INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 5)
Available online at: www.ijariit.com

An empirical study on controlling noises of building

Rishabh Anand
smile4u.civil@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

Rajneesh S.
rajneeshsharma0712@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

Chanchal D.
badshahgutkar@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

Avinash K.
thakuravinashsharma123@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

Sachin S.
sachin2410s@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

M. Shaheen W.
rishabhanand770@gmail.com
Aravali Institute of Technical Studies, Udaipur, Rajasthan

ABSTRACT

The consumption of energy in the building sector can be up to 40% of its total energy demand of an industrial country. For this reason, green building strategies can be extremely effective as far as fossil fuels reserve and greenhouse gases reduction. Sustainable materials can play an important role, lesser energy is required for their production than the one needed for conventional materials. People are more forgiving of discomfort if they have some effective means of control over alleviating that. However, many modern buildings seemed to have just the opposite effect. They take control far from the human occupants and try to place control in automatic systems which then govern the overall indoor environment conditions, and deny occupants means of intervention. In the recent year's many new materials for noise control have been studied and developed as alternatives to the traditional ones (glass or rock wool); these materials are either natural (wool, cotton, clay) or man-made from recycled materials (rubber, carpet, plastic, cork). Their importance is proven by the fact that in Europe many Municipalities have introduced into Building Regulations specific recommendations to improve their valuable use in new constructions, allowing a reduction of construction taxes or other benefits. This paper presents an updated survey of the characteristics and the acoustical properties of sustainable materials for noise control and in particular sound absorption coefficient, airborne and impact sound insulation data, as well as an analysis of the procedures to assess the sustainability of these materials (LCA, Eco invent, Eco-profiles). The improvement on the human quality of life and the continuous growth in population in developed societies have exacerbated the environmental and financial issues. Some of these problems are noise and the different types of human in industrial wastes. Many natural commodities have been recently developed and tested for acoustic applications. Sound-absorbing products absorb most of the sound energy striking them and reflect very little. Therefore, sound-absorbing products have been found to be very useful for the control of room noise.

Keywords— *Noise, Control, Sound, Vibration*

1. INTRODUCTION

It is a very noisy world. Twenty-four hours in a day, seven days a week, we are exposed to sounds we do not want, need, or benefit from. There are very few places on the planet where in our daily lives we are free from unwanted sounds. Noise from outdoor sources assails our hearing as it invades our homes and work places: traffic, aircraft, barking dogs, neighbor's voices. Noise within the workplace—from office machines, telephones, ventilating systems, unwanted conversation in the next cubicle—distracts us from our work and makes us less effective. Noises within the home—from appliances, upstairs footsteps, TV sound traveling from room to room— keep our homes from being the restful refuges they ought to be. Noise in the classroom stops the learning process and threatens our children's educational experience. Noise will frustrate and impede speech communication. It can imperil us as we drive city streets. It can be a physical health hazard as well: exposure to very high noise levels can cause permanent hearing loss.

The acoustical design issues for structures involve the principal issues like site noise considerations, including the control of noise transfer to a project's neighbors, particularly if they are residential, establishing noise standards for each uses space, room acoustics considerations, sound isolation between various equipment use spaces, control of vibration in mechanical equipment, audio/visual system considerations.

Acoustical sustainable materials, either natural or made from recycled materials, are quite often a valid alternative to traditional synthetic materials [1]. As the architectural and engineering design of the project evolves, the design should be reviewed in light of the agreed upon acoustical programmatic requirements for the structural projects. Since acoustics is typically not a code requirement, a city or state building officials cannot be expected to comment on the correctness of the acoustical design in the contract documents. Therefore, it is the responsibility of the planners, user groups, architects, engineers, and others involved with the project to assure that the project acoustical needs are delineated and that there is follow through, particularly for verification tests performed after the ventilation system has been installed and balanced.

2. SOUND AND NOISE

Sound waves in air results in physical disturbance of air molecules, such as when a truck drives by a building or when guitar strings are plucked. Sound wave combines and reaches to a listener via numerous direct and indirect pathways. The listener's inner ear is containing organs that vibrate in response to these molecular disturbances, converting the vibrations into changing electrical potentials that are sensed by the brain, allowing the hearing to occur.

2.1 Sound

It is a disturbance in an elastic medium resulting in an audible sensation.

Noise is defined by "unwanted sound" [2]. Unless it is accurately pure tone, a sound wave is typically made up of vibrations at different frequencies. Like the impact of a stone in a lake, ripples in the water are created that are similar to sound in the air. The frequency is the number of waves that pass a single point in one second, moving at the speed of sound in air. One wave per second is a frequency of 1 hertz (Hz). A frequency of one thousand hertz is a kilohertz (kHz).

2.2 Vibration

It is a disturbance in a solid elastic medium which may produce a detectable motion.

Human speech contains frequencies ranging between 200 Hz and 5 kHz, while the human ear can actually hear sound between 25 Hz and 13 kHz, a wider range. Frequencies below 20 Hz can be sensed as a vibration, thus not audible to most people. The acoustical analysis involves not only the sound source but also the receiver and everything in between on the path of the sound. The perception of the listener can be influenced by the treatment of either the path or the source. Some source sounds are desirable, for example, a lecturer's voice, and some truck outside a window. An undesirable sound called noise.

Sound and noise are described using a metric which is called the decibel. The decibel scale is logarithmic, similar to the Richter scale which is used to describe seismic events and translates a wide range of sound pressure levels that affect the human ears to a logarithmic scale. The range of decibels most commonly encountered in acoustics is from 0 to 140 db. Correlates sound pressure levels of common sound sources to the logarithmic decibel scale. Active noise control is being used only at low frequencies [3].

When designing a new library in a building or correcting deficiencies of existing library spaces, materials and constructions are selected to control noise and another unwanted sound. The human ears do not perceive all the frequencies of sound to the same degree, however, is less sensitive to lower frequency sound pressures than to middle or higher frequency sound pressures. People tend subjectively to measure their perception of the loudness of sounds based more on the SPL of these lower, middle and higher frequency sounds. Designing criteria and noise measurement devices are therefore weighted toward these upper frequencies in order to reflect the subjective perception of people in the space.

The term decibel is mainly used to describe noise levels in spaces because this type of decibel measurement averaged over the range of frequencies within the range of hearing correlates well with people's perception of the loudness of noise. Sound level meters, which average the SPL across frequencies, usually have a setting for weighting, so that measured noise levels correlate to the human perception of the differences in noise level.

3. GENERAL PRINCIPLES OF NOISE CONTROL

The very effective approach to the problem of ensuring that a building will have adequate noise control begins with a careful and Logical consideration of all the acoustical design elements during the early planning stage of the building. The important design element slit the architect should consider are listed and discussed accurately. Furthermore, many of the materials (bamboo, coco fibers) are currently available on the market at competitive prices [4]. For previous reasons, the first factors that should be considered are the selection of a building site and the proper orientation of the building on the site in an attempt to alleviate the problem of outdoor noise disturbance.

- Selection Of The Building Site
- Orientation Of Building In The Site
- Room And Space Management In Building
- Selection Of Sound Insulating Materials
- Sound Absorption

3.1 Selection of the building site

City planning authorities should be consulted for assurance that the building site has and will retain a residential rating. As a result of future rezoning or other civil planning action, suitable utilities are engulfed by industrial park areas, traffic arteries or aircraft flight patterns.

Sites should have good natural landscaping, such as rolling terrain with a good stand of trees, generally, provide more acoustical shielding than sites located in hollows or on the flat open ground.

3.2 The orientation of building site

(i) Buildings should be located so as to take advantage of any acoustical shielding provided by the existing terrain, natural landscaping or wooded areas of the building site.
(ii) Buildings should be located far as possible from the source of the greatest noise.
(iii) On a building site which is in front of an expressway, the building should be oriented so that the long axis of the building is perpendicular to the expressway.

3.3 Room and Space Management in Building

(i) Since buildings are barriers to the external noise they may have a noisy side and a quiet side. Noisy rooms such as equipment rooms, recreation rooms, and kitchens should be located on the noisy side of the building.
(ii) Obviously, it is good practice to locate noise producing areas such as garages, elevators, equipment and laundry rooms at the same end of the building far removed from dwelling areas, rather than in some central location which is often chosen for accessibility.

3.4 Selection of sound insulating materials

After the foregoing design elements have been considered and incorporated as effectively as possible in the building plans, the planner should concentrate on the selection of the sound insulating wall and floor structures which will achieve the desired privacy between dwelling units. A side from economic factors, the choice of suitable wall or floor assemblies will largely depend on the type of building the structure, i.e. masonry, steel or light frame construction. Regardless of the type of construction, the engineer should remember that the sound insulating effectiveness of a wall or floor assembly is dependent upon the following factors:

- Mass
- Stiffness
- Discontinuity in construction
- Proper installation, particularly regard to edge and boundary conditions
- Elimination of noise leaks, especially from perimeter edges, joints, and penetrations of walls and floors.

3.5 Sound absorption

Sound absorbing materials such as acoustical tile, carpets, and drapery play an indispensable part in controlling noise generation within a room or in reverberant areas such as lobbies, corridors, and staircases. Although those materials are highly effective as sound absorbers, they are relatively poor sound insulators because of their soft, porous and lightweight construction. Coconut fibers panels have an absorption peak of about 0.80 at 1000 Hz [5]. Coconut fibers panels have an absorption peak of about 0.80 at 1000 Hz. To illustrate this point, imagine a concrete wall constructed solely of acoustical tile, carpet or drapery material. Reed matting has been recently proposed for absorption applications, with excellent performance at medium-high frequencies [6]. Such a wall would provide no resistance to the passage of sound through it. Thus, the acoustical material is not a cure for sound insulation. This, of course, is contrary to the building practices and mistaken beliefs which over the years have held that acoustical tile is the panacea for any and all structure noise problems. Unfortunately, this sort of thinking still persists in the building industry and is largely responsible for many acoustically interiors and noisy buildings found today.

4. SOUND DISTRIBUTION

Sound Pressure level In a Room- The sound pressure levels at a given distance or the sound power levels for single equipment items can often be obtained from equipment suppliers. Once the characteristics of the sound source have been known, then the sound level at any location within an enclosed space can be estimated. In an outdoor environment “free field” (no reflecting surfaces accept the ground), the sound pressure level (SPL) will decrease at a rate of 6 dB for each doubling of distance from the source. In an indoor situation, however, all the enclosing surfaces of a room or enclosed area confine the sound energy so that they cannot spread out indefinitely and become dissipated with distance. As sound waves bounce around within the enclosed room, there is a build-up of sound level because the sound energy is “trapped” inside the enclosed room and escapes slowly.

4.1 Effect of distance and absorption

The reduction of sound pressure level indoors, as one move across the room away from the sound source, is depending upon the surface areas of the room, the amount of material for sound absorption on those areas, the distance for those areas, and the distance from the source. Everything here expressed are quantitatively by the curves. Curves offers a means of estimating the amount of SPL reduction for a piece of mechanical utensils (or any other type of sound source in a room), as one moves away from some relatively close-in distance to any other distance in the room, the properties of the sound absorptive of room (Room Constant) is being known. Conversely, the curve also gives a meaning of estimation of sound reduction in a room. From a given source, if the distance is kept constant and the amount of absorptive treatment is being increased.

For surfaces and materials, the sound absorption coefficients vary with frequency; hence the Room Constant must be calculated for all frequencies of interest. Even room surfaces that are not normally considered absorptive have small amounts of absorption. The sound absorption coefficient is not being measured in the 31, 63 and 8,000 Hz frequencies. The data at these frequencies are not available then use 40% of the value of the 125 Hz for the 31 Hz band, 70% of the 125 Hz value for the 63.002 Hz band and 81.23% of the 4,500 value for the 8,000 Hz octave band. Values of sound absorption coefficients for some special acoustical materials must be obtained from the manufacturer.

Estimation of Room Constant- In the early stages of a design, some of the details of a room may not be determined, yet it may be necessary to proceed with certain portions of the design. The room dimensions are required but it is not necessary to have made all the decisions on the side wall, floor, and ceiling materials.

5. SOUND ABSORBING MATERIALS

A majority of sustainable materials for sound control can be divided into two main categories:

- Natural materials;
- recycled materials;

There are many types of natural fibers which can be used for thermal and acoustical applications. These are commercially available in the form of coconut, kenaf, hemp, mineralized wood fibers [8]. Recent Literature reports a wider variety of materials, from the most common to the less conventional solutions; some LCA studies are also available, showing that natural fibers are cheaper, lighter and environmentally superior to glass fibers composites.

Sustainable materials are in many cases compared to traditional ones as far as thermal and acoustic performance. Here, many products physical properties have not been deeply analyzed and are not yet certified, because they have already reached a certain technical and commercial maturity; in Italy, for example, many sustainable materials which can be listed in official prices lists for public tenders.

There is a great variety of natural fibers proposed for thermal and acoustical applications; most of them are commercially available for example coconut, hemp, mineralized wood. As natural materials, the less treated they are, the higher they perform in energy saving; native materials have to be preferred to reduce transport energy. It is known that natural fibers have a negative impact as far as climate change due to CO_2 absorption during the growth of the plant. Nevertheless, other performances have to be considered: vegetal fibers are more subject to fungal and parasites attack and are less resistant to fire than mineral fibers.

Many recycled materials, such as waste rubber, metal shavings, plastic, textile agglomerates can be vastly used to prepare acoustic materials. It should be useful to mix various recycled materials of different granulo metries to obtain the desired performance; in these cases, a binder or glue has to be added in a proper proportion.

6. PROCESS OF SOUND INSULATION

Everyone has experienced unwanted sound– a television in the next room, a loud neighbor walking on the floor above, or a jet flying over. Measures are often required to reduce noise. One of the essential techniques in acoustics is reducing the transmission of sound through solid barriers in buildings. This form of reducing sound is referred to as Sound Insulation.

The reduction of sound energy from one building area to another area by absorbing it or reflecting it with an intervening solid panel of material is called sound transmission loss (TL). Typically, structures materials attenuate more high frequency noise than low frequency noise. The greater the mass or weight of a wall, the more force is required to make it vibrate. For this reason, a massive wall has greater TL at all frequencies than a lighter panel.

One more way to increase the transmission loss of a panel or construction, such as a wall, is by increasing its thickness and isolating one side of the construction from the other. This is done by using two panels separated by an air cavity and is known as a dual panel partition. Double the air space width increases the TL by about 5 Db. It is more effective and lower cost than increasing wall mass of the dual panel approach.

6.1 Wall Construction

A standard partition used to separate rooms in a building is typically a simple single stud wall and one layer of gypsum board on each side, and it has an STC rating of 35. The acoustic performance of the standard wall can be improved by using light gauge metal studs instead of wood studs. There are some special conditions in a library where more sound isolation will be required, which can be accomplished by adding insulation within the wall cavity, providing two layers of gypsum cardboard on each side of the partition, or using staggered stud construction. These program areas include conference rooms and offices requiring confidential speech privacy, where STC ratings in the range of STC 45-50 are being recommended. From the rooms the control noise transfer is having amplified sound systems such as meeting rooms into other library spaces, the surrounding walls should have a minimum rating of STC 55-60.

- Sound leaks through cracks. A small air or sound gap can completely compromise the effectiveness of the wall construction. Long or large cracks, such as those that normally occur at the base and top of a wall are especially detrimental. For this reason, flexible acoustic caulking should be used as the perimeter of a sound partition to seal all edge cracks.
- Structural connections between double stud partitions. The wooden made studs in each partition frame having a double stud wall must not be structurally coupled to the other frame in any way. No plumbing or electrical lines are been located in the open space of the air gap between the two partition frames.
- It is important to fix both the faces of a concrete wall with plaster or paint in order to control possible sound leaks.

6.2 Floor Construction

Floor and ceiling assemblies perform two acoustical functions. Like walls, they provide acoustical separation between adjacent spaces (airborne sound insulation), but they also reduce the sound of footfalls and other impact sounds from an upper floor (impact insulation).

Impact insulation and airborne insulation can be upgraded by decoupling ceilings from the building and by altering floor finishes. A base assembly consisting of plywood subfloor, joists and gypsum board can be upgraded from STC 37 to STC 58 by adding a lightweight concrete in the top of the slab, fiberglass bat insulation, resilient channels and two layers of gypsum board.

The concrete topping slab reduces impact noise from footsteps heard in the space below or lower floor. Using a carpet or pad or a resilient floor underlayment improves the impact insulation. The floor of wood framed, ceiling construction having an STC rating of 58.

6.3 Space Planning

Space planning can be the most cost-effective and important noise control technique. Avoid the location of mechanical equipment rooms and electrical transformer rooms near spaces (either vertically or horizontally) that require low background noise levels. If this location is unavoidable, it will be very necessary to introduce costly sound isolation methods such as a floating floor, or heavy masonry walls, if proper sound insulation is to be achieved. A floor which consists of the second type of concrete slab installed on neoprene pads and a layer of insulation.

7. REQUIREMENT OF SOUND INSULATION

Adding sound absorbing materials to space usually becomes a design issue in the library. There are many options are possible to provide sound absorption on walls and ceilings, which are attractive and maintainable. The materialsare often covered with acoustically transparent surfaces such as fabric, perforated metal and spaced wooden slats. These surfaces allow the energy to pass through and be absorbed by the material located behind.

Some of the materials which are attractively designed to be exposed to view, examples are normally suspended ceiling tiles. Basically, the bigger porous material gives better sound absorption. A one-inch thick glass fiber ceiling tile can have an NRC rating of 0.80 or greater. Many of the researches have demonstrated that the insulated sound of double-leaf walls with low density animal wool or heavy vegetal wool is equal or better than the one of walls with mineral wool or polystyrene of the same thickness (about 69 dB in heavy double walls) [9].

All materials have little sound absorbing properties. The energy that is not being absorbed must be reflected or transmitted. A material is a property of typically described as a sound absorption coefficient at a particular frequency range. Sound absorbing materials used in the buildings are rated by the use of Noise Reduction Coefficient (NRC), which is basically a type of average of sound absorption coefficients from 252 Hz to 2.1 kHz, the primary speech frequency range. The NRC theoretically can be range from perfectly absorptive (NRC = 1.0) to perfectly reflective (NRC = 0.0).

Multi-purpose rooms require special room acoustics design since these spaces often must be accommodated for speech and musical activities at different times. For speech activity, the time of reverberation should be low enough to allow syllables of parts of speech to be readily understood. Longer reverberation time is preferred for musical functions; since the sound of music need to reverberate properly. A room having reverberation time more than 1.5 seconds may be acceptable for music listening but would probably create interference with speech intelligibility. The main peculiarity of these materials is the aptitude to keep acoustical performance nearly constant in time [10].

A room having a reverberation time lesser than 1 second would probably be judged acceptable for speech intelligibility but musicians may complain about the room being too “dead”.

8. CONCLUSION

The interest in the acoustic performance of green and sustainable materials seems to be increasing in all fields.

As a matter of fact, these materials show usefulness. They generally have a lower environmental impact than conventional ones, though a proper analysis of their sustainability, through Life Cycle Assessment procedures, has to be carried out. The total energy demand is lower, but it has to be accurately evaluated, since not always an “ecological” material requires less energy in its life cycle than a traditional one many of these materials are currently available on the market at competitive prices.

Acoustical sustainable materials, either natural or man-made from recycled materials, are quite often a valid alternative to traditional synthetic materials. Airborne sound insulation of natural materials such as flax or recycled cellulose fibers is similar to the one of rock and glass wools. Many natural materials (bamboo, sisal, coco fibers) show good sound absorbing performance; cork or recycled rubber or polymers layers can be very effective for impact sound insulation. The material always shows high thermal insulation properties are often light. They are not harmful to human health. There is, however, a much needed to complete their characterization, both from an experimental and a theoretical point of view, and especially to propose a unique procedure to evaluate their actual sustainability.

9. REFERENCES

[1] Gle P, Gourdon E, Arnaud L (2011) Acoustical properties of materials made of vegetable particles with several scales of porosity. Applied acoustics pp 249-259

[2] Building Acoustics and Noise Control, by J. Paul Guyer, P.E., R.A., Fellow American society of civil engineering(ASCE), Fellow AEI pp 4-5

[3] Gorji-Bandpy M, Azimi M (2012) Technologies for jet noise reduction in turbofan engines. Aviation pp 25-35.

[4] Schiavi A, Belli AP, Corallo M, Russo F (2006) Acoustic performance characterization of sustainable materials used under floating floors in dwellings. Proceedings of Euro noise pp 2-6.

[5] G. Suzana et Al., (2003), “Eco Design in Noise Control: the Benefits, Acoustical Properties, and Applications of Coconut Fiber”, Proc. of Euro noise, Naples, Italy, May pp 3-4.

[6] V. Chilekwa, G. Sieffert, C.A. Egan, D. Oldham, (2006), “The acoustical characteristics of reed configurations“, Proc. of Euro noise Structured Session Sustainable Materials for Noise Control, Tampere, Finland, pp 1-5.

[7] An Introduction to Noise Control in Buildings, by J. Paul Guyer, P.E., R.A., Fellow American society of civil engineering(ASCE), Fellow AEI (3.1.1) pp 4-8.

[8] Pervaiz M, Sain MM (2003) Carbon storage potential in natural fiber composites. Resources Conservation and Recycling pp 325-340.

[9] Azimi M. “Noise Reduction in Buildings Using Sound Absorbing Materials” from Journal of ArchitecturalEngineering Technology Volume 6 Issue 2 pp 1-2

[10] ShikhaChoudhary, Shweta Jain, ShwetaSheokand, Vivek Kumar; “Noise Control on Buildings” from International Journal of Innovative Research In Technology December 2015 Volume 2 Issue 7 pp 615.

