

Noise Mitigation in Buildings Using Sound Absorbing Materials

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Abstract

Noise, generally defined as undesirable sound, is characterized in terms of the pressure of the sound wave. The improvement on the human quality of life and the continuous growth in population in developing and developed societies, have exacerbated the environmental and financial issues. Some of these problems are noise and the different types of human and industrial wastes. Many natural products have been recently developed and tested for acoustic applications. Sound-absorbing materials absorb most of the sound energy striking them and reflect very little. Therefore, sound-absorbing materials have been found to be very useful for the control of room noise. In this study, sound absorption technology as an effective noise reduction technology buildings using sustainable acoustic absorbers, will be discussed.

Key words: Noise, Noise Reduction, Passive Techniques, Sound Absorption, Sustainable Material.

Introduction

The recognition of noise as a serious health hazard is a development of modern times. Too much noise obviously impairs our physical and mental existence and therefore it is reasonable to pursue Technology Assessment concerning noisy technologies [1-4]. In other words, noise has turned into one of the most important among the environmental factors on which industry sets down a big part of its efforts and concerns. The conflicts of interest associated with noise that arise from the operation of airports are well known.

Recently, passive mediums have been used extensively in the industry to reduce noise. Acoustical sustainable materials, either natural or made from recycled materials, are quite often a valid alternative to traditional synthetic materials [5]. The production of these materials generally has a lower environmental impact than conventional ones, though a proper analysis of their sustainability, through Life Cycle Assessment procedures, has to be carried out.

Airborne sound insulation of natural materials such as flax or of recycled cellulose fibres is similar to the one of rock or glass wool [6]. Many natural materials (bamboo, kenaf, coco fibres) show good sound absorbing performances; cork or recycled rubber layers can be very effective for impact sound insulation [7]. These materials also show good thermal insulation properties, are often light and they are not harmful for human health. Furthermore, many of these materials are currently available on the market at competitive prices [8].

Noise reduction techniques can be broadly classified as passive and active methods. Passive control involves reducing the radiated noise by energy absorption, while the active method involves reducing source strength or modifying acoustic field in the duct to obtain noise reduction. Active noise control is being used only at low frequencies [1]. At middle and high frequencies, active noise control is hard to implement because there are different phenomena of sound propagation. Thus, the main purpose of the active sound control is to provide higher noise reduction at low frequencies. While at higher frequencies standard solutions are applied, and they are based on the application of absorbing properties of the materials.

The absorbing materials, as such, are passive mediums that lower noise by disseminating energy and turning it into heat. Acoustic absorption depends on the frequency of the sound waves.

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In current study, a bibliographical review concerning the usage of acoustic absorbers on buildings noise reduction is presented.

1. Sound Absorbing Materials

Porous materials obtained from synthetic fibres, such as mineral wool(fig.1) or glass wool(fig.2), are commonly used for thermal insulation and sound absorption, because of their high performance and low cost. Their diffuse-field sound absorption coefficient is very high at mid-high frequencies. On the other hand, they have several cons: they can be harmful for human health if their fibres are inhaled, since they can lay down in the lung alveoli, and can cause skin irritation (as stated by the European Council Directive on dangerous substances 67/548/EEC [9] and subsequent amendments). Hence such materials must be adequately overlaid if directly exposed to the air. Viscous losses convert acoustic energy into heat as sound waves travel through the interconnected pores (or fibers) of the material. Because motion of the air through the porous material is necessary to dissipate acoustical energy, a material tends to be ineffective when placed close to a rigid boundary (where the particle velocity is zero) [10]. Effectiveness of absorption is directly related to the thickness of the material; absorbers are most effective when their thickness is between one-fourth and one-half the wavelength of the sound, with the maximum performance where the thickness is one-fourth the wavelength. This means that sound absorbers do a very good job at high frequencies, which have short wavelengths [11, 12].



Fig. 1. Porous materials obtained from mineral wool [13].



Fig. 2. Porous materials obtained from glass wool [14].

A majority of sustainable materials for noise control can be divided into three main categories:

- Natural materials;
- Recycled materials;
- Mixed and composited materials.

There is a great variety of natural fibres which can be used for thermal and acoustical applications. These are commercially available in the form of coconut, kenaf, hemp, mineralized wood fibres (Fig.3) [15].

2. Building Noise Reduction

At the scale of materials and building, noise pollution is taken into account besides a number of sustainability aspects. Designing and improving acoustic environment, on the other hand, is linked to a choice of particular building techniques and materials that imply different environmental performance more than acoustic performance. An aware design should mediate between these issues, which are sometimes contradictory [16].

It is possible to obtain sufficient insulation against impact noises between different living units by interposing an element with the capacity of dampening vibrations between the sources of the noise and the adjacent structures. As circumstances or conditions change, this element may be applied in various points: Between loadbearing structure and the screed, or between the screed and the flooring, as well as directly underneath the floor by creating a false ceiling [17].

Brekreira et. Al [18] present the data elements to develop a new processing route to transform elastomeric waste residue (particulates) into acoustic and thermal insulation materials that can compete with commercial products.

Oldham et. Al [19] present an examination of the acoustical characteristics of a range of natural fibres which has confirmed their effectiveness as porous sound absorbers and also the limitations of current models for predicting their performance. Examination of the acoustical performance of materials consisting of different configurations of whole reeds and straws has revealed that these also possess considerable potential for application as broadband sound absorbers with particularly good low frequency absorption characteristics. They concluded that the combination of natural fibres and whole reeds offer the possibility of developing a range of sustainable absorbers which act very effectively across the complete audio frequency range.

Article written by Ballesteros, et al. [20] explains about the noise which turn out through the construction activities is one of the main acoustic polluting essence for society. However, there is no particular standard for this activity, which validates its own effluent factors that make it phenomenon different from other operations. This experimental information's on construction sites have been measured through four averaging and integrating sound level meters with spectrum analyzer included and a sound calibrator. The factors of sound emission for experimental data has been differentiate as five stages (excavation stage, frameworks, installation stage, roof stage, stage of walls) each stage have been analyzed and compared with the standard level. The comparison among the values is to characterize the noise emission of the construction process. These stages of the construction process cannot be reasonably enviable regarding the spectra, except for the excavation stage, given that the only staggering thing is effect of the peak at low frequency. The results show that the measures for controlling the noise and the analysis of the acoustic impact which such activity produce in the concern specified area.

Conclusion

Many public housing sites are subject to severe noise impact from various sources many recycled materials, such as waste rubber, metal shavings, plastic, textile agglomerates can be used. It can be useful to mix various recycled materials of different grain size to obtain the desired performance. For this purpose a binder needs to be added in proper proportions. This paper presents a brief review about acoustic absorbers and their usage for building noise reduction.

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