Analysis of Green Materials Efficiency for Sustainable Environment

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***Abstract*-Construction activities pose serious environmental problems ranging from excessive consumption of global resources both in terms of construction and building operation to the pollution of the surrounding environment. The building design according to green concept provides a balance between homebuilding and the sustainable environment. Careful selection of environmentally sustainable building materials is the easiest way to begin incorporating sustainable design principles in buildings. Green building materials brings together a vast array of practices, techniques, and skills to reduce and ultimately eliminate the impacts of buildings on the environment and human health and expands and complements the classical building design concerns of economy, utility, durability, and comfort. Present study evaluates efficiency of Green Building Materials for sustainable construction practices.**

***Index terms*-Sustainable Environment, Green Buildings, Green Building Materials.**

I. INTRODUCTION

Green building materials are composed of renewable, rather than nonrenewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product. The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. The use of green building materials and products represents one important strategy in the design of a building. Using green building materials and products promotes conservation of dwindling non-renewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.[1] Green building also known as green construction or sustainable building refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.

II GREEN BUILDING MATERIALS

A green product is a material that makes minimal or no impact on human health and environments in their lifecycle. The following are the green materials that are covered in the paper:Concrete specimen with waste glass

III. WOOLBRICK: A Zero Carbon Product

Since the beginning of construction, one of the most widely used building materials is brick. Brick construction, or masonry, is heavily used and the materials are relatively abundant. Brick is generally composed of kneaded clay-bearing soil, sand and lime, or concrete material, and is then fire hardened. The process of curing the bricks is not environmentally friendly. In order to promote sustainable construction and continue to build with a traditional masonry look, there has been a push for alternative style bricks. This leads us to the Wool Brick.[2]

The advancement in wool bricks is fairly new and nice step towards a more sustainable living. In a collaborative study on sustainable building materials, researchers from Spain have created bricks that contain sheep's wool and a polymer derived from seaweed. The result is bricks that are stronger and more environmentally-friendly, according to a new study.

A. *Advantages*

1) The polymer was an alginate, which occurs naturally in the cell walls of seaweed. Mixed

together, the three substances resulted in bricks that were reportedly 37 percent stronger than regular unfired bricks.

2) These fibers improve the strength of compressed bricks, reduce the formation of fissures and deformities as a result of contraction, reduce drying time and increase the bricks' resistance to flexion.
3) The bricks are environmentally-friendly in that they are composed of sustainable, non-toxic.
4) Don't require the expenditure of energy that goes into the firing of other types of bricks.
5) Made from easily available materials.
6) The wool-and-seaweed bricks also don't create the carbon dioxide that is generated by the production of Portland cement, which is an ingredient in most types of concrete.

IV. WASTE GLASS: Aggregate in Concrete

Concrete is most widely used man made construction material and its demand is increasing day by day. The use of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of bridge piers and erosion of river bed. If fine aggregate is replaced by waste glass by specific percentage and in specific size range, it will decrease fine aggregate content and thereby reducing the ill effects of river dredging and thus making concrete manufacturing industry sustainable. The amount of waste glass produced has gradually increased over the recent years due to an ever growing use of glass products. [3]Most waste glass has and is being dumped into landfill sites. The land filling of waste glass is undesirable because waste glass is non biodegradable which makes them environmentally less friendly. Utilization of this waste is the need of the hour.

There is huge potential for using waste glass in the concrete construction sector. When waste glasses are reused in making concrete products, the production cost of concrete will go down. This move will serve two purposes; first, it will be environment friendly; second, it will utilize waste in place of precious and relatively costlier natural resources.

A. *Problems due to Alkali Silica reaction*

The using of waste glass as fine aggregate in concrete creates a problem in concrete due to ASR (Alkali Silica Reaction). The reaction between alkalis in Portland cement and silica in aggregates forms silica gel. This gel is prone to swelling. It absorbs water and the volume of the gel increases. Under confinement by cement matrix and aggregate, the swelling of the ASR gel generates hydrostatic pressure. If the reaction continues and internal pressure exceeds the tensile strength of the matrix, cracks will form around the reactive aggregate particles.[4]

B. *Control on Alkali Silica reaction*

Ground waste glass was used as fine aggregate in concrete and no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as fine aggregate in concrete. In addition, waste glass seemed to positively contribute to the mortar micro-structural properties resulting in an evident improvement of its mechanical performance. Larger the particle size of waste glass more is the chance of ASR occurrence. It was reported that fine glass powder for incorporation into concrete up to 30% as a pozzolanic material suppressed the ASR. Hence the size of waste glass used was in the range 0-1.18mm.

V. BAMBOO REINFORCEMENT

There are several reasons that bamboo generates interest when it comes to considerations of sustainable materials. Along with its mechanical advantages, much of the appeal of bamboo is due to its fast growth rate. For instance, bamboo can grow to a mature and usable state in only 4-8 years from being planted, compared to wood which takes several decades from the time of being planted to the point at which it can be harvested. Recently, in the attention in response to global warming issues and sustainable society, the manufacturing using natural materials has become actively. Bamboo, low cost, fast growing, and broad distribution of growth, is expected to contribute significantly to earthquake-resistant construction and seismic retrofit technology in the developing countries. The researchers also have been studied for understanding the mechanical behaviour of bamboo reinforced concrete member and clarifying the differences of structural properties from steel reinforced concrete and bamboo reinforced concrete. The study of the feasibility of using bamboo and non-steel as the reinforcing material in concrete members has been conducted in

laboratories. The results of the investigations show that bamboo can substitute steel satisfactorily.[5]

A. *Bamboo Reinforcement, A future for construction*

The availability of combination bamboo and concrete structure can be confirmed. Therefore, for construction of the actual structure, it is necessary to verify some realistic methods. It can be said that these studies are the first step towards the development for the future. It is important to accumulate further experimental data and to consider the practical application. For practical application of the structure with bamboo, it seems to be important to consider the following conditions:

1) Design of the structure with bamboo,
2) Combinations of materials (the concrete strength and type of bamboo),
3) Construction and Workability and
4) Durability of bamboo within mortar and concrete.

VI. PAPER INSULATION

Reseachers has developed low-cost pre-insulated building panels using waste paper as insulating material that could be a more environmental friendly alternative to traditional insulation materials. The potential benefits of using waste paper, the main ingredient of which is cellulose - a highly efficient insulator, in green building products are massive and development of an easy and effective way of using cellulose could have a huge impact on the industry.

A. *Cellulose: The key ingredient*

Cellulose, the organic compound which is employed as the chief ingredient in paper, is an excellent insulator, and has immense potential in the field of green building materials.

After converting the cellulose from waste paper into a pulp, the project saw it combined with fire retardant materials and used to fill timber panels. Following a process of hermetic sealing, the panels are then ready for usage on construction sites.

B. *Paper insulation a success*

1) The mass production process developed by InsulaTFH is both thorough and precise, with each panel built to exact dimensions and sealing tape and membrane used to shore up the durability of the products by rendering them both watertight and airtight.
2) The use of recycled waste paper makes the process ecologically sound while the sourcing of these materials locally also cuts down on transportation costs, thus making it highly economical.
3) The system possesses the added advantages of broad applicability and ease of installation as the equipment required for the production process can be incorporated into any timber frame factory.
4) In addition to being more economical and environmentally friendly, the incorporation of the cellulose filler into panels during the process of mass production provides immense convenience to builders as it obviates the need for them to insert insulating material on-site following the construction of walls themselves.

VII. SOLAR TILES

Solar Shingles, also called photovoltaic shingles, are solar panels or solar modules designed to look like and function as conventional slate or asphalt shingle roofing materials.[7]

There are several varieties of solar shingles, including shingle-sized solid panels that take the place of a number of conventional shingles in a strip, semi-rigid designs containing several silicon solar cells that are sized more like conventional shingles, and newer systems using various thin film solar cell technologies that match conventional shingles both in size and flexibility.[8,9]

A. *Production of electricity*

Solar shingles or solar tiles work like traditional solar panels. They use the sun as a power source to create electricity. Each of the solar shingles is comprised of photovoltaic cells. This type of technology has been around for a while and was at first used on satellites in space. The name photovoltaic truly tells what they do. The first part of the word “Photo” means light and the second part of the word “voltaic” means electricity. Thus they take the light and turn it into electricity. Each of the cells on solar shingles or even a solar panel contains a type of material that is called semiconductors. One of the most used types of semiconductors for photovoltaic cells is silicon. [10,11]What occurs first with solar shingles is the light hitting them. When this happens a part of the light is captured within the silicon semiconductor. In simple terms what happens is the semiconductor now contains energy and with this energy electrons get loosed and begin to move more freely. Next, these free flowing electrons are acted upon by the

photovoltaic cell's (PV Cells) electric field or fields and are forced to flow in one common direction. This creates a current that can be used for electrical power. This is the basic version of how solar shingles work.

B. *Advantages*

1) Aesthetically mimics a roof.
2) Because they are a tile and not just a power source, they protect your loft space in the same way a roof tile would.
3) Easily installed to existing roofs via aluminium mounting brackets (with little or no need for structural modifications).
4) Solar tiles allegedly blend in better with their surroundings.

VIII. GLAZED WINDOWS

Insulated glazing is an evolution from older technologies known as double-hung windows and storm windows. Traditional double-hung windows used a single pane of glass to separate the interior and exterior spaces. Insulated glazing (IG), more commonly known as double glazing (or double-pane, and increasingly triple glazing/pane) is double or triple glass window panes separated by a vacuum or gas filled space to reduce heat transfer across a part of the building envelope.

A. *Insulating Properties*

The glass panes are separated by a "spacer". A spacer is the piece that separates the two panes of glass in an insulating glass system, and seals the gas space between them. To reduce heat transfer through the spacer and increase overall thermal performance, manufacturers may make the spacer out of a less-conductive material such as structural foam. Additional layers of glazing provide the opportunity for improved insulation. While the standard double glazing is most widely used, triple glazing is not uncommon, and quadruple glazing is produced for very cold environments such as Alaska.[12,13] Even quintuple glazing (four cavities, five panes) is available - with mid-pane insulation factors equivalent to walls.

B. *Advantages*

- Warmer in winter: Double glazing is the ideal form of insulation, with up to 50-70% of home heat lost through single-glazed windows. Double glazing also helps capture and store a higher percentage of the natural heat from the winter sun.
- Cooler in summer: Double glazing insulates your home against extremes of temperature, trapping some of the summer sun's rays and minimising the heat which burns through your windows on hot, sunny day
- Reduces energy usage: Because there's less need for heating systems you'll be reducing energy consumption, which saves on your power bills and helps the environment.
- Reduces condensation: Condensation can be a serious problem, particularly in older homes, as it causes mould and mildew, and in some cases it will also rot timber window frames and damage your family's health. Double glazing works to reduce excess moisture on your window panes.
- Reduces noise: Double gazing reduces noise for a calmer, quieter home. High performance double glazing can reduce outside noise by up to 60%, making it a great investment if you live by a busy road or beneat h a flight path.
- Enhances resale value: Double glazing is an excellent way to increase the resale value of your home. With double glazing, an older home can be just as desirable to the purchaser who wants to ensure that the house they buy is efficiently insulated. With retrofit double-glazing any home can get the benefits!
- Reduces interior fading: Reduces the damaging effects of UV light on drapes, carpet and furniture (special glass types required) Reduced interior fading by using glass combinations that reduce the transmission of UV radiation. Reduce the need for thermal drapes that can block the exterior view.
- Increases security: Discourage intruders for safety and security. It's more difficult for intruders to break in through double glazed windows, particularly if you include laminated or toughened glass.[14,15]

Among these five materials, concrete specimen with waste glass and Bamboo reinforcement were selected for present study.

IX. MATERIAL SELECTION

Product selection can begin after the establishment of project-specific environmental goals. This paper presents the feasibility of using green building materials for sustainable development. Among the tonnes of materials existing in world the paper focused on following green building materials Concrete specimen with waste glass

1) Concrete specimen with waste glass
2) Bamboo reinforcement

These materials were tested for compressive strength, splitting tensile strength, durability (water absorption) and light weight nature.

X. EXPERIMENTAL RESULTS

A. *Concrete specimen with waste glass*

1) Fine aggregates were partially replaced by waste glass. Concrete specimens were tested for compressive strength, splitting tensile strength, durability (water absorption) and light weight nature for different waste glass percentages. The results obtained can be summarised as follows:
2) It was found that maximum increase in compressive strength occurred for the concrete mix containing 20% waste glass as fine aggregate.
3) With increase in waste glass content, water absorption decreased indicating increase in durability.
4) Density of concrete decreased with increase in waste glass content thus making concrete light weight in nature.
5) Workability of concrete mix increases with increase in waste glass content.
6) Splitting tensile strength decreases with increase in waste glass content.
7) Use of waste glass in concrete can prove to be economical as it is non useful waste and free of cost.
8) Use of waste glass in concrete will eradicate the disposal problem of waste glass and prove to be environment friendly thus paving way for greener concrete.
9) Use of waste glass in concrete will preserve natural resources particularly river sand and thus make concrete construction industry sustainable.

B. *Bamboo reinforced concrete slab*

1) The tensile strength filled with cement paste cured w/c=80% and 100% significantly increase with aging time.
2) The behaviour of pull-out test with bamboo is almost the same as the plain steel bar; however, the bond strength with bamboo was higher than the one with plain steel bar. It can be expected that the bond strength covering with full treatment shows the high value 1.2-1.35MPa.
3) When fresh concrete is poured, its water will moisten the bamboo; then, the concrete will harden and lose water so that the bamboo will again dry out. This drying process will completely break any bond between the bamboo and the concrete. It can be considered that underground humidity is high at any times therefore supply of water to the concrete can be accomplished.
4) As for conventional steel reinforced concrete beams and slabs subjected to increasing bending load up to collapse, the bamboo reinforced elements also go through three characteristic stages of stress and strains in their cross-sections.[16,17,18]

XI. CONCLUSION

This paper presents the feasibility of using green building materials for sustainable development. The main points are that the wool bricks are 37 percent stronger and produce no carbon dioxide, making the wool bricks an excellent choice of sustainable development.

In the attention in response to global warming issues and sustainable society, the manufacturing using natural materials has become actively. Bamboo, low cost, fast growing, and broad distribution of growth, is expected to contribute significantly to earthquake-resistant construction and seismic retrofit technology in the developing countries.

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