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An Experimental Study on Polymer Reinforced Concrete with Marble Dust as Replacement of Cement

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ABSTRACT
The quantities of wastes, generated in industry are increasing every year. Their utilization became a priority for solving pollution problem and save energy and resources. The wastes are investigated as materials for obtaining new concrete with different applications. Polymer concrete is a composite material, in which the aggregates of different sorts are bound together by a resin. As in the case of cement concrete, different types of wastes (slag, glass, marble, etc). Consuming of wastes helps to clean the Environment; preservation of natural resources which are replaced by wastes; etc. In the experimental study, marble waste is used for obtaining polymer concrete. The effects of this of waste on the mechanical properties of polymer concrete were investigated. The mechanical properties (compressive strength, flexural strength at 7days and 28 days) were experimentally determined and compared with the characteristics of polymer concrete (considered as reference mix).

I. INTRODUCTION

Various Researches are going on in the field of construction heading towards the modern sustainable materials for replacement of cement as binder in traditional concrete in order to reduce the carbon dioxide. (Concrete made of cement, water and aggregates is the mostcommon material for construction of various structures. It has good mechanical properties and it is widely used in buildings, bridges, airports, dams and marine structures. Unfortunately, construction of concrete structures due to the weak properties of cement concrete such as low wear resistance, high permeability, low chemical resistance and phenomena such as cavitation and chlorine-induced corrosion. The solution used in recent years to address these problems is the use of polymer concretes. In general, over 75-80% of a PC is occupied by fine and coarse aggregates. Epoxy and polyester resins are two common polymers used as matrix. In addition to aggregates and matrix, micro fillers are sometimes added to the composition to fill the air void.

The advantages of PC are: a) easy application in thin cross section, b) saving concrete from carbonation, c) loss of alkalinity, d) very good resistance against corrosion and chemical reactivity and weathering effect, e) set very quickly, f) useful for repairing of existing structures. The disadvantages of PC are: a) it is very expensive than a conventional concrete, needing high skill and precise work, c) the chemicals or resins used in the polymer concrete can be risky.

Experimental studies show that the tensile strength and fracture toughness of PC are 3.5-4.5 times the common plain cement concrete materials and hence it can be a good replacement for cement concretes.

History of Polymer concrete

Since the early research and development of polymer concrete in the late 1950s to the early 1960s, their research and development has actively been carried out. As a result, polymer concrete is one of the most common construction materials at present in advanced countries such as the United States, Germany and Japan. Standardization work on the quality requirements, test methods and execution for the polymer concrete has been in progress in such advanced countries.

Marble dust powder

Marble Dust Powder is an industrial waste made from cutting of marble rock. In INDIA, the marble processing is one of the most booming industries. Marble industries in India grow more than 3500 metric tons of marble powder slurry per day. India is among the top world exporters of

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marble rock. The Indian marble industry has been rising steadily at an annual pace of about 10% per year. 20 to 30% of marble blocks are changed into powder. 3,172 M tons of marble dusts were produced in year 2012-13. Recently, marble dust powder has been employed in the construction industry and research has been carried on to examine their fruitful result. Soon, big amount of marble dust is taken forth in natural stone processing plants with an important impact on the environment and humans.

II. LITERATURE REVIEW

Marinela Barbutaet. al. (2016) [1]:

The use of marble waste in polymer concrete as filler or as aggregate, the compressive strength value is smaller than the reference mix. Reference mix compressive strength is 60 MPa. Increase of the resin dosage from 8% to 12%. The mix with aggregates of marble waste (PCMA6) had the best results of compressive strength is 47.22 MPa. Now in the case of split tensile test value is decreases as compare to reference mix.

Gavril Sosoi et. al.(2017) [2]:

The experimental test was done on epoxy resin concrete with fly ash and two types of waste (saw dust and chopped PET). 25% and 50% saw dust and 50% and 75% chopped PET the polymer concrete with waste substitution presented higher values PET presented higher values of compressive strength than control mix.

C. Kiruthika et. al. (2020) [3]:

In this paper, authors developed a mix for polymer concrete using isophthalic resin of more than 60 MPa compressive strength for manufacturing inspection covers and frames.

T. Jaya Krishna et. al. (2021) [4]:

Base on the experimental work in the study, consider 70:30 (fly ash: ggbs), 4% of super plasticizers, and 0.1%,0.2%,…0.5% of polypropylene fibre, basalt fibre, andar glass fibre were considered.

There is an increment in compressive strength, flexural strength is noticed with the percentage of above fibres 0% and0.4% and at 0.5% there is a decrease in compressive strength, flexural strength, split tensile strength test was observed respectively with 0.1% and 0.4% of fibres the strength of geo polymer concrete is increased when compared to 0% of fibre.

M. Padmakar et. Al. (2020) [5]:

In this study, replacing entire cement content with GGBS (70%) and silica fumes (30%). Geopolymer dense additions with the development in sodium silicate fixation and most extreme happened at 40% of na2sio3. Frome the results of study two different mix proportion 1:1.5:3 and 1:1:2, and got higher compressive strength values for 1:1:2. The compressive strength value of cubes & cylinders 13M of NaOH and 40% of Na2siO2 gave better results than all other considered mixes.

III. METHODOLOGY

DiscussionofCubecasting :

This section includes thediscussion of cubes of Marble dust as a replacement for cement with 5%, 10% and 15%by volume of cement to findcompressive strength of concrete.

Casting :

The compression test is performed on a cubical shape mold having asize of 150X150X150 mm. The metal molds are made up of cast iron which helps to make the finished surface of the cube.

Mixing of Concrete :

The mixture of concrete includes cement, sand, fine aggregates, coarse aggregates, epoxy resin and marble dust. M-25 grade of concrete having a proportion of 1: 2 :2.84 is used. The quantities of polymer concrete required for cube casting are multiplied by the quantities which are found for thedesign of 1m3 of concrete.

Casting of concrete :

The materials are proportioned by the above method. materials are mixed thoroughly by hand mixing. The moulds are pre-oiled before the casting is done to guarantee for smooth removal of concrete. Each mould is filled in 3 equal layers. Each layer is compacted 25 timeswith a tamping rod of 16 mm.

IV. RESULTS AND DISCUSSIONS

Compression strength test :

The maximum characteristic property of concrete depends upon compressive strength. In this work, the specimen is prepared and the curing period is 7 and 28 days. It is dried for two hours before the test is performed. The cubes are placed in a compression testing machine. The load at which the cubes indicate initial cracking is recorded and the compressive strength is evaluated.

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Compressive Strength of Polymer Concrete At 7 Days

Table 1

MDP %	Load(KN)	Compressive strength (N/mm2)
0%	411	18.26
5%	399	17.73
10%	382	16.97
15%	357	15.86

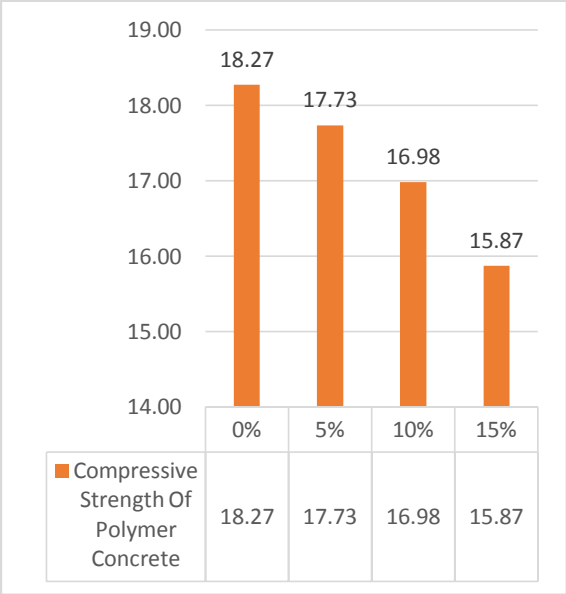

Fig.1. Compressive Strength of Polymer Concrete At 7 Days

Compressive Strength of Polymer Concrete At 28 Days

Table 2

MDP %	Load(KN)	Compressive strength (N/mm2)
0%	886	39.38
5%	872	38.76
10%	816	36.27
15%	758	33.69

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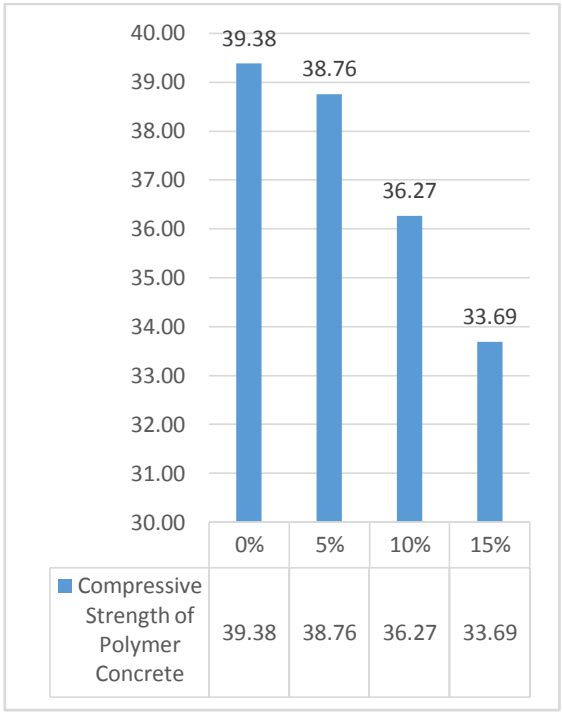

Fig.2. Compressive Strength of Polymer Concrete At 28 Days

Fig.3. Compressive Strength testof cube.

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Discussion Of Beam Casting:

This section includes thediscussion of beam casting of Marble dust as a replacement for cement with 5%, 10% and 15%by volume of cement to find Flexural strength of concrete.

Casting :

The Flexural strength test is performed on a rectangular shape mold having a size of 700X150X150 mm. The metal molds are made up of cast iron which helps to make the finished surface ofthe beam.

Mixing of Concrete :

The mixture of concrete includes cement, sand, fine aggregates, coarse aggregates, epoxy resin and marble dust.M-25 grade of concrete having a proportion of 1: 2 :2.84 is used. The quantities of concrete required for beam casting are multiplied by the quantities which are found for the design of 1m3 of concrete.

Casting of concrete :

The materials are proportioned by the above method. materials are mixed thoroughly by hand mixing. The moulds are pre-oiled before the casting is done to guarantee for smooth removal of concrete. Each mould is filled in 3 equal layers. Each layer is compacted 25 times with a tamping rod of 16 mm.

V. RESULTS AND DISCUSSIONS

Flexural strengthtest :

The maximum characteristic property of concrete depends upon Flexural strength. In this work, the specimen is prepared and the curing period is 7 and 28 days. It is dried for two hours before the test is performed. The beams are placed in a Flexural testing machine. The load at which the beams breaks is recorded and the Flexural strength is evaluated.

Flexural Strength of Polymer Concrete At 7 Days

Table 3

MDP %	Load (KN)	FlexuralStrength(N/mm2)
0%	41	7.29
5%	37	6.58
10%	32	5.66
15%	25	4.46

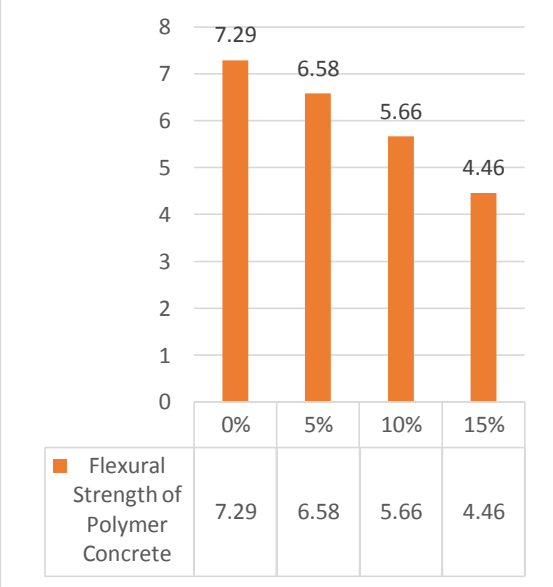

Fig.4.Flexural Strength of Polymer Concrete At 7 Days

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Flexural Strength of Polymer Concrete At 28 Days

Table 4

MDP %	Load (KN)	FlexuralStrength(N/mm2)
0%	87	15.47
5%	81	14.43
10%	78	13.87
15%	74	13.12

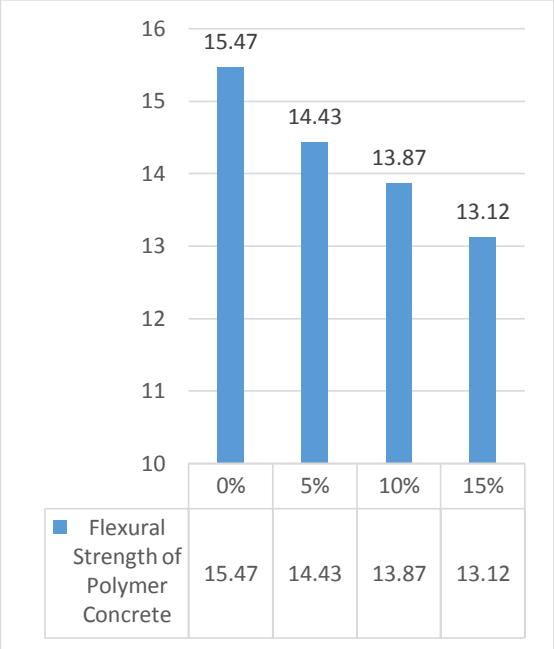

Fig.5.Flexural Strength of Polymer Concrete At 28 Days

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Fig.6. Flexural strength test of beam.

VI. CONCLUSION

From the experimental research had resulted those different types of wastes (slag, glass, marble, etc). used as filler in polymer concrete. The proper Dosages was bigger or similar value of compressive strength, flexural strength, tensile strength as compare to control mix.

The research study had demonstrated that different wastes can be used as replacement of cement or aggregates in polymer concrete, saving in this way the natural resources and consuming the wastes.

The experimental tests were done on polymer concrete with marble dust powder as cement substitution in different dosages from 5%, 10% and 15% volume percentage. The waste substitution influenced the properties of concrete. Compressive strength and flexural strength are determined at 7days and 28 days after successful curing period. Due to lower percentage of silica oxide in marble dust powder its compressive strength and flexural strength decreases continuously. But 5% replacement of cement by marble dust powder value nearby normal mix design.

VII. FUTURE WORK

Waste materials such as marble dust, waste glass powder as filler, copper slag as fine aggregates can also be tried in future to get the sustainable polymer concrete with different combination. The developed polymer concrete can be varied with different resin types and various other fibres to improvise the developed mix. Also, coupling agents can be recommended in future work to increase the bond strength and the mechanical properties of developed polymer concrete.

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