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Effect of Waste Plastic as Partial Replacement of Aggregate in Concrete Mixture: A Review

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Abstract – *This paper represents a collection of ideas of various studies done on the use of Waste Plastic Materials in concrete mixes. Conclusions are drawn based upon the respective results of all the mentioned research papers.*

Key Words: Waste Plastic, Concrete Replacement, Concrete, Waste Management, Plastic, Environmental Friendly, PFRC

1. INTRODUCTION

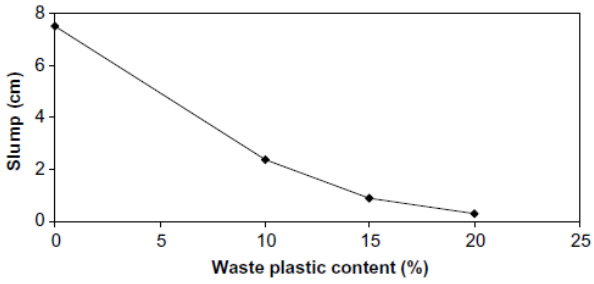
According to Central Pollution Control Board of India, Total plastic waste which is collected and recycled in the country is estimated to be 9,205 tonnes per day (approximately 60% of total plastic waste) and 6,137 tonnes remain uncollected and littered. This is a major environmental issue. Stray animals sometimes eat the waste plastic and die causing further aesthetic and environmental issues.

Much of it is not recycled, and ends up in landfills or as litter on land, in waterways and the ocean. For the first time, researchers have estimated the amount of plastic that makes its way into the oceans. A study published in December 2014 estimated the quantity of plastic floating in the ocean at nearly 270,000 tonnes. This is but a fraction of the total that finds its way into the oceans. Other studies suggest that the surface of the water is not its final resting place. Alarmingly, an unknown quantity of degraded plastic in the form of particles enters the food chain. Besides affecting marine life, plastic that gets into the food chain has serious health implications for humans. While the estimate of eight million tonnes of plastic being dumped into the oceans by 192 coastal countries in 2010 may appear staggeringly high, in reality the quantity would be many times more. Among the top 20 countries that have dumped the most plastic waste into the oceans at twelfth position, India is one of the worst performers. It has dumped up to 0.24 million tonnes of plastic into the ocean every year; the amount of mismanaged plastic waste per year is 0.6 million tonnes. In the case of China, the No. 1 polluter, the coastal population sends up to 3.53 million tonnes of plastic waste into the oceans each year.

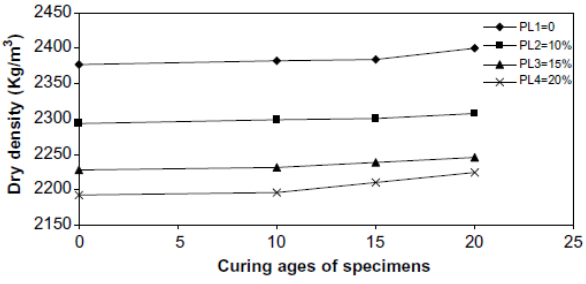
It is essential to manage this non decomposable waste as soon as possible. One of the methods can be using this waste in structural purposes, for example the use of plastic waste as partial replacement of the constituting materials of concrete mix, which is the current topic of discussion.

2. Literature Review

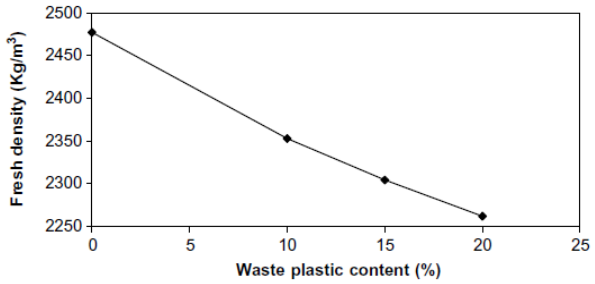
Zainab Z. Ismail [1] in his study concluded that, the adhesive strength between the surface of the waste plastic and cement paste decreases which causes the strength of the plastic concrete to decrease. In addition waste plastic is hydrophobic material which may restrict the hydration of cement. The slump values of waste plastic concrete mixtures showed a tendency to decrease below the slump of the reference concrete mixture. In spite of this decline in the slump of those mixtures, those mixtures are easy to work based on the consideration that workability has a broad range from very low to high workability for different applications.



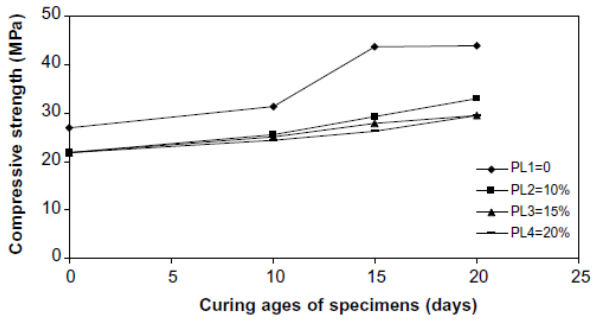
Slump of waste plastic concrete.



Dry densities.



Fresh densities.

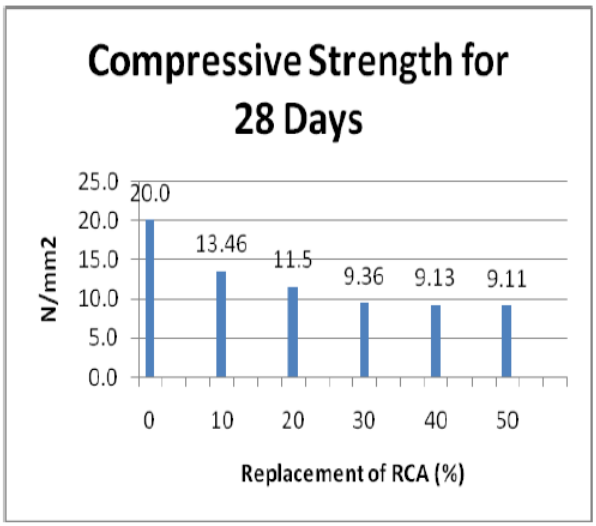


Compressive strength.

Raghatate Atul M [2] observed in 2012 that, Compressive strength of concrete is affected by addition of plastic pieces and it goes on decreasing as the percentage of plastic increases addition of 1 % of plastic in concrete causes about 20% reduction in strength after 28 days curing. The splitting tensile strength observation shows the improvement of tensile strength of concrete. Up to 0.8 % of plastic improvement of strength recorded after that addition of strength of concrete decrease with addition of plastic. It was established that it is, in fact possible the use plastic can be used to increase the tensile strength of concrete.

Nibudey. R.N [3], in 2013 observed in his study that, workability is reduced in PFRC. It was due to resistance offered by the fibers to the movement of aggregates. The dry density is also reduced in PFRC but it is beneficial to reduce dead weight of concrete. The relationship between cube and cylinder compressive strength is linear. The ratio of PFRC cube compressive strength to cylindrical compressive strength is nearly same as for reference concrete but no certain trend is observed. This preliminary study has thus shown that the relationships between compressive strength, as used in European standard for plain concrete, can be applied to concrete containing PET-fibers. It was observed during experimentations that normal concrete specimens were suddenly broken into two pieces either cubes or cylinders but PFRC specimens did not suddenly break and failure was ductile.

Promod S. Patil [4] observed that he modified concrete mix, with addition of plastic aggregate replacing conventional aggregate up to certain 20% gives strength with in permissible limit. Modified concrete casted using plastic aggregate as a partial replacement to coarse aggregate shows 10 % it could be satisfy as per IS codes. Density of concrete is reducing after 20% replacement of coarse aggregates in a concrete



Compressive Strength test of Concrete for 28 Days

T. Subramani [5] observed that, plastic waste can be disposed by using them as construction materials. Since the plastic waste is not suitable to replace fine aggregate it is used to replace the coarse aggregate. The compressive strength and split tensile strength of concrete containing plastic aggregate is retained more or less in comparison with controlled concrete specimens. However strength noticeably decreased when the plastic content was more than 20%. Has been concluded 20% of plastic waste aggregate can be incorporated as coarse aggregate replacement in concrete without any long term detrimental effects and with acceptable strength development properties.

3. CONCLUSIONS

1. Fine aggregate can't be replaced by plastic material so only coarse aggregates are used
2. The strength decreases drastically after replacing more than 20%.

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