International Journal of Advanced Technology in Engineering and Science
Vol. No.7, Issue No. 04, April 2019
www.ijates.com
ijates
ISSN 2348 - 7550

NOISE CONTROL ON BUILDINGS

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ABSTRACT

The energy consumption in the building sector can reach up to 40% of the total energy demand of an industrial country. For this reason, green building strategies can be extremely effective as far as fossil fuels savings and greenhouse gases reduction. Sustainable materials can play an important role, since less energy is generally required for their production than the one needed for conventional materials. Comfort, including personal control Research work in the 1980s into what was then called sick building syndrome (now building-related ill health) confirmed to a new generation of researchers what was already well known to an older one - that people's perception of control over their environment affects their comfort and satisfaction. Work on thermal comfort, notably that of Humphreys and McIntyre in the 1970s, had shown that the range of temperatures that building occupants reported as"comfortable" was wider in field studies than in controlled conditions in the laboratory. People seemed to be more tolerant of conditions the more control opportunities - switches, blinds and opening windows, for instance - were available to them. This is a vital finding to take from pioneering thermal comfort research and is the basis for what later came to be called 'adaptive comfort theory'. People are more forgiving of discomfort if they have some effective means of control over alleviating it.

INTRODUCTION

According to the definition of sustainability of the Brundtland Report , "Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs". A product can be therefore considered sustainable if its production enables the resources from which it was made to continue to be available for future generations and has the lowest possible impact on human health and on the environment. A sustainable product is generally made from natural or recycled materials and its production requires a small amount of energy, makes a limited use of non- renewable resources and has a low environmental impact. Many currently used acoustic materials can not be considered sustainable, at least as far as energy consumption and greenhouse gases emissions; moreover, some of them can be harmful for human health. Mineral wools are widely used for thermal and sound insulation, because of their good performance and low cost, but their fibres, when inhaled, can lay down in the lung alveoli, and can cause skin irritation. Hence such materials must be adequately overlaid if directly exposed to the air. Moreover they can pulverize and are not resistant to water, oil and chemical agents and this can make their application not suitable for absorbing noise barriers. In the last years a great attention has been focused on "green" materials, especially in the building sector. Many research centres have developed new sustainable materials, in many cases with interesting acoustical properties.

Also the public sector started to consider these materials; in Italy, for instance, many Municipalities have introduced into Building Regulations specific recommendations to improve the use of ecological materials in new constructions, allowing a reduction of construction.These Regulations also contain a list of materials that should be avoided (e.g. mineral fibres). An increasing attention has been turned to natural fibres as alternatives to synthetic ones, in order to combine high acoustic and thermal performance with a low impact on the environment and human health. Natural fibres have very low toxicity and their production processes can contribute to protect the environment. Recycled materials, such as recycled plastic fibres and recycled rubber mats, can even be regarded as a sustainable alternative, as they contribute to lower waste production and use of raw materials.

ASSESSMENT OF GREEN PRODUCTS

The correct approach to assess the real sustainability of a product is the so-called Life Cycle Assessment (LCA), a procedure which analyses the potential impacts deriving from the entire life history of a product (from cradle to grave). Material extraction, production, transport, construction, operating and management, de-construction and disposal, recycling and reusehave therefore to be taken into accountFor designers and decision-makers, LCA analysis results are available as "ecoprofiles"; among these the most known are Ecoinvent, BRE Eco-profiles and Eco-indicator. Ecoinvent is a Swiss LCA database which takes into account various impact assessment results: Cumulated Energy Demand, Non- Renewable Energy fraction, Global Warming Potential and Acidification Power. A comparison based on the Ecoinvent database between the environmental impacts of some traditional and natural sound insulation materials from cradle to grave.

GREEN AND SUSTAINABLE MATERIALSFOR NOISE CONTROL

As previously said, many new materials for noise control as alternatives to the traditional onesHave been proposed in recent years. These materials can be divided into two main categories:
1.Natural materials. 2. recycled materials.
Recent Literature reports a wide variety of materials, from the most common to the less conventional solutions; some LCA studies are also available, showing that natural fibres are cheaper, lighter and environmentally superior to glass fibres composites.Sustainable materials are in many cases comparable to traditional ones as far as thermal and acoustic performance. Though for many products physical properties have not been deeply analyzed and are not yet certified, they have already reached a certain technical and commercial maturity; in Italy, for example, many sustainable materials are listed in official prices lists for public tenders.There is a great variety of natural fibres proposed for thermal and acoustical applications; most of them are commercially available such as coconut, kenaf, hemp, mineralized wood. As for 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 well known that natural fibres have negative impact as far as climate change due to CO2 absorption during the growth of the plant. Nevertheless other performance have to be considered: vegetal fibres are more subject to fungal and parasites attack and are less resistant to fire than mineral fibres.

SOUND ABSORPTION

Natural fibres are generally good absorbers. The extremely wide variety of natural fibres allows to find a suitable material for almost every absorbing need. Many natural materials as kenaf, flax, sisal,hemp, cork, sheep wool, bamboo or coconut fibres show good absorbing performance and can therefore be used as sound absorbers in room acoustics and noise barriers. Table 2 reports the coefficients of absorption as well as the values of Noise Reduction Coefficient (NRC), for some conventional and sustainable materials. The NRC rating is an average of how absorptive is a material at four frequencies (250, 500, 1000 and 2000 Hz) and is here used for a comparison of the various materials.In particular, bamboo and sisal fibres show an absorption coefficient at 1000 Hz and more very close to the one of glass fibres (more than 0,90). Kenaf panels show an absorption coefficient higher than 0.80 above 500 Hz . Coconut fibres panels have an absorption peak of about 0,80 at 1000 Hz [16], for flax panels the peak reaches 0,90 at 800 Hz while for sheep wool panels the peak is 0,90 at 3000 Hz. Vegetable wastes such as grass, pine or gorse leaves, corn cobs, used in sandwich panels, have an absorption coefficient similar to polyurethane foam or mineral wool. Reed matting has been recently proposed for absorption applications, with excellent performance at medium-high frequencies [18]. Not all natural materials, of course, have satisfying absorption performance: wood and cork, for example, due to their structure, show poor absorption properties.

AIRBORNE SOUND INSULATION

Several natural materials are commonly used as thermal and acoustical insulation in multilayered walls: among these flax, coconut, cotton, sheep wool and kenaf mats are the most present on the market. Their sound and thermal insulation performance are in many cases as good as those of traditional materials (Tables 3 and 4): many studies have demonstrated that the sound insulation of double-leaf walls with low density animal wool (sheep wool) or heavy vegetal wool (latex-coco) 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). Loose- fill cellulose fibres and batts made of cellulose or flax fibres in timber frame walls showed the same airborne insulation of glass wool. Also mineralized wood panels with magnesite or Portland concrete are used for sound insulation applications, as well as cork panels, with satisfying properties. Dry loose cellulose fibres are already commonly used for thermal and acoustical insulation by filling the cavities in walls and roofs, especially in the United States. When it is obtained fromrecycled newspapers, it appears to match energy and raw materials savings and health issues. As for the acoustical properties, they are as good as traditional material ones .

IMPACT SOUND INSULATION

This is probably the most common use for many natural materials (cork, coconut fibres, wood, wool) and also for many recycled materials. Resilient layers made of natural materials can be very good for floating floors to increase impact sound insulation: when the panels are accurately designed and installed, their performances NNUBare as good as other traditional materials. Recycled rubber layers made of waste tyres granules are an interesting alternative to traditional materials, especially now that tyres are banned from landfills.

Because of the large amount of used tyres available worldwide, new applications have to be found and their use as impact sound insulating layers is very promising . Also recycled carpet wastes are interesting materials as far as impact sound insulation, especially if made of a mixture of fibrous and granular waste.

CONCLUSIONS

The interest in the acoustic performance of green and sustainable materials seems to beincreasing in technical and scientific Literature. Many related researches have been recently published in International Journals and in the Proceedings of International Conferences; a Structured Session on "Sustainable Materials for Noise Control, As a matter of fact, these materials show many advantages. They generally have a lower environmental impact then conventional ones, though a proper analysis of their sustainability, through Life Cycle Assessment procedures, has to be carried out. Also the total energy demand is generally 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. Furthermore, many of these materials are currently available on the market at competitive prices.

ACKNOWLEDGEMENTS

The support provided by IIMT college of engineering and iimt polytectnic in the form of a short term research grant for this study is very much appreciated. The authors wish to acknowledge the technicians of polytectnic laboratory Civil Engineering and technicians of Material Engineering, hod mam.

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