© May 2023 | IJIRT | Volume 9 Issue 12 | ISSN: 2349-6002

Research And Development of Thermal and Sound Insulation Materials

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***Abstract*— The project's goal is to produce thermal and sound insulating materials utilizing readily available, reasonably priced components. The walls made of manufacturing sand (M sand) and fly ash were tested for the thermal and sound insulation in Anjuman College of Engineering and Technology Nagpur. These can be effective temperature and moisture controllers, maintaining a pleasant atmosphere and improving human health. One of the most significant environmental challenges is the disposal of fly ash, that is created by power plants that burn coal for fuel. It is far more challenging to find an answer to this problem when the volume of fly ash increases at the same time that landfill capacity decreases. Another issue is the environmental deterioration of natural sand supplies such as river sand, pit sand, stream sand, sea sand, and other sands for use as aggregate in construction, which are becoming scarce and depleted. M sand is the result of a growing need for alternative aggregates in the building industry. It is a superior alternative to river sand since it is generated by machines in suitable particle size proportions. The research on fly ash and M sand is analysed in this research. The comparative results showed that M-sand proved to be the most effective material for both purposes out of the materials tested, earning it top rating.**

Key words— thermal insulation, sound insulation, manufacturing sand, fly ash, sound meter.

I. INTRODUCTION

The decrease of heat transfer—that is, the transmission of thermal energy between things with different temperatures—between items that are in thermal contact or within the range of radiative effect is known as thermal insulation. In addition to using the right item forms and materials, specially developed technologies or processes can also be used to provide thermal insulation. The unavoidable result of contact between things with differing temperatures is the passage of heat. Thermal insulation creates an area of insulation where thermal conduction is lessened, forming a thermal barrier or break, or when thermal radiation is reflected rather than absorbed by the body at a lower temperature. The inverse of thermal conductivity (k) is used to determine a material's insulating capacity. Low thermal conductivity equates to high resistance (insulating value). Insulation is achieved by encasing an object in a material with low heat conductivity and a high thickness. Reduced exposed surface area might potentially reduce heat transmission; however, this amount is generally set by the shape of the insulated item. A significant amount of the worldwide energy usage is used to maintain comfortable temperatures in buildings (via heating and cooling). A structure is energy-efficient and less costly to keep warm in the winter or cool in the summer when it is properly insulated. The effect on the environment will be less as a result of energy efficiency and more pleasant because the room's temperatures are constant. When the outside temperature is particularly cold or hot, there is less temperature gradient between outside walls, ceilings, and windows to the internal walls, which creates a more pleasant occupant habitat. Thermal insulation has been shown to increase the thermal emittance of passive radiative cooling surfaces by boosting the surface's capacity to decrease temperatures below ambient under direct sun intensity. Thermal insulation materials that limit sun absorption and parasitic heat gain can enhance emitter performance by more than 20%. The ability to retain heat and offer inertia against temperature swings is referred to as thermal mass in building design. Structures may be built to use both the lighter thermal resistance components and the thermal mass of heavier structural parts to produce structures that are energy efficient. For instance, when the outside temperature varies throughout the day, a large thermal mass inside the insulated part of a house can help "even out" these variations because the thermal mass will absorb thermal energy when the outside temperature is higher than the mass and release thermal energy when the outside temperature is lower, without achieving thermal equilibrium.

Soundproofing refers to a technique for preventing sound from spreading. By using distance and intervening objects in the sound path, soundproofing can lessen the transmission of unwanted noise by the source to an unintentional listener. Soundproofing can lessen unwanted transmitted vibrations, like reflections that cause echoes and resonances that result in reverberation. A hollow, enclosure, or room's reverberant noise levels are controlled by sound-absorbing material. Adding thick material to a treatment aid in preventing sound waves from escaping a source wall, ceiling, or floor. A variety of frequency ranges are reduced using soundproofing materials with varying widths and densities. Residential sound programmes try to reduce or eliminate the impacts of outside noise. Mass is the only way to avoid sound. Sound insulation is a form of insulation that is meant to limit noise transfer both inside and outside of a house. To stop the transmission of airborne noises like voices, aircraft, or traffic, soundproofing can be utilised. Footsteps and vibrating equipment are examples of impart sounds. Sound waves travel across the air. When they strike a surface, they are either reflected or absorbed, Hard, smooth surfaces tend to reflect sound the best, resulting in a loud atmosphere. Sound absorbing and sound blocking materials can help to create a more pleasant and peaceful interior environment. Sound Insulation has been carefully developed to absorb sound waves and decrease noise transmission.

Thermal conductivity testing measures a material's capacity to transport heat. Heat transmission is slower across low thermal conductivity materials and faster across high thermal conductivity materials. As a result, the application of this material varies with its conductivity. Temperature, humidity, composition, application time, the amount of solid matter, or spaces in materials all have an effect on thermal resistivity (reciprocal of thermal conductivity). Similarly, the use of thermal conductivity or resistivity has its own relevance in ensuring proper material utilization. A thermometer is used to measure the readings.

In a comparable manner, sound insulation testing, also referred to as acoustic insulation testing, determines how much noise passes through a property's walls, floors, and ceilings to neighbours or structures nearby. This is to guarantee that persons who live within or near the premises have a high quality of life. If a new build or renovation results in two contiguous residences separated by party components, sound insulation testing is unquestionably required. Sound insulation testing occurs at the project's 'pre-completion' stage. The site should be silent throughout the sound insulation tests. Sound meter app is used to measure the readings.

II. LITERATURE REVIEW:

1.According to -Environmentally-friendly thermal and acoustic insulation materials from recycled textiles Shafiqul Islam, Gajanan Bhat

Some of the major concerns of the twenty-first century are the continuing rise in energy use and environmental damage. One option for overcoming these issues is to expand the use of recycled materials and ecologically friendly production methods. Thermal and acoustic insulation made from recycled textiles in buildings and transportation vehicles can help save energy and reduce pollution. Textiles contribute significantly to waste since the majority of these precious fibre products are discarded after use. These adequate but discarded textiles may be recycled to generate a wide range of products, including thermal and acoustic insulation materials. This research article provides an in-depth analysis of thermal and acoustic insulating materials made from textile waste. The process of thermal and acoustic insulation, as well as the measuring technique using international standards, are addressed. The impact of wasted textiles on the environment and health, as well as strategies to mitigate it through the recycling process, have been summarized. A comprehensive review of the process of conversion of textile waste into insulating materials is also presented. The present investigation of textile waste as insulation materials by many researchers is thorough, and the insulating capabilities of various materials are compared. Although some traditional synthetic insulation materials now dominate the market, recovered textiles have the potential to replace these conventional materials.

2. According toDevelopment of thermal insulating and sound absorbing agro-sourced materials from auto linked flax-tows- Nemr El Hajj**, Brice Mboumba-Mamboundou*, Rose-Marie Dheilly, Zoheir Abourab The Lin-K technique is a basic patent manufacturing method used to create these self-linked polymers. The thermal conductivity, absorbing acoustic coefficient, and hydric characteristics are discussed, as well as the influence of various factors on these performances. The use of fine flax-tows allows more organic components from the core fibres to be extracted during the microwave treatment, which increases mechanical properties while decreasing thermal conductivities. The environment has a large impact on the thermal resistance and durability of these substances. The current study looked at how the size of flax-tows affected the mechanical, thermal, hydrous, and acoustic characteristics of these green composites. The manufacturing method and compaction rate both have a major impact on these results. Mechanical features such as three-point flexural strength at failure to diminish as flax-tow size increases. However, the thermal conductivity of these composites reduces as the size grinding of flax-tow increases, resulting in higher thermal performances. This decrease is attributed to the usage of thin flax tows, which resulted in decreased compacity of these composites. The use of larger flax-tows raises the sound absorption coefficient. The environment has a large impact on the thermal stability and durability of self-linked composites. The materials investigated in this work have fascinating thermal and acoustic properties (thermal conductivities ranging between 0.06 and 0.09 W m1 K1 and an acoustic coefficient greater than 0.5), as well as sufficient mechanical properties to allow incorporation into sandwich panels when combined with more mechanically resistant materials.

III. MATERIALS

The following materials are classified as:

3.1 Fly ash

Fly ash is a by-product of combustion that consists of tiny particles that rise with the flue gases. Bottom ash is ash that does not rise. In the industrial setting, fly ash is often defined as ash generated during the burning of coal. Fly ash is a diverse substance. Fly ash has the following chemical components: silicon dioxide, aluminium oxide, ferric oxide, and calcium oxide. Fly ash solidifies while floating in the exhaust gases and gets gathered by precipitators with electrostatic charges or filter bags. Fly ash particles are usually spherical in form and range in size from 0.5 mm to 300 mm because they harden quickly while floating in exhaust fumes. Fly ash greatly enhances concrete performance and offers several advantages in both cement and non-cement applications. Fly ash seems to work effectively as a catalyst for turning polyethylene into a material equivalent to crude oil in a high-temperature process known as pyrolysis when treated with sodium hydroxide. Fly ash in concrete serves a dual purpose in the creation of strength. It combines with the released lime to form a binder that gives strength to the concrete mix. Because fly ash particles are spherical in form, they minimise friction between aggregates and hence improve the workability of concrete. The use of fly ash in concrete improves fines volume while decreasing water content, reducing concrete bleeding. When fly ash exists in concrete, it inhibits permeability, limits the accessibility of excess lime by pozzolanic reaction, and so improves concrete's resistance to carbonation. The usage of fly ash limits the availability of free limes and permeability, which prevents corrosion.

Fig. 1 Fly ash

3.2 Manufacturing sand (m sand)

Manufactured sand (M-Sand) is a type of artificial sand made by crushing hard stones into small sand-sized angular shaped particles, which are then cleaned and carefully graded before being utilised as building material. It is a substitute for river sand in building. Crushing hard granite stone produces it. For use as a construction material, crushed sand is cubical in structure with rounded edges, washed, and graded. Manufacturing sand enables the protection of ecosystems such as riverbanks and shorelines wherever sand could have been mined, in addition to reduced energy usage and aggregate waste utilisation. Another reason to use M-Sand is its simplicity of use and inexpensive delivery costs. It possesses greater compressive and flexural strength. M sand has a higher modulus of fineness than natural sand and crusher dust because it is graded properly and continuously. It may be manufactured close to building sites, lowering transportation costs and ensuring a steady supply of the desired quantity. It has the ideal form, smooth texture, and consistency, as well as the required fineness gradation. M Sand has balanced physical and chemical qualities and can tolerate tough environmental conditions. It may address faults in concrete such as segregation, honeycombing, reinforcing steel corrosion, voids, capillary, bleeding, and so on.

Fig. 2 Manufacturing sand

IV. METHODOLOGY

4.1 APPARATUS:

1. Thermometer
2. Coal with good calorific value.
3. Smartphone and sound meter app (https://play.google.com/store/apps/details?id=com.splendapps.decibel)
4. Audio speaker emitting 95 dB sound.

4.2 PROCEDURE:

1. First, the standard bricks (19X9X9cm), were submerged in clean water for an hour in the tank. The bricks were completely dried after soaking.
2. A normal cavity wall of 1.5-inches cavity was produced.
3. Manufacturing sand was added to the void between the two layers of bricks. The model was fully compacted.
4. For the fly ash model, 12 kg of fly ash, 3 kg of cement, and 6 kg of sand were fully mixed and weighed in one batch of concrete.
5. The formwork for the casting of the fly ash model was constructed in the first step. Concrete was subsequently poured into the formwork and properly compacted.
6. The other two models were made in the same manner using normal bricks. Slab casting was also completed with normal bricks.
7. Both models were plastered after two days of curing. The thickness of the plaster was 6 mm.
8. A closed structure was created by connecting all the models for optimal testing. The models were then allowed two days to cure. They were sprinkled with water.

4.3 TESTING:

A. THERMAL INSULATION TEST

I. To begin the test, first model's interior is cleaned. Dust is being removed from the surface and checked for moisture.
II. After the coal has been entirely lit to the temperature of 65℃ and no longer emits flames, the pan containing the coal is gently placed into the model. Once the pan is in place, the top of the model is covered with the slab, ensuring that no gaps are there to prevent heat loss.
III. The temperature of both walls is then measured after 2 hours with a thermometer for thermal insulation measurements.

Fig. 3 Thermal insulation test

B. SOUND INSULATION TEST

I. To begin the test, first model's interior is cleaned. Dust is being removed from the surface and checked for moisture. The sound source is now properly set.

II. A Bluetooth device with consistent frequency of 95 dB is connected.

III. Once the setup is complete, the Bluetooth device is placed within the model with the same distance between it and all of the walls.

IV. the top of the model is covered with the slab, ensuring that no gaps are there to prevent sound leakage.

V. The sound is then measured by positioning the smartphone with the sound meter app directly in front of both walls, and readings are recorded.

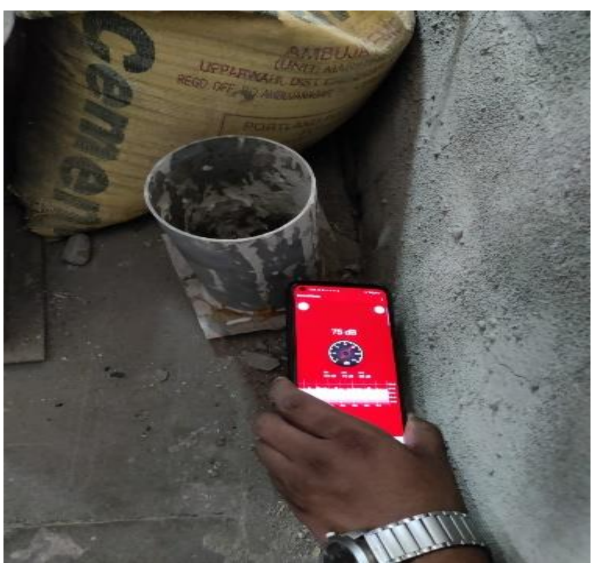

Fig. 4 Sound insulation test

V. RESULT

4.1 THERMAL INSULATION TEST RESULTS:

Sr No.	Materials	Temperature
1.	M sand	28.5℃
2.	Fly ash	29℃

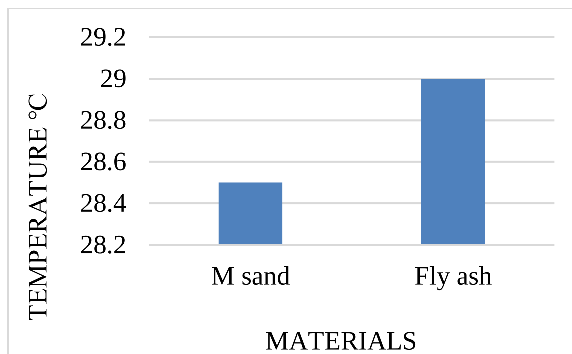

Fig. 5 Readings of thermal insulation test

4.2 SOUND INSULATION TEST RESULTS

Sr No.	Materials	Readings in decibel
1.	M sand	74
2.	Fly ash	75

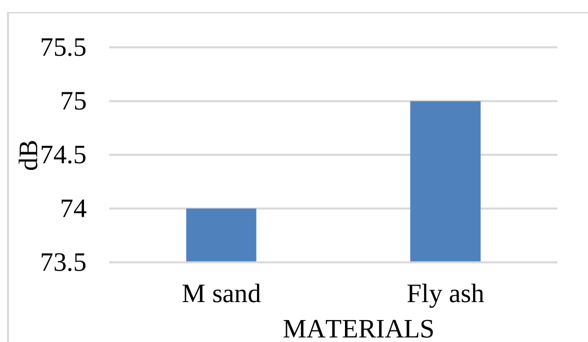

Fig. 6 Readings of sound insulation test

VI. CONCLUSION

- As per the research:

1. The lowest temperature observed was 28.5°C for the manufacturing sand wall, whereas the wall with fly ash recorded 29°C, respectively.
2. The emitted temperatures of the manufacturing sand and fly ash walls differed a little.
3. The manufacturing sand wall produced the lowest sound at 74 dB, while the wall made of fly ash produced 75 dB, respectively.
4. Despite the fact that the walls are made of entirely different materials, there is no major difference in their sound output.
5. From sound insulation test and thermal insulation test, we conclude that manufacturing sand is better building insulating material.

REFERENCE

1. Practical Study to Find the Best Sound Insulation for Walls From Different Building Materials Khalid Ahmed Salih[1], Aktifaa Salih Khudhur[1] and Aziz Ibrahim Abdulla[1] Al-Homoud, M.S., 2005. Performance characteristics and practical applications of common building thermal insulation materials. Build. Environ. 40, 353–366
2. Organic Thermal Insulation Based on Wheat Straw Ioan Olimpiu Miron**, Daniela Lucia Manea", Dana Maria Cantor (Andres)", Claudiu Aciu
3. Yousif khalaf Yousif, 2009 Proposed new formula to determine the sound insulation of concrete walls Anbar journal of engineering sciences folder2 University of Anbar Iraq
4. Anwar Al-Ghaith, 2012 The Effect of Sound on Buildings Urban and Architectural, Basil Al-Assad Journal of Engineering Sciences Issue 15 Iraq
5. Al-Ahmadi, Qusay Kamal Al-Din and Abd, Muthanna Khader, 2017 Noise Isolation Capability for a Range of Construction Materials Used In Iraq Tikrit Journal of Engineering Sciences 24 (2) -p (77- 85) Collage of Engineering Tikrit university
6. K.J. Kontoleon, D.K. Bikas The effect of south walls outdoor absorption coefficient on time lag, decrement factor and temperature variations Energy Build., 39 (2007), pp. 1011-1018
7. R. Dylewski, J. Adamczyk Economic and environmental benefits of thermal insulation of building external walls Build. Environ., 46 (2011), pp. 2615-2623
8. S.A. Al-Sanea, M.F. Zedan Improving thermal performance of building walls by optimizing insulation layer distribution and thickness for same thermal mass Appl. Energy, 88 (2011), pp. 3113-3124
9. X. Meng, B. Yan, Y.N. Gao, J. Wang, W. Zhang, E.S. Long Factors affecting the in situ measurement accuracy of the wall heat transfer coefficient using the heat flow meter method Energy Build., 86 (2015), pp. 754-765
10. S.A. Al-Sanea, M.F. Zedan Effect of insulation location on thermal performance of building walls under steady periodic conditions Int. J. Ambient. Energy, 22 (2011), pp. 59-72
11. O. Kaynakli A review of the economical and optimum thermal insulation thickness for building applications Renew. Sustain. Energy Rev., 16 (2015), pp. 415-425
12. L.D. Kraev, E.M. Shuldeshov, M.M. Platonov, G.Yu. Yurkov. "The review of composite materials that combine sound andradio protection properties". Aviation materials and technologies journal 2016, 60-65 p.
13. Ivanov N. I. Main directions and problems of environmental acoustics. Sat. TEZ. Dokl. XXVII session of RAO. SPb., 2014. p. 11.
14. Strokin, A. A. (2019, December). Modelling of noise reduction using reverberation fields of echoic rooms. In AIP Conference Proceedings (Vol. 2195, No. 1, p. 020072). AIP Publishing LLC.
15. Lunkov, A. A. (2019). Bottom Reverberation in the Presence of Intense Internal Waves. Acoustical Physics, 65(6), 694-702.
16. Stacy, E. 1959. Sound Insulation in Buildings. pp. 789–797.
17. Code of Requirements 23-103-2003. The design of sound insulation of enclosing structures of residential and public buildings.
18. Environmentally-friendly thermal and acoustic insulation materials from recycled textiles Shafiqul Islam, Gajanan Bhat

19. An environmentally friendly sound insulation material from post-industrial textile waste and natural rubber D.G.K. Dissanayake, D.U. Weerasinghe, L.M. Thebuwanage, U.A.A.N. Bandara.