Use of Plastic Waste in Concrete Mix

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Abstract - *Dumping of plastic waste in environment is considered to be a giant issue due to its very low biodegradability and existence in huge quantities. Present time use of such, industrial and urban wastes from polypropylene (PP) and polyethylene terepthalate (PET) were considered as substitute replacements of part of the conventional aggregates of concrete. As a result, finding substitute methods of disposing waste by using affable methods are becoming a main research problem. In this research, high density polyethylene waste is mixed with Portland cement to examine the option to make plastic cement, and learn the outcome of replacing sand by fine polyethylene waste with different quantities and percentage on the properties of product. The research was done by using the waste of polyethylene parcels including bottle and food crates and other wastes. As much as 60% of both industrial and urban plastic waste is recycled which carried from various sources. People in India have released many types of wastes in which plastic waste on large scale have huge economic value, as a result of this, recycling and dumping of waste plastic plays an important role in providing employment.*

***Key Words*: Compression testing machine; Sieve machine; Sound test equipment, vicat apparatus.**

1. INTRODUCTION

Plastic has become the most common and necessary material since the starting of the 20th century and modern life is unimaginable without it. Humans have always produced garbage and disposed of it in some way so solid waste management is not a new problem. Unluckily, it is very important for ud because of its durability, light weight and low cost. . Despite the suitability of plastic for a wide variety of applications, organizations are faced with the growing problem of finding substitute methods for disposing a large volumes of waste packaging. Disposal of plastic waste in environment is considered to be a challanging problem due to its very low biodegradability and presence in huge quantities. Dozens of millions of tones of plastic debris end up floating in world oceans broken into microplastic, the so-called plastic soup. Microplastic are very dangerous, sea mammals and birds that die from eating plastic debris. One of the main environmental issues in the most region of any country is the large number of package made from polyethylene materials such as shampoo sachets, carry–bags, nitro packs, milk and water pouches, and vegetable packages etc., which are deposited in domestic waste and landfills. The largest component of the plastic waste is polypropylene, polyethylene terephthalate, and polystyrene. The reuse of wastes is important from different point of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the environment and it also helps to save and recycle energy production process. In recent times, plastic waste is one part of municipal solid waste which is becoming a main research problem to study the possibility of disposal the waste in mass concrete especially in self compacting concrete, light weight concrete, and in pavements. It can be used as a component of a composite construction material, as an inorganic filling material, and aggregate of concrete. Recycling of plastic waste material in concrete has many profit and advantages since it is broadly used and has a long service life, which means that the waste is being removed from the waste stream for a long period. Besides, using of plastic waste material in concrete mix will not only be its safe disposal and dumping technique but may get improved the concrete properties like tensile strength, chemical resistance, drying shrinkage and creep on short and long term basis. The scientist has been discovered new types of engineering that include sustainable engineering and green engineering to reduce energy and natural resources consumptions. The aim of green engineering is to minimize adverse conditions while at the same time maximizing benefits to the economy, society, and the environment. It is focusing on the increasing the efficiency of a process to reduce the amount of pollution generated to be as eco-efficiency. Baboo et al, was found that the workability and compressive strength were reduced due to partially replacement of sand by waste plastic flakes in varying percentages by volume to produce waste plastic mix concrete with plasticizer. Pezzi et al, found that the addition of polymeric material in fraction less than 10 % in volume inside of cement matrix does not imply a significant variation of the concrete mech anical features. However, Marzouk et al, found that density and compressive strength of concrete decreased when the polyethylene terephthalate aggregate exceeded 50% by volume of sand. Binici H. et al, has been successfully used polyethylene bottles wastes in cement less concrete production and found that the ductility of concrete was improved. Plastic has different properties such as durable and corrosion resistant, good isolation for cold, heat, and sound, saving energy, economical, has a longer life, and light weight. As a result, in this research, solid-state recycling process is proposed to realize the direct recycling of polyethylene as the green engineering forming technology. Moreover, it will be used to produce plastic cement directly from solid state to improve the mechanical properties and workability of products.

2. Materials

First, Polyethylene is a semi-crystalline material with tremendous chemical resistance, good corrosion resistance, and good fatigue and wear resistance. It provides good resistance to organic solvents and strength with low moisture

absorption. Furthermore, it is light weight material, non-toxic material, resistance to stain, and offers admirable impact resistance and high tensile strength. Polyethylene terephthalate PET is the most normal thermoplastic polymer resign of the polyester family and is used in fibres for clothing, contains for liquids and foods, thermoforming for manufacturing, and in grouping with glass fiber for engineering resigns. Polyethylene box or plastic waste material have been collected from municipal and landfills as a waste of human activities. Then cutting into small size by using special cutting and grinding machine to get fine particles. The result grinding polyethylene waste are sieving to separate the fine particles from the coarse particles to be ready for mixing with Portland cement and water as shown in figure 1.

(A) **(B)**

Fig-1 (A) Polyethene waste before cutting and grinding after cutting **(B)** Grinding polythene Waste

3. Methodology

The concrete mix design as recommended by IS: 10262-1982 was used to prepare test samples.The concrete mix was design to study the effect of replacement of sand by fine plastic waste material. Portland cement mixed with fine plastic wastes material and water using different percentages of wastes as shown in table 1. The percentages of materials and water take by volume.

Table 1. Concrete mix design for high density plastic waste with Portland cement and water

Experiment No.	HDPE %	Portland cement%	Water%
1.	0%	100%	25%
2.	5%	95%	25%
3.	10%	90%	25%
4.	13%	87%	25%

Portland cement and fine polyethylene waste mixed with water to get a homogenous concrete to cast on the small mold. Samples left in the mold until it dried, then put in water for 3-4 days for solidifying and curing to increase their cohesion. After that, samples left from water to dry and test their properties. The second step was putting the samples again in water for 7 and 28 days to study their stability and the effect of water on their properties.

4. Results

4.1 Shape of Product

The shape of wet plastic cement that produced from mixing Portland cement with fine polyethylene waste after casting and drying are shown in figure 2. These materials are mixed and casting without any vibration or press.

Fig-2 Shape of cubes

4.2 Density

Density of plastic cement produced in this work was measured and the results show in below

Table 2. Concrete mix design for high density polyethylene waste with Portland cement and water.

Experiment No.	HDPE %	Portland cement %	Density % (gm/cm3)
1	0%	100%	2.4
2	5%	95%	2.1
3	10%	90%	1.9
4	13%	87%	1.6

4.3 Moisture

Use Table 3 shows moisture of plastic cement produced in this research after immerged 7 and 28 days in water. The results show after 28 days the moisture percentage will be less than the moisture of plastic cement that immerged 7 days.

Table 3. Moisture % of plastic mix concrete cube after 7 and 28 days

Experiment No.	HDPE %	Moisture% after 7 days	Moisture % after 28 days
1	5%	13.3	15.9
2	10%	11.2	12.4
3	13%	10.5	11.4

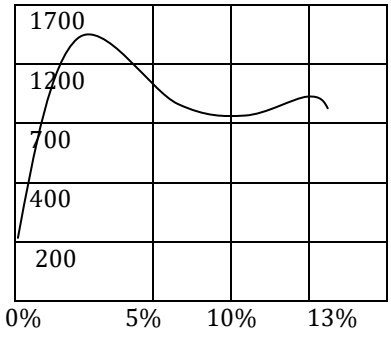
4.4 Compressive Strength

Figure show compressive strength diagrams for plastic cements that produce by mixing fine polyethylene wastes and Portland cement after immerged 7 days in water. The yield points for different specimens have been found which lie in the range of 874 to 1700 N after 7 days and from 1155 to 2125 N after 28 days as shown in table 4. It is depended on the percentage of fine polyethylene waste. By increasing the waste plastic ratio, the compressive strength values of waste plastic concrete mixtures decrease at each curing age. It states that the bonding between the plastic particles and the cement paste is feeble.

Table 4 Yield point in (N) plastic mix concrete after 7 and 28 days

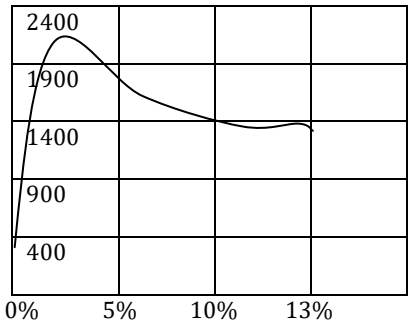
Experiment No.	HDPE %	Yield point after 7 days	Yield point after 28 days
1	0%	1700	2125
2	5%	970	1520
3	10%	797	1296
4	13%	874	1155

Compressive Strength after 7 days



Waste plastic content (%)

Compressive Strength after 28 days



Waste plastic content (%)

5. CONCLUSION

It is possible to produce plastic cement from waste of polyethylene materials that generated from human activities like food packages or crates. The results show that density of produced plastic cement was differed depending on the percentage of waste polyethylene in the concrete mix design. It is increased with increasing the percentage of waste up to 13% then decreased gradually. The best compressive strength for product was found in the mixture has 5%, 10%, and 13% polyethylene. The yield points for them are 970, 797, and 874 N, for immerged 7 days, respectively, and 1520 for mixed of 5% and 1296 N 10% after immerged 28 days. The stress-strain behavior is plastic behavior which has several stages of deformation. It works as semi crystalline polymer, flexible concrete and not brittle as Sand-Portland cement concrete. Therefore, their stress – strain diagram exhibited both elastic and plastic deformation before fracture. Moreover, the products with 5% to 13% waste plastic material have good workability to make holes without any problem. However, when the percentage of waste decrease or increase, the workability will be weak and power was generated during the cutting operation. Solid-state recycling process becomes an effective and powerful methodology to realize the green state forming from recyclable wastes to useful parts. The developed process can be considered as a typical green-forming or environmentally manufacturing process for lightweight materials. It has many benefits including simple, cost and energy saving, and clean recycling because it is not harm the environment. From the above information found that the best and suitable percentage of waste plastic waste material is 5 to 13% which give a good properties of mixture.

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