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Experimental Investigations on Partial Replacement of Coarse Aggregate by Waste Plastic and Waste Marbles in Concrete

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ABSTRACT

Plastic waste is big issue in todays environments and which results in public health issues. Now a days public does not have any alternative on any kind of plastic produce so, to overcome this problems, plastic products are used in construction industries due to scarcity of cement, sand, aggregate in future. This review paper includes the partial replacement of waste plastic(20%)as a coarse aggregate and studied the properties of waste plastic in concrete. large amount of waste has been produced during mining and processing stages by Marble industry. This waste is dumped on to open land which creates a lot of environmental problems. The main objective of this study was utilization of marble waste as a replacement for conventional natural coarse aggregate in concrete. Experimental investigations were carried out to determine the accessibility of use of marble waste as a coarse aggregate in concrete. Conventional natural coarse aggregate was replaced by marble aggregate in different percentages 40% by weight. The average compressive strength of all the concrete mixes containing marble aggregate increased 40% by weight. From the results it was found that, the workability, compressive strength and permeability increased with increase in substitution of marble aggregate.

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

Keywords: Environment, Plastic Waste, Natural Fine Aggregate, Compressive Strength Permeability, Waste Marbles.

I. 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. This is a major environmental issue. Plastic waste is a material which is harmful for public health and environment also. Plastic waste is a non bio-degradable material. The degraded plastic waste in the form of particle which enters the food chain and it will directly affects the health of human beings, stray animals . So it can be reuse in construction industry. 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. 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. Keeping in view the disposal issues of plastic waste, its utility in concrete is studied and experimented by various researchers. They have worked on the use of pulverized plastic in

concrete as partial replacement of waste plastic in concrete as partial replacement of coarse aggregate. Testing was conducted on the samples casted by using plastic waste in the laboratory to study the variation of concrete properties from normal concrete. This research paper includes the partial replacement by waste plastic up to 20% by weight and results were studied. Research paper is based on the study which gives the idea of utilizing various Marbles. Approx. 85% of production of marble in India is from Rajasthan state. The marble mining industry has grown up widely in recent past years. Rajasthan has around 4000 marble mines. The industries produce a lot of waste of marble in the form of powder/slurry and pieces of irregular size of stones. large quantity of waste marbles has been generated during the quarrying operations. Wastes is mainly in the form of rock fragments The stones obtained from the quarries are usually dumped in open trenches in the forest area; thereby creating huge amounts of waste. There is absolutely no method of appropriate disposal of waste in the quarrying areas. The waste is dumped on forestland, Roads, riverbeds, & agricultural fields leading to overall environmental degradation. fertility of top soil is reduces. In the present investigation , the generated waste marble was used in concrete as a replacement of conventional coarse aggregate in different percentages 40% by weight. The idea of working concrete mixes was maximum utilization of marble waste which saves the natural resources.

T. Subramani (02)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.

Promod S. Patil (01).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. R. Siva Kumar, H. Mohammed Yousuff, M. Haripriya (03), observed that the coarse replaced with granite waste at 30% in concrete is suitable for construction. Jay P. Chotaliya, Kuldip B. Makwana, Pratik D. Tank (04) carried an experimental study on "waste marble chips as coarse aggregate". They proved that the marble concrete proves more economical at rate of around 7.44% than concrete made with conventional coarse aggregate.

II. MATERIALS

2.1.Cement : The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grade confirming to IS 12269 : 2013 It constitutes only about 20 percent of the total volume of concrete mix; it is the active portion of binding medium and is the only scientifically controlled ingredient of concrete.

Table 1. Properties of cement

Sr No	Physical property of cement	Result	Reqd.as per IS:12269:2013
1.	Specific gravity	3.15	3.10 - 3.15
2.	Soundness (Le Chatelier's)	9	10
3.	Initial setting time (hours, min)	35min	30 min. minimum
4.	Final setting time (hours, min)	178 min	600 min. maximum
5.	Compressive strength- 3 days	26.51 N/mm^2	27 N/mm^2
6.	Compressive strength- 7 days	38.49 N/mm^2	37 N/mm^2
7.	Compressive strength- 28 days	52.31 N/mm^2	53N/mm^2

2.2.Coarse aggregate :-The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 2386 (Part 4) - 1963 .

Table 2. Properties of coarse aggregate

Sr.no.	Characteristics	Value
1	Colour	Grey
2	Size	20mm
3	Shape	Angular
4	Specific gravity	2.80

2.3.Fine aggregate:-The aggregates most of which pass through 4.75 mm IS sieve are termed as fine aggregates. According to size, the fine aggregate may be described as coarse, medium and fine sands. Depending upon the particle size distribution IS: 383-1970 has divided the fine aggregate into four grading zones (Grade I to IV). The grading zones become progressively finer from grading zone I to IV. In this experimental program, fine aggregate was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and conforming to grading zone II. It was coarse sand light brown in colour. Sieve analysis and physical properties of fine aggregate are tested as per IS:383-1970 and results are shown in below Table.

Table 3. Properties of Fine Aggregate

Sr.no.	Characteristics	Value
1	Specific gravity	2.65
2	Bulk density(kg/m3)	1.3
3	Fineness modulus	2.62
4	Water absorption	0.02

2.4.Water : Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Water cement ratio used is 0.467 for M25.

2.5.WASTE PLASTIC:

Table 4. Properties of Waste plastic

Sr.no.	Properties	values
1.	Density	930-970(kg/cm^2)
2.	Yield stress	26 (N/mm^2)
3.	Elongation at yield stress	10 %
4.	Tensile modulus of Elasticity	900 (N/mm^2)

2.6.Waste marble

Table 5. Properties of Chemical compositions of marble waste

Sr. No.	Properties	values
1.	Colour	White
2.	Texture	Smooth, glossy
3.	Hardness	3 Mohr's scale
4.	Tensile strength	9.95 (N/mm^2)
5.	Compressive strength	12.45 (N/mm^2)

III. DESIGN MIX METHODOLOGY

A mix M25 grade was designed as per IS 10262:2009 and the same was used to prepare the test samples. The design mix proportion is shown in

Table 6. Properties of Concrete Design Mix Proportion

Sr No	Materials	Grade of Concrete	Average Compressive Strength of Conventional Concrete (N/mm^2)			Average Compressive Strength for variations in (N/mm^2)		
			7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
1	Waste Marbles	M25	16.2	22.5	24.75	20.66	28.61	31.79
2	Waste Plastic	M25	16.2	22.5	24.75	8.61	11.92	13.24

3.1.Casting of Cubes

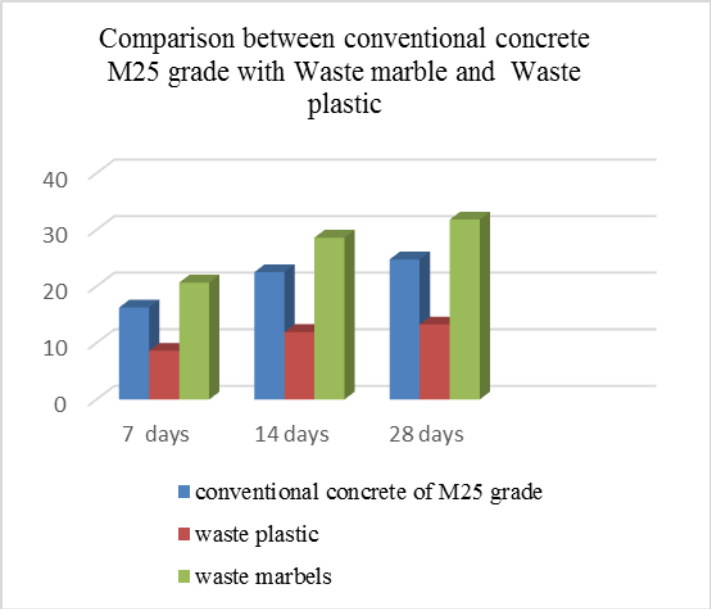
(As per IS 516:1959)

Standard metallic cube moulds (150*150*150 mm) were casted for compressive strength The specimens were demoulded after 24 hours and subsequently immersed in water for different age of testing. For each age three specimens were tested for the determination of average compressive strength.

Figure 1. Casting of cubes

Table 7. Comparison between Conventional concrete with replacement of course aggregate (waste marble and waste plastic)

Sr. no.	Material replace	Concrete type	Concrete Design Mix Proportion (By Weight)				Replacement %
			W/C Ratio	C (kg)	F.A. (kg)	C.A. (kg)	
1	Waste plastic	M25	0.467	1	1.5	2.696	20
2	Waste marble	M25	0.467	1	1.5	2.696	40



Graph 1. Comparison between conventional concrete M25 grade with Waste marble and Waste plastic

3.2 Test on Concrete Cubes

3.2.1.Slump Cone Test:

(As per IS: 1199:1959)

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability.

Table 8. slump value of various materials

Sr. No.	Materials replacement	% replacement	Slump in mm
1	Waste marble	40	130
2	Waste plastic	20	230

3.2.2.Compression Test

(As per IS 516:1959)

Compression Test was performed on compression testing machine .The load was applied axially without shock till the specimen was crushed. Results of the compressive strength test on concrete with and without varying proportions(50%)of fly ash,(40%) of waste marble ,(15%) of silica fume replacement at

the age of 7days, 14 days and 28 days were noted. The cubes were tested using compression testing machine (CTM). P/A = Compressive stress. Where, P = Load (N) and A = Area (mm^2).

IV. CONCLUSION

1. In this paper the effect of use of waste marble aggregate and waste plastic on properties of concrete were studied and it can be concluded that
2. The workability of all the concrete mix increases with increased percentage of replacement of natural coarse aggregate by waste marble aggregates.
3. Compressive strength of the concrete shows upward trend till 40% waste marble used as coarse aggregate in concrete.
4. The modified concrete mix, with addition of waste plastic aggregate replacing conventional aggregate up to certain 20% gives reduces the strength.
5. By using recycled waste plastic in concrete can reduce the land fill and environmental issues.
6. This type of aggregate replacement is useful where aggregates are in crisis .By this we can conserve natural resource.

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