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# Reuse of Polyethylene in Concrete

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***Abstract-*** *The increase in population and the changed in lifestyle has resulted in a significant rise in the quantity of plastic waste. This project in particular deals with the possibility of using the waste polyethylene as partial replacement of fine or coarse aggregate in concrete. Concrete with 10%, 20%, 30%, 40% pulverized / non-pulverized polyethylene material is prepared after doing the mixed design. Various test on cement like fineness ,initial and final setting time of cement, etc., tests on aggregate like sieve analysis ,etc., are performed. Mix design using IS code method is done and cubes and cylinders are performed to understand their behaviour and usefulness as replacement. The standard mechanical properties of concrete like compressive strength, flexural strength are tested and compared with the result of standard specimen.*

***Key Words:*** **concrete, Natural Sand, Aggregate, polyethylene, Environmental Problem, Partial Replacement and workability, compressive Strength, flexural Strength.**

## 1. INTRODUCTION

Due to rapid increase of population in world, the amount of waste products such as waste plastic also increases rapidly. At present, these plastic wastes are disposed by either burning or burying. However, these processes are costly. These waste plastic will remain in the environment for hundreds of years. The combined of these waste plastic in concrete may reduces the environmental problems up to certain extent. 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. 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 us 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 large volumes of waste packaging. 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.

### 1.2 Objectives of the study:

1. To identify the affordable and suitable plastic waste material for the production of light weight concrete.
2. To utilize the waste plastic in concrete, and also to minimize global warming. To study the properties of plastic waste concrete.
3. To compare the strength and density of waste Polythene mix in concrete with normal concrete.
4. To Examine the uses and the application of PMC (Polythene mix concrete) in construction
5. To minimize the cost of concrete products. To study the possibility of make it as the alternative for coarse aggregate.

## 2. METHODOLOGY:

In this methodology a concrete can be made utilizing the crushed plastic waste, in which the coarse aggregate is partially replaced with the crushed plastic waste. The utilization of industrial waste in a useful manner is a major challenge in this current situation, because of the pollution there is a great harm to the nature and common life. For this purpose the very harmful and non-degradable material waste, Plastic is chosen, in order to minimize the stack piling of plastics in the environment and to control the pollution on earth. Hence it needs an immediate remedy and according to

the past studies made on the use of plastic waste plastic in concrete tell us that the usage of waste material in structural elements is a challenging activity in the construction industry. 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 and fine polyethylene waste mixed with water to get a homogenous concrete to cast on the small mould. Samples left in the mould 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.

## 3. MATERIAL TO BE USED:

### 3.1 Polythene:

Polyethylene or polythene (abbreviated PE; IUPAC name polythene or poly (methylene)) is the most common plastic in use today. It is a linear, man-made, addition, homo-polymer, primarily used for packaging (plastic bags, plastic films, geomembranes, containers including bottles, etc.). As of 2017, over 100 million tonnes of polyethylene resins are being produced annually, accounting for 34% of the total plastics market.

### 3.2 Cement:

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produce mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is only behind water as the planet's most –consumed. In this study we used ordinary Portland cement(OPC) which having 53 grade.

### 3.3 Sand:

Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand –sized particles by mass.

### 3.4 Coarse Aggregate:

Coarse –grained Aggregate will not pass through a sieve with 4.75 mm opening (no. 4). Those particles that are predominantly return on the 4.75 mm (no.4) sieve and will pass through 3- inch screen are called coarse aggregate.

## 4. MIXED DESIGN:

### 4.1General:

Mixed design of concrete is the process of deciding the proportion of the ingredients of concrete so as to be produced most economically, that would satisfy the desired properties of fresh and hardened properties as well. The requirements of concrete mix design are as follows:

1. The minimum compressive strength required from structural consideration.
2. The adequate workability necessary for full compaction with the compacting equipment available.
3. Maximum water-cement ratio and maximum cement content to give durability for the particular site conditions.
4. Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

### 4.2 Mix Proportion:

**Table-1:** Mix Proportion of the Concrete(kg/m3)

| Materials (kg) | Reference concrete (RC) | Concrete with plastic bag waste | | | |
|---|---|---|---|---|---|
| | | CPBW 10 | CPBW 20 | CPBW 30 | CPBW 40 |
| | | 10% | 20% | 30% | 40% |
| Cement | 400 | 400 | 400 | 400 | 400 |
| Water | 190 | 190 | 190 | 190 | 190 |
| Sand | 467 | 420.3 | 373.6 | 326.9 | 280.2 |
| PBW | 0 | 16.25 | 32.5 | 48.75 | 65 |
| Gravel 3/8 | 276 | 276 | 276 | 276 | 276 |
| Gravel 8/15 | 1064 | 1064 | 1064 | 1064 | 1064 |

## 5. TEST CONDUCTED ON POLYETHYLENE MIXED CONCRETE:

### 5.1 Test on fresh concrete:

It is important to understand and quantify the ease with which the concrete to implement. The consistency and workability of all the concrete mixtures was determined through slump tests. The slump tests were performed according to NF P 18-451. The vertical distance between the original and displaced positions of the centre of the top surface of the concrete was measured and reported as the slump.

### 5.1.1 Workability of concrete:

Depending upon the water cement ratio in the concrete mix, the workability can be determined by the following three methods:

1. Slum test
2. Compaction factor test
3. Vee-bee consistometer test

In this study, we used slum- cone test. This test carried out with a mould called slump cone whose top diameter is 10 cm, bottom diameter is 20 cm and height is 30 cm.

**Table- 2:** Workability of concrete

| Type of concrete | Slump value (mm) | Remarks |
|---|---|---|
| **Conventional concrete** | 58 | Workable |
| **Polyethylene mixed concrete** (10% replacement of coarse aggregate) | 64 | Workable |
| **Polyethylene mixed concrete** (20% replacement of coarse aggregate) | 68 | Workable |
| **Polyethylene mixed concrete** (30% replacement of coarse aggregate) | 74 | Workable |
| **Polyethylene mixed concrete** (40% replacement of coarse aggregate) | 80 | Workable |

The above table shows the slump value for Conventional Concrete, polyethylene waste concrete 10%, 20%, 30% and 40% replacement of coarse aggregate as 58 mm, 64 mm, 68 mm, 74 mm and 80 mm.

### 5.2 Tests on Hardened Concrete:

The tests have been performed to determine the mechanical properties were compressive and flexural strength. The test results were reported as the average of three tested specimens in the respective testing. From each concrete mixture, 150 x 150 x 150 mm cubes, and 160 x 320 mm cylinders has been casted for the determination of flexural and compressive strength test respectively.

### 5.2.1 Compressive Strength test:

Compressive strength formula for any material is the load applied at the point of failure to the cross section area of the face on which load is applied.

**Fig-1:** Compression test on block

**Compressive strength =load/cross- sectional area**

**Table -2:** Compressive Strength of Concrete

| % of Polyethylene (Replacement for Coarse Aggregates) | 7days ($N/mm^2$) | 28days ($N/mm^2$) |
|---|---|---|
| 0 | 35.10 | 54.14 |
| 10 | 32.12 | 45.84 |
| 20 | 28.34 | 43.30 |
| 30 | 25.62 | 40.16 |
| 40 | 22.50 | 39.10 |

The above table represent the 7 days of Compressive Strength of Conventional concrete and replacement of coarse aggregate by Polyethylene as 10%, 20%, 30%, 40% as 35.10 $N/mm^2$, 32.12 $N/mm^2$, 28.34 $N/mm^2$, 25.62 $N/mm^2$, 22.50 $N/mm^2$, and 28 days strength as 54.14 $N/mm^2$, 45.84 $N/mm^2$, 43.30$N/mm^2$, 40.16 $N/mm^2$,39.10 $N/mm^2$.

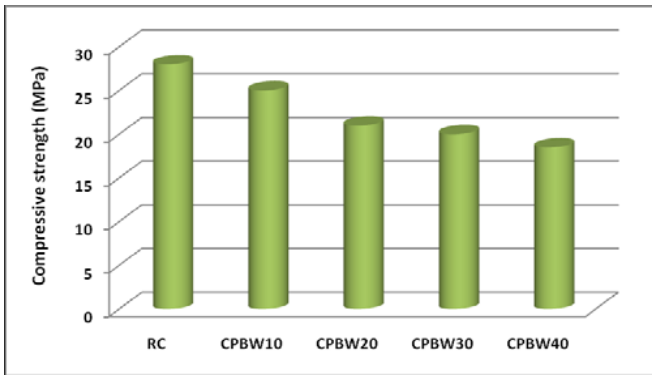


**Fig-2:** Compressive Strength

### 5.2.2 Flexural Strength Test:

Flexural strength evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending. The result on flexural strength of concrete express as modulus of rupture which denote as (MR) in MPa or psi. The flexural test on concrete can be conducted using either three point load test (ASTM C78) or centre point load test (ASTMC293).

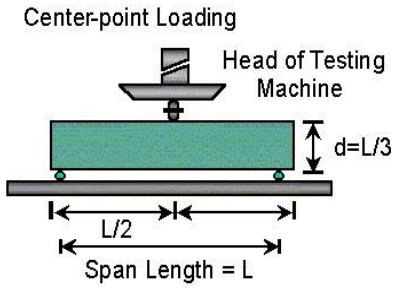


**Fig-3:** Arrangement for Flexural Test

It should be noticed that the modulus of rupture value obtained by centre point load test arrangement is smaller than three point load test configuration by around 15 percent Moreover it is observed that low modulus of rupture is achieved when larger size concrete specimen is considered.

**Table -3.8:** Flexural Strength of Concrete

| % of Waste Plastics (Replacement for Coarse Aggregates) | 7days (N/mm 2) | 28 days (N/mm2) |
|---|---|---|
| 0 | 3.48 | 5.27 |
| 10 | 3.50 | 5.15 |
| 20 | 3.33 | 4.85 |
| 30 | 3.23 | 4.40 |
| 40 | 3.20 | 4.35 |

The above table represent the 7 days of Flexural Strength of Concrete of Conventional concrete and replacement of coarse aggregate by Plastic Waste as 10%, 20%, 30%, 40% as 3.48 N/mm $^2$, 3.50 N/mm $^2$ , 3.33 N/mm $^2$ , 3.23 N/mm $^2$,3.20 N/mm$^2$ and 28 days strength as 5.27 N/mm $^2$, 5.15 N/mm $^2$, 4.85 N/mm $^2$, 4.40 N/mm $^2$,4.35 N/mm$^2$.

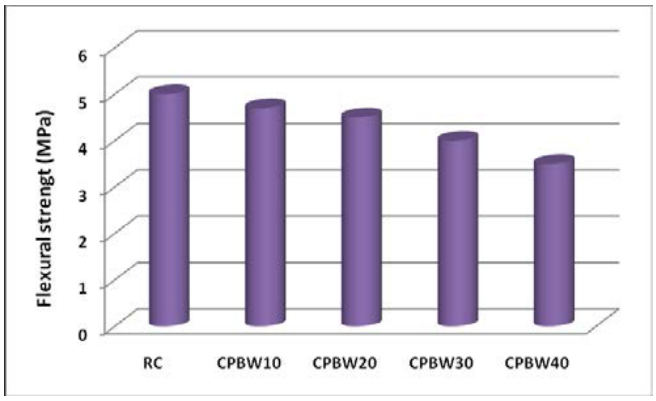


**Fig-3:** Flexural Strength

## 6. CONCLUSION:

It is possible to produce polyethylene mixed concrete from waste of polyethylene materials that generated from human activities like food packages or crates. The results show that density of produced polyethylene mixed concrete was differed depending on the percentage of waste polyethylene in the concrete mix design. With increase in the percentage of plastic there has been a sudden decrease in early strength but the strength developed to the value as that of the conventional M25 concrete when 28 day tests were performed. The use of waste plastic in concrete is a partial solution to the environmental and ecological challenges associated with the use of plastics. The aim of these resarch is to reduce environmental pollution by using waste plastic in concrete. The studies can be further extended by addition of admixture to make the concrete not to alter its strength considerably even with the addition of more percentage of plastic waste.

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