

Potential use of Recycled Plastic for Cost-Effective Building Construction

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Abstract - Today, from packaging to construction, plastic is everywhere. The production of plastic products has seen unprecedented growth, which has caused significant environmental and social damage throughout its life cycle. Majority of plastic produced each year is used to make disposable items of packaging or distinct short-lived products that are discarded within a year of manufacturing. The technical and chemical properties of plastic, play an important role in determining the characteristics of different types of plastics. This paper analyzes the possible applications of recycled plastic as a building material. And to study the key properties of recycled plastic and the benefits of using it in building construction. The bottom line is that the use of recycled plastic for construction applications will significantly improve environmental sustainability and can also serve as a reliable source of material for construction of cost-effective housing.

Key Words: Plastic, Polymer, Building material, Recycled plastic, Construction.

1. INTRODUCTION

Plastics are synthetic organic polymers mainly composed of carbon (C), hydrogen (H) and oxygen (O) elements, and their repeated basic molecular units are monomers. Plastic in construction is nothing new. It was originally developed in organic form from cellulose in plants. Once heated, it can be molded into any shape, and it is resilient in nature. As a material, plastic is resistant to corrosion and certain chemicals, has a high strength-to-weight ratio, shock resistance, high stress and resistance to environmental influences. Different monomer combinations produce plastic resins with different characteristics, such as strength or plasticity. Today, plastics are artificially produced from crude oil and other hydrocarbons to meet the requirements of modern construction technology. Mass production began in the early stages of industrialization. Now this material is ubiquitous in almost all aspects of our lives.

In India, methods of handling plastics are harmful in the long run. The current pandemic of COVID -19 has normalized the use of plastic as an appropriate raw material for safety products. The plastic safety products including the gloves, masks, and PPE kits contribute to the mountain of trash all over the country. There are many types of plastic waste, and the most common waste streams are polyethylene and

polyethylene terephthalate (PET). Since the recycling of plastic waste was found to be effective, the packaging industry has extensively explored different methods to recycle these wastes. However, very little recycled plastic finds its way into the construction industry. This provides an opportunity to explore the possibilities of its usage in the construction industry.

1.1 Plastic waste

Consider existing statistics: A global material balance study on plastics shows that 79% of the total plastic produced in the world enters our environment as waste. Only 9% of plastic waste in the world is recycled. A report from the Central Pollution Control Board (CPCB) 2018-19 shows that India generates 3.3 million tons of plastic waste each year. The Center for Science and Environment recommends a series of action plans: One of them is to recycle plastics. Compared with other materials that are heavily used (such as paper, ceramics, and metals), the recycling rate of plastics is low. It can be recycled mechanically, chemically, and thermally. The plastic waste treatment and reprocessing techniques are divided into four major categories which are re-cycling, mechanical, chemical and energy recovery.

The following Table-1 showcases the chemical composition of various types of plastics along with their properties and applications for reference.

Table -1: Plastic Types and Common use of Recycled Plastic

Plastic composition	Physical properties	Application from recycled plastic
Low density polyethylene (LDPE)	Flexible	Plant packaging, Bricks and Blocks
Polystyrene (PS)	Flexible	Laundry pegs, coat hanger and Insulation material
Polyethylene Terephthalate (PET)	Hard and Brittle	Rug fibers, Fibers in cementitious
Poly carbonate (PC)	Hard and flexible, Hard and rigid	Fibers in cementitious composites and Aggregates in

		cementitious composites.
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2. Possible application of Recycled Plastic in Building Construction

2.1 Plastic Blocks from Plastic Beads

The recycled plastic for building construction must satisfy both mechanical and strength requirements of the intended application. In addition to the performance, it should be low-cost, to motivate the end user over other types of material. Plastic beads are generated from LDPE and are successfully transformed into plastic blocks. These beads are used in the casting of bricks. Fly ash which is used along with the exceptional composition of plastic beads to get the most compressive strength. The density of bricks varies from 500 kg/m³- 2000 kg/m³. The maximum compressive load sustained with the aid of LDPE plastic beads brick is 13.69 N/mm², this is followed through plastic fly ash composite brick having force between 11.48-10.42 N/mm² [2]. These strengths are much greater than the force of ordinary clay brick which is around 3-5 N/mm². The energy of composite bricks varies in accordance with a change in fly ash content.

2.2 Blocks of recycled plastic and rice husks in Vietnam

The building material RHPP, the fundamental raw material used are Recycled plastic in form of polypropylene and Rice husks which are a by-product of rice cultivation. It is used to assemble homes supported by solid basis and metal framework. The materials are produced in Ho Chi Minh City by using Trong Danh Co [3]. The aspects of these building material are rice husks, polypropylene plastic, baking powder, catalyst, and different additives. The ensuing material is resistant to furnace and presents warmth insulation and sound insulation. Moreover, it is waterproof and lightweight, which reduce transport prices and makes it convenient to cope with the material duration construction. This material can be used for brick block and roof tiles. People can quickly construct homes from these materials in areas affected by natural disasters and place which is meant for less expensive housing. Houses made from this material can be built in flood affected and earthquake prone area.

2.2 Door Panels from Recycled Plastic.

Door panel can be manufactured from recycled plastic which is combined with timber to produce an eco-friendly door panel [4]. These panel are made by combining plastic waste in pellets or powder with cellulose fiber or wooden powder to form a thermoformable wooden plastic matrix.

2.3 Panels from Recycled Plastic.

This kind of Panel is made from plastic bottles which are made from Polyethylene Terephthalate (PET). The plastic flakes are bonded with epoxy consist of resin, Methyl Ethyl

Ketone Peroxide, Cobal and Kaolin is introduced to save the production costs. The mixture is positioned on the mould and solidified. Panel boards made from plastic waste can also be expanded to a larger dimension such as 60 cm x 120 cm with a thickness of 5cm. These panel boards can be made into partition boards with unique surface texture. The partition boards with translucent surface resemble glass block panels and can be used for interior design. As these panels are porous in nature, they can be used as a damper wall. These panels can be manufactured easily, even by using people who have no special expertise on chemistry or wood carpentry, into partition boards or walls.

2.4 Insulation material from Recycled Plastic.

Insulation materials can be used for noise proof panel, roofing systems and wall. Plastic Waste in shape of expanded polystyrene can be incorporated as insulation material at some point of the building process. However, the low density of EPS couples with its fire protection has limited capacity to recycle and transport the recycled materials. Production of insulation material does not require additional chemical and natural binding agent, as these are thermally strengthened at 170 degrees Celsius. The recycled fabric can be used as thermal and sound insulation for pitched roofs, attics, ceilings, and wall structures. It is breathable, dimensionally stable and emission free.

2.5 Conceptos Plasticos in Columbia.

In Colombia there's shortage of homes, lack of building materials and abundance of plastic waste. Building materials like cement and concrete are too expensive. It has higher number of plastic waste accumulated in landfills, with dire consequences for the local environment. The Colombian start-up "Conceptos Plasticos" tried to solve these two issues, by turning plastic and rubber waste into low-cost and sustainable, easy and quick to assemble building materials [9].



Fig -1

The innovative company managed to patent its system of bricks and pillars made from recycled plastic as shown in Fig 1., which is then put together like Lego pieces Fig 2., during a construction system from which the houses are build up to two stories high in five days Fig 3. 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 for Colombia, considering the country's high level of seismic activity.



Fig -2



Fig -3

3. CONCLUSION

The above-mentioned recycled building materials have better performance than traditional building material, yet provide a cheaper and more sustainable alternative. The possible application of these materials depends on local and regional conditions. Material made from plastic waste can be used as an alternative to conventional material, to reduce plastic waste and pollution. Houses made from recycled plastic have benefits like quicker construction at a very low cost. In places which experience frequent natural disasters like earthquake such material should be used as an alternative to conventional material for construction of houses as the density of these materials is low yet strength is greater.

More collaborative research and exploration should be conducted by various stake holders like government agencies, technical institutes and R&D Centre etc. Further

investigation may be carried out to develop more innovative products based on recycled plastic like bioplastics, which uses organic material along with polyethylene for construction of cost-effective houses. The use of such material for construction will reduce the overall cost of the structure.

Conceptos Plasticos case study provides a good example where social, environmental, and economic benefits can be achieved through innovative approach. The case encourages more entrepreneurs to take up the challenges of vulnerable communities and find creative housing solutions which would not only contribute in environment preservation, but also be a better alternative to conventional housing.

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