Strength and Behavior of Concrete by Partial Replacement of Fine Aggregate With Recycled Plastic

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Abstract- *Due to rapid growth of population in countries like India the disposing of Solid waste is a major problem in our daily life. Numerous waste materials are generated from manufacturing processes, service industries and municipal solid wastes. The increasing awareness about the environment has tremendously contributed to the concerns related with disposal of the generated wastes. Solid waste management is one of the major environmental concerns in the world. With the scarcity of space for land filling and due to its ever-increasing cost, waste utilization has become an attractive alternative to disposal. Among the waste material, plastic is the material that is the major concern to most of the environmental effects. Research is being carried out on the utilization of waste plastic products in concrete. The use of waste products in concrete not only makes it economical, but also helps in reducing disposal problems. The development of new construction materials using recycled plastics is important to both the construction and the plastic recycling industries. Reuse of waste and recycled plastic materials in concrete mix as an environmental friendly construction material has drawn attention of researchers in recent times, and a large number of studies reporting the behavior of concrete containing waste and recycled plastic materials have been published. This paper summarizes a comprehensive review on the research articles on the use of recycled plastics in concrete based on whether they dealt with concrete containing plastic aggregates or plastic fibers. Furthermore, the morphology of concrete containing plastic materials is to explain the influence of plastic aggregates and plastic fibers on the properties of concrete. The properties of concretes containing virgin plastic materials were also reviewed to establish their similarities and differences with concrete containing recycled plastics. Concrete cube, cylinder and beam were casted taking 0% to 25% of plastic as partial replacement of fine aggregate and tested for 28days of compressive strength, flexural strength and split tensile strength of concrete.*

Keywords- Plastic waste, strength, cement, concrete, workability.

I. INTRODUCTION

Research concerning the use of by-products to augment the properties of concrete has been going on for many years. In the recent decades, the efforts have been made to use industry by-products such as fly ash, silica fume, ground granulated blast furnace slag (GGBS), glass cullet, etc., in civil constructions. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products.Big attention is being focused on the environment and safe guarding of natural resources and recycling of wastes materials. Many industries are producing a significant number of products which incorporate scrap (residues). In the last 20 years, a lot of works concerning the use of several kinds of urban wastes in building materials industrials process have been published. Many researchers have been extended to study new kinds of wastes to investigate deeply particular aspects. The addition of wastes, apart from the environmental benefits, also produces good effects on the properties of final products.

II. GENERATION OF PLASTIC WASTE

The quantity of solid waste is expanding rapidly. It is estimated that the rate of expansion is doubled every 10 years. This is due to the rapid growth of the population as well as the industrial sector. In a report, the National Council on Public Works Improvement identified the solid-waste crisis as an area of the infrastructure with great needs for improvement. The solid-waste crisis is important from an environmental and economical point of view. As landfill areas are rapidly depleting, the cost of solid-waste disposal is rapidly increasing.

Among the solid-waste materials, plastics have received a lot of attention because they are generally non-biodegradable. On a weight basis, there are about 10 billion kg of plastic wastes in the India per year, which represents about 7% by weight of the total solid wastes. However, plastic wastes are very visible, since they constitute about 30% by volume of the total solid wastes (Kline 1989). The various types of plastics in municipal wastes are Polyethylene terephthalate (PET), High density polyethylene (HDPE), Low density polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS) etc.The major users of plastic are the pack aging industries, consuming about41%,20% in building and construction, 15% in distribution and large industries, 9% in electrical and electronic, 7% in automotive, 2% in agriculture and 6% in other uses.One of the environmental issues with the plastics is that in most regions is the large number of plastic bottles, ploy thins and other plastic materials are deposited in domestic wastes and landfills. These plastic materials are not easily biodegradable even after a long period. Due to this, more landfill space is needed for disposal every year. However, the plastics have many good characteristics which include versatility, lightness, hardness, low linear dilation coefficient and good chemical resistance. These qualities render it well apt for concrete production or for other uses in building industry. Along with this, since it is not easily biodegradable, it is thought that plastics can be utilized as inert matter in cement matrix. In particular, plastic material particles can be incorporated as aggregates in concrete.

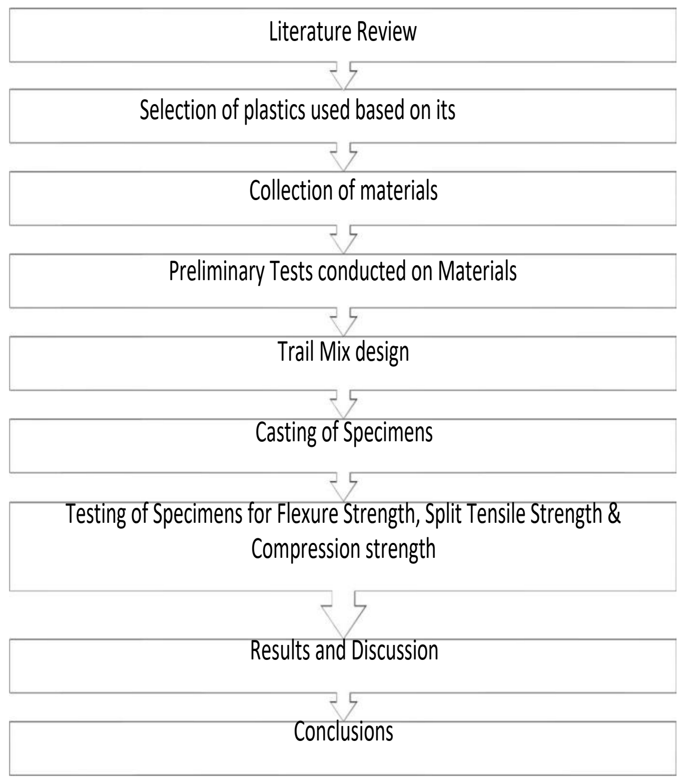
Recycled Plastics Aggregates

Three types of plastic aggregates (smaller, medium and coarser size)

Physical Properties of LDPE

S. No.	Characteristics	Value
1	Tensile Strength	0.20 - 0.40 N/mm^2
2	Notched Impact Strength	No break
3	Thermal Coefficient of Expansion	100 - 220 x 10^{26} Max.
4	Continued Use Temperature	65˚C (149 ˚ F)
5	Melting Point	110 ˚C (230 ˚ F)
6	Glass Transition Temperature	-125˚ C (-193 ˚ F)
7	Density	0.910 - 0.940 kg/m^3

III. METHODOLOGY



IV. EXPERIMENTAL PROCEDURE

Moulds cubes, cylinders

WORKABILITY TEST

Workability of fresh concrete is an important characteristic. It can be defined as the ease with which concrete can be worked. Working includes mixing, placing, compacting and finishing. It can be assessed by conducting two tests they are

1.Slump cone test

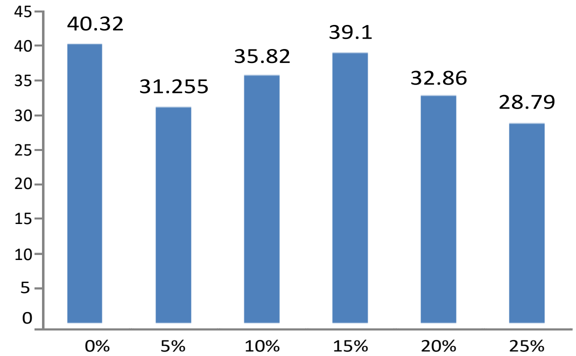
2.Compaction factor test

Slump cone test

V. RESULTS & DISCUSSIONS

Type of concrete	Specimen	Initial Crack Load(KN)	Compressive strength (N/mm^2)	Average value
Conventional Concrete	1	893.47	39.71	40.315
	2	920.7	40.92	
5% Replacement of FA with PA	1	750.15	33.34	31.25
	2	656.32	29.17	
10% Replacement of FA with PA	1	813.15	36.14	35.82
	2	798.52	35.49	
15% Replacement of FA with PA	1	860.4	38.24	39.015
	2	895.27	39.79	
20% Replacement of FA with PA	1	776.1	34.49	32.86
	2	702.7	31.23	
25% Replacement of FA with PA	1	702.22	31.21	28.79
	2	602.78	26.79	

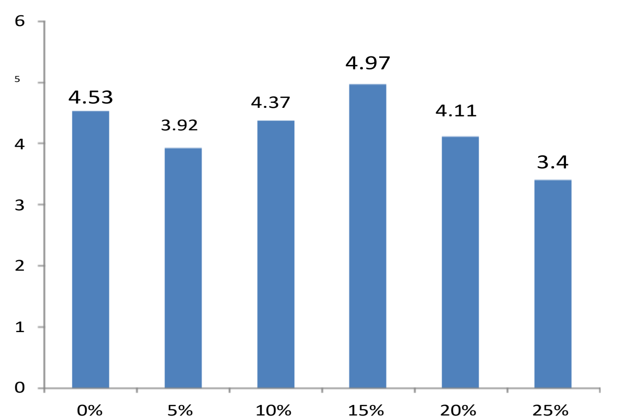
Compressive strength results of the cubes



Graph between percentage of fine aggregate replacement and respective compressive strength of the plastic replaced concrete

Type of concrete	Specimen	Initial Crack Load(KN)	Flexure strength (N/mm^2)	Average value
Conventional Concrete	1	11.85	4.74	4.53
	2	10.4	4.28	
5% Replacement of FA with PA	1	9.4	4.08	3.92
	2	10.2	4.94	
10% Replacement of FA with PA	1	11.98	4.79	4.37
	2	9.89	3.95	
15% Replacement of FA with PA	1	12.35	4.94	4.97
	2	12.5	5	
20% Replacement of FA with PA	1	10.4	4.16	4.11
	2	10.15	4.06	
25% Replacement of FA with PA	1	10.25	4.1	3.4
	2	6.75	2.7	

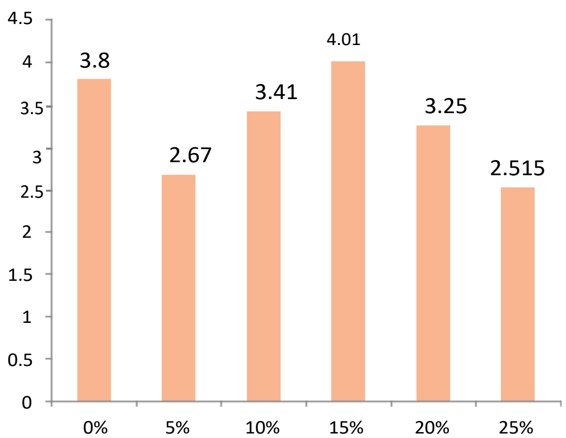
Flexure strength of beams



Graph between percentage of fine aggregate replacement and respective Flexural strength of the plastic replaced concrete

Type of concrete	Specimen	Initial Crack Load(KN)	Split Tensile strength (N/mm^2)	Average value
Conventional Concrete	1	291.22	4.12	3.80
	2	254.98	3.48	
5% Replacement of FA with PA	1	223.75	3.165	2.67
	2	153.55	2.17	
10% Replacement of FA with PA	1	248.1	3.51	3.41
	2	232.55	3.29	
15% Replacement of FA with PA	1	281.3	3.98	4.01
	2	289.8	4.1	
20% Replacement of FA with PA	1	250.22	3.54	3.25
	2	208.52	2.95	
25% Replacement of FA with PA	1	174.05	2.46	2.515
	2	181.60	2.57	

Split Tensile strength of beams



Graph between percentage of fine aggregate replacement and respective Split Tensile strength of the plastic replaced concrete

VI. CONCLUSIONS

In the present work, recycled plastics were used as fine aggregates and the properties of resultant mix was studied and compared with the control mix having normal aggregates. The conclusions drawn from the present study and the scope for further research are discussed in this chapter.

- The purpose of using plastic fibers in concrete is to enhance the mechanical and durability properties of conventional concrete in addition to securing environmental benefits.
- Concrete containing plastic aggregates exhibits lower slump than conventional concrete. Plastic aggregates with a smooth surface and spherical shape have a lower negative influence on the workability of concrete.
- For a given w/c ratio, the compressive strength, elastic modulus, splitting tensile strength, and flexural strength of concrete containing Plastic aggregates decrease with an increase in Recycled Plastic Aggregates (substitution level of plastic aggregates).
- The water absorption and porosity of concrete containing Plastic aggregates increases with an increase Recycled plastic aggregates
- Plastics can be used to replace some of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. This is useful in applications requiring nonbearing lightweight concrete, such as concrete panels used in facades.
- The effect of water-cement ratio of strength development is not prominent in the case of plastic concrete. It is because of the fact that the plastic aggregates reduce the bond strength of concrete. Therefore, the failure of concrete occurs due to failure of bond between the cement paste and plastic aggregates.
- Introduction of plastics in concrete tends to make concrete ductile, hence increasing the ability of concrete to significantly deform before failure. This characteristic makes the concrete useful in situations where it will be subjected to harsh weather such as expansion and contraction or freeze and thaw.

REFERENCES

[1] IS 516: 1959 Method of test for strength of concrete
[2] IS 2386 (Part VIII): 1963Methods of Test for Aggregates for Concrete.
[3] IS 383:1970, Specification for coarse and fine aggregates from natural sources forconcrete
[4] IS 10262:2009 Concrete Mix Proportioning-Guidelines
[5] Al-Manaseer, A.A., T.R., Dalal. 1997. "Concrete containing plastic aggregates", Concrete International, 47–52.
[6] Batayneh, M., Marie, I., AsiI., 2006. "Use of selected waste materials in concrete mixes". Waste Management (27)1870–1876
[7] Ravindrarajah, R.S., Tuck, A., 1994. Properties of hardened concrete containing
[8] Treated expanded polystyrene beads. Cement Concr. Compos. 16,273–277.
[9] Sabaa, B., Ravindrarajah, R.S., 1997. Engineering properties of lightweight concrete containing crushed expanded polystyrene waste. In: Fall Meeting, SymposiumMM,
[10] Advances in Materials for Cementitious Composites December 1997. Materials Research Society, pp.1–3.
[11] Tang, W., Lo, Y., Nadeem, A., 2008. Mechanical and drying shrinkage properties of structural-graded polystyrene aggregate concrete. Cement Concr. Compos. 30, 403–409.

[12] Wang, R., Meyer, C., 2012. Performance of cement mortar made with recycled high impact polystyrene. Cement Concr. Compos. 34,975–981.
[13] Mesbah, H.A., Buyle-Bodin, F., 1999. Efficiency of polypropylene and metallic fiberson control of shrinkage and cracking of recycled aggregate mortars. Constr. Build. Mater. 13,439–447.
[14] RahmatMadandoust, Malek Muhammad Ranjbar, S. Yasin Mousavi.2011. An investigation on the fresh properties of self-compacted lightweight concrete containing expanded polystyrene.3721–3731
[15] Kumar, K., Prakash, P., 2006. Use of waste plastic in cement concrete Pavement. Adv.Mater. Res. J. 15, 1–21
[16] Naik, T.R., Singh, S.S., Huber, C.O., Brodersen, B.S., 1996. Use of post-consumer waste plastics in cement-based composites. Cem. Concr. Res. 26, 1489–1492.Lima,P.R.L.,