

An investigation into the sound insulation performance of common construction materials in urban environments

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Abstract:

This study investigates the sound insulation performance of common construction materials in urban environments and explores the physical properties that influence this performance. Relevant literature on noise pollution and construction materials was reviewed, and a questionnaire was designed and distributed to examine public attitudes towards noise pollution and perceptions of the insulation performance of common materials. In addition, an experiment was conducted to compare the sound insulation performance of four materials—wood panel, concrete, foam board, and plastic—by measuring their sound attenuation under controlled conditions. The results indicate that noise pollution has a noticeable negative impact on people's daily lives. Among the materials tested, wood panel and concrete showed stronger sound insulation performance than foam board and plastic. The findings further suggest that density, hardness, and structural strength are important factors influencing sound insulation. Overall, the study highlights the practical importance of selecting suitable construction materials for reducing urban noise exposure and suggests that future research should explore composite materials that combine multiple beneficial physical properties.

Keywords: Noise pollution; Sound insulation performance; Construction materials; Physical properties

1. Introduction

In recent years, noise pollution in urban areas has become increasingly serious due to the growth of traffic volume and construction activity. Previous research reported that 32% of people complained about noise problems in 2016, and that this proportion had increased by 2021 (Chung and Hsieh, 2024). These

findings indicate that noise pollution is a significant urban issue. To investigate this problem further, a questionnaire survey was conducted to examine whether noise pollution is a major disturbance to urban residents, and 105 valid responses were collected. The results showed that 91.35% of respondents had been disturbed by noise, and 16.35% experienced such disturbance almost every day. Both the litera-

ture and questionnaire findings suggest that road traffic is one of the main sources of urban noise pollution (Rahman et al., 2025). Therefore, reducing the impact of noise pollution on daily life is an important practical issue.

Urban residents are exposed to much higher levels of noise pollution than those living in rural areas. Noise not only disrupts study and everyday life, but may also contribute to cardiovascular problems and increase the risk of depression (Munzel et al., 2024). In addition, school noise exposure has been shown to reduce children's cognitive abilities, including reading and memory performance (Stansfeld and Clark, 2015). Reducing exposure to air and noise pollution may therefore improve population mental health (Newbury et al., 2024). The questionnaire also revealed that, when asked to rate the sound insulation performance of their walls or windows on a scale from 0 to 100, respondents gave an average score of only 44.16. Previous studies suggest that the sound insulation performance of building materials is influenced by factors such as density, thickness, and porosity (Gao, 2025).

This project was selected because it combines concepts from both physics and chemistry, two disciplines closely related to the study of sound transmission and material properties. Physics provides the theoretical basis for understanding sound waves, while chemistry helps explain the internal structure and behaviour of materials. Together, these perspectives support a more comprehensive investigation of sound insulation performance. Noise pollution is a widespread problem in cities, and studying how different materials respond to sound transmission may contribute to better material choices in noise-sensitive urban environments. The topic therefore has both academic relevance and practical significance.

This study examined public attitudes towards noise pollution and the importance of sound insulation through a questionnaire survey. It also included a comparative experiment designed to measure the decibel reduction achieved by different construction materials under controlled conditions and repeated trials. The aim was to identify which materials offer better sound insulation performance and, through analysis of their physical properties, to determine how these characteristics influence acoustic behaviour. This may provide a theoretical basis for improving the sound insulation performance of construction materials. Before the experiment, it was hypothesised that materials with higher density, such as concrete and wood panel, would show better sound insulation. This is because denser materials are generally more effective at resisting sound transmission. By contrast, foam board and plastic were expected to show weaker insulation performance.

2. Literature Review

2.1 The problem of noise pollution

As mentioned above, noise pollution not only affects physical health but also has negative impacts on mental health. Among these, traffic noise is an important environmental factor contributing to the development of various cardiovascular and cerebrovascular diseases. Such noises can increase the risks of traditional cardiovascular conditions such as arterial hypertension and diabetes, and can also accelerate the process of atherosclerosis, raising the overall risk of cardiovascular disease (Munzel et al., 2024). Furthermore, research has found a link between noise pollution in Scotland and depression. Although noise pollution does not directly cause mental illness, it acts as a mediating factor and significantly contributes to conditions such as depression (Tsimpida and Tsakiridi, 2025). Therefore, improving the sound insulation of buildings to reduce the impact of noise on people's lives and enhance their quality of life is both necessary and meaningful.

2.2 The source of noise

Research shows that noise in urban environments is related to land use and a variety of human activities. The main sources of noise include road and rail traffic, construction sites, industrial areas, and public recreational activities. Road traffic is the biggest contributor to urban noise. A study comparing Alexandria and Zagreb found that Zagreb had 141 car or taxi noise sources, ranking first, while Alexandria ranked third with 45 such sources. Noise sources and noise levels in cities were analyzed using noise maps, crowdsourcing applications, and spatial analysis (Othman et al., 2024).

2.3 Existing technology to reduce noise pollution

The main methods for improving sound insulation in buildings can be divided into three areas: treatment of floor slabs, soundproofing of partition doors and walls, and noise control for pipelines and elevators (Meiqin Hu & Guilin Zou, 2022).

In building sound insulation, treatment of floor slabs is particularly important. A common method is to add elastic vibration isolation pads to concrete floor slabs. These pads absorb impact shock waves caused by daily activities, thereby reducing vibration and noise between upper and lower floors.

When doors and windows are tightly closed, the sound insulation of a residence depends mainly on the protective door and wall. The air sound insulation performance of

protective walls is closely related to the frequency of the incident sound wave, and good results can be achieved by increasing density.

For bathrooms, where noise mainly comes from pipes and elevators, measures such as silencing spiral PVC pipes and thin-walled cast iron pipes can be used to reduce sound.

2.4 Existing studies on sound insulation performance

Previous research suggests that the sound insulation performance of building materials is closely related to physical properties such as porosity, density, and thickness (Gao, 2025).

Lightweight and porous materials, such as foamed cement boards, foam glass boards, and ceramic porous bricks, can absorb and reduce sound waves through their pore structures and sound absorption mechanisms (Wushuang Gao, 2025). This provides new ideas for developing better sound insulation materials. For example, one could combine two physical properties or apply one property, such as porosity, to another dense material, enhancing sound absorption while maintaining strength.

So far, there have been relatively few studies on polymers. Previous research focused mainly on the acoustic properties of polyurethane foams and their modifications, but did not analyze the chemical, mechanical, and thermal properties of polymers in depth, particularly in terms of durability or resistance. Future research could extend to biodegradable polymers, supporting the path toward green and renewable materials (Wilk-Jakubowski et al., 2025).

The literature also indicates a lack of testing on the sound insulation performance of composite materials and other building materials under real-life conditions. Most existing studies have been carried out in laboratory settings, which may limit the direct application of their findings to practical situations. In addition, relatively few studies have developed prototypes that could be applied directly in real construction contexts (Wilk-Jakubowski et al., 2025).

2.5 Gaps in existing research and technology

Although lightweight and porous materials such as foamed cement boards, foam glass boards, and ceramic porous bricks show good performance, their relatively low strength and hardness limit their effectiveness in sound insulation (Wushuang Gao, 2025).

In addition, most measurements of sound insulation are performed in laboratories, often ignoring real-world factors such as weather, mechanical wear, and the long-term performance of materials under constant use

(Wilk-Jakubowski et al., 2025).

In conclusion, although it is important to develop more effective sound insulation materials, current research and technology still face several limitations. It is therefore necessary to conduct more on-site experiments in residential buildings and to analyse the physical properties of materials individually. This may help identify materials with superior insulation performance under practical conditions. Future studies may also focus on combining different properties or integrating multiple materials while considering sustainability, cost, and practicality. Such work would contribute to the development of building materials with improved acoustic insulation.

3. Methodology

3.1 Overview

This dissertation employed both primary and secondary research methods. Secondary research was first conducted to examine noise pollution, common noise sources, experimental methods used in previous studies, and the physical properties affecting the sound insulation performance of building materials. Primary research then consisted of a questionnaire survey and a comparative experiment. The questionnaire mainly investigated whether noise is a significant problem for urban residents, which building materials are commonly associated with sound insulation in daily life, and what respondents consider to be the main sources of noise.

3.2 Literature research

Relevant literature was collected mainly through Google Scholar to identify previous research on noise pollution, sound insulation, and construction materials. The selected sources were then evaluated using the CRAAP framework in order to assess their credibility, relevance, and academic value.

3.3 Questionnaire design

(a) Questions displayed

A questionnaire consisting of 15 items was designed, including multiple-choice, single-choice, rating-scale, and scoring questions. The first four items collected basic demographic information. Participation was voluntary, and no personally identifiable information was collected in order to protect respondents' privacy.

Questions 4 and 5 examined whether respondents lived in urban areas and how long they had lived there. This was intended to ensure that participants had sufficient experience of urban living to provide reliable responses. Ques-

tions 6 to 8 explored the impact of noise on daily life, including how often respondents were disturbed by noise and what they considered to be the main noise sources. Questions 9 to 14 focused on common construction materials in homes and respondents' attitudes towards sound insulation materials. The final question aimed to identify which common building materials were perceived as having better sound insulation performance through a combination of multiple-choice and open-ended responses.

(b) Data treatments and analysis

The questionnaire was designed and distributed through an online platform called "Questionnaire Star". For data analysis, the most relevant questions and response patterns were selected and summarised. The impact of noise on daily life was treated as a major analytical category. The questionnaire data were analysed mainly through response frequencies and percentages, and the results were presented in the form of charts. To improve the reliability of the data, respondents who did not meet the criteria for urban residency were excluded from the final analysis. Charts were used because they provide a clear visual rep-

resentation of the distribution of responses across different options. The questionnaire results were also used to identify commonly mentioned construction materials, which were then selected for experimental testing.

3.4 Experiment design

(a) Aim

The experiment aimed to compare the sound insulation performance of different construction materials and to analyse how their physical properties may influence this performance.

(b) Instruments and materials selection

The apparatus included a sound level detector, a smartphone used to play white noise, and a ruler with a precision of 1 mm.

The construction materials selected for testing were plastic, concrete, foam board, and wood panel. These four materials were chosen because they appeared frequently in both the literature review and the questionnaire results (Gao, 2025).



Figure 1.1. Construction materials used in the experiment (plastic, concrete, foam board, and wood panel).

(c) Experiment Setup

This experiment was designed to evaluate the sound insulation performance of various building materials. The apparatus consists of a sealed rectangular cardboard box divided into two independent chambers by a removable central partition. The materials under test are inserted into the slot in the central panel.

One chamber contains a mobile phone continuously play-

ing white noise, acting as the sound source. The opposite chamber houses the detector to measure the transmitted sound level in decibels (dB).

The entire setup is placed in a quiet indoor environment. Throughout the experiment, the positions of the devices, the materials, and the box were kept fixed in order to ensure consistency and minimise external interference.

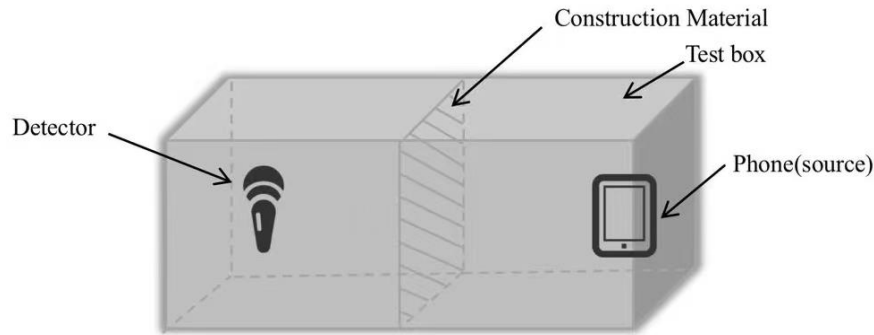


Figure 1.2. Diagram of the experimental test box for sound insulation performance.

(d) Experimental Procedure

1. Prepare the building materials to be tested (foam board, plastic, wood panel, and concrete) and cut them to uniform sizes that match the central slot dimensions.
2. The experimental device was placed in a quiet room. A mobile phone was inserted into the right chamber to play looped white noise at maximum volume.
3. The detector was placed in the left chamber, and the baseline noise level was recorded for 10 seconds with no material inserted into the slot.
4. Insert the test material into the central slot.
5. With the material in place, use the detector to record the sound level again for 10 seconds. Calculate the average reading.
6. The measurement was repeated three times for each material, and the average value was calculated.
7. Calculate the sound attenuation using the following formula:
Attenuation (dB) = Input sound level – Output sound level
8. The results were presented using bar charts to compare

the effectiveness of each material in reducing sound. Bar charts provide a clear visual representation of the relationship between construction material type and attenuation reduction.

(e) Controlled Variables

To ensure a fair and reliable comparison, the following variables were controlled throughout the experiment:

1. Distance: The distance between the sound source, the material, and the detector remained constant.
2. Sound input: All tests used the same white noise track at the same volume level.
3. Environment: The experiment was conducted in the same room under similar lighting and temperature conditions.
4. Time: Each measurement lasted exactly 10 seconds.
5. Devices: The same smartphone, detector, and measurement application were used throughout all tests.

(f) Data and information needed

The table below shows the data that needed to be recorded during the experiment.

Table 1.1 Average Sound Levels and Attenuation for Each Material

Measured with Decibel X app; test duration per trial: 10 seconds; no-material reference average: 69.6 dB.

Material	Trial 1 (dB)	Trial 2 (dB)	Trial 3 (dB)	Average <T>	Attenuation Re (dB)
Foam board					
Plastic					
Wood panel					
Concrete					

Some of the formulas involved in the experiments are shown here.

Average decibel of sound passing through each construction material

$$\langle T \rangle = \frac{T1+T2+T3}{3}$$

Formula 1 Attenuation Re=Input sound level-output sound

level

(g) Data treatment and analysis

For the experiment, the data were recorded and organised into a table to show the sound attenuation of different construction materials. Based on these data, a graph was produced to illustrate the relationship between material type and attenuation Re (dB).

4. Results

4.1 Questionnaire

Table 2.1 The frequency of residents being disturbed by noise

Option	Frequency	Percent	Cumulative Percent
Almost everyday	17	16.35%	16.35%
Usually	20	19.23%	35.58%
Occasionally	59	55.77%	91.35%
Never	9	8.65%	100.00%
Total	105	100.00%	

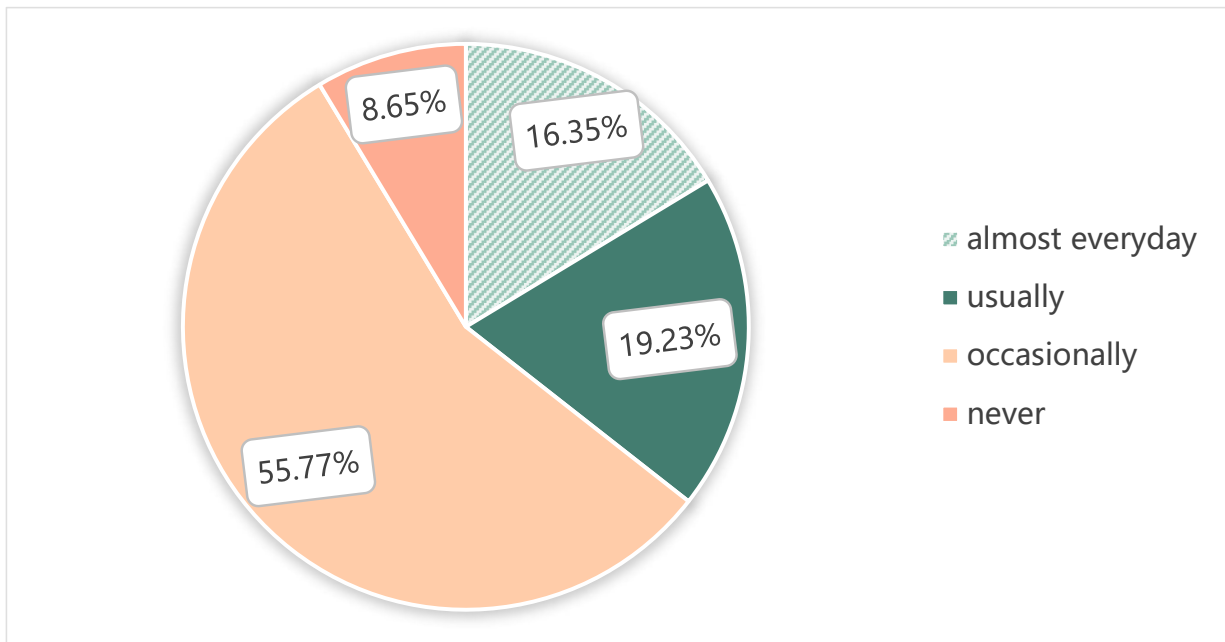


Figure 2.1 How often are you disturbed by noise in your current residence?

It can be seen from Table 2.1 and Figure 2.1 that about every day. 19.23% of people are usually disturbed, while only 8.65% of people have never been disturbed by noise. which is 55.77%. 16.35% of people are disturbed almost

Table 2.2 Importance of sound insulation of construction material

Option	Frequency	Percent	Cumulative Percent
Very important	66	62.86%	62.86%
Quite important	31	29.52%	92.38%
Not very important	7	6.67%	99.05%
Not important at all	1	0.95%	100.00%
Total	105	100.00%	

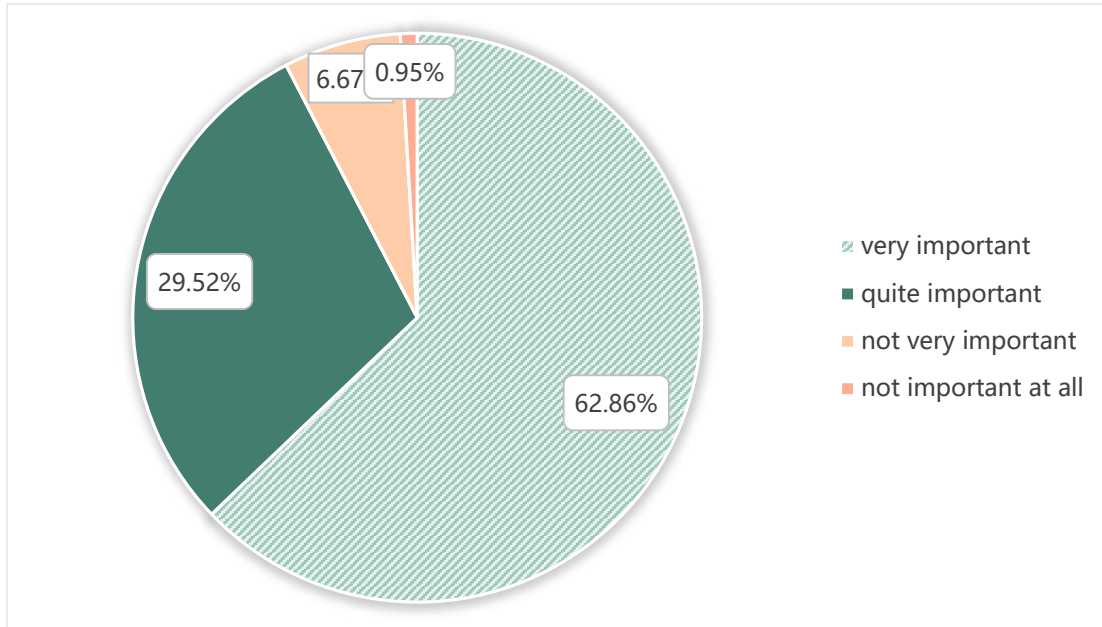


Figure 2.2 How important is sound insulation when choosing a home?

It can be seen from Table 2.2 and Figure 2.2 that more than half of the respondents think sound insulation is very important when choosing a home (62.86%). 29.52% believe it is quite important. Only 6.67% think it is not very important, and 0.95% think it is not important at all.

Table 2.3 Sound insulation performance of different construction materials

Option	Frequency	Percent	Cumulative percent
Glass	49	46.67%	46.67%
Concrete	45	42.86%	89.53%
Foam board	44	41.9%	131.43%
Brick	20	19.05%	150.48%
Wood	18	17.14%	167.62%
Drywall	23	21.90%	189.52%
Plastic	4	3.81%	193.33%
Others	11	10.48%	203.81%
Total	214	203.81%	



Figure 2.3 Which of the following materials do you believe are effective at blocking noise?

In Table 2.3, since people could choose more than one option, the total frequency is greater than the number of respondents, and the percentages add up to more than 100%. To avoid misunderstanding, the data is also shown in Figure 2.3 as a bar chart. From the results, the three most frequently chosen materials are glass (49), concrete (45), and foam board (44). Plastic was chosen the least, with only 4 responses.

In total, 105 valid responses were collected. The participants were between 15 and 60 years old and had lived in urban areas for an average of 12.3 years. The data indicate

that noise pollution has a significant impact on daily life. Among the respondents, 35.58% reported being frequently disturbed by noise, while 55.77% reported being occasionally disturbed. Many respondents believed that materials such as glass, concrete, and foam board have good sound insulation performance. These perceptions were then compared with the results of the experiment.

4.2 Experiment results

(a) Experimental data

Table 2.4 Average Sound Levels and Attenuation of Different Construction Materials

Material	Trial 1 (dB)	Trial 2 (dB)	Trial 3 (dB)	Average <T>	Attenuation Re (dB)
Foam board	64.8	66.0	61.8	64.2	5.4
Plastic	60.8	59.7	61.8	60.8	8.8
Wood panel	56.9	58.5	56.9	57.4	12.2
Concrete	60.8	60.8	59.7	60.4	9.2

(b) Bar chart (Sound Attenuation of Different Construction Materials)

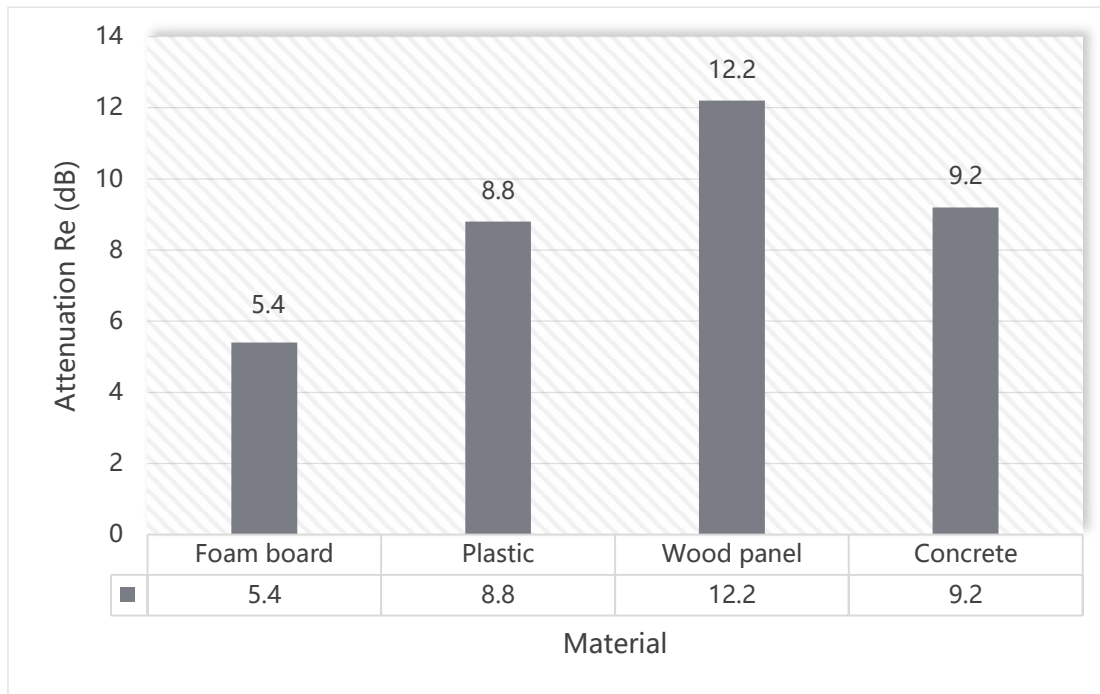


Figure 2.4 Sound attenuation values of different construction materials measured in the experiment

As shown in the above results, the attenuation value of foam board is 5.4 dB, plastic is 8.8 dB, wood panel is 12.2 dB, and concrete is 9.2 dB. Small variations between trials may be due to background noise changes or slight device position differences.

In this experiment, control variables such as background noise and distance were kept constant. The wood panel showed the highest attenuation value, indicating the strongest sound insulation performance among the four tested materials. Concrete also performed relatively well, followed by plastic and foam board. Compared with plastic and foam board, wood panel and concrete generally have greater density and structural strength, which may help explain their higher attenuation values.

5. Discussion

5.1 Relationship between physical properties and sound insulation

The results of this study show that the sound insulation performance of building materials is influenced by their physical properties. Among the four tested materials, wood panel achieved the highest attenuation value of 12.2 dB. Concrete followed with a value of 9.2 dB, plastic with 8.8 dB, and foam board with 5.4 dB. These values reflect clear differences between materials and suggest that densi-

ty, hardness, and thickness are important factors affecting insulation effectiveness.

Wood panel performed best, which may be explained by its combination of density and thickness. When sound waves strike a denser material, a greater proportion of energy is reflected rather than transmitted, making the material more effective at blocking sound. Concrete also performed well for similar reasons. Its hardness and density likely increased its resistance to sound transmission. Plastic showed moderate performance. Although it is lighter and less dense than wood or concrete, it still provided better attenuation than foam board. Foam board ranked last. Its porous structure may allow some sound absorption, but its relatively low density and limited thickness reduce its ability to prevent transmission effectively.

These findings confirm that materials with greater density and thickness tend to perform better in sound insulation. This is consistent with fundamental physics, where heavier materials resist vibrations and reduce energy transfer (Wu et al., 2025). The results also highlight that porosity alone is not enough to guarantee effective insulation. Although foam board can absorb some sound, its low density reduces overall performance.

5.2 Comparison with previous literature

Previous literature on sound insulation often highlights the ability of foam-based or porous materials to absorb

sound because of their internal structure (Hung et al., 2014). Related studies also suggest that porous materials and some plastics may help reduce indoor noise levels by improving sound absorption and reducing reverberation time (Monkova et al., 2020). However, the experimental results of this study suggest a different pattern under the specific testing conditions used. Despite its absorption capacity, foam board did not perform well in actual attenuation tests. The average attenuation value was much lower than those of wood and concrete.

This difference may be explained by the dual nature of porosity. While pores can absorb part of the sound, they also allow vibrations to pass through. In practical construction, porous materials are often combined with denser layers to maximize performance. Foam boards used alone are less effective. The results of this study support this idea and suggest that foam board works better when it is not the only barrier but part of a layered structure.

Wood and concrete performed better, which is consistent with many engineering reports. Both materials are widely used in residential buildings because of their strength and durability. Their insulation properties come as an additional advantage. The strong reflective effect created by their hardness makes them suitable for urban housing, where noise pollution is a common issue.

The sound insulation performance of plastic is discussed less frequently in the literature, yet this experiment suggests that it can provide a moderate level of attenuation. Its value of 8.8 dB places it above foam board in this study. This may indicate that plastic panels could play a role in lightweight or temporary structures, although they are unlikely to replace denser materials such as concrete or wood in situations where strong sound insulation is required.

5.3 Comparison with questionnaire results

The questionnaire survey provided additional insights into public perceptions. Many respondents believed that glass, foam board, and concrete offered good insulation properties. The majority expressed that insulation was an important factor when choosing a home, with 62.86% rating it as very important. These results show that people are aware of the impact of noise pollution and value insulation in their living environment.

Yet, the questionnaire also revealed differences between perception and actual performance. Foam board was considered by many respondents to be effective, but the experiment showed it to be the weakest among the four tested materials. This gap between perception and reality may be explained by limited public knowledge of material properties. Foam boards are lightweight and easy to handle, which may give people the impression that they are practical and efficient. In reality, their low density reduces

effectiveness.

The results also demonstrate that people's daily experiences with noise vary. According to the survey, 55.77% of respondents were occasionally disturbed by noise, 16.35% almost every day, 19.23% usually, and only 8.65% reported never being disturbed. These findings confirm that noise pollution is a widespread issue in urban areas. People's strong preference for sound insulation when choosing a house reflects this daily reality.

5.4 Practical implications for construction materials

The results provide clear evidence for the choice of construction materials in residential buildings. Wood panels and concrete show strong sound insulation properties, making them suitable for main structural use. Their strength, hardness, and thickness make them reliable barriers against external noise. In contrast, foam boards and plastic provide lower levels of protection and should not be used as the primary insulation materials.

This does not mean that foam board and plastic have no practical value. Previous studies suggest that one effective way to reduce medium- and high-frequency noise is to absorb sound-wave energy using porous materials (Burdeina et al., 2025). These materials may still play an important role when combined with denser layers. For example, foam board could be placed between denser materials to improve sound absorption, while microperforated panels (MPPs) are known to perform well across a relatively wide frequency range (Mu, Toyoda and Takahashi, 2011). Because of its light weight, plastic may also be combined with wood in the form of wood-plastic composites. Such composites may reduce environmental impact through the use of recycled plastic and natural fibres (Yang et al., 2019). However, as standalone materials, plastic and foam board are unlikely to provide sufficient sound insulation for urban residents exposed to high levels of environmental noise.

Another practical implication is the need for awareness. People often rely on general impressions when evaluating materials, but perceptions do not always match experimental results. Foam boards may appear effective but perform poorly in controlled testing. Educating the public about the actual properties of construction materials could help them make better choices when building or purchasing houses.

5.5 Broader significance of results

Noise pollution is increasingly recognized as a public health issue. Studies link long-term exposure to high noise levels with stress, sleep disturbance, and even cardiovascular problems. In this context, improving sound insulation in residential buildings is not only a matter of comfort

but also of health. The findings of this study contribute to this broader issue by showing which materials are most effective in blocking noise.

Wood panel and concrete stand out as the most reliable materials in this study. Their use in construction could help reduce the harmful impact of environmental noise on residents. Wood is also a renewable material, which aligns with the growing demand for healthier and more sustainable urban living environments (Zhao et al., 2023). At the same time, the relatively weak performance of foam board and plastic suggests that convenience and low weight should not be mistaken for effective sound insulation.

The study also highlights the value of combining experimental research with surveys. While experiments provide objective data, surveys reveal public attitudes and perceptions. Together, they give a more complete picture of the problem and possible solutions.

The combination of primary and secondary research gives the study strength. The survey results support the importance of insulation for residents, while the experiment clarifies which materials can actually deliver it. Together, they provide evidence that can guide better material choices in residential construction.

6. Evaluation

Admittedly, there are some limitations in this experiment. In the experiment design, the materials selected may differ from those actually used in construction. For instance, foam boards come in various types, including both porous and non-porous ones. The test results may be slightly different from the actual sound insulation of the building. If the experiment is repeated in the future, a wider range of building materials could be tested to make the results more applicable to real construction contexts.

In the experimental procedure, background noise remained a potential source of error. Although an effort was made to keep the background noise level constant through measurement, it could not be guaranteed that the value remained completely stable throughout the experiment. If the experiment were repeated in the future, it should be conducted in a soundproof room in order to minimise this source of uncertainty. In addition, when the material was inserted into the cardboard box, narrow gaps may have remained around the edges, which could have affected the measured decibel values of the transmitted sound.

However, the study also has several strengths. In terms of data collection, a relatively precise detector was used, and the experiment adopted both control variables and repeated trials, which helped improve the reliability of the measurements. Measurement error was further reduced by calculating average values. In addition, the study addressed an important research gap by simulating a simplified

building scenario and examining the relationship between the physical properties of building materials and their sound insulation performance. Finally, the experimental method used in this research was practical and relatively simple to carry out, which may make it useful for similar small-scale investigations in the future.

7. Conclusion

This research aimed to identify which common construction materials provide the strongest sound insulation performance and to explore the physical properties that influence this performance. Through experimental testing, it was found that wood panel and concrete performed better than foam board and plastic. Among these materials, wood panel achieved the highest attenuation value, followed by concrete. The results suggest that density, hardness, and structural strength are important physical factors affecting sound insulation performance. Materials with greater density and higher structural strength appear to be more effective at blocking sound transmission, whereas lighter materials such as foam board, although sometimes assumed to be effective because of their porous structure, performed relatively poorly in this experiment.

The comparison between the questionnaire and the experiment also revealed interesting differences. Many respondents believed that foam board was effective at soundproofing, which shows that public perception does not always align with scientific evidence. This gap between expectation and actual performance highlights the importance of experimental research. By comparing people's attitudes with real data, this project not only tested materials but also raised awareness of the hazards of noise pollution and the need for evidence-based decisions when selecting building materials.

The significance of this research lies in its practical value. Noise pollution is a growing problem in urban areas and can negatively affect both physical and mental health. Better awareness of which materials perform effectively in sound insulation may help improve housing design, support healthier living environments, and reduce stress caused by unwanted noise. The findings may also guide engineers and researchers in exploring new material combinations to enhance insulation effectiveness.

Looking ahead, combining different physical properties may lead to the development of new building materials with improved sound insulation. Composite materials that integrate density with controlled porosity may help balance structural strength with sound absorption, leading to more effective overall performance. Porous materials may be particularly useful for reducing high-frequency noise, whereas low-frequency noise may require other approaches, such as acoustic metamaterials (Ren et al., 2025). In

addition to improvements in building materials, technical standards and mandatory policies may also play an important role in reducing noise pollution (Kuehne et al., 2025). Moreover, with the rapid development of artificial intelligence, smart noise detection and control systems may become increasingly important. Previous research suggests that AI-based systems can be used to monitor noise levels in real time and support adaptive control strategies, thereby helping to reduce the impact of noise pollution on daily life (El-Bardisy, 2025).

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Appendix

Questionnaire

Website: <https://www.wjx.cn/vm/exkh1NR.aspx>

Questions

* 1.你的年龄段是What is your age? (单选)

- 18岁以下(Under 18 years old)
- 18-25岁 (18-25 years old)
- 26-35岁 (26-35 years old)
- 36-50岁 (36-50 years old)
- 50以上 (Over 50 years old)
- 不愿透露 (Prefer not to say)

* 2.你的性别是What is your gender?(单选)

- 男(male)
- 女(female)
- 不愿透露 (Prefer not to say)

* 3.你的职业类型是What is your occupation type? (单选)

- 学生(Student)
- 上班族 (Office worker)
- 自由职业者 (Freelancer)
- 退休人员 (Retiree)
- 其他 (Other)_____

* 4.你现在住在哪里Where do you currently live?(单选)

- 市中心 (City center)
- 郊区(Suburban) (跳转到[6.你在目前住..])
- 多功能区域 (Mixed-use area) (跳转到[5.居住在城市..])
- 靠近工业区(Near industrial zone) (跳转到[7.请按照噪音..])
- 农村 (Rural area)

*此题设置了跳转逻辑

* 5.居住在城市区域多久了How long have you been living in the urban area?(单选)

- 小于一年(less than one year)
- 一到五年(one to five years)
- 六到十年(six to ten years)
- 大于十年(over ten years)
- 不适用 (Not applicable)

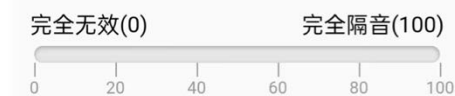
* 6.你在目前住所中受到噪音干扰的频率是How often are you disturbed by noise in your current residence?(单选)

- 几乎每天 (almost everyday)
- 经常 (usually)
- 偶尔 (occasionally)
- 从未 (never)

* 7.请按照噪音对你的困扰程度对下列进行排序 Which noises bother you the most?

- 交通噪音 (Traffic: cars, buses, horns)
- 建筑工地 (Construction sites)
- 邻居/住宅噪声 (Neighbors/Residential noise)
- 夜生活 (Nightlife: bars, events)
- 飞机/火车 (Airplanes/trains)
- 其他 (Others)

* 9.你认为目前住宅的墙体或窗户的隔音性能如何How effective are the walls or windows of your residence in sound insulation?从0(完全无效)到100 (完全隔音)



* 10.你是否认为建筑材料类型会影响住宅的隔音效果 (Do you think the type of construction material affects the level of noise you hear at home?(单选)

- 是 (Yes)
- 否(No)
- 不确定 (Not sure)

* 11.你认为隔音材料会对生活质量产生影响吗? (Do you think sound insulation materials will have an impact on the quality of life?) 从一颗星 (完全没有) 到五颗星 (有非常大的影响) (打分题)

1 5

(1) (2) (3) (4) (5)

* 12.你是否采取过改善家中隔音的措施Have you taken any steps to reduce noise at home?(多选题) [多选题]

- 安装隔音墙 (Installed soundproof windows)
- 密封门缝或窗框 (Sealed gaps or doors)
- 使用吸音材料(use sound-absorbing materials)
- 没有(No,I haven't)
- 不确定(I am not sure)

* 13.在选择住所时, 你认为隔音性能的重要性是How important is sound insulation when choosing a home(单选)

- 非常重要 (very important)
- 较重要(quite important)
- 不太重要(not very important)
- 完全不重要(not important at all)

* 14.你是否愿意为了更好的隔音选择更贵的材料或住房Would you be willing to choose more expensive materials or housing for better sound insulation?(单选)

- 一定不会 (Definitely not)
- 可能不会 (Probably not)
- 不确定 (Unsure)
- 可能会 (Probably yes)
- 一定会 (Definitely yes)

* 15.你认为以下哪些材料具有良好的隔音性能 Which of the following materials do you believe are effective at blocking noise? (You may choose more than one)

[多选题]

- 玻璃(glass)
- 混凝土(Concrete)
- 泡沫板(Foam board)
- 砖块(brick)
- 木材(wood)
- 石膏板(gypsum board /drywall)
- 塑料(Plastic)
- 其他, 请填写Others_____

结语Closing Statement :

感谢你的填写! 你的回答将帮助我们更深入地了解不同居住环境中的噪音体验与隔音认知。

Thank you for completing this questionnaire!

Your responses will help us better understand how people perceive and experience noise in different living environments.

Results

(Number of valid questionnaires:105)
Experiment
photos of experimental equipment

1.你的年龄段是What is your age? (单选) [单选题]

选项	小计	比例
18岁以下(Under 18 years old)	13	12.38%
18-25岁 (18-25 years old)	9	8.57%
26-35岁 (26-35 years old)	32	30.48%
36-50岁 (36-50 years old)	41	39.05%
50以上 (Over 50 years old)	8	7.62%
不愿透露 (Prefer not to say)	2	1.9%
本题有效填写人次	105	

饼状 圆环 柱状 条形 折线



Figure 3.1. All devices and materials used in the experiment.



Figure 3.2. The setup of the experimental apparatus using foam board.