Research Article

Comparative Experimental Study between Hemp and Pineapple Fiber Wastes as Additional Materials to Improve Acoustic Performance in Concrete Blocks

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DOI: 10.14416/j.asep.2025.09.004
Received: 29 May 2025; Revised: 26 June 2025; Accepted: 16 July 2025; Published online: 12 September 2025

Abstract
The sustainability of building materials is receiving increasing attention, particularly through the use of agricultural waste as a low-cost, renewable raw material in concrete mixtures, either as a replacement or an additional component. The additions of hemp and pineapple fibers at 10, 20, and 30% by volume of sand with lengths of 6, 12, and 18 mm were compared for their physical, mechanical, and sound acoustic properties. The results showed that increasing the fiber content decreased the density and led to higher water absorption in concrete containing hemp fiber, while there was a trending decrease in concrete containing pineapple fiber. The optimal fiber was found to be 10% with 12 mm of the highest compressive and tensile strengths. Superior acoustic performance at 1,000–3,150 Hz was detected in pineapple fiber incorporated with concrete, whereas hemp fiber was superior at the higher frequency of 4,000 Hz. For concrete blocks, the density and water absorption were higher than those of plain concrete blocks. Although the compressive strength of concrete blocks mixed with hemp and pineapple fibers decreased, it was still within the range of non-load-bearing concrete blocks. The finding demonstrated that hemp and pineapple fibers incorporated with concrete blocks proved effective for sound absorption on walls.

Keywords: Agricultural waste materials, Concrete block, Hemp fiber, Pineapple fiber, Sound absorption

1 Introduction

Construction is one of the most relevant sectors for environmental impacts due to the significant use of raw materials, fossil energy consumption, and the consequent greenhouse gas emissions [1]. Commonly, the traditional materials used in construction come from production processes, which causes a significant consumption of energy and non-renewable resources. In addition, these materials often have end-of-life problems due to non-recyclability [2]. The increased awareness of global environmental threats, such as climate change, non-renewable resource depletion, and water shortage, has renewed the interest of the construction sector in more sustainable materials. A key factor in decreasing material and energy consumption in buildings is the use of unconventional and environmentally friendly materials and technologies that are recognized worldwide [1]. Therefore, the development of building materials from plant biomass has gained attention because these materials offer the benefits of carbon sequestration, low embodied energy [3], and being cheap, sustainable, and easily available.

After pineapple cultivation, there are around 37.5 tons of waste per hectare, or 2.7 million tons per year, which is generated from leaves, stems, and rhizomes. Most farmers burn this waste rather than decompose it [4], causing carbon dioxide (CO_2), carbon monoxide

(CO), particulate matter (PM), and polycyclic aromatic hydrocarbons (PAHs) to be released into the atmosphere. To mitigate these pollutions, pineapple waste should be used as a source of natural fiber that can be used in many industries, such as the textile industry, packaging industry, paper industry, automobile reinforcement, and building material [5], [6]. As hemp is naturally resistant to disease and pests, conserves water, degrades quickly, and produces environmentally friendly industrial products such as bioconcrete, biocomposite, biodiesel, paper, and textiles, hemp proves competency for new sustainable resources [7]. In addition, it has gained considerable attention as a reinforcement in the polymer matrices due to its renewable, biodegradable, and recyclable properties [7].

Sound pollution is the major challenge faced by people living and working in factories or apartments, and there is a need for concrete materials that can absorb sound waves. Concrete is generally a preferred product to block noise transmitted into a room due to its excellent performance as a sound-reflecting material. However, it is extremely limited in terms of sound-absorbing capability. Therefore, previous studies explore the acoustic performance of the cement-based products to act as effective sound absorbers [8]-[11]. The sound quality of the concretes can be enhanced by changing the mixtures in different ways, like using lighter or more porous materials, adding a foaming agent to create cellular concrete, and allowing the concrete mixes to let water pass through [12]. Previous studies have altered the granular materials in cement-based products, which have been shown to positively impact sound quality control in rooms due to their light mass and porosity properties. For example, some recommended materials that can be used to change the properties of cement-based products include crumb rubber [8], bottom ash [13], cenosphere [10], expanded clay [14], vermiculite [15], waste polypropylene fiber [16], hemp fiber [17], and pineapple leaf fiber combined with paper waste in concrete composite as a noise-absorbing material [18].

Recycling waste materials or transforming waste to produce fibers is cost-effective, provides long-term economic benefits, and eliminates the challenging sorting and pre-treatment processes [19]. The fibers from waste materials would be used in either textile [20] or non-textile value-added applications, such as bio-composites [21], [22], filter materials [23], polymer composites [24], thermal and sound insulation panels [18], [25], [26], concrete, concrete reinforcement, and cement-based as an additional aggregate [16], [17], [26]–[28]. Reinforcing masonry units with fibers could enhance the performance of concrete because concrete and masonry units have low flexural strength, brittle behavior, and strain-carrying capacity [29]. Previous studies found that 0.3% of pineapple leaf fiber (50 mm) added to the concrete mixture provides the highest compressive and tensile strengths [30]. In addition, when the *Arundo donax* fiber dosage was 0.6%, the split tensile strength was improved. However, an increase in fiber content did not improve compressive strength [31]. An increase in hemp fiber (20–40 mm, 0.6%) and flax fiber (20–40 mm, 0.8%) improved compressive and flexural strengths with decreased water absorption [18], while with a hemp fiber increase of 1–4%, the compressive strength was less than the control [32]. However, when natural fibers were used as reinforced materials, that led to improper contact between the adherent surface and polymer matrix, resulting in a detrimental interaction load transformation from matrix to fiber [33]. Hemp and pineapple fibers can split into a single fiber and have good matrix adhesion properties [34] due to their high cellulose content [12], [35]. Therefore, increasing fiber content and decreasing fiber length may improve fiber adhesion properties.

Due to light mass and porosity properties, adding natural porous materials in cement-based products may improve sound quality and reduce GHG emissions from burning agro-waste. This study investigated the physical, chemical, and sound absorption properties of hemp and pineapple fibers added to concrete blocks. The incorporation of hemp and pineapple fibers in concrete blocks offers a solution to address the surplus of agricultural waste by transforming it into new, green, and sustainable concrete materials, fulfilling the circular economy principles.

2 Materials and methods

2.1 *Materials*

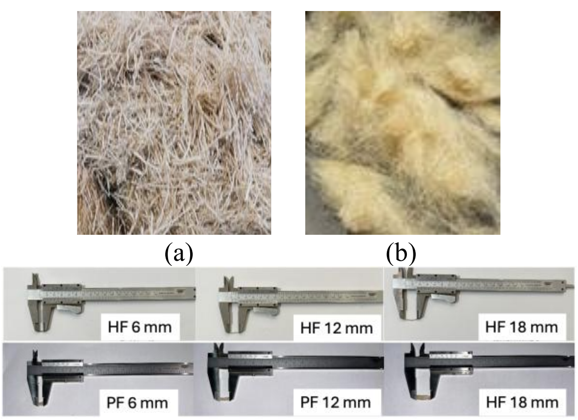
The materials used in this study consisted of hydraulic cement, fine river sand, dust stone, hemp fiber, pineapple fiber, and tap water. Hydraulic cement, which has properties according to ASTM C1157 [36], was used as a binder, while fine river sand and dust stone were used as aggregate. The specific gravity of hydraulic cement, sand, and dust stone was analyzed according to the standard of ASTM C642 [37], and the gradation of sand and dust stone was tested in accordance with ASTM C136 [38].

Hemp fiber waste was supported by the hemp products of Ban Huai Sai community enterprise housewives (Chiang Mai, Thailand), whereas pineapple fiber waste was obtained from Ban Lamo Phatthana Pineapple Fiber Paper Community Enterprise (Prachuap Khiri Khan, Thailand). The chemical composition and physicochemical properties of hemp and pineapple fibers are listed in Table 1.

In the previous research, 12 mm of hemp fiber with 10% sand replacement showed superior compressive strength compared to the control mortar [39], while the highest strength was derived from 50 mm in length with 0.3% of pineapple leaf fiber added in the concrete mixture [30]. Therefore, in this study, hemp (Figure 1(a)) and pineapple (Figure 1(b)) fibers were compared in three length sizes: 6, 12, and 18 mm (Figure 1(c)), where 10, 20, and 30% of hemp and pineapple fibers were added by volume of sand. The schematic diagram of the study is shown in Figure 2.

Table 1: Chemical composition and physicochemical properties of hemp and pineapple fibers.

	Hemp Fiber [12]	Pineapple Fiber [12], [35]
Chemical composition (%)		
Cellulose	70.2–74.4	68.5
Hemicellulose	17.9–22.4	18.8
Lignin	3.7–5.7	6.04
Ash	2.6	0.9
Pectin	0.9	1.1
Wax	0.8	3.2
Properties		
Density (g/cm^3)	1.5	0.8–1.6
Tensile strength (MPa)	530–1,110	1,020
Elongation at break (%)	1.6–3	14.5
Young's modulus (GPa)	23.5–90	71



(a) (b)

(c)

Figure 1: Fibers derived from (a) hemp and (b) pineapple.

Figure 2: Schematic diagram of the study.

2.2 *Specimen preparation*

The mixture proportion of the mortar is shown in Table 2. The binder-to-aggregate ratio is 1:2.75 by weight. The specimen of 50 × 50 × 50 mm was prepared in accordance with ASTM C109 [40] as shown in Figure 3 (Top). The water-to-cement ratio (W/C) was calculated while maintaining the flow value between 100 and 115%. After being removed from the mold, the specimens were cured for 28 days before being tested.

Table 2: Mixture of mortar with hemp and pineapple fibers.

Mortar	Fiber (mm.)	Cement (g)	Aggregate (g)	Fiber (g)	W/C ratio	Water (mL)
Standard	-	500	1,375	-	0.70	350
HF10	6	500	1,375	110	0.80	400
	12	500	1,375	110	0.80	400
	18	500	1,375	110	0.80	400
HF20	6	500	1,375	225	0.90	450
	12	500	1,375	225	0.90	450
	18	500	1,375	225	0.90	450
HF30	6	500	1,375	330	1.00	500
	12	500	1,375	330	1.00	500
	18	500	1,375	330	1.00	500
PF10	6	500	1,375	110	0.69	345
	12	500	1,375	110	0.69	345
	18	500	1,375	110	0.69	345
PF20	6	500	1,375	225	0.80	400
	12	500	1,375	225	0.80	400
	18	500	1,375	225	0.80	400
PF30	6	500	1,375	330	0.93	465
	12	500	1,375	330	0.93	465
	18	500	1,375	330	0.93	465

Figure 3: The specimen samples of cube (top) and briquette (bottom) mortars.

2.3 *Testing for mortar mixed with hemp and pineapple fibers*

(a)

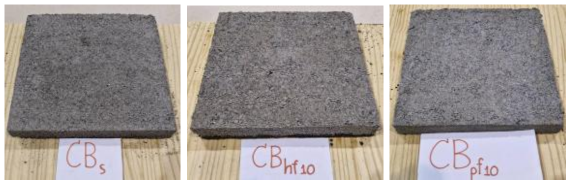
(b)

(c)

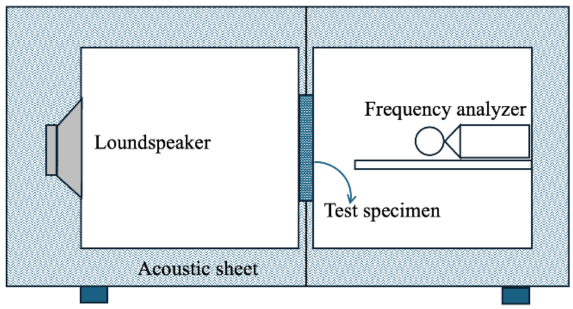
Figure 4: Experimental setup for (a) curing and the test of (b) compressive and (c) tensile strengths.

Each fresh mortar mixture was tested for flow tables according to ASTM C230 [41]. After curing in a water tank at ambient temperature for 28 days (Figure 4(a)), six cubes of each mixture were used for the analysis of density (ASTM C642 [37]), water absorption (ASTM C642 [37]), and compressive strength (ASTM C109 [40]), while six briquettes were used for the test of tensile strength in accordance with ASTM C190 [42]. After that, the length of hemp and pineapple fibers was chosen, which shows adequate compressive strength compared to the control mortar, for further tests of sound transmission loss and sound absorption.

2.4 *Testing of sound transmission loss*



(a)



(b)

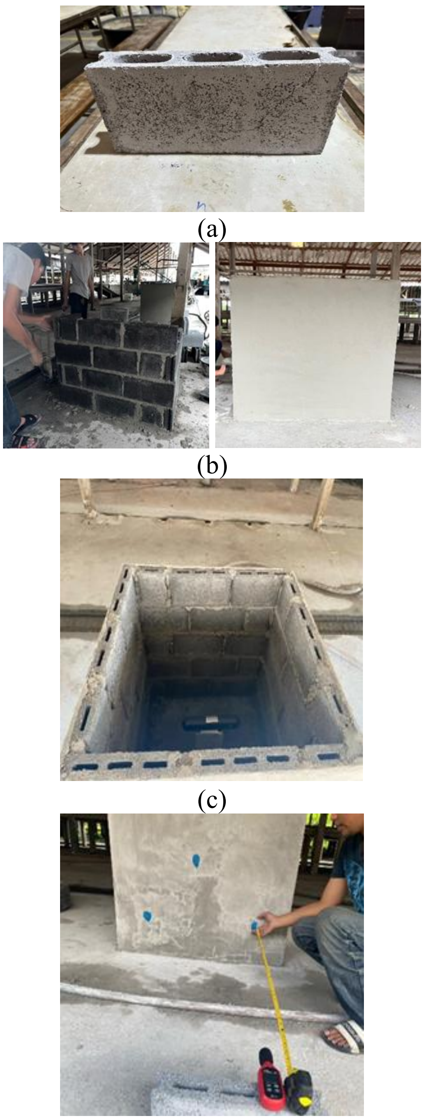
(c)

Figure 5: The (a) specimen for the STL test, (b) schematic diagram and (c) experimental setup used for the sound transmission loss test by the custom two-room method.

Each hemp and pineapple fiber mortar with good compressive strength was further analyzed for the sound transmission loss (STL). The concrete specimen, 3,048 × 3,048 × 38 mm, was prepared for the STL test (Figure 5(a)). The custom-made two-room method based on ASTM E90 [43] and ISO 10140 [44] was conducted, which is divided into a sound source room and a receiver room. The specimen to be tested is installed in the middle of the room

(Figure 5(b)–(c)). The background noise level in both the source room and the sound-receiving room before starting the test was measured. The 100 dB speaker of 1,000 W was used for the test, in which the frequencies started from 12.5 Hz to 16 kHz. The sound waves from a speaker were monitored with a digital sound level meter (Brüel & Kjaer BZ 5503). Then, the STL was calculated for each frequency range.

2.5 *Preparation of concrete block and sound absorption testing*



(a) (b) (c) (d)

Figure 6: Reverberation chamber for sound absorption performance test.

The ratio of cement: sand: dust stone: tap water used in this study for concrete block is 1:2:6:0.9 by weight. The findings from Section 2.3 determined the amount of hemp and pineapple fiber added to the mixture, in which the fiber content added is calculated based on the volume of sand. A concrete block (thickness x height x length) of 70 × 190 × 390 mm was constructed according to the Thai industrial standard (TIS) 58-2560 [45] (Figure 6(a)). The specimens, once removed from the mold, underwent a 28-day curing period before testing. The concrete block was tested according to TIS 58-2560, non-weight-bearing type.

To measure the sound absorption of modified concrete, the walls of 1 × 1 × 1 m on 4 sides were constructed and plastered with standard mortar for the reverberation chamber (Figure 6(b)). A loudspeaker at the center of the chamber test generates a sound wave (Figure 6(c)). The test uses three frequencies: 500, 1,000, and 1,500 Hz. A smart board sheet sealed the top of the chamber. 5 points of the sound intensity measurement were marked on all 4 sides of the chamber. The sound waves from a loudspeaker were monitored with a digital sound level meter (UNI-T UT353) that can convert ambient sound into electric signals, process data, and display results on an LCD (Figure 6(d)). The digital sound level meter was placed 1 m from the chamber.

3 Results and Discussion

3.1 *Properties of mortar mixed with hemp and pineapple fibers*

Specific values of hydraulic cement, sand, and dust stone are 2.95, 2.45, and 2.77, respectively. All specific values used in this study were within the range of the standard. That is, the standard values for sand and dust stone are 2.40–2.90, 2.50–2.80, respectively. The fineness modulus values of sand and dust stone are 2.91 and 2.88, which are graded as fine aggregate. The fine aggregate suitable for use as a concrete mixture is between 2.30–3.20, with a lower value indicating greater fineness. The proportions of sand and dust stone passing through sieve No. 50 (0.30 mm) were 12.40% and 19.11%, and those passing through sieve No. 100 (0.15 mm) were 0.40% and 7.20%, respectively (Figure 7). Hemp and pineapple fibers are natural fibers that can absorb water. Therefore, extra water was added to the mixture, which affected the water-cement (w/c) ratio (Table 2). The w/c ratio increases with an increase in fiber content.

Table 3: Physical properties and compressive strength of hemp and pineapple fiber mortars.

Mortar	Fiber Adding (% w/w)	Fiber Length (mm.)	Water Absorption (%)	Density (g/cm^3)	Flow Table	Compressive Strength (MPa)	Tensile Strength (MPa)
Standard	-	-	1.66 ± 0.01	2.09 ± 0.03	105 ± 0.52	23.04 ± 0.40	4.42 ± 0.18
HF10	10	6	1.65 ± 0.02	2.07 ± 0.01	105 ± 0.75	19.04 ± 0.35	4.15 ± 0.19
		12	2.12 ± 0.01	2.10 ± 0.02	107.5 ± 1.64	23.11 ± 0.25	4.82 ± 0.14
		18	2.33 ± 0.03	2.09 ± 0.01	108.8 ± 0.75	21.13 ± 0.39	4.37 ± 0.20
HF20	20	6	2.53 ± 0.03	1.97 ± 0.03	106.3 ± 1.51	13.88 ± 0.35	3.89 ± 0.16
		12	2.65 ± 0.04	1.95 ± 0.02	108.8 ± 0.75	14.57 ± 0.39	4.00 ± 0.17
		18	3.15 ± 0.04	1.93 ± 0.03	107.5 ± 1.87	14.08 ± 0.24	3.93 ± 0.09
HF30	30	6	3.23 ± 0.03	1.88 ± 0.04	106.3 ± 1.21	10.98 ± 0.27	3.19 ± 0.08
		12	3.41 ± 0.01	1.86 ± 0.03	107.5 ± 2.07	12.25 ± 0.33	3.40 ± 0.05
		18	4.61 ± 0.01	1.83 ± 0.02	110 ± 3.29	11.12 ± 0.28	3.05 ± 0.04
PF10	10	6	2.72 ± 0.03	2.15 ± 0.05	106 ± 1.10	20.56 ± 0.26	3.91 ± 0.09
		12	2.51 ± 0.02	2.14 ± 0.04	107 ± 1.26	23.49 ± 0.35	4.81 ± 0.13
		18	2.58 ± 0.02	2.19 ± 0.03	109 ± 1.79	21.86 ± 0.20	4.10 ± 0.06
PF20	20	6	2.89 ± 0.03	1.94 ± 0.02	113 ± 2.83	15.62 ± 0.16	3.75 ± 0.08
		12	2.72 ± 0.02	2.06 ± 0.01	111 ± 3.52	16.38 ± 0.22	4.06 ± 0.09
		18	2.70 ± 0.02	1.99 ± 0.06	110 ± 1.79	14.01 ± 0.11	3.52 ± 0.08
PF30	30	6	3.07 ± 0.02	2.00 ± 0.02	106 ± 2.37	9.58 ± 0.13	3.40 ± 0.10
		12	2.90 ± 0.01	1.94 ± 0.03	106 ± 1.41	12.70 ± 0.11	3.93 ± 0.07
		18	2.79 ± 0.02	1.90 ± 0.02	105 ± 0.89	9.61 ± 0.08	3.29 ± 0.07

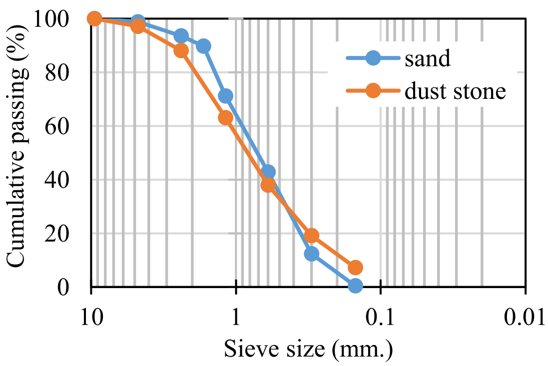


Figure 7: Particle gradation of aggregate.

Table 3 shows the physical properties of mortar samples. Water absorption of mortar mixed with hemp fiber and pineapple fiber increases with an increasing proportion of fiber. The fiber affects the moisture content of the concrete mixture due to its absorption [46]. The water absorption of mortar mixed with hemp fiber and pineapple fiber was higher than that of standard mortar, except for the mortar mixed with 10% hemp fiber, which was 6 mm in length. The optimal content of hemp fiber contributes to the concrete composite's more organized, slightly denser structure and more coherence, owing to its fibers being distributed fairly evenly throughout the entire volume of the composite and having satisfactory adhesion to the cement stone. Therefore, dispersed reinforcement has a positive effect on the water absorption rate of concrete [18]. Pore structure and interface density affect water absorption. That is, larger and more interconnected pores lead to higher water absorption, whereas denser interfaces and refined pore networks can reduce water uptake. The quality of the structure and its cohesion are improved by the rational fiber additive dosage. Therefore, the number of pores is reduced [18]. As the length of hemp fiber increases, the water absorption increases. In contrast with hemp fiber, the water absorption tends to decrease with an increase in the length of pineapple fiber.

When the fiber proportion increases, the density will decrease. The mortar mixed with 20–30% hemp and pineapple fibers had a low density compared with the standard mortar. The density of mortar mixed with hemp fiber was lower than that of mortar mixed with pineapple fiber. The flow table of all mortar mixtures was in the range of 105–115%.

The length and proportion of fiber affect the compressive strength. The length of 12 mm in both hemp and pineapple fibers shows the best compressive strength among other lengths. As the proportion of fiber increases, the compressive strength decreases. However, the compressive strength of 10% fiber added into mortar was not much decreased compared with other proportions. The surfaces of pineapple fiber are relatively clean due to the fine fiber size and have a high cellulose content and have the lowest non-cellulose content, leading to good adhesion to the matrix and high tensile strength [34]. In a previous study, adding 0.3% pineapple leaf fiber (50 mm. length) to concrete improved its compressive strength because the fiber helps boost the initial compressive strength and support the weight applied to it [30]. Roselin *et al*., [47] demonstrated that adding 0.75% pineapple leaf fiber to the concrete mixture increased the maximum compressive strength.

The length of the fiber influences its tensile strength. That is, 12 mm of fiber yielded the highest tensile strength among other lengths for both hemp and pineapple fibers. The highest tensile strength was detected when 10% fiber was added. The presence of hemp and pineapple fibers helps in bridging microcracks on concrete, just as polypropylene fibers act on concrete [48]. Similar to Osmi *et al*. [30], pineapple leaf fiber could resist the shear failure by bridging cracks within concrete materials. However, when the fiber content is excessive, the strength of the concrete decreases. This attributed the increase in porosity from the addition of fibers to the concrete [49], which creates more voids, reduces density, and weakens compressive strength [50]. Additionally, this attributes the congestion or balling of the fibers to the increase in volume, which leads to a reduction in adhesion between the fibers and the matrix [51]. Therefore, mortar mixed with 12 mm in length with 10% fiber addition was investigated in the sound transmission loss.

3.2 *Sound transmission loss of concrete mixed with hemp and pineapple fibers*

Figure 8 presents the sound transmission loss (STL) of 10% hemp and pineapple fiber (12 mm in length) specimens. It was observed that both hemp and pineapple fibers contribute to the noise reduction of the specimen. At all frequencies, the specimens from pineapple fiber exhibited a higher sound transmission loss (STL) compared to the control, whereas only at the 2,000–2,500 Hz frequency did the hemp fiber specimen show a lower STL than the control (0.52–2.26 dB). These results can imply that the fiber absorbs and reduces sound energy more effectively than the control. The hemp and pineapple fibers may act as sound traps to prevent sounds from landing on the surface, which penetrates the material. Wijesinghe *et al*., [52] reported that fibers create frictional resistance against sound waves. This process leads to a decrease in the amplitude of the transmitted sound due to the conversion of sound energy into thermal energy.

In the previous experiments, it was found that 30 mm hemp fiber [53] and 30 mm pineapple leaf [54] show superior sound absorption in the frequency range of 500–2048 Hz, which is the most sensitive frequency range of the human auditory system [55]. In addition, hemp particles with a size distribution demonstrate better sound absorption at low frequency than single-sized spherical aggregates [56].

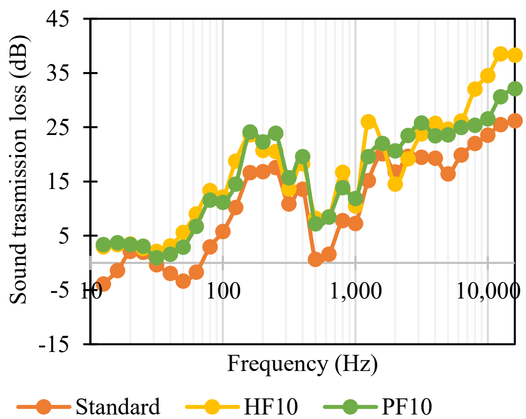


Figure 8: Sound transmission loss of concrete mixed with hemp and pineapple fibers.

3.3 *Properties of concrete block mixed with hemp and pineapple fibers*

In accordance with the compressive strength result, 10% fiber with 12 mm of length was added to the concrete block mixture. The water absorption and density of block concrete are presented in Table 4. Based on ASTM C90 [57] and C129 [58], these concrete blocks can be considered as normal-weight blocks, whose density is more than 2,000 g/cm³. When hemp and pineapple fibers were added, the density and water absorption of the concrete block increased compared with the standard concrete block. The water absorption of concrete mixed with 10% hemp and pineapple fiber increased 3.72% and 3.14%, respectively, compared to the control. Lack of water due to absorption by fiber can be overcome by adding water, following the absorption capacity of water by fiber. The low water-to-concrete ratio increases concrete strength despite the presence of pineapple leaf fiber in the mix [59].

Table 4: Physical properties of concrete block mixed with hemp and pineapple fibers.

Sample	Fiber Adding (% w/w)	Fiber Length (mm.)	Weight (kg)	Density (g/cm^3)	Water Absorption (%)
Standard	0	-	6.42 ± 0.00	2,371.53 ± 0.26	6.47 ± 0.05
HF10	10	12	6.71 ± 0.01	2,391.10 ± 0.28	6.72 ± 0.02
PF10	10	12	6.68 ± 0.01	2,390.72 ± 0.22	6.68 ± 0.01

When 10% hemp and pineapple fibers were added to concrete, the compressive strength of concrete blocks mixed with hemp and pineapple fibers was decreased by 22.75% and 20.46%, respectively, compared to standard concrete blocks (Figure 9). However, the concrete block mixed with hemp and pineapple fibers had the compressive strength that is acceptable for TIS 58-2560 [45] and ASTM C129 [58] for non-load-bearing concrete masonry units, which requires a minimum of 2.45 and 4.14 MPa, respectively. The concrete block mixed with pineapple fiber had a compressive strength higher than that of hemp fiber. The increased compressive strength of concrete is attributed to the presence of pineapple leaf fiber, which helps bridge microcracks in the material [34]. Therefore, the concrete block mixed with pineapple fiber can be used for wall construction by strengthening it with additional beams to increase strength in the case of walls with wide areas.

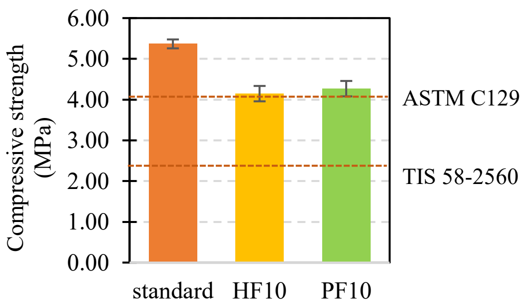


Figure 9: Compressive strength of concrete blocks.

The sound absorption performance was tested in a chamber made from a 1 m² concrete wall, using a concrete block mixed with 10% fiber in a 12 mm length. Both hemp and pineapple fibers showed better sound absorption of the wall than the standard concrete block (Figure 10). It was noticed that the wall absorbed sound more effectively at the frequencies of 500 and 1,500 Hz than at 1,000 Hz. A concrete block mixed with pineapple fiber had a slightly better ability to absorb sound than hemp fiber. That is, the wall made of concrete blocks mixed with pineapple and hemp fibers absorbed 3.07% and 2.89% more at 500 Hz, 2.89% and 2.45% more at 1,000 Hz, and 3.31% and 3.14% more at 1,500 Hz at those same frequencies compared to standard concrete blocks.

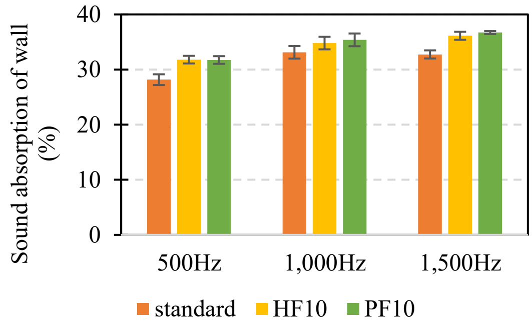


Figure 10: Sound absorption performance of a wall made from concrete blocks.

4 Conclusions

In mortar specimens, increasing the length of hemp fiber leads to higher water absorption, while increasing the length of pineapple fiber tends to reduce it. When the fiber content increases, the density will decrease. The length and proportion of fiber affect the compressive and tensile strengths. Therefore, the length of 12 mm and 10% in both hemp and pineapple fibers shows the best compressive and tensile strengths among other lengths. Both hemp and pineapple fibers contribute to the noise reduction of the specimen. Pineapple fiber incorporated with concrete exhibits superior compressive strength and acoustic performance (at 1,000–3,150 Hz) compared to hemp fiber. However, hemp fiber incorporated with concrete is suitable for the higher frequency of 4,000 Hz.

For concrete blocks, when 10% of hemp and pineapple fibers with 12 mm were added, the density and water absorption were higher than those of plain concrete blocks. The compressive strength of concrete blocks mixed with hemp and pineapple fibers decreased 22.75% and 20.46%, respectively; however, their compressive strength is acceptable for non-load-bearing concrete blocks of TIS and ASTM. Both hemp and pineapple fibers showed the sound absorption of the wall better than the plain concrete block, which was more effective at the frequencies of 500 and 1,500 Hz.

Concrete with hemp and pineapple fibers can solve the abundance of agricultural waste by converting the waste into new green and sustainable concrete material that can be fully used in the construction of various buildings. Further research should study the long-term durability of concrete blocks that contain fibers, as well as the impact of porosity measurements and microstructure imaging on compressive strength, tensile strength, and sound absorption.

Acknowledgments

This research was supported by National Science, Research and Innovation Fund (NSRF) and Rajamangala University of Technology Rattanakosin (RMUTR) (Ref. No. FF68037/2568). Special thanks to Asst. Prof. Dr. Suparoek Junsupasen, Department of Instrumentation and Electronics Engineering, King Mongkut's University of Technology North Bangkok, for supervising the STL test.

Author Contributions

K.K.: conceptualization, methodology, investigation, data curation, writing an original draft; A.P.: conceptualization, research design, investigation, data curation, writing an original draft; M.K.: conceptualization, investigation, data analysis, writing-reviewing and editing, funding acquisition, project administration. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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