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ENERGY EFFICIENT MODERN BUILDINGS USING ADVANCED MATERIALS

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ABSTRACT

Energy is essence of life. Now days we see that all the activities performed by mankind are being optimized in terms of use of resources. The list of resources being optimized is long, few are very general in nature of their application for example manpower, investment and energy.

Yes, energy is important resource. In last few decades population has increased tremendously day by day and pressure on land has increased day by day tremendously, per capita energy consumption is so increasing. And as the sources of energy are limited, therefore it is very necessary to utilize very joule of energy efficiently where ever and whenever possible. This text gives a look on few methods which can reduce the use of energy especially in the field of building construction.

Keywords- *Energy consumption, building construction, Modern building.*

I. INTRODUCTION

Building construction activities consume a huge amount of energy. United Nations Environment Program's Sustainable Building and Climate Initiative (UNEP-SBCI), is a partnership of major public and private sector stakeholders in the building sector, which works to promote sustainable building policies and practices worldwide, according to its report buildings use about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 1/3 of green house gases emissions[1].In US alone these operations account for 74.9% energy consumption. As shown in figure 1

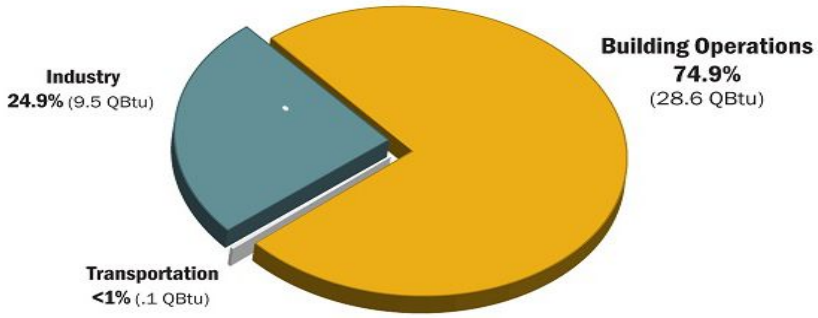

Figure 1: Showing pie chart distribution of various energy consumption sectors wise in USA

We see that there is a huge population on this globe and obviously to shelter them there is a need of structures or commonly known as buildings. Building constructed in this current scenarios are not just ordinary buildings they are modern buildings. These buildings are modern because they care every principle involved in sustainable development of human kind, from methods to be used for construction activities to materials used in construction and even the recycling of the building materials after their useful life is over.

Due to more urge to pursue the principles of modern buildings, there have been extensive emphasis on the methods which can make modern buildings more sustainable. Therefore every aspect of these modern building is

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considered from the view of energy saving. Where ever the building is constructed then energy is consumed in various stages like.

During construction:

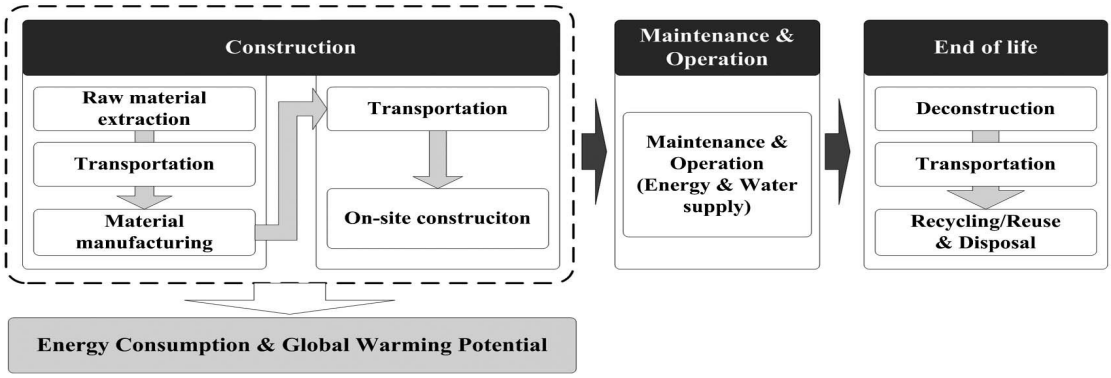

Figure 2[2]

During its habitation or when it is habited by persons during its useful time:

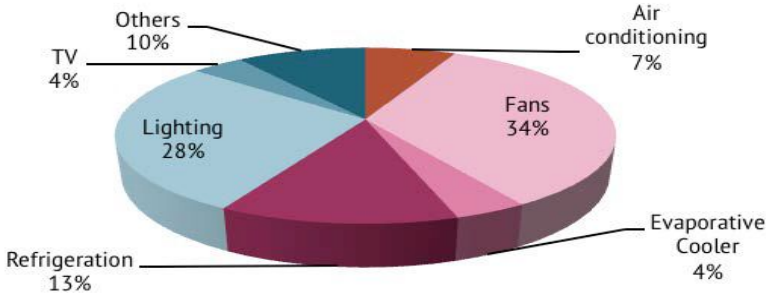

Figure 3[3]

Post habitation during demolition or recycling or renovation.

Figure 4[4]

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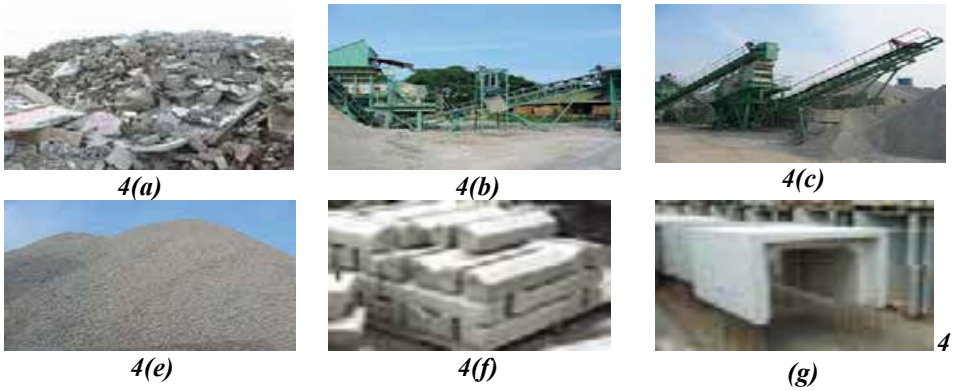

Figure 4(a-g) showing various stages of recycle of concrete waste.

Our focus in this text is to discuss various methods by which the energy consumption can be reduced during the construction phase and habitation phase which is to be done by introducing innovative ideas by choosing some advanced materials which contribute to overall reduction in energy consumption during the construction phase as well as during useful building life and support this cause.

From the various points presented above we may derive one important conclusion that modern buildings must use such advanced materials which themselves are nature friendly and thus they may contribute to the goal of sustainable development.

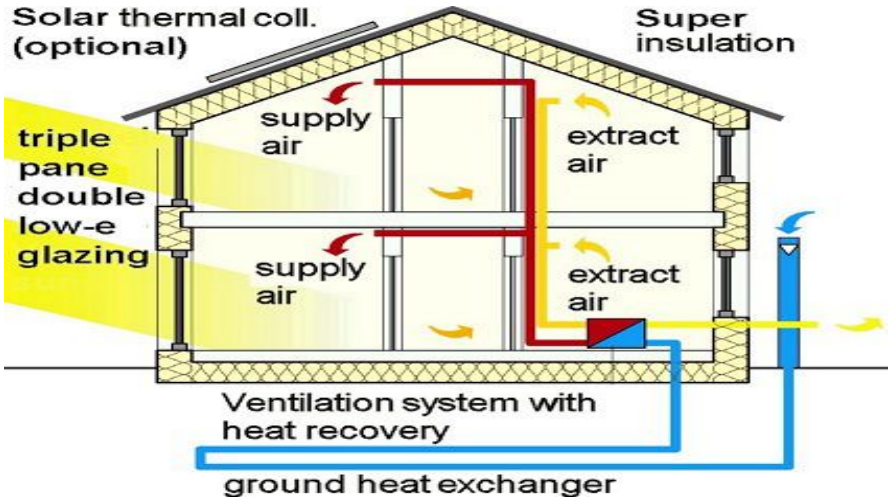

Figure 5[5]: Solar thermal collector, super insulation, triple pane double low e glazing is some advanced materials products used in this typical modern building

We must scrutinize such materials which consume less energy during their installation in the building construction work as well as their recycling.

To help us for this there are various organisations of international reputation which have made various criteria for selection of materials. There are over fifty such organisations across the globe which takes care of all these criteria. These organisations theoretically deal and support same thing. Some issues are common which are taken into consideration. Few of them which have repute of domestic and international status are worth mentioning.

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- Green Globe
- Green seal
- Energy Star
- LEED stands for Leadership in Energy and Environmental Design (LEED)
- Forest Stewardship Council (FSC)
- Bureau of Energy Efficiency (BEE)
- The Indian Green Building Council (IGBC)

Figure 6[5]: showing logos of different organisations.

At present the Green Building Rating Schemes TERI – GRIHA and LEED – INDIA NC are also used for the certification of environmental – friendly and energy efficient building.
Since some of the rating criteria involved are costly and demands technology, it becomes difficult to adapt them to the requirements of low – budget projects. [6]

So, any material which is good for environment and is good for recycling and has global certifications will be good contender in this context. The choice of an advanced material depends on following parameters:
1. Its physical suitability determined by properties like compressive strength, tensile strength, water resistance etc.
2. Its dependability on other materials for its aesthetic or functional efficiency.
3. Economics and affordability which is subjected to the budgetary constraints.
4. Ease with which it can be moulded worked upon and used
5. Recyclability of material measured by material's capacity to be used as a resource in the creation of new products.

II. ADVANCED MATERIALS

Here are some advanced materials which are promising to be used in modern buildings fulfilling most of criteria of sustainable development.

***Copper Slag*:** Copper slag is obtained as a waste material during processing of copper. It may be used in non-structural components like partition walls and roads and has proven its efficiency as a sand replacement. For structural usage, the use of copper slag as partial replacement of sand in concrete is allowed for up to 10% by mass. Tests conducted to ensure that chloride and sulphate contents in the slag give information about their presence within the allowable limits. Further research may be necessary if the percentage replacement for sand is to be increased.[7]

Insulated Concrete Forms (ICF) with polystyrene fill: When blocks of polystyrene which is expandable as well as can be stacked are filled with cement concrete and reinforced with reinforcement bar, they become very strong and are well insulated, so they gather good structural strength.

Insulated Concrete Forms (ICF) with recycled wooden chips: The above example shown may contain volatile organic compound which could further harm the human health, thus a good substitute for this is use of wooden chips instead of polystryrene fill. This is called DUROSIL.

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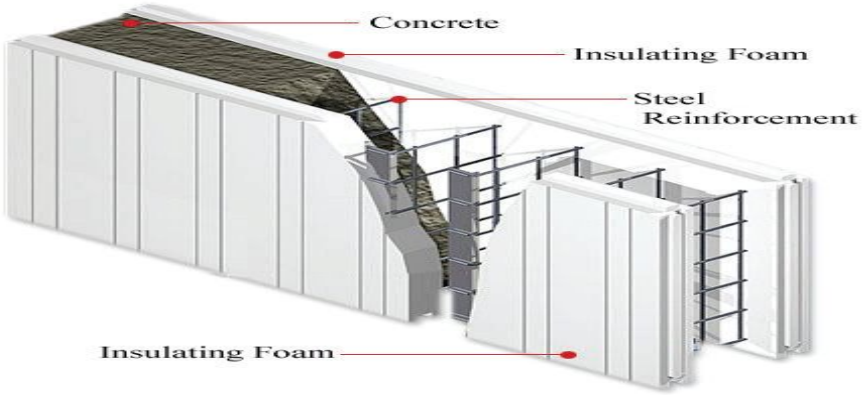

Figure 7[8] ICF.

Bamboo: it is a subfamily of flowering perennial evergreen plants. They fall under the grass family. Their species are found in diverse climates, from cold mountains to hot tropical regions. They occur across East Asia, northern Australia, India and even Himalayas. There are more than 1400 species of bamboo throughout the planet. [9]

They have high growth rate does not need special care thus now this property of bamboo has made them good candidate for commercial use. More the FSC have also certified its commercial use. It is mostly used as flooring.

Bamboo in buildings can help reduce the amount of wood, steel and concrete needed. As a substitute for wood, it can take great pressure off forests, and contribute to local self-reliance, since great quantities can be produced in small areas. It has great compressive and tensile strength, and has shown great resistance to earthquakes[10]

Figure 8[11]: bamboo mat

***Denim Insulation*:** This material used here is 100% recycled. It is waste of various denim products available commercially. The main advantage of this product is its cheap cost. Although, it has some inherent disadvantages with it like poor insulation. Other, it absorbs vapour.

Figure[12] 9: denim insulation

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Structurally Insulated Panels (SIPS): These wall panels comprise of rigid foam insulation which is sandwiched between two pieces of oriented strand board. They can have insulative values up to R-60. Due to this it saves high value of energy and of course money. However, there is usually a choice for manufacturer to make it from bio-based materials or use expanded polystyrene.[12]

Figure 10[12]: SIPS

***Fly Ash*:** Flyash is a byproduct of coal burning power plants. In coal based power plants the coal is first pulverised before combustion to get best results. As a result the residual material is left as what we know it as flyash. It can be a cheap substitute for a portion of cement used in concrete. Typically, 15-50% of cement can be replaced with flyash in residential concrete mixes, however, personnel involved should know that it changes slightly the curing characteristics as compared to standard concrete. It increases the strength and durability of the concrete. Using it also reduces the amount of cement needed, thereby indirectly decreasing the overall environmental impacts of cement production.

Various use of fly ash is the manufacture of bricks, Portland pozzolana cement blocks, light weight aggregates, tiles and hollow blocks.[13]

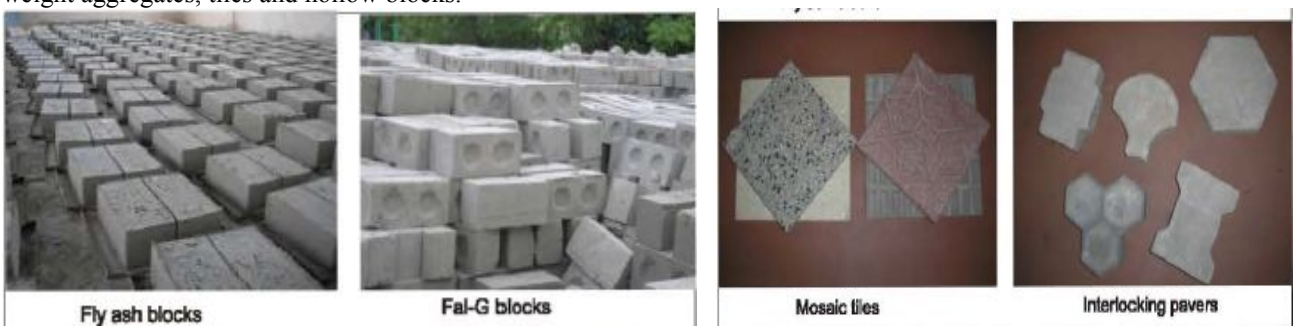

Figure 11[13]: fly ash products

***Iron ore Tailings*:** Building materials used for construction are directly or indirectly derived from earth's crust. The basic ingredients are more or less same the constituents are silica, aluminium oxide and iron. Iron ore tailings are actually the waste earth from which iron ore has been extracted. They have very suitable characteristics like they are They are infertile as well as biodegradable. Iron ore waste from mines can be used for manufacturing of construction materials.[13]

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Figure 12[13]: products made from iron ore tailings

***Red Mud*:** it is produced during aluminium production, as a waste product when bauxite ore is digested with caustic soda, then most of the aluminum passes into solution as aluminate. The muddy red residue which consists of alumina, iron oxide, titanium oxide and small quantities of silica, calcium oxide and alkali is left. When it is reinforced with jute fiber and mixed with polymers then it becomes Red mud jute fibre polymer composite. India generates over 4 million tonnes of this by-product annually which is not otherwise put to any use. Red mud is usually disposed of in ponds.[13]

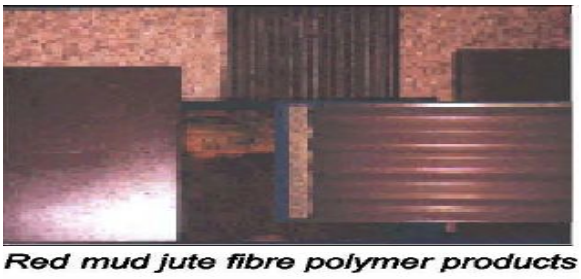

Figure 13[13]

***Glazed Glass*:** Glass however is one of the materials which are known from beginning of the human civilization when it learned to make homes. And it is still used widely. But, its use as window panes creates some problems of green house effect, and heating. But, now the modern building employs glazed glasses, which reflect back major amount of sunlight, and thus avoid heating of buildings. This also decreases the cooling requirement of the building and thus are good for energy saving. As, the glasses are used in Windows and skylights they allow daylight to reach the interiors of buildings, reducing the need for artificial light. Glazed glass serves both purposes. Efficient window design and Improved glazing techniques give low-emissivity glass also there is gas-filled air spaces between adjacent panes. The inert gas like argon when filled in between gives low conductivity, and thus overall reduced heat transfer. Double- and triple- paned glass use airspace between is better option.

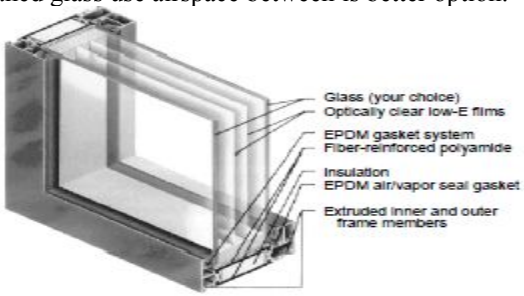

Figure 14[14]: glazed glass with air gap.

Apart from these materials discussed some recycled materials are also used. A product featuring recycled content has been produced partially or entirely industrial or consumer waste. The use of waste materials coming out of from households' processes or industrial processes into usable building products helps in reducing the waste and

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reducing the demand on natural resources. For example glass is easy to recycle it is obtained from number of household sources. Glass is commonly used as a raw material in making window glass and ceramic. Other one is concrete although like unlike steel and glass, concrete cannot be re-formed once it is set, but as shown in group figures 4(a-g) it can be ground up and used as aggregate in new concrete or as road fillers.

Use of Non-Toxic Materials: materials which are less-toxic or have no toxicity are less hazardous in construction environment for workers as well as building's occupants. Many materials used may have an adverse affect on indoor air quality as they expose occupants to health hazards. For examples adhesives, emit dangerous fumes due to volatile organic components. This is avoided by using low voc compounds or by proper ventilation of buildings.[15]

III. CONCLUSION

According to data of United Nations Environment Program's Sustainable Building and Climate Initiative (UNEP-SBCI), which is a partnership of major public and private sector stakeholders in the building sector, which works to promote sustainable building policies and practices worldwide, about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 1/3 of green house gases emissions[1].In US alone these operations account for 74.9% energy consumption. More over the pursuit of energy conservation and its increasing demand has compelled us to rethink about the way we construct. In future these modern buildings will definitely supersede their present counterparts, and the materials presented above will be of great advantage to them.

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