# Green Concrete using Plastic Waste

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***Abstract*— This experimental study presents the use of major plastic wastes as fine aggregates in concrete as an effective way to deal with the scarcity of sand and disposal of plastic waste. Aggregates in concrete account for the largest volume of solid material extracted around the globe at a rate far greater than their regeneration. The removal of aggregates has a major impact on rivers, deltas and marine ecosystems which results in deterioration of land through coastal or river erosion, Depletion of the water table and decrease in sediment supply. This paper emphasizes on using major plastic waste such as polyvinyl chloride (PVC), Polypropylene (PP), Polyethylene to substitute the sand in concrete to tackle the ill-effects of sand extraction and the problems related to disposal of plastic waste. In addition, Aluminum powder is used to minimize the weight of concrete and plastic itself is lighter than sand which results in lightweight concrete. Overall using these ingredients to replace sand will give new dimension in concrete mix design and if applied universally would transform the construction, by reducing the cost and enable us to conserve natural resources.**

***Key words*— Artificial sand, Plastic Waste, Aerated concrete.**

## I. INTRODUCTION

Concrete is a crucial building material utilized all over the world. Aggregates are the vital constituents of the concrete. The mining of aggregates in rivers has led to deterioration of river basins, also increase in pollution and changes in pH level. The process of extraction of sediments causes the river to cut its channel through the bottom of the valley floor in both upstream and downstream of the removal site. The sand mining in rivers had gone up to such an extent that in many countries, there is a legal prohibition on sand mining. Even In places where there is no debar, nowadays satisfactory sand is not promptly available which is required to transport sand over a long distance. The search for an alternate source is of high-priority. Artificially manufactured sands are used as a substitute to the natural sands but are uneconomical. If an appropriate industrial or agricultural by-product, which is a waste material, is used to replace sand partially it will diminish the problems and complications due to the inadequacy of sand [1]. On the other hand, it will also be an environment friendly technique of disposal of huge quantities of materials that would otherwise contaminate land, air and water [5]. If this waste can be used as a partial sand replacement material in concrete, it will be an extremely valuable resource [3].

Lightweight concrete has been universally used in several structural applications and its utilization increments every year on a global basis [4]. The explanation for this is that using lightweight concrete has countless benefits. These encompass: a decrement in the dead load of the building, which contracts the size of structural members; the production of smaller and lighter precast components with economical casting, handling and transportation operations; the allocation of additional space due to the curtailment in size of the structural members; shrinkage in the risk of destruction due to earthquake and escalated thermal insulation and fire resistance [2].

As the scarcity of natural sand and its ill effects to the environment were solved by using artificial sand, but due to the high cost it is uneconomical to be employed in construction. Elementally the objective of this paper is to minimize the sand content in concrete by utilization of major plastic wastes and in addition, to reduce the dead load of concrete by using light weight plastic waste and air entraining agents resulting in economical and sustainable concrete.

The rest of this paper is organized as follows: Section II gives a description of the proposed in detail. Section III reports the experimental results and analysis. Finally, the conclusions are presented in Section IV.

## II. METHODOLOGY

### *I. Reducing sand content in concrete.*

There are numerous types of industrial plastic waste materials. The use of such materials in concrete is economical and helps in reducing disposal concerns. Collection of such waste is feasible and easily available. Hence Plastic waste such as polyvinyl chloride (PVC), Polypropylene (PP), Polyethylene (PE) can be used as a replacement of fine aggregate in concrete. Tests were carried out for replacing sand by 10%, 20%, 30%, 40% and 50% in concrete. Mixture of these wastes was used to fight against sand scarcity which is increasing day-by-day. Plastic waste such as polyvinyl chloride (PVC), Polypropylene (PP), Polyethylene (PE) having small granular particles of size 3mm to 4.5mm were collected from the industry. These granular particles were used as a replacement for sand in concrete. Following properties of plastic waste were determined in laboratory.

TABLE 1
PROPERTIES OF MATERIALS

| Sr. No. | Property | Types of plastic waste used | | |
|---|---|---|---|---|
| | | PE | PP | PVC |
| 1 | Density ($Kg/m^3$) | 910 to 925 | 946 | 1380 |
| 2 | Specific Gravity | 0.92 | 0.9 | 1.2 |
| 3 | Melting Point | $105^0$ to $115^0$ | $85^0$ to $145^0$ | $100^0$ to $260^0$ |

| | |
|---|---|
| PE | Polyethylene |
| PP | Polypropylene |
| PVC | Polyvinyl chloride |

TABLE 2
PROPERTIES OF AGGREGATE

| Physical Properties | Coarse Aggregate | Fine Aggregate |
|---|---|---|
| Specific Gravity | 2.85 | 2.433 |
| Bulk Density | 1600 Kg/m$^2$ | 1700 Kg/m$^2$ |
| Fineness Modulus | 4.65 | 2.2 |
| Water Absorption | 0.49% | 0.22% |
| Free Moisture (%) | NIL | 2 |

*II. Minimizing the dead load of concrete*

Superimposed load of concrete is reduced by using Aluminum powder which is used to obtain autoclaved aerated concrete by a chemical reaction generating gas in fresh concrete. So that when the concrete, it contains gas bubbles. Aluminum powder of about 0.2% to 0.5% is added. The powder is made from foil scrap and exists of microscopic flake-shaped aluminum particles. Aluminum powders that contain fractions finer than 100µm or 50µm are used as it is important in order to obtain required mechanical properties of the aerated concrete [6].

## III. RESULTS

Following results were obtained from the investigation with an aim to achieve Green concrete. Density of concrete was decreased with increase in Plastic waste content in concrete, which proves that the weight of concrete was decreased.

TABLE 3
DENSITY OF CONCRETE

| Replacement of sand in % | Average density of concrete Kg/m3 |
|---|---|
| 0 | 2594 |
| 10 | 2503 |
| 20 | 2427 |
| 30 | 2288 |
| 40 | 2204 |
| 50 | 2130 |

Fig 1 and Fig 2 shows the compressive strength of concrete cubes achieved after 7 days and 28 days respectively.

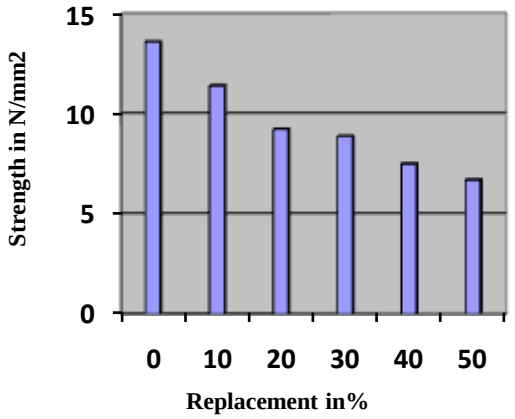


**Fig 1 Compressive Strength of concrete after 7 days**

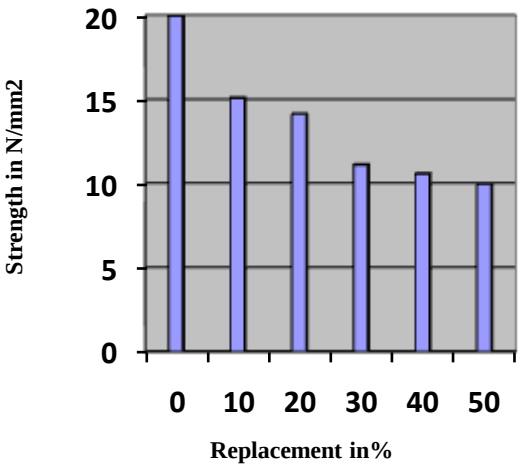


**Fig 2 Compressive Strength of concrete after 28 days**

## IV. CONCLUSION

Based on the results of the experimental investigation, following conclusions could be drawn as follows: In Concrete, Natural sand can be replaced with plastic waste by 10 to 20% to achieve green concrete. Sand can also be replaced up to 30% in the members of building which do not carry high load. Using plastic waste such as polyvinyl chloride (PVC), Polypropylene (PP), Polyethylene in concrete reduces the environmental issues and minimizes the difficulties of dumping the major plastic waste. This will help to tackle the increasing pollution all over the world, especially in countries that face the complications regarding waste. In addition to the environmental benefits, it was noted that using plastic scrap can be used to fight against the obstacle of scarcity of natural sand in India. Also it was perceived that using aluminum powder in

concrete containing plastic waste will minimize the dead load of concrete which is of crucial importance. Ultimately the use of such plastic waste material cuts down the cost of construction and also the aftermath of using plastic scrap in concrete will be magnificent.

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