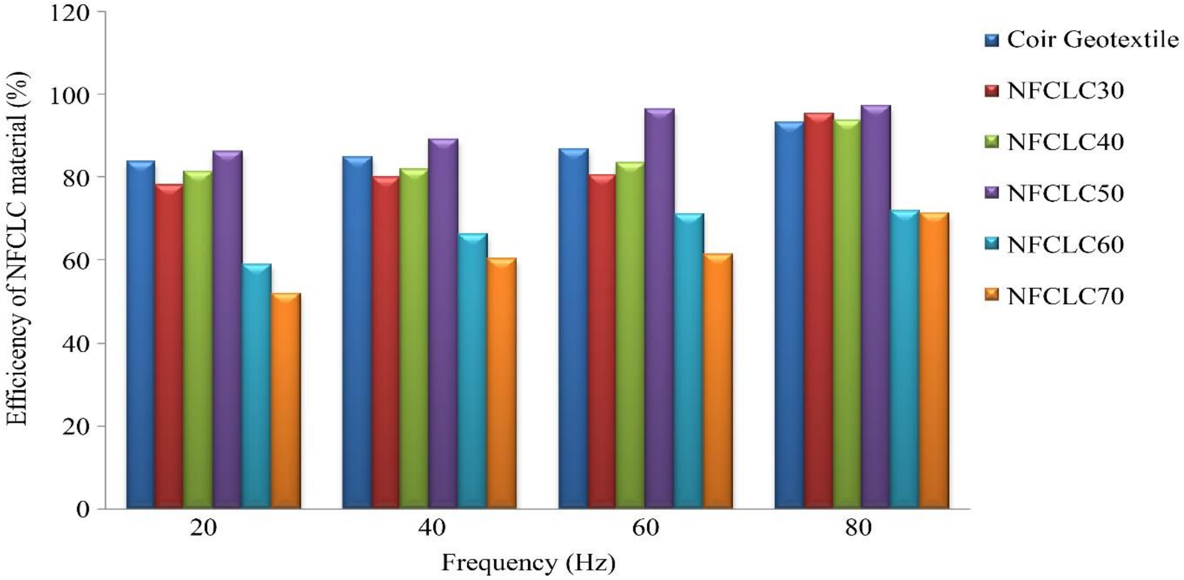

Fig. 12 Variation of efficiency of NFCLC material with frequency (Hz) (1.0mx0.03mx0.9m)

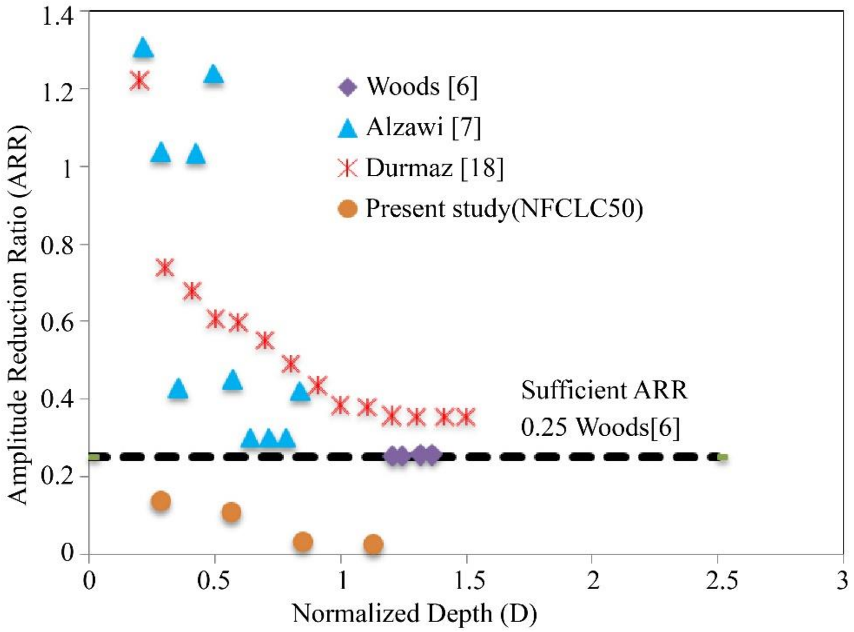

Fig. 13 Comparison between wave barriers reported in previous literature and those exhibited by the present NFCLC50 material (1.0mx0.03mx0.9m)

Experimental tests were conducted, and the results were compared with published literature, including data from Woods [6], Ashref [7], and Durmaz [19]. The vibration was applied through an electrodynamic shaker and converted to frequency using FFT, while the Rayleigh wavelength normalized the geometric dimensions of the trench. Figure 13 illustrates a plot of amplitude reduction ratios against normalized depth D for the efficient NFCLC50 material used in this study, along with data from previous literature for Geofoam [7], concrete [19], and open trench [6] cases. The results for NFCLC50 were consistent with the open trench case studied by Woods, and sufficient ARR values occurred for both.

Compared to Geofoam [7], NFCLC50 had slightly lower ARR values. Compared to concrete [19], NFCLC50 had lower ARR values and effectively reduced vibration. Overall, NFCLC50 was an effective and eco-friendly solution for reducing ground vibrations.

5. Conclusion

Based on the laboratory model studies, the following conclusions were drawn regarding the vibration isolation efficiency of Coir Geotextile and NFCLC under different frequencies of vibrations:

- Ground vibration isolation barriers utilizing Coir Geotextile and varying percentages of latex content (ranging from 30% to 70%) were developed, with the NFCLC50 material showing the best performance.
- Specifically, the NFCLC50 barrier with 50% latex content exhibited the most effective isolation, with an average Amplitude Reduction Ratio (ARR) value of 0.076 across all frequencies. Surprisingly, a similar trend was observed even in the absence of latex, with an average ARR value of 0.128. However, barriers with higher percentages of latex (60% and 70%) exhibited less efficiency, with ARR values of 0.328 and 0.396, respectively.
- The results of this study indicate that the effectiveness of NFCLC barriers depends on the depth at which they are installed. Specifically, a deeper trench is required to achieve significant amplitude reduction ratios (ARR). Furthermore, the influence of latex content on the efficiency of the material varies with depth. For materials containing up to 50% latex, an increase in depth results in improved efficiency. However, the efficiency decreases with increasing depth for materials with 60% and 70% latex content. It is also noteworthy that higher frequencies result in better isolation for the same normalized depth, as evidenced by the ARR values obtained in this study.
- The study revealed that the efficiency of all NFCLC materials increased as the frequency of the vibration source increased. However, an increase in the latex content beyond 50% decreased the vibration isolation performance of NFCLC. When comparing the efficiencies at all frequencies, it was evident that NFCLC50 exhibited the highest efficiency. Therefore, it can be concluded that NFCLC50 is well-suited for ground vibration isolation applications, especially at high frequencies.
- In this study, the performance of NFCLC50 material was compared with other materials (Geofoam, Concrete, and open trench) studied in the previous literature regarding amplitude reduction ratio (ARR) values obtained from the experiments. The results indicate that the ARR values obtained in this study align with the trends observed in the previous study by Woods [6], having an open trench case and demonstrating good performance compared to other materials studied.

Author’s contribution

Lekshmi Chandran M, Jaya V, and K Balan designed the study. Lekshmi Chandran M conducted the experiments and analysed the data, while Jaya V and K Balan contributed to interpreting the results and preparing the manuscript. All authors reviewed and approved the final version of the manuscript.

Data Availability

The data used to support the findings presented in this paper are available within the article. Raw data, including any data not presented in the article, can be obtained upon request from the corresponding author.

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