

Scope of Using Recycled Plastic and its Components as Building Materials

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ABSTRACT-

Due to rise in unleashed industrial development, our world is now engulfed by solid wastes. In that huge pile of wastes, plastic is one of the prime culprits for degrading our nature. The used plastics (which are not recycled) are either end up in oceans or landfills and continue to create environmental problems. On regular basis, thousands of tonnes of plastic waste is being created all around the world. Such type of situation can be created by using plastic as a primary construction material for small houses.

The main objective of the research is to show how plastic as a construction material and various construction elements can reduce the stacks of junk plastic piles around the globe. Along with that how it can reduce the time and labour required for construction and also help to reduce the casualties during natural calamities like earthquake and to understand the 'total plastic' construction phenomenon with its advantages and disadvantages. On one hand we have problem of plastic waste management and on the other hand we have housing crises in urban areas. To combine and come up with a solution we can use plastic recycled building materials as an affordable and quick construction source for housing development for urban Regions. Also to understand the actual practical situation of using plastic houses and required structure and method for shelters made out of such material will be analysed.

Keywords: *Plastic waste, Sustainability, Building material, Recycled plastic, Construction.*

1. INTRODUCTION-

The rise in unleashed industrial development; our world is now filled by solid wastes. In that huge pile of wastes, plastic is one of the prime culprits for degrading our nature. The used plastics (which are not recycled) are either end up in oceans or landfills and continue to create environmental problems. On regular basis, thousands of tonnes of plastic waste are being created all around the world. In some cases, recycling plastic is costlier than using virgin plastic. Some companies which are trying to use plastic as a primary construction material but none of them tried for the total plastic approach.

The recycling rates are wildly varying across the world based on countries regulations and other factors. Although many people are trying to make recycling figures look higher, but only 22% of plastic is being recycled all across the world. On one hand we have problem of plastic waste management and on the other hand we have housing crises in urban areas. To combine and come up with a solution we can use plastic

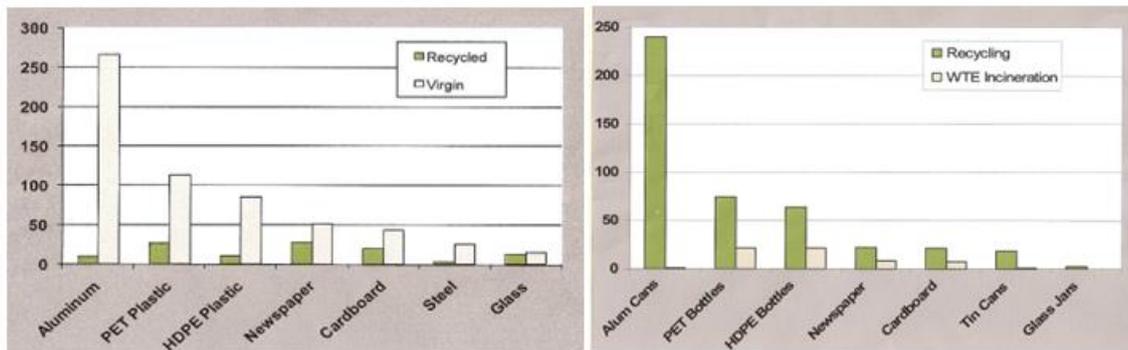
2. Analysis on various qualities

2.1 Material content –

Polyethylene Terephthalate (PET), Polypropylene (PP), Poly Vinyl Acetate (PVA), Poly Vinyl Chloride (PVC), Polystyrene (PS), Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), etc. all these comes in thermoplastic category which contribute to 80% of total plastic use. Whereas Bakelite, Epoxy, Melamine, Polyester, Polyurethane, Urea – Formaldehyde, etc. comes under thermoset plastics category which contributes 20% of our plastic use.

For recycling plastics into Recycled plastic lumbers, thermoplastics are used. These mixed plastic blocks are known as Recycled Plastic Lumbers (RPL). To form these blocks, mixed thermoplastics are not sorted out by their chemistry, they are properly cleaned only. After that, the mixed waste plastics are heated and compressed and then extruded/moulded to quickly form whatever shape you want. The products made out of RPL are very long lasting, even companies give 50 years’ warranty on any RPL product. Plastic lumbers are 100% plastics. They are made up by mixing thermoplastics all together at around 400 degrees Celsius and then extruded or moulded into desired shapes.

2.2 Energy consumption –



Source: Morris, 2008 Source: Morris, 2008

Chart 1: Energy Use: Recycled & Virgin Content Chart 2: Energy Savings: Recycling Versus Waste. Products (MJ/kg) To Energy (WTE) Incineration (MJ/kg)

Charts 1 and 2 above show relative energy uses and savings when recycling of wastes are applied. Likewise, extracting and processing petroleum into common plastic containers (Polyethylene terephthalate ‘PET’ and High Density Polyethylene ‘HDPE’) takes four to eight times more energy than making plastics from recycled plastics. The recycling rate for these plastic containers was only 20.2% in 1998. Energy conservation is just one of the environmental benefits attained by eliminating waste, increasing material efficiency and manufacturing products from recycled rather than virgin materials.

2.3 Stability-

Instead of using fresh plastic, the plastic that has already discarded are used for construction. With extrusion the plastic is melted and emptied into final mould, creating 3 kilo bricks(6.6lbs), like clay ones with an equivalent dimension. When assembled under pressure, the bricks insulate heat and have additives that retard combustion. And its thermoacoustic and earthquake-resistance is up to code.

The frame would be made with steel structures for resistance against the climate changes. For the toiling, one can do it with the regular tiles of ceramic, granite or marble. And The roof and the walls are made of plastic comprising low-density plastic (LDP) and multi-layered plastic (MLP). In some portion, one can use the aluminium partition panels. Certainly these houses can be constructed in the outside covering to make the plastic bricks less exposed to UV, use the bricks accordingly where the building is used for a less heat activity, etc. In the window frames and shutters, plastic panels are good to make the room airy.

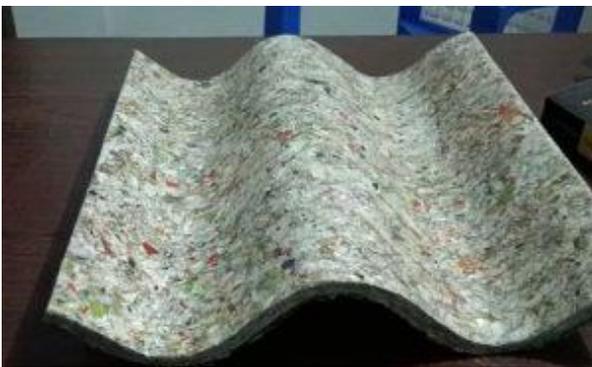
Foundation- It could be made from brick and concrete. Digging 3 ft. around the location of land. Marking it properly and prepare for the foundation.

Steel Frame- steel or GI will be better to frame the structure for fixing recycled steel panels. Keep the sizes of panels and according to that, weld throughout the structures.

Plastic panels- Plastic plans are required to buy or ordered from the manufacturer. Plastic frame structures are used to make the house. These panels are Easy to install and dismantle. Plastic panels each of 25 kg of recycled plastic structures can be joined with the other panels. These are now manufacturing in the many parts of country.

Recycled Bricks – These recycled bricks are found in some places and are named like Paver blocks, interlocking tiles. Plastic things should be crushed, melted and form the bricks like structures. These are easily available in the market.

Roofing material- For roofing recycled plastic corrugated sheets can be used in the roof



Plastic corrugated sheets

Benefits-

Thermal Conductivity- It has very high thermal conductivity which reduces 8 to 10-degree temperature as compared to the other sheet. Save the electricity bill by 300 to 400 per month which AC and fan consume.

Roasting & Corrosion- no roasting and corrosion problem and deflect the ultraviolet rays.

Reduce Noise– In Rainy season, cement asbestos sheets make irritatingly noisy sounds. These 3 R sheets have sound absorption properties which reduce the noisy sound.

Lighting Rooms– In cement asbestos houses generally need 5-6 lights. With these sheets, 2 to 3 bulbs is enough for full lighting the rooms. The bottom side is coated with Aluminium foil which has good reflection properties.

Eco- Green Material- These are waterproof, no bed smell and 100% Eco green materials and not even harmful.

Lifespan- Maintenance cost is zero and 6 to 7 times more lifespan than simple GI sheets. no need to change again and again.

Easy Installation- No breaking and cracking problems, easy flexible fitting used while installing.

2.4 Insulation -

The insulation materials like fibreglass, glass wool can be easily installed in between recycled plastic walls.

2.4.1 Wedge Mineral Wool (Rock Wool) Batts

Made from natural rock or slag, mineral wool batts are denser than fiberglass and offer superior fire resistance and soundproofing. Ideal for both exterior and interior walls, particularly in areas requiring higher fire resistance or soundproofing.

Benefits: Non-combustible, resistant to moisture, mould, and pests, and provides excellent thermal and acoustic insulation.

2.4.2 WedgeMag MgO Rigid Foam Board Insulation

Available in various materials like expanded polystyrene (EPS), extruded polystyrene (XPS), and polyisocyanurate. These boards offer high R-values per inch of thickness. Used in exterior walls, basements, and as continuous insulation on exterior walls to reduce thermal bridging.

Benefits: High R-value, moisture resistance, and durability. They can be installed on the outside of the building envelope, providing continuous insulation and reducing thermal bridging.

An Eco-brick is a plastic bottle packed with used plastic to a set density. They serve as reusable building blocks. Eco-bricks can be used to produce various items, including furniture, garden walls, and other structures [4]. Eco-bricks are produced primarily to manage consumed plastic by sequestering it safely by terminally reducing the packed plastic's net surface area to secure the plastic from degrading toxins and micro plastics effectively.

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2.5 Time considerations -

2.5.1 House built in 10 days.

This is an innovative and environmentally sustainable project that converts hard-to-recycle plastic waste into building material



About 60 panels produced by recycled plastic have been used. Each panel is prepared using 25 kg of plastic. “This is an innovative and environmentally sustainable project that converts hard-to-recycle plastic waste into building material that can be used to construct low-cost shelter.” “This is Karnataka’s first environmentally-friendly ‘recycled plastic house’ in Mangalore. The durability test of the construction material has been conducted before building the house.

2.5.2 Plastic house at Chandpur, Maharashtra,



Located in the botanical garden of Chandpur, Maharashtra, is a unique two-storey house that opens up to a large hall, a bedroom, and a staircase that leads to the first floor — where there’s a small room for kids to play and a veranda that gives a beautiful view of the botanical garden. Built by Dr Balmukund Paliwal, the house is spread across 625 sq. ft., 18 feet in height and 10 feet wide. Every part of the house from plastic. For this, we utilised all kinds of plastic waste — including potato chips packets, water bottles, medicine wrappers, cosmetics bottles, and milk pouches.

Method of construction-The pellets are melted into a semi-solid substance through an extruder. This substance can thus be moulded into any shape, like doors, legs of a bench, tiles, etc. Thereafter, it is passed through a chiller and later on, polished and coloured.

Duration: It took Dr Balmukund three months to construct the plastic house. He has carved designs on the doors and beds in the house to give it a wooden look. Seeing the house, nobody can guess it is completely made of plastic waste. We have also used an additional 2.5 tonnes of steel for rigid support and framework Sharing more

about the features of the house, he says, “This house can be used in areas which are prone to electric shock or extreme hot and cold. As it is made from plastic, it provides insulation from outside weather. The house is comparatively three to four degrees cooler than outside temperature Compared to a cement home, you do not require any water to construct a plastic house. Also, in reinforced concrete, percolation and cracks will eventually occur, but in a plastic home, there won’t be any cracks. The reinforced cemented structures require maintenance in 20 to 25 years but no such maintenance is needed in structures made of plastic, which can last for decades, even after your Lifetime.



Talking about the safety risks, this house is rust-free, fireproof, and shock-free. Usually, plastic melts at around 250 degrees and requires above 300 degrees for it to burn. Wooden homes catch fire faster than a plastic house. We stressed on ways to reduce pollution. Dr Paliwal pitched in to design a house made of plastic. This is a demo house and was replicated in the housing scheme under the Pradhan Mantri Awas Yojana. By constructing such homes, tonnes of plastic waste from villages and cities can be utilised. In future, if we ever desire to dismantle the house, we can reuse and recycle all the demolished plastic material, which is not possible in reinforced concrete structures Including collection, machinery, and labour, the cost of constructing the plastic house was Rs 9 lakh, claims the doctor. Of the total cost, the Zila Parishad sanctioned Rs 5 lakh (the upper limit for the construction of the demo house). This is comparatively 20 percent less than the conventional cemented house. I invested the remaining amount so that funds do not become an issue and we have an example for others to adopt.

2.6 Climatic considerations -

We all know how strong and robust polycarbonate material is. Their strength and impact-resistant ability make them a widely used product even though they’re costlier than most plastic materials. For a large part of the population that lives in either earthquake, cyclone, flood, or any other harsh weather condition prone areas, it’s quite important. Because choosing the right material for the right cause can save you from a lot of unwanted situations. For these areas, where natural calamities occur often, polycarbonate sheet is a great material to use.

If it’s an earthquake, polycarbonate material is solid and can take a lot of impact on it without cracking. PC plastics are 250 times stronger than glass with great flexibility, and 20 times stronger than clear acrylic sheets enabling them to be virtually unbreakable. Even if it breaks for some reason, it won’t chirp like glass, so there is no major risk of cutting yourself with the broken pieces.

Polycarbonate sheets are completely waterproof, even with heavy rains or floods, you don’t have to worry about leaks on them. This material is also widely used in cyclone-prone areas because it can withstand strong air and water pressure and let you be safe in your home. One of the best things about this is that even if the plastic gets broken or damaged, it won’t shatter into million places and hurt you with the small pieces. It’ll still work even if it gets broken and shattered. You’ll get enough time to change it.

The bricks used in the house with plastic hollow frame are stronger and not fragile. These Houses are suitable for cold climates or semi-arid regions. Due to the sun degradation, Plastic bricks heated easily and the human body became warm. The plastic bricks are good for the indoor walls. However, in hot climates such as northern Queensland in

Australia, or in desert regions, these houses can run into some issues. Using the plastic brick for external wall are not practical in hotter climates. Overall these house are best for the Cold and semi-arid region

2.7 Thermal performance –

A dwelling with poor indoor climate enhances the risk of health problems such as:

- Headaches
- Abnormal fatigue
- Irritation of the skin and mucous membranes (eyes, upper respiratory)

In combination with the previous symptoms various types of stress and individual circumstances like allergies or other hypersensitivity issues, the problems may be exacerbated. However, the concept of indoor climate is broad and highly subjective, thus difficult to evaluate. It is also an individual estimation since humans prefer various climates due to:

- Clothing
- Activity
- Age
- Gender

Problems regarding maintaining the temperature of residential places are huge. In many parts of the world, during summer season concrete in masonry structures absorb too much heat and then emit it continuously throughout the rest of 24-hour cycle after dusk. The result of such absorption rate causes irritation in the day to day living. Hence material with low solar absorptivity coefficient can keep the houses cool during summer. Plastic is one of them, it does not absorb radiation as that of concrete do. The absorptivity of the concrete is around 0.6 and absorptivity of plastics is around 0.3 (without any dye or color addition).

Also, the thermal conductivity of plastic lumber is 0.3317 W/mK and thermal conductivity of air is 0.0271W/m·K at 40oC. Whereas, the thermal conductivity of cement and concrete is 0.72 and that of bricks is 1.3.

One of the main reasons that plastics generally avoided for construction is their flammability. They can catch flame at around 2240C. However, nowadays almost every company add flame retardant to recycled plastic lumbers. Hence, it does not catch fire easily. But, the fire safety must be the utmost priority.

3. Advantages of Plastic House Construction

Here are the List of advantage of house constructed with waste plastic.

- The Waste thing turn into better thing
- The innovative and environmentally sustainable house can be built with these waste materials.
- Collecting the Plastics, the government can support in terms of money to the homeless and make house for themselves.
- less to build these plastic house.
- weight-bearing properties are excellent.
- Plastic recycled house has a life cycle of at least 30 years.

4. CONCLUSIONS AND RECOMMENDATIONS-

With combination of different techniques and materials recycled plastic waste can be a very good opportunity to create places for living. Not only it reduces the cost of the project but also it's a faster way of providing housing for all specially in this era of growing population and housing crises.

4.1. Encourage Recovery of Waste Plastic

Recovery of waste plastic materials, especially polyethylene, should be encouraged by recycling industries and governments, by payment of collection fees, so as to make it worthwhile scavenging for them.

4.2. Setting common targets

It should be considered the best environmental alternative for solving the problem of waste disposal. The fraction of plastic wastes in household wastes is large and increases with time, especially in urban centres. In each country the waste composition is different, since it is affected by socioeconomic characteristics, consumption patterns and waste management programs, but generally the level of plastics in landfill waste composition is high. In many countries of West Africa, plastic still remains the waste component not properly handled because of lack of technological know-how for its recycling. The large volume of materials required for construction offers a potentially major area and attraction for reuse in other sectors outside construction.

4.3. Encourage Research in Recycling

Universities and government authorities should encourage research in plastic waste recycling, establish workshops and materials-testing laboratories. Inter university exchanges, especially with advanced and recognized universities should be encouraged.

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