Vishal Yadav al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 1, Issue 3, December 2014, pp. 24-27

Study on Properties of Concrete Containing Recycled Plastic Aggregate

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***Abstract*— The use of plastic is increasing day by day. This creates substantial garbage every day which is much unhealthy. A healthy and sustainable reuse of plastics offers a host of advantages. The aim of this study covers the use or recycled plastics as replacement of coarse aggregates in concrete. The main aim of the study is to investigate the change in properties of concrete with the addition of plastics in concrete. It is found that the use of plastic aggregates results in the formation of lightweight concrete. The compressive, as well as tensile strength of concrete reduces with the introduction of plastics.**

***Keywords*— Concrete, Plastic aggregate, Coarse aggregate.**

I. INTRODUCTION

The use of by-products is to increase the properties of concrete has been going on for many years. Quantities of waste material have been increasing significantly without being recycled increasing the risk to public health due to the scarcity of land area. This growing problem can be alleviated if new disposal options other than landfill can be found 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.

One of the new waste materials used in the concrete industry is recycled plastic. For solving the disposal of large amount of recycled plastic material, reuse of plastic in concrete industry is considered as the most feasible application. Recycled plastic can be used as coarse aggregate in concrete. However, it is important to underline that re-using of wastes is not yet economically advantageous, due to the high costs of transport and its effect on the total costs of production. Moreover, it is important not to neglect other costs, directly referable to the kind of wastes, due, in particular, to the need of measuring gas emission, during firing, and the presence of toxic and polluting elements.

DEFINITION OF PLASTIC

A material which contains one or more number of polymers having large molecular weight.Solid in its finished state or same state will manufacturing or processing into finished articles is known as Plastic .Plastics can be separated into two types. The first type is thermoplastic, which can be melted for recycling in the plastic industry. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylen etc. The second type is thermosetting plastic. This plastic cannot be melted by heating because the molecular chains are bonded firmly with meshed crosslink. These plastic types are known as phenolic, melamine, unsaturated polyester, silicone, and polyurethane Looking to the global issue of environmental pollution by post-consumer plastic waste, research efforts have been focused on consuming this waste on massive scale in efficient and environmental friendly manner. Researchers planned to use plastic waste in form of concrete ingredient as the concrete is second most sought material by human beings after water. The use of post-consumer plastic waste in concrete will not only be its safe disposal method but may also improve the concrete properties like tensile strength, chemical resistance, drying shrinkage on short and long term basis.

Polymers have a number of vital properties, which exploited alone or together, make a significant and expanding contribution to constructional needs.

1. Light weight
2. Good Insulation for cold, heat and sound saving energy.
3. It is economical and has a longer life.
4. Maintenance free (such as painting is minimized)
5. Durable and corrosion resistant

Table no 1

S.No	Characteristics	Values Obtained
1	Normal Consistency	33%
2	Initial Setting time	48 min
3	Final Setting time	240 min
4	Fineness	4.8 %
5	Specific gravity	3.09

II. EXPERIMENTAL PROGRAM ME

The concrete properties made with and without plastics, used as coarse aggregates. The basic tests carried out on materials used for casting concrete samples followed by a brief description about mix deign and curing procedure adopted. At the end, the various tests conducted on the specimens are discussed.

Materials a) Cement b) Coarse aggregate c) Fine aggregate(sand), d) Recycled Plastic aggregate e)Water.

a)Cement :- In the mix design Cement of 53-grade was used and results have been tabulated in table.

b) Coarse Aggregate:- Coarse aggregate shall comply with the requirement of IS 383 as for as possible crushed Aggregate shall be used for ensuring adequate durability. The results of various tests conducted on coarse aggregate used and results have been tabulated in table.

Table no 2

Sno	Characteristics	Value
1	Type	Crushed
2	Maximum size	20 mm
3	Specific gravity (20 mm)	2.825
4	Total water absorption (20 mm)	3.645
5	Fineness modulus (20 mm)	7.68

C) Fine aggregate:- Fine aggregate shall conform to requirement of IS 383. The fine aggregates belongs to grading zone 3 For river sand following table should be reviewed.

Table no 3

S. No.	Characteristics	Value
1	Type	Uncrushed (natural)
2	Specific gravity	2.68
3	Total water absorption	1.02%
4	Fineness modulus	2.507
5	Grading zone	III

d) Plastics Aggregates:- Recycled plastic was used to replace coarse aggregates for making concrete specimens. These aggregates were available in three different sizes therefore All the three aggregates were mixed together in a proportion so as to achieve maximum packing density. The results of various tests conducted and results have been tabulated in table.

Figure 1: Picture showing plastic aggregates

Table no 4

Trial s no	Percentage of plastic aggregate		Packing density
	PB (%)	PM(%)	
1	100	0	0.543
2	90	10	0.545
3	80	20	0.555
4	70	30	0.564
5	60	40	0.567
6	50	50	0.564
7	40	60	0.563
8	30	70	0.554
9	20	80	0.556

Table showing Coarser sized plastics aggregates and the medium sized plastics aggregates

Table no 4

Trials no	Percentage of plastic aggregate density(kg/m^3)		Packing density
	Coarse sized size (60%PB+40 %PM)	Small size aggregate	
1	100	0	0.565
2	90	10	0.572
3	80	20	0.579
4	70	30	0.578
5	60	40	0.590
6	50	50	0.586
7	40	60	0.585
8	30	70	0.582
9	20	80	0.589

Table showing Coarser sized plastics aggregates (60% PB+40%PM) and smaller sized plastics aggregates (PS)

e) Water: - Generally, water that is fit for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it is suspected that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent discharge of harmful wastes into the stream. In the present, potable tap water is used for casting.

III. MIXTURE PROPORTIONING

As per design mix tests are carried out on a wide range of water-cement ratios, ranging from 0.4 to 0.52. The control mix is designed with the Indian Standard Code guidelines. For making the mixes containing plastics, the amount of plastics is calculated by using the specific gravity of plastics, in place of the specific gravity of coarse aggregates. The resultant mix proportions of all the mixes are tabulated below

S. No	W/C Ratio	Water Kg/m^3	Cement Kg/m^3	Fine Aggregates Kg/m^3	Coarse Aggre3gates Kg/m^3	Plastics Kg/m^3	Mix proportions Kg/m^3
1	0.40	194.4	485.9	503.8	1121.4	-	1:1.04:2.31
2	0.42	194.4	462.8	517.8	1127.9	-	1:1.12:2.44
3	0.44	194.4	441.8	528.3	1134.3	-	1:1.20:2.57
4	0.46	194.4	422.5	542.6	1138.7	-	1:1.28:2.69
5	0.48	194.4	404.9	552.8	1143.2	-	1:1.37:2.82
6	0.50	194.4	388.7	566.1	1143.9	-	1:1.46:2.94
7	0.52	194.4	373.8	575.4	1144.3	-	1:1.54:2.99
8	0.40	194.4	485.9	503.8	-	474.3	1:1.04:0.98
9	0.42	194.4	462.8	517.8	-	476.7	1:1.12:1.03
10	0.44	194.4	441.8	528.3	-	479.5	1:1.20:1.08
11	0.46	194.4	422.5	542.6	-	481.8	1:1.28:1.14
12	0.48	194.4	404.9	552.8	-	483.4	1:1.37:1.19
13	0.50	194.4	388.7	566.1	-	484.2	1:1.46:1.25
14	0.52	194.4	373.8	575.39	-	484.7	1:1.54:1.29

Table no 4

As per design mix tests are carried out on a wide range of water-cement ratios, ranging from 0.4 to 0.52. The control mix is designed with the Indian Standard Code guidelines. For making the mixes containing plastics, the amount of plastics is calculated by using the specific gravity of plastics, in place of the specific gravity of coarse aggregates. The resultant mix proportions of all the mixes are

IV. CASTING AND CURING

For casting, all the moulds were cleaned and oiled properly. These were securely tightened to correct dimensions before casting. Care was taken that there is no gaps left from where there is any possibility of leakage out of slurry. Careful procedure was adopted in the batching, mixing and casting operations .After the casting the cube remove from the mould after 24hrs and than put the curing tank for curing of 28 days after the curing completed .remove from curing tank and dry to normal atmosphere at least 2hrs for the surface dry then to check it for compression testing machine and get the results.

Table no 5

w/c Ratio	Compressive strength (MPa)		Percentage reduction in compressive strength (%)
	control concrete	plastic concrete	
0.40	40.67	13.50	66.80
0.42	39.53	11.50	70.90
0.44	38.47	10.35	73.09
0.46	36.24	10.21	71.82
0.48	35.0	9.92	71.65
0.50	31.5	9.0	71.42
0.52	26.67	10.0	62.50

Figure 2 Picture showing Compression testing machine

Figure 3 Picture showing Cube test

V. CONCLUSIONS

Following are the conclusions can be made based upon the studies made by various researchers:-

1. 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
2. For a given w/c, the use of plastics in the mix lowers the density, compressive strength and tensile strength of concrete.
3. 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.

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