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A comparative study of plastics in civil engineering

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Abstract

With each passing millennium, plastic is making its way into the categories of essential items for a human being to survive in this world. As plastic makes our lives easier and easier with each passing day, the waste associated with plastic tightens its grip on our mother nature's survival wrist. These wastes are now managed by the 3R system, which stands for reuse, reduce, and recycle. These wastes are used in a variety of ways in civil construction. These are used in pavements, building construction, decoration, and other applications. This paper will look at various ways to use plastic in civil construction.

Keywords: Plastic; Plastic polymer; Pavement.

1. Introduction

It is a well-known fact throughout the world that plastic waste is a significant issue for everyone and should be addressed as soon as possible, as its hazardous effects are degrading life on the planet. Plastic garbage is predicted to be created at a global rate of 275 million tonnes per year, with just 4.8 million to 12.7 million tonnes thrown in oceans and seas. Approximately 130 million tonnes of waste plastic are either disposed of in landfills or recycled. Plastic waste is increasing on a daily basis, but a permanent solution has yet to be discovered. Landfills, which are used to alleviate the problem of plastic waste, hurt the ecosystem indirectly. Humans, on the one hand, are continually looking for more diverse supplies at cheaper prices, while on the other hand, they are looking for a way to dispose of trash. Waste can now be produced anywhere there are human footprints, alerting him that he has not chosen the most acceptable strategy for exploiting nature.

One of the main variables accountable for the large increase in the age of plastic solid trash is worldwide urbanisation, which necessitates attention to the expansion in environmental consequences caused by solid plastic accumulation and failures. The lack of a standard for proper waste management in developing nations encourages the use of unofficial process models, which encourages inconsistent dumping, such as in open dumps. [1].

Plastic is made from scarce resources such as petroleum and other hydrocarbons. Plastic is available as a polymer, but to obtain its different structure, vinyl, propylene, styrene, benzene, and other monomers are formed when it is broken down in the presence of a catalyst. These monomers are then chemically polymerized to produce various classes of plastic, and two examples of the equivalent are thermoplastics and thermostat plastics. Regardless, there is a significant difference between these two types of plastic. Plastic is heated in thermoplastics and can be formed into any shape; however, its advantage is that it can be reheated and the plastic will be softened further. It contains various materials such as PPS, LDPE, PVC, HDPE, PET, and so on. Thermoset plastics are not the same as thermoplastics. It can be melted into a liquid state, but once solidified, it cannot be reheated and remains in the same shape.

These wastes generated by all types of plastic can only be reduced through the use of intellectual methods. The utilisation of discarded plastic in civil construction is one of these approaches. Plastic in civil construction can be used in a variety of ways, including as building blocks in the form of bricks, as plastic fibres and in course form in concrete, as a blend with bitumen in paving flexible pavement, and as rigid pavement mixing with concrete.

2. Utilization of waste plastic in various sector of civil construction.

S.Rajasekaran et al. (2013): The author used waste plastic as a partial replacement for bitumen, coating aggregate with a plastic blend to be used in flexible pavement to increase its life and strength. [2]

S. Perera, et al. (2019): To test the strength of the final product, the author used crushed PET bottles and food packaging in percentages of 3% and 5% with rubble concrete and crushed bricks.[3]

Mohammed Jalaluddin et al. (2017): The author used plastic waste as an innovative way to decorate both eco-friendly and non-eco-friendly buildings. He also used a plastic bottle on the outside of a building.[4]

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J.A.P Filho, et al. (2016): The compressive strength and water absorption of soil-cement bricks made from crushed PET trash from drinkable water bottles in soil cement blocks were assessed by the author. [5]

A. Al-Fakih, et al. (2020): The author employed milk pouches, Poly bags, and bottles of water as a partial replacement for fine aggregate in the concrete to examine the changing behaviour of the material. [6]

J.M.L Barreto, et al. (2019): The physical and mechanical properties of pressed concrete blocks with recycled PET additives were studied using PET that had been recycled and crushed at a recycler. [7]

A.S Esfandabad, et al. (2020): The fracture and mechanical properties of an asphalt mixture incorporating PET granules in the pavement were investigated by the author. [8]

P. Górak, et al. (2020): To test the microstructure and physicochemical performance of the Portland cement mortar, the author used flakes from recycled PET packages.[9]

H. Limami, et al. (2020): The author employed grinded PET flakes in three sizes to examine the feasibility of unfired clay bricks with polymeric HDPE & PET wastes additions as a construction material: In the unfired clay brick, 1 mm; 1 mm 3 mm; 3 mm 6 mm. [10]

3. Properties of waste plastic as a construction material

- STRENGTH

The plastics are strong enough to be employed for load bearing structural elements. Plastics' strength may be boosted further by reinforcing them with different fibre elements.

Because of the following reasons, plastic has not achieved significant appeal as a structural material.

- High construction costs
- High temperature sensitivity
- Inadequate rigidity
- Under continual stress, being exposed to creep

- RESISTANCE TO WEATHER

The phenolic resin-based polymers are only effective at resisting weather impacts. UV radiation has a negative impact on certain polymers.

- FIRE RESISTANCE

Plastics are flammable because they are biological in nature. However, the resistance to fire temperature is determined by the plastic structure.

- Plastics made of cellulose acetal burn slowly.
- Plastics made of polyvinyl chloride (PVC) are non-flammable.
- Plastics containing phenol formaldehyde and urea formaldehyde are utilised as fire retardants.

- DURABILITY

Plastics are generally durable as long as they have a sufficient surface hardness. Termites and rodents have been observed attacking thermoplastic variants.

- STABILITY IN DIMENSIONS

Plastics readily keep their shape and are not prone to plastic deformations.

- CHEMICAL TOLERANCE

Plastics are very resistant to water, chemicals, and solvents. Many polymers have been discovered to have exceptional corrosion resistance. Chemicals are transported via plastics.

- THERMAL RESISTANCE

Because polymers have low heat conductivity, foamed or expanded plastics are employed as thermal insulators.

- WORKING CONDITIONS

Drilling, sawing, punching, clamping, and other operations are as simple to perform on plastics as they are on wood.

- RESISTANCE TO MOISTURE

This feature is impacted by the kind of plastic used; for example, cellulose plastics are significantly affected by the presence of moisture, but polyvinyl chloride plastics have strong moisture resistance.

- DUCTILITY

Plastics in general have little ductility, hence plastic structural elements may break unexpectedly.

- MISCELLANEOUS PROPERTIES

Plastics include the following characteristics in addition to the ones listed above.

- Plastics come in a wide range of hues, both opaque and translucent.
- Plastics have great insulating properties and are hence employed as electric insulators.
- Plastics are clean, light, and gleaming, therefore they do not require any finishing, such as painting or polishing.
- Typically, thermoplastics have a low melting point and cannot be employed in conditions where temperature or heat persist.
- They have strong optical and sound absorbing properties.

4. Why is plastic waste an excellent construction material?[11]

Every year, the globe generates around 400 million tonnes of plastic, of which only 9 percent is recycled. Plastic that does not degrade is a big contributor to climate change and has been discovered in the depths of our seas as well as on the highest summits of our mountains.

Scientists predict that the quantity of plastic debris in our seas will quadruple over the next two decades.

In addition, the United Nations cautions that the coronavirus epidemic is worsening the plastic catastrophe. Plastic masks, gloves, and protective medical equipment are in high demand all around the world. So it appears that plastic is an unavoidable problem that isn't going away anytime soon.
Faced with this realisation, individuals all over the world are devising novel ways to recover and reuse plastic garbage from their surroundings. People are recycling plastic garbage into construction materials and utilising it to create homes, schools, community centres, and storage facilities from Canada to Colombia to Ivory Coast.

"The problem is not plastic; the problem is economics," explains Sibele Cestari, a plastic materials expert at Queen's University in Belfast.

"All plastic can be recycled or repurposed, but most of it isn't because it's unprofitable," she says.

According to Cestari, plastic is the ideal construction material. "It is inexpensive [to turn into construction materials], readily available, and simple to mould." She says that the material is long-lasting, waterproof, and insulating, making it suited for use in a variety of climates.

Cestari points out that it uses far less heat or power than conventional building materials. Most polymers melt at roughly 200 °C, although glass and aluminium melt at significantly greater temperatures.

According to the researcher, the world should reconsider its connection with plastic and learn how to use plastic garbage in a sustainable manner. Construction is one effective method. "You are not only eliminating plastic from the environment, but also placing it into a fixed application." "It will never circulate again," she declares.

Another advantage is the magnitude of the building industry. "If you want to solve the problem of plastic waste, you must find a solution on the same magnitude." "It has to be industrial to be worthwhile," Cestari argues.

5. The Benefits of Using Plastics in the Construction Industry[12]

Plastics of various types are utilised in a variety of sectors for a variety of purposes. However, one of the most common industries where plastics are employed is building, where polymers are vital.

Plastics may be quite beneficial in this industry due to the many qualities of the plastics available; there is a plastic to suit almost any application. These are just a few of the many reasons why plastics are such an important material in the building industry.

- Cost

One of the primary benefits of utilising plastic as a construction material is that it is less expensive to make and use than most other materials. It is often less expensive and can be manufactured in far bigger numbers than metal. This is the primary reason for the widespread usage of plastic in building. The quantity of energy required to generate plastics is significantly less than that required to produce metals.

- Resistance

Plastics have a strong corrosion resistance, making them ideal for applications where metals may rust and corrode. As a result, plastics are the most often used material for water pipe construction.

- Weight

Plastic is a lightweight material when compared to many other building materials, giving it greater flexibility in its usage on the job site and in transportation. Because of its light weight, plastic can be delivered in considerably larger quantities than other materials, lowering transportation expenses to a building site. Plastics can be hoisted into position or moved around the site simply and safely.

- Colour

Plastics can be readily coloured throughout the production process, which is a handy quality to have on a construction site. Parts can be colour labelled according on size or application; this would be considerably more difficult and time consuming with metal parts.

- Environment

Plastics' great resilience implies that no rust will form on them, which means that no rust will leak into the ground or water supply. This is a significant advantage for utilising components underground or for conveying water. Plastics consume a lot less energy than metals in the manufacturing and building processes since they are lighter, hence the energy used in construction and transportation is substantially lower.

Plastic is a recyclable material that will not corrode, which is advantageous when utilising a material that may generate trash. When you examine the mining and melting of metals processes, the probability of contamination for plastics is reduced.

- Moulding

In a building job, small, complicated elements are typically required. Plastics are ideal for building because they can be

melted down and moulded into complicated designs in vast numbers. Because it may join together without the need of clips or other materials, it is utilised for cable conducts.

This material is utilised across the construction sector, however the following are some of the most common applications:

- Water pipelines
- Frames for windows
- Doors.
- Insulation is used in the construction of green or low-energy buildings.
- Defending the roof's outer layer from harm.

6. Conclusion and Future scope

Waste plastic is used extensively and in a variety of ways in civil construction. It's used in a variety of ways, with differing amounts of various sorts of plastic trash.

According to the studies mentioned above, plastic waste has managed to increase the strength and life of various projects, such as flexible pavement.

Because of its ease of access, it makes any project more cost effective.

The recycling of plastic waste in construction work makes our planet a better place to live.

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