Expererimental Study with Sulphuric acid on Compressive Strength of Concrete using Waste Marble Powder as a Partial Replacement of Sand

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Abstract- The disposal of Waste marble powder from the marble industry is one of the environmental problems worldwide today. As marble powder is a waste product, obtained during the process of sawing and shaping of marble by parent marble rock, so it contains heavy metals which makes the water unfit for use, so it cannot be disposed in the environment as it causes environmental pollution. Therefore, it has a great impact on human health as well as on nature. To control its effect we can use Waste marble powder as a replacement in fine aggregate in concrete. This study aims at investigating the effect of using Waste marble powder as a partial replacement of fine aggregate in the proportion of 0%, 5%, 10%, 15% and 20% and to study its Compressive Strength after curing it in Water and Sulphuric acid for a curing period of 14 days, 28 days and 56 days and to check the effect of concrete against acid rain. The concrete mix used was M35 grade. Results showed that, with the addition of Waste marble powder Compressive strength gradually increases upto certain limit and then it decrease when cured in water and Sulphuric acid. So, it can be used for economical structures as it has higher strength ,improved durability and good workability. Furthermore, the chemical reaction between the cubes and acid were seen, the colour of the cubes dipped in Sulphuric acid change to yellow at 56 days.This may be due to acidic reaction.

Keywords-*Waste marble powder, Fine agregate, Compressive strength, Physical properties*

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I. INTRODUCTION

Concrete is the most important component used in the construction industry, where the fine aggregate is generally natural sand. The use of sand in construction results in excessive sand mining which is objectionable. Due to rapid growth in construction activity, the available sources of natural sand are getting exhausted. Therefore, it is necessary to replace natural sand in concrete by an alternate material either partially or completely without compromising the quality of concrete [1].

Waste marble dust is one such material which can be used to replace sand as fine aggregate. The present study is aimed at utilizing Waste marble powder as fine aggregate in concrete, replacing natural sand by marble powder in different proportions (0%, 5%, 10%, 15% and 20%) and to investigate its physical and mechanical properties by dipping it in Water and Sulphuric to study the effects of acid rain in concrete for 14, 28 and 56days. The concrete mix used was M35 grade.

Acid rain refers to a mix of deposited material, both wet and dry, coming from the atmosphere containing more than normal amount of Nitric and Sulphuric acids. Acidity is determined on the basis of pH level of water droplets. Normal rain water is slightly acidic with a pH range of 5.3-6 because Carbondioxide(CO_2) and water present in the air react together to form Carbonic acid which is weak acid. So this study aim at investigating the effect of acid rain in concrete by partial replacement of sand with Waste marble powder.

Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its color and appearance: it is white if the limestone is composed solely of Calcite (100% CaCO3) [4].

Marble has cementing properties like high fineness value and high oxide calcium content which imparts the cohesiveness in concrete. So by using marble powder as the constituent of concrete by partially replacing the sand makes it economical and improves the environmental problem [10]. A large quantity of powder is generated during the cutting and sawing process. Leaving these waste materials to the environment directly can cause environmental problem. The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment [3].

II. OBJECTIVE

The main interest of this thesis is to study the physical and mechanical properties of concrete with partial replacement of fine aggregates with Waste marble powder. The concrete so formed was then dipped separately in Water and Sulphuric acids for a curing ages of 14, 28 and 56 days and their strength and water absorption were investigated.
The precise objective of this study are as follows:-

- To study the Compressive strength of Waste marble powder mixed concrete dipped in Water, and Sulphuric acids for 14, 28 and 56 days.
- To study the physical appearances of the cubes cured in Water, and Sulphuric acid for 14 days, 28days and 56 days.

PROPERTIES OF MATERIAL USED

A. CEMENT

Ordinary Portland Cement of grade 53 is used for the preparation of concrete mix. 53 Grade OPC provides high strength and durability to structures because of its optimum particle size distribution and superior crystallized structure.

B FINE AGGREGATE

Fine aggregate available from nearby Khizrabad river sand (confirming to IS 383) is used. It is the aggregate most of which passes 4.75 mm IS sieve and contains only so much coarser as is permitted by specification. The fineness modulus of sand used was obtained as 2.52 and belonged to Zone II.

C . COARSE AGGREGATE

Coarse aggregate available from nearby Nangal Crushed Stone (confirming to IS: 383) was used for this study. It is the aggregate most of which is retained on 4.75 mm IS sieve and contains only so much finer material as is permitted by specification. According to size coarse aggregate is described as graded aggregate of its nominal size i.e. 40 mm, 20 mm, 16 mm and 12.5 mm and 10mm. In this study coarse aggregate of size 10mm and 20mm are used.

D . WATER

Bore well water was used for mixing and curing which was clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials and all other substances that was harmful to concrete as per clause 5.4 of IS456:2000.

E. ADMIXTURE

Superplasticizers are also known as **High Range Water Reducers(HRWR)** which are chemical admixtures used where well-dispersed particle suspension is required. In this study 100gm of this admixture was used. It imparts high workability and allows a large decrease in water content. In this study, superplasticiser admixture named SIKAMENT 2002 NS was used. It provides high durability with improved water tightness and good surface finish and is suitable for hot weather conditions.

F . MARBLE POWDER

Marble Powder used in this project was purchased from N.S. Enterprises loacated at Dhanas. Fineness modulus test and specific gravity test of the marble powder was done whose values were found as 1.5 and 2.73.

Fig 1: Marble powder

III. CASTING OF CUBES

A total number of 90 cubes of size 100mmX100mmX100mm were casted separately. In this study 0%, 5%, 10%, 15% and 20% of fine aggregate are replaced with Waste Marble Powder. The design was first prepared for $1m^3$ which was then used to cast concrete for different replacement proportion on different days. The design details are as follows:

Table 1: Replacement with Marble Powder

	0 %	5 %	10 %	15 %	20 %
Cement (kg)	10	10	10	10	10
Sand (kg)	16.4	15.81	14.98	14.15	13.67
Water (ltr)	5.12	5.11	5.09	5.07	4.70
10mm (kg)	11.53	11.53	11.53	11.53	11.53
20mm (kg)	17.3	17.3	17.3	17.3	17.3
Admixture(gm)	100	100	100	100	100
Marble powder (kg)	0	0.85	1.70	2.55	3.4

Using the above data, each ingredient were weighed accurately and mixed in a Pan mixer. The mixing process started with the addition of coarse aggregate, which was followed by sand and then cement. These ingredients were first dry mixed. The water was then weighed and added slowly to the dry mix followed by addition of admixture. The mix so formed was kept for half an hour after which slump test was done. The diameter of slump test apparatus is 10cm on top, 20cm on bottom and 30 cm in height. The concrete mix was poured in three layers in the slump apparatus. Each layer was tamped for 25 times. The slump cone was then removed gradually. The height of slump was then noted down. Again the mix was further left for one and half hour and again the slump test was done. It is done to check the workability and retention of the concrete. Finally after two hours the cubes were casted. The steel mould were of size 100mm X100mmX100mm . First the moulds were given a coat of engine oil, so that the concrete does not stick to the mould. The mix were made by replacing sand with waste marble powder by 5%, 10%, 15% and 20%.

The cubes were casted in two layer. Each layer were tamped for 25 times and vibrated. Finally the finishing of cubes were done. The finished cubes were kept for a period of 24 hours and removed carefully. The cubes were first marked then 9 cubes were dipped in water and 9 cubes in Sulphuric acid. These cubes were kept for curing period of 14, 28 and 56 days. The result of the test performed is given later in table.

IV. EXPERIMENTAL STUDY

A. SLUMP TEST

The slump test of the concrete is done to assess the workability and consistency of fresh concrete. Consistency refers to the ease with which concrete flows. It is used to indicate degree of wetness. Slump test is done to check the correct amount of water to be added to the mixture. In this study, the test is conducted as per IS specification.

Table 2: The result of slump test was done after 2 hours :

	0%	5%	10%	15%	20%
Result	75mm	57mm	54mm	52mm	50mm

B. COMPRESSION TEST

The limit of compressive strength of the cement concrete depends on both, the strength of the matrix and the particle tensile strength of the aggregate. The strength of the concrete is usually related to the cement content and water to cement ratio. 3 cubes each from water and sulphuric acid were cured for 14, 28 and 56 days. The cured specimens were allowed to dry in air. The dried specimens were centered on a compression testing machine of capacity 2000 kN. The load was applied at a uniform rate of 2.3 kN/sec.

Fig 2: Cubes after Compression test

Fig 3: Compression Testing Machine

Table 3: 14 days Compression Test

	Dipped in water(N/mm^2)		Dipped in sulphuric acid(N/mm^2)	
0%	42.73	40.45	31.33	34.14
	38.4		37.26	
	40.22		33.84	
5%	39.91	40.63	37.21	36.54
	41.36		37.25	
	40.62		37	
10%	41	41	38.39	37.35
	41.22		36.67	
	40.8		37	
15%	40.49	40.39	37.99	34.52
	40.43		36.36	
	40.25		35.23	
20%	46.27	39.68	38.76	34.31
	34.52		28.64	
	38.25		35.55	

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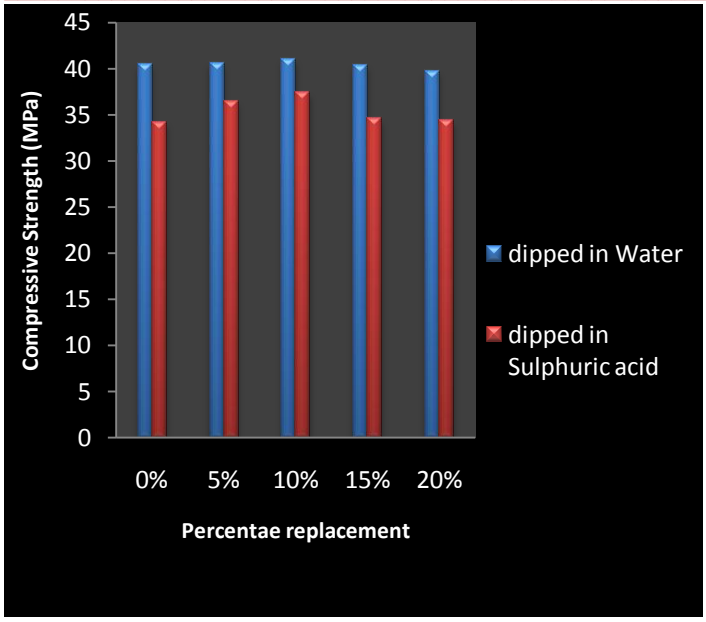

Chart1: Comparision between cubes dipped in Water and Sulphuric acid after 14 days

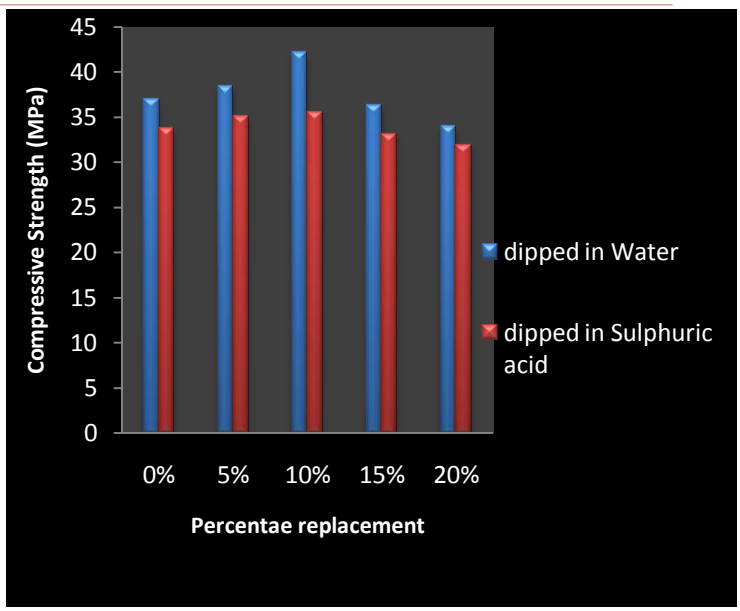

Chart 2: Comparision between cubes dipped in Water and Sulphuric acid after 28days

Table 4: 28 days Compression Test

	Dipped in water(N/mm^2)			Dipped in sulphuric acid(N/mm^2)		
0%	39.29	36.95		29.41	35.86	33.73
	36.58			35.86		
	35			34.85		
5%	36.46	38.4	33.48		36.9	35.09
	40.54					
	38.64		34.57			
10%	37.46	42.2	32.56		39.69	35.6
	47.19					
	42.03		34.57			
15%	37.39	36.31	31.08		35.18	33.15
	36.28					
	35.28		33.21			
20%	34.82	33.93	28.24		35.89	31.79
	33.98					
	33		31.26			

Table 5: 56 days Compresssion Test

	Dipped in water(N/mm^2)			Dipped in sulphuric acid(N/mm^2)		
0%	40.68	35.12		34.48	38.33	36.46
	29.41					
	35.27			36.58		
5%	49.6	46.28	41.68		40.2	40.96
	45					
	44.24		41			
10%	49.1	47.64	47.65		48.89	47.81
	46					
	47.81		47.29			
15%	48.3	44.5	37.46		39.69	38.57
	39.58					
	45.62		38.57			
20%	43.45	37.98	33.6		41.4	37.85
	32.7					
	37.79		38.56			

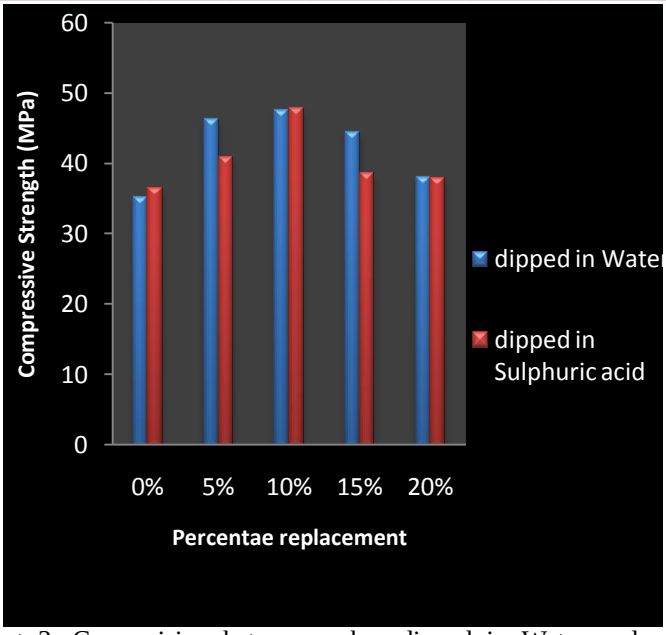

Chart 3: Comparision between cubes dipped in Water and Sulphuric acid after 56 days.

V. PHYSICAL APPEARANCE OF CUBES

The chemical reaction between the cubes and acid were gradually seen. The cubes dipped in water and sulphuric acid showed a gradual change in its physical properties. There was no change noticed on the 14th day of test . On 28th day some cubes dipped in sulphuric acid started to gain yellowish colour. No changes were seen in cubes dipped in water. However, strong changes were noticed on 56th day. Cubes dipped in sulphuric acid had completely become yellow in colour. However no certain change was noticed in cubes cured in water. Following are the pictures that will elaborate the reaction between the concrete and acids clearly:

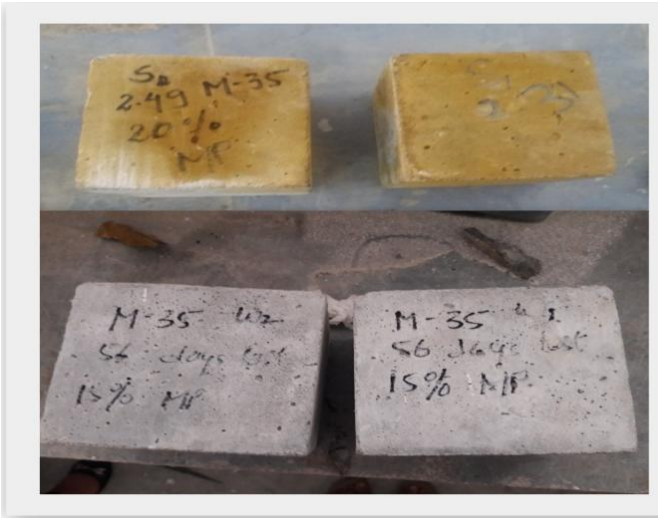

Fig 4: Cubes dipped in Sulphuric acid and Water

Fig 5: Cubes dipped in Sulphuric acid

VI. CONCLUSION

The aim of this study is to examine the Compressive Strength of concrete by utilising Waste marble powder in concrete. The Waste marble powder is used as an alternative in fine aggregate. The fine aggregate has been replaced by Waste marble powder in the proportion of 0%, 5%, 10%, 15% and 20%. The concrete mix used was M35 grade. The Compressive strength of concrete by partial replacement of fine aggregate with Waste marble powder was cured with Water and Sulphuric acid for 14days, 28days and 56days to check the resistance of concrete to acid rain.

The following conclusions are derived based on the tests conducted:

1) With the partial replacement of fine aggregate by Waste marble powder the dropping of slump is less as compared to river sand. Due to the presence of silt in river sand the water requirement in concrete is generally high, but with the use of Waste marble powder as replacement of fine aggregate the quantity of water required is generally low. Hence, there is possibility of less cracks
2) With the addition of Waste marble powder the Compressive Strength gradually increases upto certain limit when dipped in Water and Sulphuric acid then it gradually decreases. It has been noticed that there was not much difference in the Compressive strength of cubes which were dipped in Water and acids. Furthermore, the overall Compressive Strength of the cubes replaced by Waste marble powder was more than that of cubes with 0% replacement.
3) The replacement of 10% of fine aggregate with Waste marble powder attains maximum Compressive strength of 47.81 MPa when dipped in Sulphuric acid at 56days test.

4) It is concluded that, the optimum percentage of replacement of fine aggregate with Waste marble powder in concrete is almost 10%.
5) It has been noted that the colour of cubes dipped in Sulphuric acid change to yellow at 28 and 56 days. This may be due to acidic reaction.
6) The concrete with the addition of Waste marble powder offers interesting advantages over the conventional control concrete that is higher strength, improved durability, good workability and good pumping.
7) In addition, re-use of Waste marble powder in concrete has great advantages in terms of long term maintenance as their use in concrete will eliminate the problem of their disposal and environment pollution

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