Research Paper | Engineering | ISSN No : 2454-9916 | Volume-1 | Issue-2 | Sep-2015

COMPOSITE PLASTIC FOR THERMAL INSULATION OF STRUCTURES

Sagar Rathod

7th sem. Environmental Engineering Department, L. D. College Of Engineering, Ahmedabad.

ABSTRACT

Every day, a terrible amount of electricity is used for cooling the insides of the living area in a building, be it in form of air conditioners or a huge HVAC system. And this accounts for 17% of the national delivered energy and 19% on the total carbon dioxide emissions of our nation and is almost the same for all the tropical and sub-tropical countries. This not only pressurises the extended use of electricity, but also the pockets of middle class individuals. The need of cooling arises from the fact that masonry or concrete block walls absorb a high amount of incident solar radiations, and conduct it too to the inside. This results in increased heat content in the inside and subsequently increased loads on the air conditioning systems which in turn results in increased electricity use and increased bills. The problem occurs during night time also when the walls have absorbed heat, they tend to release it towards the colder end, which in most cases are the inside of the buildings. This further contribute to higher loads in terms of kWs on the AC compressor and thus further increase of expenditures on cooling alone.

The concept lies in insulating a structure (residential or commercial), with the use of plastic sheets of nominal thickness (say, 8-10mm.) of extremely low thermal conductivity, which would cut down the two of three methods of heating i.e. radiation and convection. This would prevent the walls to absorb heat during day time and thus, lesser cooling costs. The idea serves dual purpose, the first being lowering of electricity use would ultimately lead to saving of fossil fuels, the second, as it would be made from partly virgin and Municipal Solid Waste, it would help in lowering down of the plastic heap from the dump yards. It would be applied on the exteriors of the building walls, in form of 5ft*3ft sheet of thickness 8-10mm and thermal conductivity of the order of 10^{-1} W/m K or lower, which would be sufficient to resist inward flow of heat to the walls. Hence, no absorption of heat would mean no release of heat and thus cooler insides would directly have positive effects on the cooling costs.

KeyWords: More savings, lesser electricity and lesser waste.

1. INTRODUCTION

During day time, the walls of a modern masonry or concrete blocks absorb the radiations in infrared or convective way. This increases the cooling cost of individuals in a residential building or companies in a commercial structure. As the walls absorb the heat and release it in night time, the cooling costs also increases partially at night time.

The concept lies in insulating buildings, so that no radiations in the form of INFRARED are absorbed by the structure. This eliminates the transfer of heat from the atmosphere to the inside of the living area of a structure. Also the as the heat variations in a wall decreases, it results in reduced heat stress in the masonry walls thus increasing its durability and life.

The insulation would be in a form of a plastic sheet of a nominal thickness which would be applied on the exterior of the walls of a building, thus protecting it from direct action of solar radiations and waters from rains. The plastic sheet would be produced from partly virgin and partly from MUNICIPAL SOLID WASTE thus resulting in decreased plastic waste from the area.

2. NEED FOR BUILDING STRUCTURE INSULATION

During any given day, structures account for almost 17% of total national delivered energy and 19% of total CO2 emissions. Out of the 19%, 15% is accounted by solely commercial and public buildings. And cooling of structures is the main consumer of energy in a building.

Why this cooling is required?

This is due to mainly absorption and release of heat by the masonry walls. During the day time, the particles of the wall absorb heat from the solar radiations and conduct it to the inside of the room. As the thermal conductivity of the masonry or concrete block is very high, there is a minimum of temperature difference between the outside and the inside which results in the heated living area i.e. the rooms or the offices. And thus further results in increased compressor loads of the cooling system in the building or of the individual (air conditioners).

During the day time, as the wall has absorbed a very high quantity of heat, it releases it during the night time. The direction of heat release would be towards a colder end, which in many cases is the room or the inside itself. This results in a heat stress towards the room in the night time also (a reason why people prefer to sleep in the outside in summer season and inside in the winter season).

This, on an overall scale is a very big consumer of national electricity and thus contributes largely (20%) towards the emission of carbon dioxide and other gases which, finally enhances the global warming effect.

The scenario is same for all the tropical and sub-tropical countries which also contributes towards the release of these gases.

MUNICIPAL WASTE problem is also addressed by this product. As it is an economical composite produced from solid waste materials, it would also, in a way, solve the plastic excess crisis.

3. PREPARATION OF COMPOSITE PLASTIC SHEET :

For the specific performance requirements, we would be using composite plastic material produced from municipal solid waste and virgin plastics partly. Also, a specified amount of fibre reinforced plastic like foam glass, would be used to enhance the strength properties of the sheet so made.

For the production of this sheet, we would use extrusion machinery like sheet plant or calendaring process in which we have to produce the composite plastics (plastics waste + virgin plastics + fibres) sheet in required shape and size. The plastic materials which we would be using for our product will be made of commodity plastics, engineering plastics and some amount of fibres. The examples being LDPE, HDPE, PP and other engineering plastics which fall under the specified characteristics.

The sheet would have the following desired properties:

- Low thermal conductivity(U-value)
- Low water absorption(highly hydrophobic)
- High strength.
- Favourable elasticity(to accommodate thermal stress).
- Easy pigmentation.
- High durability and retaining of properties over a long period of

time.

The sheet would be desired to have thermal conductivity as low as 0.05W/m K and would be available in different grades as per thermal intensities in a place or as per user definition.

4. BENEFITS :

The concept is a multi-applied one with advantages at all three levels i.e. user level, community level and ecological level.

All three are discussed separately here.

1) USER LEVEL BENEFITS:

For a middle class individual, it always becomes necessary to cut down costs at various possible situations. Application of this product lowers down the heat transfer and thus cooling costs of a small living area by Acs.

To an estate or property owner too, like shopping malls, it is always important to operate the atria cooling, which results in enormous energy uses and subsequent costs to the person.
Thus, this product could help people bring down their cooling costs and thus more savings.

2) COMMUNITY LEVEL BENEFITS:

To a residential community, it is the first need to address the waste and its disposal issue. And plastic forms a major component of the solid waste that is produced. And this concept serves to it too. By making use of the solid waste, we can not only lower down the amount of it, but could also make proper strategies for its use in future.

For the residents of a building, the maintenance issue over the water bleeding from the outside, crack filling, re-paint etc forms a major component of the monetary use.
This product, according to the concept, can protect the structure against the rains and would not allow water seepage through the walls, which would lead to protection of electrical wirings and steel reinforcements.

3) ECOLOGICAL LEVEL BENEFITS:

The main purposes of this project are to address the solid waste issue and simultaneously address the global warming issue too.

- The concept derives its resemblance from Antarctic and Arctic ICE BLANKETS, which perform the task of reflecting back the incident solar radiations to the atmosphere, which contributes to the lowering of the temperatures. Similarly, the concept is about Urban Ice Caps, in which there would be complete elimination of a structure from being a heat sink at day and heat source at night.

- Reduction of energy use directly means saving of energy, which means saving of fossil fuels to produce energy that in turn results in lesser green house gas emissions and finally a cooler Earth.

- As the structures doesn't now absorb solar radiations, more and more AVAILABLE SOLAR is induced in an area, which could result in enhanced productivity of plants in that area (a reason why villages are not densely packed).

- Stability in the ecosystems, as now more energy is available in the atmosphere and may be used by nature wherever it is required.

- An overall conservation of energy to an extent of 17-20% of the gross energy production could be achieved in the tropical and temperate countries.

5. LIMITATIONS :

- As the sheet would undergo excess of variations in end point temperatures and other environmental stresses, its life time would vary from place to place.

- Internal stress generations could not be completely eliminated, but reduced to a minimum extent. This stresses could result in minor changes in the properties of the sheet in long term use.

6. Conclusion :

Thus we conclude that elimination of structures from heat sink & source would bring positive effects in varied proportions to different users. As the composite is made up of municipal solid waste, the recurring problem of solid waste disposal is addressed to a considerable extent. Also, future problems occurring due to its excess dumping could be resolved in a way. The produced sheet would be a step ahead in the composite technology in plastic industries. This would also pave way for newer composites for being used from solid waste. As the product would decrease cooling costs for middle class individuals, it would enhance their savings.