International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018) pp. 82-84

Insulating Materials for Building Energy Conservation: Review

[1]S.M.Biradar
[2]Sharad Shanbhag
[3]Chetan Gaonkar
[4]Ambesh Shetye
[1,2,3,4]*Assistant Professor, Mechanical Engineering Department, DBCE, Fatorda ,Goa-403602*

Abstract

Building insulation is commonly recognised using materials obtained from petrochemicals (mainly polystyrene) or from natural sources processed with high energy consumptions (glass and rock wools). These materials cause significant harmful effects on the environment mainly due to the production stage, i.e. use of non-renewable materials and fossil energy consumption, and to the disposal stage, i.e. problems in reusing or recycling the products at the end of their lives. The concept of "sustainability" in building design process encouraged researches intended at developing thermal and acoustic insulating materials using natural or recycled materials. Some of them, such as kenaf or wood fiber, are already commercialized but their diffusion could be further improved since their performance is similar to the synthetic ones. Others are currently alternate and their development is only at an early stage. The main objective of the paper is to report a state of the art of building insulation products made of natural that are not or scarcely commercialized.

Keywords: Insulating materials, Unconventional materials, Thermal conductivity.

1. INTRODUCTION

A standout amongst the most essential difficulties of future structures is the lessening of vitality utilizations in all their life stages, from construction to destruction. The United Nation Environment Program [1] estimates that structures expend around 40% of the world worldwide energy, 25% of the worldwide water, 40% of the worldwide assets; structures are additionally capable of around 1/3 of ozone harming substance discharges of the whole planet.
Comparative esteems were seen by ponders achieved by the U.S .Department of Energy [1] and by the European Commission [3]. In Europe, this circumstance encouraged the meaning of a few environmental policies: the most vital ones are the Energy Performance of Building Directive (EPBD, [4]) and the Energy Efficiency Directive (EED, European Commission assessed that these activities will contribute to reduce the vitality interest for warming and cooling purposes by 8% in2020, 12% out of 2030 and 17% out of 2050 contrasted with 2005 information Procedures for the decrease of warming and cooling requests are centred not just around improving appliance productivity or changing national ways of life, yet in addition on upgrading the protection properties of building envelopes. The last activity could assume an unequivocal part since it can prompt noteworthy changes with a low pay-back time[7–10]. The significance of expanding the warm execution in the building division was likewise featured by a similar examination about vitality generation and utilization.

2. UNCONVENTIONAL BUILDING INSULATION MATERIALS

The warm and acoustic protection properties of some green materials and of some horticultural and mechanical side-effects were contemplated by a few creators. The utilization of these items is not widespread and, at times, it is restricted to an exploratory and research centre stage. A review of these materials is condensed in the present section, which reports for every material the most critical warm and acoustic parameters and the wellspring of the information The real maintainability of the considered protection materials is connected to their accessibility; they ought to be utilized ideally where they are reaped, delivered or produced

2.1 Reeds

Reeds utilized as a part of the building segment are principally gotten from Phragmites australis, a plant as a rule gathered inwinter season and set up together with iron or nylon wires in boards. Reed isn't appropriately a flighty building material since some reed boards can be found in the market and they are utilized as a part of rooftops and dividers, both as interior or outside protection secured with mortar. However their utilization isn't extremely far reaching aside from where there is wealth of this material (Eastern Europe specifically). The warm conductivity of a reed board is in the vicinity of 0.045 and 0.056 W/mK, the thickness shifts from 130 to 190 kg/m3 and the particular warmth achieves a most extreme esteem of 1200 J/kgK by J Pinto et al. [23,25]. By the by a 0.045 W/mK S. Panyakaew et al [19] estimation of warm conductivity is by all accounts too low; measures performed by the Authors by methods for hot plate technique gave values around 0.055 W/mK by G. Iannace et al. [14].

2.2 Sugar cane waste

Sugar cane waste is a standout amongst the most critical buildups of sugar creation and it is as of now principally oversaw as a waste. Its extraordinary accessibility in areas where sugar stick is developed, its low cost and furthermore its substance of cellulose that helps diminishing the utilization of manufactured folios, encouraged a few research attempts to create inventive warm protection particleboards made of this material. Manohar et al. considered the impact of thickness the evident warm conductivity. Tests described by thickness in the vicinity of 70 and 120 kg/m3 were broke down. The most performing one was described by a thickness of 100 kg/m3 and a warm conductivity of 0.046 W/mK by F. Ardente et al. [15,16]. Denser binderless examples were tried by Panyakaev and Fotios that additionally report the cellulose

substance of the tried bagasse (76.31%).

2.3 Maize corn cob

Corn cobs are the residuals of corn plants and handling industry. Pinto et al. found that some Portuguese tabique structures were acknowledged utilizing corncobs and earth as filling materials. This blend was acknowledged predominantly to reuse this agrarian waste as opposed to enhance the warm protection properties. The warm conductivity of particleboards made of ground corn cobs and wood glue was assessed in], however the best esteem was still too high (0.101W/mK) to think about this material as a legitimate warm encasing.

2.4 Cotton stalks

Cotton is the most boundless non-agrarian development utilized fundamentally for texture generation. An examination completed by X. Zhou et al. tested the warm execution of a creative material acknowledged utilizing the cotton stalks, a deposit of cotton generation. Cotton stalks were gotten changing the stalks in filaments without utilizing concoction fasteners. The warm conductivity of the tried example was between 0.0585 and0.0815 W/mK the denser the material, the lower the warm protection. The normal cotton build up world creation in the period 1993– 2013 is 2.14 × 1010 kg, fundamentally delivered in Asia (63.7%) and in the Americas (24.6%) [18].

2.5 Date palm

The date palm is developed in semi-bone-dry zones for the dates generation. The deposits, for example, leaves, petioles (13 for every plant for every year) and groups (7 for each plant for every year) are normally considered as squander According to FAO official information, Agoudjil et al. evaluated that 1,200,000 tons of petioles, 410,000 of leaves and 300,000 of clusters are delivered each year worldwide. The immense accessibility of these materials proposed to the creator to test the warm protection properties of these materials, after their change in filaments. Six examples were tried to consider the impact of palm date type and the distinction amongst petioles and clusters based material. Additionally the course of the fiber was tried.

2.6 Pineapple clears out

Pineapple accumulation and assembling produces a few buildups; one of them is constituted by their leaves that are presently treated in vitality plants or basically consumed. The air and soil contamination because of these procedures causes natural issues that could be restricted by finding an inventive utilization of this material in the building segment. Tangjuank contemplated the warm protection properties of a board made of destroyed and dried pineapple leaves bound utilizing characteristic elastic latex. The tried examples had thickness in the vicinity of 178 and 232 kg/m3 and warm conductivity in the vicinity of 0.035 and 0.043W/mK.

2.7 Wheat and Rice

FAO 2013 authority information expresses that rice is the third most delivered item on the planet after sugar stick and maize with a generation of more than 740 million tons for every year [6]. As an outcome a huge amount of deposits is created causing transfer concerns, while they could be utilized effectively for the generation of valuable green materials. Yarbrough et al. assessed the warm protection execution of particleboards made of rice structures, a vital side-effect of rice development. The warm conductivity at 24 °C was in the vicinity of 0.0464 and 0.0566 W/mK; the least esteem was estimated for the 154 kg/m3 thick example by D.J. Oldham et al [13]. A similar research work reports the consequences of warm protection tests performed on particleboards made of pecan shells, yet the outcomes demonstrated that this material isn't sufficient for protection purposes (0.0884 W/mK).

2.8 Composite materials of Sunflower

The sunflower is a standout amongst the most cultivated crops on the planet, because of the high oil substance of its seeds. Warm conductivity of particleboards acknowledged utilizing ground sunflower substances were estimated in K. Doost-hoseini et al. [20] varying material thickness and grain measure distance across. The most minimal esteem was gotten for the less thick material, 36 kg/m3, portrayed by grain measure width lower than 1 mm . In the cake created amid sunflower refinery forms was utilized to deliver a warm protection fibreboard: by and by the most performing test was very delicate and described by a high warm conductivity, 0.0885W/mK.

CONCLUSION

The present paper reports an up to date review of some of building insulation products made up of unconventional material. While the market is now dominated by few categories of thermo-acoustic insulators such a mineral wool, extruded and expanded polystyrene, the rush towards more environmentally friendly buildings outlines developing opportunities for new sustainable materials. These unconventional products can be manufactured using natural sources such as residues of agricultural production and processing industries. Other sources are represented by recycled products or industrial plants derivatives. Some of the investigated materials are characterized by performance similar to commercial ones. Concerning thermal issues, an example is given by a recycled cotton insulator having density and thermal conductivity comparable to EPS, XPS and sheep wool. As far as the acoustic performance, high sound absorption and insulation values were measured in materials made of recycled denim. Products made of recycled PET and textile are also characterized by environmental performance better than rock wool and kenaf fiber ones.

References

[1] U.S. Department of Energy, Building energy data book, available,http://buildingsdatabook.eren.doe.gov/ChapterIntro1.aspx.
[2] European Commission, data available at http://ec.europa.eu/energy/en/topics/ energy-efficiency/buildings;
[3] Directive 2010/31/EU of the European Parliament and of the Council of 19 May2010 on the energy performance of

building;
[4] European Union, Decision no 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living Well, Within the Limits Of Our Planet', 7th Environmental Action Programme, 2013.
[5] F. D'Alessandro, S. Schiavoni, A review and comparative analysis of European priorityindices for noise action plans, Sci. Total Environ. 518–519 (2015) 290-301, http://dx.doi.org/10.1016/j.scitotenv.2015.02.102.
[6] Building Thermal Insulation Market — By Material (Wool Insulation, Plastic Foams and Others) and Application (Roof,Wall and Floor) — Global Trends and Forecasts (2011–2016);
[7] Asdrubali, G. Baldinelli, F. D'Alessandro, F. Scrucca, Life cycle assessment of electricity production from renewable energies: review and results harmonization, Renew. Sust. Energ. Rev. 42 (2015) 1113–1122, http://dx.doi.org/10.1016/j.rser. 2014.10.082.
[8] EN 13501-1:2007A1+2010, Fire classification of construction products and building elements-Part 1: Classification using data from reaction to fire tests
[9] F. Asdrubali, S. Schiavoni, K.V. Horoshenkov, Review of sustainable materials for acoustic applications, J. Build. Acoust. 19 (4) (2012).
[10] FAO Official data available at: http://faostat3.fao.org/;
[11] F. Asdrubali, F. D'Alessandro, S. Schiavoni, N. Mencarelli, Sound absorption properties of reed, Proceedings of the 22nd International Congress on Sound and Vibration,Florence, Italy, July 12–16 2015.
[12] V. Chilekwa, G. Sieffert, C.A. Egan, D. Oldahm, The acoustical characteristics of reed configurations, Proceedings of Euronoise 2006, Tampere, Finland, 2006.
[13] D.J. Oldham, C. Egan, R. Cookson, Sustainable acoustic absorbers from the biomass,Appl. Acoust. 72 (2011) 350–363, http://dx.doi.org/10.1016/j.apacoust.2010.12.009.
[14] G. Iannace, L. Maffei, P. Trematerra, On the use of "green materials" for the acoustic correction of classrooms, Proceedings of Euronoise 2012, Prague, Czech Rep., 2012.
[15] http://www.hiss-reet.de/;
[16] F. Ardente, M. Beccali, M. Cellura, M. Mistretta, Building energy performance:a LCA case study of kenaf-fibres insulation board, Energy Build. 40 (2008) 1–10,http://dx.doi.org/10.1016/j.enbuild.2006.12.009.
[17] K. Manohar, D. Ramlakhan, G. Kochar, S. Haldar, Biodegradable fibrous thermal insulation, J. Braz. Soc. Mech. Sci. Eng. XXVIII (1) (2005) 45–47.
[18] K. Manohar, Experimental investigation of building thermal insulation from agricultural by-products, Br. J. Appl. Sci. Technol. 2 (3) (2012) 227–239.
[19] S. Panyakaew, S. Fotios, New thermal insulation boards made from coconut husk and bagasse, Energy Build. 43 (2011) 1732–1739, http://dx.doi.org/10.1016/j. enbuild.2011.03.015.
[20] K. Doost-hoseini, H.R. Taghiyari, A. Elyasi, Correlation between sound absorptioncoefficients with physical and mechanical properties of insulation boards made from sugar cane bagasse, Compos. Part B 58 (2014) 10–15, http://dx.doi.org/10.1016/j.compositesb.2013.10.011.
[21] C. Onésippe, N. Passe-Coutrin, F. Toro, S. Delvasto, K. Bilba,M.-A. Arsène, Sugar canebagasse fibres reinforced cement composites: thermal considerations, Compos.Part A 41 (2010) 549–556, http://dx.doi.org/10.1016/j.compositesa.2010.01.002.
[22] T. Luamkanchanaphan, S. Chotikaprakhan, S. Jarusombati, A study of physical, mechanical and thermal properties for thermal insulation from narrow-leaved cattailfibers, APCBEE Procedia 1 (2012) 46–52, http://dx.doi.org/10.1016/j.apcbee.2012.
[23] https://www.fraunhofer.de/en/press/research-news/2013/may/using-cattails-forinsulation.
[24] US3063125 A, available at http://www.google.com/patents/US3063125;
[25] J. Pinto, A. Paiva, H. Varum, A. Costa, D. Cruz, S. Pereira, L. Fernandes, P. Tavares, J.Agarwal, Corn's cob as a potential ecological thermal insulation material, EnergyBuild. 43 (2011) 1985–1990, http://dx.doi.org/10.1016/j.enbuild.2011.04.004.
[26] J. Pinto, D. Cruz, A. Paiva, S. Pereira, P. Tavares, L. Fernandes, H. Varum, Characterizationof corn cob as a possible raw building material, Constr. Build. Mater. 34,(2012)28–33, http://dx.doi.org/10.1016/j.conbuildmat.2012.02.014