Indian Journal of Science and Technology, *Vol 8(12), DOI: 10.17485/ijst/2015/v8i12/54462, June 2015*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Utilisation of Waste Plastics as a Partial Replacement of Coarse Aggregate in Concrete Blocks

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Abstract

The rapid industrialization and urbanization in the country leads lot of infrastructure development. This process leads to several problems like shortage of construction materials, increased productivity of wastes and other products. This paper deals with the reuse of waste plastics as partial replacement of coarse aggregate in M20 concrete. Usually M20 concrete is used for most constructional works. Waste Plastics were incrementally added in 0%, 2%, 4%, 6%, 8% and 10% to replace the same amount of Aggregate. Tests were conducted on coarse aggregates, fine aggregates, cement and waste plastics to determine their physical properties. Paver Blocks and Solid Blocks of size 200 mm X 150 mm X 60 mm and 200 mm X 100 mm X 65 mm were casted and tested for 7, 14 and 28 days strength. The result shows that the compressive strength of M20 concrete with waste plastics is 4% for Paver Blocks and 2% for Solid Blocks.

Keywords: Coarse Aggregate, Fine Aggregate, Paver Blocks, Solid Blocks, Waste Plastics

1. Introduction

As the world population grows, wastes of various types are being generated. The creation of non–decaying and low biodegradable waste materials, combined with a growing consumer population has resulted in waste disposal crisis. One solution to this crisis is recycling wastes into useful products. Many Government agencies, private organizations and individuals have completed or in the process of completing a wide variety of studies and research projects concerning the feasibility, environmental suitability and performance of using waste plastics in construction field which needs better and cost effective construction material and reuse of waste plastics and save our world from environmental Pollution. With the increase in development, there is an increase in cost of construction and the maintenance of pavements. So, the Engineers and Designers have been looking for new concept of using waste plastics in cement concrete Paver Blocks and Solid Blocks. This pavement are less susceptible to rutting, minimum fatigue or thermal cracking, low stripping due to moisture and offers great durability, little or no impact on processing and also produces ecofriendly construction and costs less.

Ankur Bhogayata and Narendra K. Arora[1], discussed the fresh and hardened properties of waste virgin plastic mix concrete have been studied (CUR Report 1991). A number of concrete mixes were prepared in which sand was partially replaced by waste plastic flakes in varying percentages by volume. Waste plastic mix concrete with and without superplasticizer was tested at room temperature. Forty-eight cube samples were molded for compressive strength tests at three, seven, and twenty-eight days. Eight beams were also cast to study the flexural strength characteristic of waste plastic mix concrete. It was found that the reduction in workability and compressive strength, due to partially replacement of sand by waste plastic, is minimal and can be enhanced by addition of superplasticizer.

Prvinkumar and Kaushik S. K.[4], stated in the era of unbridled consumption, and mountains of waste generated every day, the quest for a Clean Chennai demands a multi-faceted response. The 'city' now extends

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to distant suburbs, and the Chennai Corporation's official record puts the volume of garbage collected at over 4,500 tons a day, with each resident generating about 700 grams on average. As the capital of arguably the most urbanized State in the country, Chennai is in a race to contain garbage. For most residents, 'out of sight, out of mind' is the operative principle, and the sight of the trash compactor lorry carrying away the waste overflowing from street bins is a big relief. Aesthetically, it is wet, putrefying waste from kitchens, hotels, vegetable markets and even offal from meat shops thrown on the street, around overflowing bins, that is giving the metro a 'dirty' reputation.

1.1 The Problem of 'Inerts'

There is another major component that jeopardizes the Clean Chennai aspiration. Construction and demolition work contributes a staggering 35 per cent of trash classified as 'Inerts'-rubble and debris. Inerts are commercially valuable to fill up road surfaces in newly-formed housing layouts, suburban land developments and so on. Yet, it is seen as a problem with no demand-supply match. The legendary earth-friendly architect, Laurie Baker promoted the reuse of such material to make fresh bricks, using just a mould, debris and lime mortar and a small quantity of cement for quick setting. A fair amount of debris, dirt and muck is generated along road margins by the Corporation and its contractors.

A Clean Chennai would have to find ways to handle waste batteries, fluorescent bulbs, discarded detergents, paints, solvents, cosmetics, pharmaceuticals, pesticides and insecticides, which are classified as 'household hazardous waste' – and the odd dangerous object kept in the attic.

1.2 Spare the Suburbs

If new uses can be found for about 75 per cent of Chennai's waste nothing less than 3,300 tonnes it need not be carted off to dumps in a never-ending stream of expensive lorry trips. This can spare the 400 acres of suburbs in Perungudi and Kodungaiyur now in use as dumps, with an officially estimated life until 2015. The hostile bid to take land from suburban villagers in Kuthambakkam (near the vulnerable Chembarambakkam drinking water lake) to create new dump sites can also be ended.

Is the citizen doing enough to reduce the 700 grams that he is contributing per capita? Consider that waste that biodegrades easily (is broken down biologically by natural microbial action), forms about 40 per cent of the garbage. It should be possible, therefore, to reduce this quantum substantially with community initiatives such as composting. The idea is not new, and organisations such as Exnora and many others were actively pursuing this activity before mechanised waste transport, corporatised waste management and out-of-sight land filling became the norm.

1.3 Wake Up and Act

A 'Clean Chennai' would therefore have to be led by a middle class renaissance in the way waste is handled right at the source, sorted in a manner that leaves little for the dump. It would replicate the rainwater harvesting success, where enlightened citizens led and the government followed, making it compulsory. That would of course involve rekindling the community action agenda, and suppressing the 'not in my backyard' instinct. Small hotels and traders who dump their waste on the street under cover of darkness would need to reform. Shopping malls would have to make source segregation part of mall-crawling fun activity, using colourful bins for paper, metal, glass, and biodegradables. Informal waste-pickers would have to be mainstreamed into the system.

A massive barrier exists for citizens who wish to work with the Corporation. That is the model of waste management that flows from the 'out of sight' goal. The civic body has been following the policy of engaging private contractors whose duty it is to meet the requirements of law, which is the Municipal Solid Waste [Management and Handling] Rules, 2000. These include segregation of different kinds of trash at source, but ultimately, the companies are paid merely to transport the waste to the dumping yards. The heavier the waste is the better.

1.4 Invert the Model

A campaign to do things differently would mean inverting the model. The Corporation should encourage less and less waste being transported to landfills at great expense. The intrinsic value of the waste — organic, plastic or inerts — must be recovered by reusing or recycling it.

2. Methodology

- To find properties of Coarse, Fine Aggregates and Cement

- To find out physical properties of Waste Plastics
- To conduct mixed design as per IS: SP 23 – 1982 (1)
- To cast both Paver Block (Interlocking) and Solid Blocks with Waste Plastics
- To study the Compressive strength in 0%, 2%, 4%, 6%, 8% and 10% of waste plastics added samples as a replacement of coarse aggregate.

2.1 Materials

2.1.1 *Aggregates (Coarse and Fine Aggregates)*

Various properties of aggregates can influence the performance of concrete; therefore various considerations have to be kept in mind while selecting the material. Aggregates used in present study, were tested for their specific gravity and other properties and results have been tabulated.

2.1.2 *Cement*

Ordinary Portland cement of 43 – grade was used as it satisfied the requirements of IS: 269 – 1969 and results have been tabulated

2.1.3 *Mixing and Curing Water*

IS: 456 – 2000 (Cl. 2.20) water, used for mixing and curing of concrete. Permissible limits for solids in water are as per IS: 456 – 2009. The maximum permissible limit of chloride content in water for RCC work has been reduced from 1000mg per litre in IS: 456 – 1978 to 500mg per litre in IS: 456 – 2000. In addition to these requirements acidity and alkalinity for water has to be considered.

2.1.4 *Plastics*

Plastics that cannot be degraded further is been powdered into fine particles. These plastics consist mainly of High Density Polyethylene (HDPE).

2.2 Casting and Curing

Usually M20 concrete is used for most constructional works, hence in this project M20 concrete is taken and waste plastics is used as Replacement of aggregate. Aggregates such as 0%, 2%, 4%, 6%, 8% and 10% was added in percentage, in order to replace the same amount of Aggregate. Tests were conducted on coarse aggregates, fine aggregates, cement and waste plastics to determine their physical properties. Concrete blocks (Interlocking Paver Block) and Solid Blocks of size 200 mm X 150 mm X 60 mm (Paver Block) and 200 mm X 100 mm X 65 mm were casted and tested for 7, 14 and 28 days strength.

2.3 Testing for Compressive Strength

Testing of casted specimens are tested for 7, 14 and 28 days compressive strength by using hydraulic compressive testing machine strength. After conducting Compressive strength testing the test Results are tabulated.

Table 1. Physical Properties of Aggregate

Type of Aggregate	Coarse	Fine
Specific Gravity	2.6	2.7
Water Absorption	0.50 %	1.0 %
Free (surface) Moisture	Nil	2.0 %
Aggregate Impact Value	18.57 %	----
Aggregate Crushing Value	17.88 %	----
Los-Angeles Abrasion Value	23.60 %	----

Table 2. Physical Properties of Cement

Specific Gravity	3.15
Initial Setting Time	36 Minutes
Final Setting Time	10Hours
Soundness (by Autoclave method)	0.6

Table 3. Physical Properties of Plastics

Specific Gravity	1.04
Density (g/cc)	0.945 - 0.962
Melting Point (^{0}C)	75 – 100
Softening Point (^{0}C)	110
Elongation at Break (%)	>500
Fineness	<2.36 mm

Table 4. Compressive Strength Test Report M 20 Grade Paver Block

Sl No	Waste Plastic in %	7 Days compressive strength in N/mm2	14 Days compressive strength N/mm2	28 Days compressive strength N/mm2
1	0 %	9.5	16.5	26.9
2	2 %	9.3	16.2	26.4
3	4 %	9	16	26.1
4	6 %	7	13.5	20
5	8 %	5.5	12.7	17
6	10 %	4	9	14

Table 5. Compressive Strength Test Report M 20 Grade Solid Block

Sl No	Waste Plastic in %	7 Days compressive strength in N/mm2	14 Days compressive strength N/mm2	28 Days compressive strength N/mm2
1	0 %	8.7	15.3	23.3
2	2 %	8.5	15.5	23
3	4 %	7	14.5	19
4	6 %	6	12	16
5	8 %	4,5	9	14,5
6	10 %	4	7	11

Figure 1. Daily used Waste Plastics.

Figure 2. Cutting of Waste Plastics.

Figure 3. Mixing of Waste Plastics with Concrete.

Figure 4. Casted Concrete Blocks.

Figure 5. Testing of Blocks.

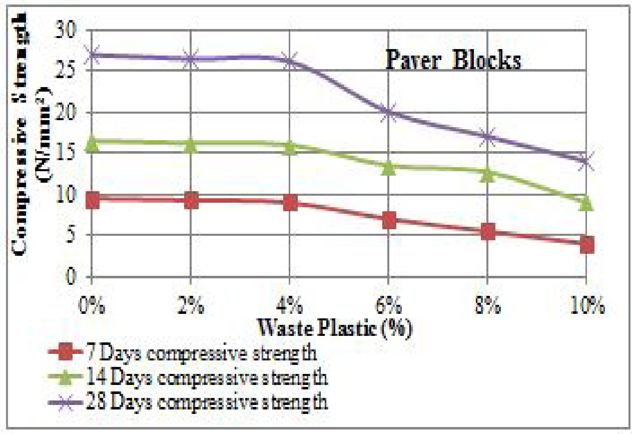

Figure 6. Test results of Paver Blocks.

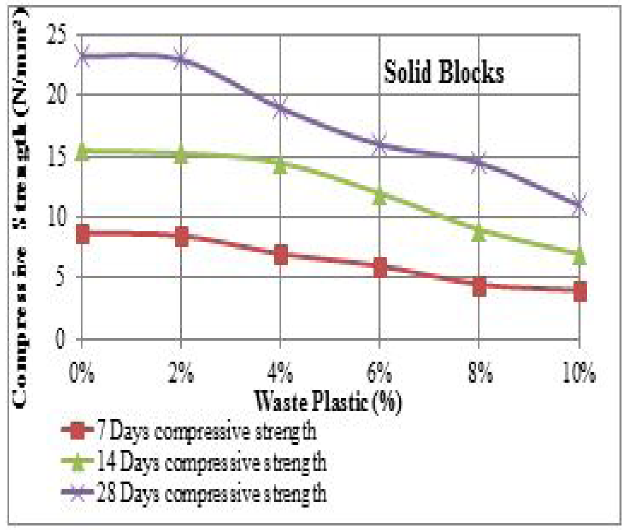

Figure 7. Test results of Solid Blocks.

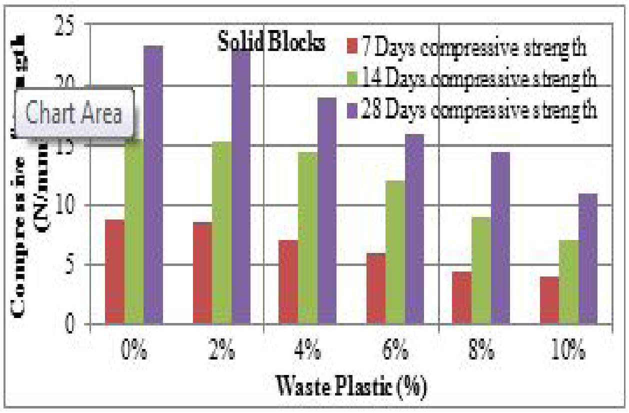

Figure 9. Experiment inferences of Solid Blocks.

3. Results and Discussion

In the present investigation it is found that optimum up to 4% by replacing of waste plastics there is a slight deviation of compressive strength. From the test results it was observed that the compressive strength value of the concrete mix decreased with the addition of waste plastics more than 4% of waste plastics. So we can add waste plastics in concrete blocks so this will helps to reuse of plastics in concrete blocks.

4. Conclusion

Looking into the above aspects, the analysis concluded that the waste plastics can be used in the cement concrete mix. This modified cement concrete mix is applicable in the construction of rigid pavements. The compressive strengths of modified cement concrete are as equal as plain cement concrete. The optimum modifier content of waste plastics is found to be 4% for paver blocks and 2% for solid blocks. The cost of construction will reduce and also helps to avoid the general disposal technique of waste plastics namely land filling and incineration which have certain burden on ecology.

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