Thermal Insulation Material for Building and Construction using Waste Products

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Abstract— Nowadays there is rapid increase in the energy demand and consumption, hence it is necessary to discover alternate energy resources to meet the demand. Along with it, it is also necessary that there should be proper insulation of the thermal systems so that available energy can be fully used. Building and construction sector have high consumption of material energy and water, we have much waste elements near us which can be used as building insulation materials. In this research we will see the usage of textile waste, fly ash, barite, agricultural waste etc. as insulation material. The additional advantage we get with it is sound insulation and moisture gain.

Key words: Thermal Insulation, Waste Products, Building and Construction

I. INTRODUCTION

Many researchers have made thermal insulations using different waste materials like textile waste, fly ash, agricultural waste etc.

A. Briga-Sá et al. studied mainly two types of textile waste i.e. woven fabric waste (WFW) and woven fabric subwaste (WFS) as an alternative to commercially available building insulation materials like expanded polystyrene or extruded polystyrene products. By performing experiments they found out the thermal properties of WPS and WFS and compared it with the properties of commercial building insulation materials.

The experimental work showed that filling the air-box with WFW and WFS increase the thermal resistance of the wall in 56% and 30%, respectively, when compared to the double wall with the air-box empty. The value of the thermal conductivity (k) of the WFW is similar to the values of the well-known thermal insulation materials XPS, EPS and MW. [1]

H. Binici et al. made chipboards by combining four waste materials i.e. fly ash, epoxy resin, cotton waste and barite in different proportion as shown in Fig.ure below. They on experimental basis found out properties of different composition chipboards and compared the result.

They found that using textile waste increases the values of thermal conductivity, sound insulation and bending strength. Besides, samples with barite have low radioactive permeability. These samples should be preferred for places which are exposed to radioactive effect. [2]

T. Hanzlíček and I. Perná calculated the thermal resistance of foamed material made from fluidized bed ash (FBA) and natural smectite.

Experimentally it was found that this foamed material had good thermal resistance, good strength, no shrinkage and no visible cracks even after being exposed to such a high temperature. Hence this could be one of the good life guarding material. [3]

C. Leiva et al. found that zeolitised fly ash can be a good fire resistant product. It shows good fire resistance than commercial products like gypsum plasterboard. It only has low mechanical strength which can be improved by adding additives. To be used potentially it has to be painted after applying it to construction. [4]

J. Vejeliene et al. developed thermal insulation from agricultural waste like straws. They tried different straw structure and orientation and thermal conductivity were calculated.

It was noticed that thermal conductivity was directly proportional to the orientation of straws and density. Lowest thermal conductivity was observed in perpendicularly oriented straws with 50 kg/m3 density. Hence this can be better insulation material. [5]

II. TYPES OF INSULATIONS

A. Textile Waste Insulation

We know that India has many textile industries. The textile waste from these type of industries are useful in many ways viz. to make mattress and car industries. The below Figure shows the type of waste fibers obtained from industries.

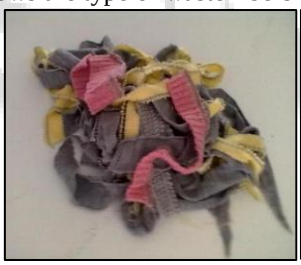

Fig. 1: Tissue waste

Fig. 2: Tissue subwaste

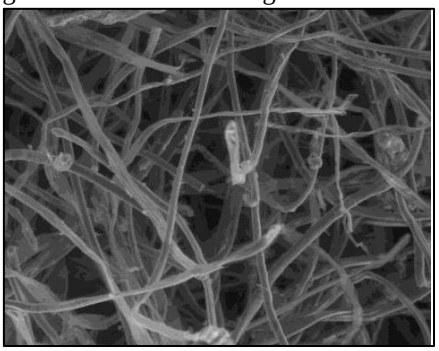

Fig. 3: Microstructure of the Tissue Subwaste

This textile waste can be used as thermal insulation for double external walls. The composition of this subwaste depends on the composition of the thread which may be wool, cotton, acrylic among other types. In this case, the subwaste is mainly acrylic and the particles have a diameter between 8 and 15 μm.

Experiment were carried out on double wall and results were obtained for two months span i.e April-May,

May-June and readings of heat flux (q) and temperature gradient (ΔT) was obtained.
Overall heat transfer coefficient (U) was found out using below formula.

$$U = \frac{\sum_{n=1}^{n\ toatal} q(n)}{\sum_{n=1}^{n\ total} (Ti(n) - Te(n))}$$

Within two cases U were found as 0.42 W/m^2 ºC and 0.14 W/m^2 ºC.
From this it was found that 33% heat transfer in building was decreased. [6]

B. Agriculture Waste Insulation

India is an agricultural based country; much amount of agriculture waste is produced every year. This waste can be used to produce the thermal insulation.

Fig. 4: Straw roll

Fig. 5: Straw Bale

The thermal conductivity tests were performed on it and the result based on orientation of the straws were found.

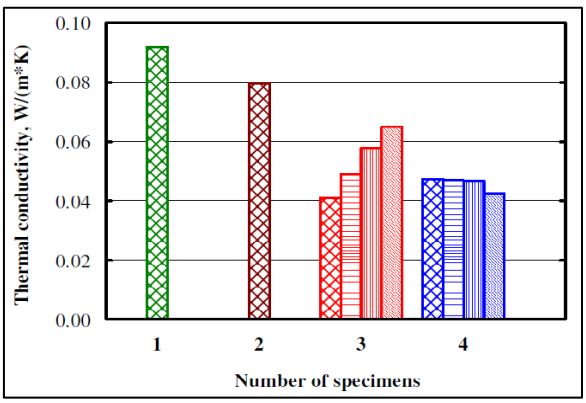

Fig. 6: Measurements of thermal conductivity of straw (1 – specimen made from straw bales; density 100 kg/m3; 2 – specimen made from straw roll; density 90 kg/m3; 3 – loose straw perpendicularly oriented to the heat flow; density consecutively, kg/m3 – 50.0, 70.0, 90.0, 110; 4 – chopped straw; density consecutively, kg/m3 – 57.0, 65.0, 76.0, 82.0)

The overall heat transfer coefficient was found to be as low as 0.041 W/m^2 ºC. It was also found that with increase in density conductivity increased. [5]

C. Insulation using Corn Cob

India produces corn in large quantity hence large amount of corn cob is available as a waste material which can be used as insulation in building material.

Fig. 7: Corn Cob

Fig. 8: Corn Cob Panel

Experiment were carried out on corn cob panel and results were obtained for two months span i.e Feb-March, March-April and readings of heat flux (q) and temperature gradient (ΔT) was obtained for different thickness panel.
Overall heat transfer coefficient (U) was found out using below formula.

$$U = \frac{\sum_{n=1}^{n\ toatal} q(n)}{\sum_{n=1}^{n\ total} (Ti(n) - Te(n))}$$

The result obtained for different configuration are tabulated below.

Sample	U_(ntotal) (W/m^2 ◦C)
3 cm panel	2.14
5 cm panel	1.89
6 cm panel	1.84
1.648 cm panel	0.95

Table 1: overall heat transfer coefficient for different size of panel. [7]

III. CONCLUSION

Thus, from the above research we conclude that using the waste material available to us easily, efficient and cheap

thermal insulation can be produced for building and construction sector.

By using these type of insulation we can avoid wastage of energy which is need of today's world scenario.

REFERENCES

[1] Ana Briga-Sa, David Nascimento, Nuno Teixeira, Jorge Pinto, Fernando Caldeira, Humberto Varum, Anabela Paiva (2013), "Textile waste as an alternative thermal insulation building material solution", Construction and Building Materials vol. 38, pp 155–160.
[2] Hanifi Binici, Remzi Gemci, Adnan Kucukonder, H. Hale Solak (2012), "Investigating sound insulation, thermal conductivity and radioactivity of chipboards produced with cotton waste, fly ash and barite", Construction and Building Materials vol. 30 pp 826–832.
[3] Tomáš Hanzlíček and Ivana Perná (2011), "Thermal resistance of foamed fluidized bed ashes", Acta Geodyn. Geomater Vol. 8, pp 115–122.
[4] C. Leiva et al. (2007), "Use of zeolitised fly ashes in fire resistant plates", World of cold ash.
[5] Jolanta Vejeliene, Albinas Gailius, Sigitas Vejelis, Saulius Vaitkus, Giedrius Balciunas (2011), "Development of thermal insulation from local agricultural Waste", Selected papers in "Environmental Engineering, The 8th International Conference", May19–20, 2011, Vilnius, Lithuania.
[6] Anabela Paiva, Humberto Varum, Fernando Caldeira, Ana Sá, David Nascimento, Nuno Teixeira (2011),"Textile Subwaste as a Thermal Insulation Building Material", International Conference on Petroleum and Sustainable Development IPCBEE vol. 26, Singapore.
[7] Anabela Paiva, Sandra Pereira, Ana Sá, Daniel Cruz, Humberto Varum, Jorge Pinto (2012), "A contribution to the thermal insulation performance characterization of corn cob particleboards", Energy and Buildings vol. 45, pp 274-279.

