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Replacement of Melt Densified Light Weight Plastic Aggregate with Natural Aggregate

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Abstract

Disposal of plastic waste in an environment is considered an important issue due to its very low biodegradability and presence in large quantities. Hence, recycled plastic is a major solution. Present investigation melt-densified material used as light weight coarse aggregate in concrete. Melt-Densified Aggregates (MDA) was prepared from post-consumer recycled plastic bags by melting. A comparative study was done with conventional specimens. Melt-Densified Aggregates can be used for partial replacement of aggregates in a concrete mixture. The unit weight of the concrete mix was reduced contributing to light weight structures and ecological sustainability. As much as 60 % of both industrial and urban plastic waste is recycled which obtained from various sources. Hence, MDA solves the 3-fold problem of pollution, light weight structure and economy.
Keyword- Polypropylene (PP), Melt Low Densified Plastic (MLDP), Light Weight Aggregate, Recycled Plastic

I. INTRODUCTION

A. General Information

Current trend of research in concrete technology is to utilize waste materials in fine aggregates, cement or concrete so as to save natural resources, to achieve economy and to save environment polluting from this waste.

Concrete is the most widely used man made construction material in the world. The exploitation of aggregates for construction results in negative consequences such as noise pollution, air pollution and the destruction of the habitats of flora and fauna, damages to landscape, loss of land, reduction in water quality and displacement of inhabitants. To mitigate these and other negative impacts, research efforts have been directed towards alternative materials, especially those that can potentially contribute to the reduction of negative environment impacts. The advantages of replacing natural rock aggregates with materials which would otherwise impact negatively on the environment include reduction of the cost of construction, sustainability of concrete production and reduction of negative environmental impacts.[1]

B. Need of Research

Plastics waste scenario in the world, of the various waste materials, plastics and municipal solid waste are great concern. Finding proper use for the disposed plastics waste is the need of the hour. Generation of plastic waste is one of the fastest growing areas. Every year more than 500 billion plastic bags are used. The biggest component of the plastic waste is polyethylene [7].

Disposal of waste plastic consumer bags from the domestic has become a major problem to the agencies in the town and cities. The waste plastic bags available in the domestic waste mainly consist of low density polyethylene (LDPE). Plastic bags dumped in the dustbins find their way into the drainage system and clog them. Often, these are burnt along the roadside, which produces fumes causing air pollution. Panigrahi et al., 2005, described as the postconsumer plastic are the materials arising from products that have undergone a first full service life prior to being recovered. The biggest source of plastic waste is households. It is a big challenge though to collect and sort the plastic waste. The processes of separating materials according to resin types are very important because most resin types are thermodynamically incompatible with other resins. Mixed plastics moulded product generally has poor, brittle properties unless a modifier is added to improve compatibility [2]. Recycling plastic usually. Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. PCAs which have low crushing values will not be crushed as easily as the stone aggregates. These aggregates are also lighter in weight compared to stone aggregates. Since a complete substitution for NCA was not found feasible, a partial substitution with various percentage of PCA was done.

II. OBJECTIVE/BROAD SCOPE OF THE RESEARCH

Involves processes such as melting, shredding or granulation of waste plastics. Plastic waste has been used with relative success to produce concrete, lightweight concrete and components of construction. 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 and creep on short and long term basis.

Naik et al., 1996 [5] investigated the effect of post-consumer waste plastic in concrete as soft filler. The compressive strength decreased with increase in the amount of the plastic in concrete, particularly above 0.5% plastic addition. Therefore, in order to maintain a particular compressive strength level, plastic concentration in concrete must be controlled. However, the amount of plastic addition can be increased substantially if particles are further processed to improve the bond area and stress transfer capacity of the particles. Meg Calkins, 2009 [4], says that plastics offer several benefits for site construction. Some can be durable, waterproof, decay resistant, flexible, integrally coloured, inexpensive, and low maintenance. They can incorporate substantial recycled content, can be recycled themselves, and are relatively lightweight, conserving transportation energy use. Low-density polyethylene (LDPE) has been used by many to modify asphalt cement and to improve the properties of bituminous mixes as an asphalt modifier in order to improve the performance and extend the lifetime of asphalt pavement mixtures [3]. LDPE is a thermoplastic polymer consisting of long chains of the monomer ethylene. It is created through polymerization of ethane.

III. MATERIAL USED

In this project work Materials used as Ordinary Portland Cement (OPC) , Melt-Densified light weight aggregates, Fine aggregates, Coarse aggregates and Portable water. Properties of each material were tested & verify in the laboratory.

A. O.P.C. Cement

Determination of Preliminary properties of cement can be determined as mentioned in below table.

SR NO.	CHARATERISTIC	RESULT	AS PER IS: 8112-1939
1	Specific Gravity	3.14	3.15
2	Initial Setting Time	35 Min	>30 Min
3	Final Setting Time	225 Min	<600 Min
4	Fineness of cement	10%	10%
5	Compressive Strength 3 days 7 days 28 days	 23.5 35.8 60	 >23 >33 >53

Table 1: Test results of OPC Cement

B. Melt-Densified Light Weight Aggregates (MDA)

Polyethylene consumer bags were gathered from residential houses and from retail shops. [10] The plastic waste sheet was shaped as desired, e.g., as a ball with a diameter of 15-20mm. The melting temperature was maintained at 160°C in Muffle Furnace. The plastic waste aggregates were densified by heat treatment, which consisted of heating it at temperatures 160°C for 20Seconds in the Muffle Furnace. Then, the hot aggregate was removed from the furnace and allowed to cool at room temperature. [8] The shapes and textures of the samples were not homogenous or circular, but they were a mixture of angular shapes and round shapes, much like crushed stone and thus making of MDA. Present study MDA materials of more or less 20 mm were replaced as part of conventional coarse aggregates to make mixture specimens.

TEST OF PLASTIC AGGREGATE	RESULT
Nominal size	20 mm
Specific gravity	0.87 kg/m^3
Water absorption	0.342L
Impact value	0.65%

Table 2: Test results of Melt-Densified lightweight aggregates

C. Fine Aggregates

Natural sand with a 4.75-mm maximum size was used as a fine aggregate. It was tested as per Indian Standard Specifications IS: 383-1970. Its properties are shown in table.

TEST OF FINE AGGREGATE	RESULT
Fineness modulus	2.4
Zone	2
Specific Gravity	2.59 kg/m^3
Water Absorption	0.017L

Table 3: Properties of Fine aggregates

D. Coarse Aggregates

Coarse aggregate used in this study were 20-mm nominal size, and were tested as per Indian Standard Specifications IS 383-1970.

TEST OF NATURAL AGGREGATES	RESULT
Nominal size	20 mm
Specific gravity	2.90kg/m^3
Water absorption	0.019L
Impact value	5.40%
Los Angeles	2.4%

Table 4: Properties of Coarse aggregates

E. Potable Water

Water used in this experiment work for mixing as conforming to IS: 3025-1964

IV. PREPARATION OF CONCRETE SPECIMENS

The fresh concretes were cast into 15 cm cube moulds with vibration following the procedure prescribed by ASTM, C31-84. The tests are carried out on water-cement ratio of 0.33. The concrete specimens were separated out from the mould after 24 hours of moulding and kept in water for 7-28 days for curing. Average 28 days compressive strength of at least three 15 cm concrete cubes. The control mix (M20) is designed with the Indian Standard Code guidelines (IS: 10262:2009). The melt densified aggregate were added to the mixture in various amounts 10- 20% of weight of the conventional aggregates. Table shows the mix proportion of MDA concrete and conventional concrete.[9]

PARAMETER	CONCRETE SPECIMEN PROPOTIONS		
	REFERANCE MIX	10%	20%
W/C Ratio (%)	0.33	0.33	
Water (Kg/m^3)	175.29	175.29	175.29
Cement (Kg/m^3)	375	375	375
FA (Kg/m^3)	778.37	778.37	778.37
CA (Kg/m^3)	1094.49	985.04	875.59
MDA (Kg/m^3)	-	109.449	218.898
Mix Proportions	1:2.07:2.918:0	1:2.07:2.626:0.29	1:2.07:2.334:0.58

Table 5: Preparation chart of concrete specimens

V. CONCLUSIONS

The initial feasibility tests with partial replacement of aggregates with Melt Densified Light Weight Plastic aggregates gave positive results indicating practical feasibility of the material. From the experimental test results there was considerable decrease in the overall weight of the cube with negligible change in strength. Further tests will be done for comparative study of strength. Hence, the MDA can be used for pavements and light weight structures.

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