Comparison of Compressive strength of self-compacting concrete on partial replacement of cement with waste marble powder

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ABSTRACT

The aim of this investigation is to the study the behaviour of self-compacting concrete, having partial replacement of cement with waste marble powder. The function of self-compacting concrete is to increase the ability to spread and self-consolidate within the formwork. In this study, compressive strength of self-compacting concrete is investigated and compared with self-compacting concrete on partial replacement of cement with waste marble powder. It is found through this experimental study that concrete cast with waste marble powder is stronger than that obtained by self-compacting concrete.

Keywords: - waste marble powder and compressive strength.

I.INTRODUCTION

In the construction industry Self-compacting concrete (SCC) has been very common in designing tall structures and other advantages of Self-compacting concrete is its increased workability, reductions of labour costs, perfect finished surface, soundless and higher strength properties compared to conventional concrete. Waste marble powder is also a waste material and it is a calcium and lime rich wastes. The benefits of recycling industrial wastes are environmental and economical for the user additional technical benefits may be attained from recycling. For the producer, the environmental benefit can be attained as far as the waste is recycled. It is independent of where it is recycled. But the economic benefit is determined on the demand for the waste by different users. One of the greatest environmental concerns in construction industry is the production of cement which emits large amount of CO_2 gas to the atmosphere. It is estimated that 1 tone clinker production releases 1 tone CO_2.Mixing of clinker to supplementary materials called blending is considered as a very effective way to reduce CO_2 emission. Waste marble powder is also a waste material and it is a calcium and lime rich wastes. Self-compacting concrete (SCC) is that the new class of high performance concrete characterised by its ability to spread and self-consolidate within the formwork exhibiting any significant separation of constituents. Elimination of vibration for compressing concrete during placing through the utilization of Self Compacting Concrete results in substantial benefits associated with higher homogeneity, improvement of working environment and improvement within the productivity by increasing the speed of construction. Self-compacting concrete (SCC) was developed in the middle of the 1980's in Japan. SCC flows alone under its dead weight up to levelling, airs out and consolidates itself thereby without any entry of additional compaction energy and without a nameable segregation. SCC owns over three key characteristics. These characteristics were made possible by the development of highly effective water reducing agents (Super Plasticizers), those usually based on polycarboxylate ethers. The mixture composition of SCC deviates from conventional concrete.

II.MATERIALS AND METHODOLOGY

Ordinary Portland cement

In this work, 43 grade Ordinary Portland Cement (OPC) is used for all concrete mixes. The cement used is fresh and without any lumps. The initial, final setting time of cement specific gravity and normal consistency was found as per Indian standard specifications. The testing of cement is done as per IS: IS 8112 - 1989

Fine Aggregate

The fine aggregate used for the experimental program was locally available river sand which is passed through 4.75 mm sieve. The sand was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand confirms to grading Zone II as per IS: 383-1970. The properties of sand such as fineness modulus and specific gravity were determined as per IS: 2386-1963. The specific gravity of fine aggregate is found to be 2.650. The water absorption is 0.50%. The bulk density of fine aggregate in loose and compact state is 1579 kg/m^3 and 1689 kg/m^3 respectively.

Coarse Aggregate

The material which is retained in 4.75 mm sieve is termed as a coarse aggregate. The crushed stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 10mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970.

Table : Physical Properties of Coarse Aggregates (10 mm)

S. No	Characteristics	Value
1	Type	Crushed Granite
2	Specific Gravity	2.7
3	Bulk density	1774 kg/m^3
4	Total Water Absorption	0.08
5	Fineness Modulus	6.45

Fineness Modulus = 654.04/100=6.54

Waste Marble Powder

Waste marble powder was collected from the locally available manufacturing unit. It was initially in wet form (in slurry form), after that it is dried by exposing in the sun and finally sieves by IS 4.75 mm sieve before mixing. Physical properties of waste marble powder are given in table-3.4.1.

Table: Physical Properties of Waste Marble Powder

S. No.	Characteristic	Result
1.	Colour	White
2.	Form	Powder
3.	Odour	Odourless
4.	Specific gravity	2.67

Water

Potable water shall be used in the mix design of self-compacting concrete. The water should be free from organic matter and suspended impurities.

Super Plasticizer

Conplast SP430-SRV obtained from Fosroc chemicals (I) ltd. was used in present experimental research. It conforms to Indian standard code, IS: 9103-1999. Conplast SP430-SRV is used where a high degree of workability is required and also as an aid to workability retention where delays in transportation or placing are likely or when high ambient temperatures cause rapid slump loss to facilitate production of high quality concrete of improved durability and water tightness 2 liters of super plasticizer per 100 kg of cementitious material was used as per the manufacture recommendations.

Experimental work

In this study, a total 70 numbers of concrete specimens were casted. In those 35 numbers of cubes for 7 days and 35 numbers of cubes for 28 days The size of cube were 150mm x 150mm x 150 mm respectively. The mix design of concrete was done according to IS: 10262-2009 for M25 grade with water cement ratio of 0.5 waste marble powder was partial replaced with cement with the different percentage (0%, 5%, 7.5% 10%, 12.5%, 15%, and 20%). The ingredients of concrete were thoroughly mixed in concrete mixer machine. Before casting oil was smeared to the inner surface of the moulds. Concrete was poured in to the moulds and compacted thoroughly using needle vibrator. The top of the surface was finished by means of a trowel. After 24 hours the specimens were removed from the mould and then cured under water for period of 7 and 28 days. The specimens were taken out from the curing tank just prior to the test. The test for compressive strength was conducted using a 2000kN compression testing machine. Several tests, such as slump flow test, T_{50cm}test, V-funnel test, j-ring test, L-box test and Orimet test were carried out to determine the properties of fresh concrete.

While compressive strength test were carried out to determine mechanical properties of hardened concrete.

III.EXPERIMENTAL RESULTS

Properties of fresh concrete

The following table 4.2.1 shows the result of fresh concrete properties of self-compacting concrete with waste marble powder.

Table: Results of Fresh properties of SCC with waste marble powder

Mix	Percentage of waste marble powder in SCC	Slump test		V-Funnel (sec)	J-Ring	L-Box (H_2/H_1) ratio	Orimet test (sec)
		Slump flow (mm)	T_5(sec)		Height difference (mm)		
Limit value (EFNARC 2002)		650-800	2-5	6-12	3-10	0.8-1	0-5
SCC 1	0%	6644	4.6	10.7	9.4	.896	5
SCC 2	5%	682	3.7	9.5	8.6	.907	4.6
SCC 3	7.5%	696	3.9	10.2	8.3	.916	4.4
SCC 4	10%	712	3.2	9.6	7.6	.924	3.8
SCC 5	12.5%	726	2.6	8.5	6.6	.936	3.2
SCC 6	15%	780	2.9	9.6	7.5	0.98	3.2
SCC 7	20%	880	3.6	10.3	8.9	0.97	2.9

In all the mixes of SCC with silica fume, the slump test, T5, V-funnel, J-ring, L-box and Orimet test were carried out under limiting value.

These mix proportions were given in table 4.2.

Table 4.2.2: mix proportions of SCC with waste marble powder

S. No.	% of fine aggregate	% of waste marble powder	No. of cube for 7 days compressive strength	No. of cube for 7 days compressive strength
1	100%	0%	5	5
2	95%	5%	5	5
3	92.5%	7.5%	5	5
4	90%	10%	5	5

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5	87.5%	12.5%	5	5
6	80%	15%	5	5
7	70%	20%	5	5
Total			35	35

Table 4.3.1: Comparison of compressive strength at 7 days between all the samples of SCC with waste marble powder

Sample no.	Percentage of waste marble powder in SCC	Average value of compressive strength at 7 days of 5 samples of cubes in MPa
1	0%	18.265
2	5%	18.598
3	7.5%	19.117
4	10%	19.369
5	12.5%	19.556
6	15%	19.761
7	20%	17.212

The graphical representations of average compressive strength of SCC with waste marble powder as given in Figure 4.1.

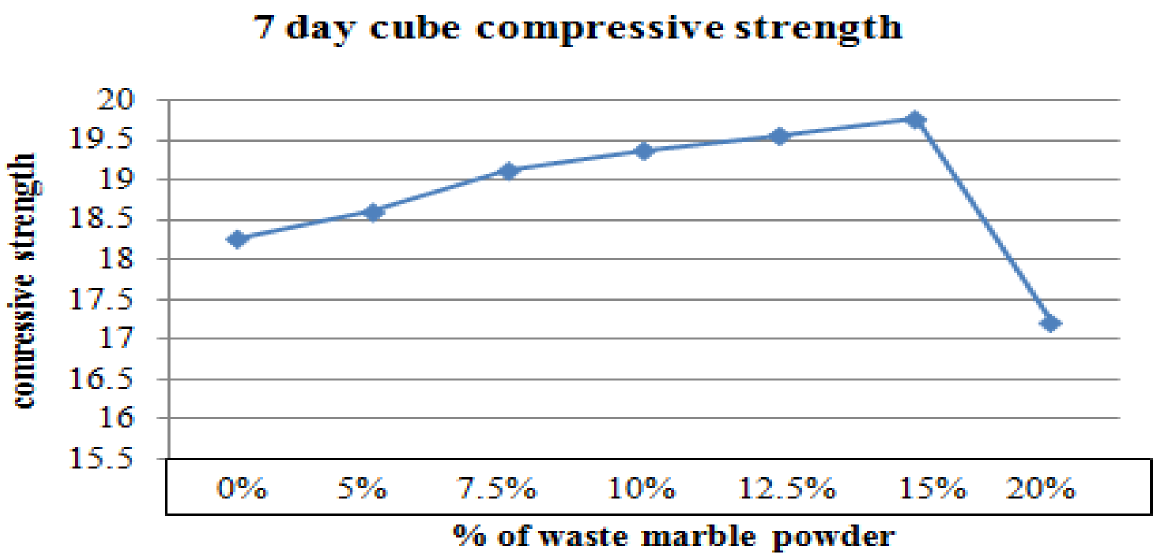

Figure 4.1: Comparison of compressive strength at 7 days between all the samples of SCC with waste marble powder

Table: Comparison of compressive strength at 28 days between all the samples SCC With waste marble powder

Sample no.	Percentage of waste marble powder in SCC	Average value of compressive strength at 28 days of 5 samples of cubes in MPa
1	0%	37.33
2	5%	38.92
3	7.5%	39.87
4	10%	40.56
5	12.5%	42.55
6	15%	45.12
7	20%	35.11

The graphical representations of Comparison of compressive strength at 28 days between all the samples of SCC with waste marble powder are given in Figure 4.2:

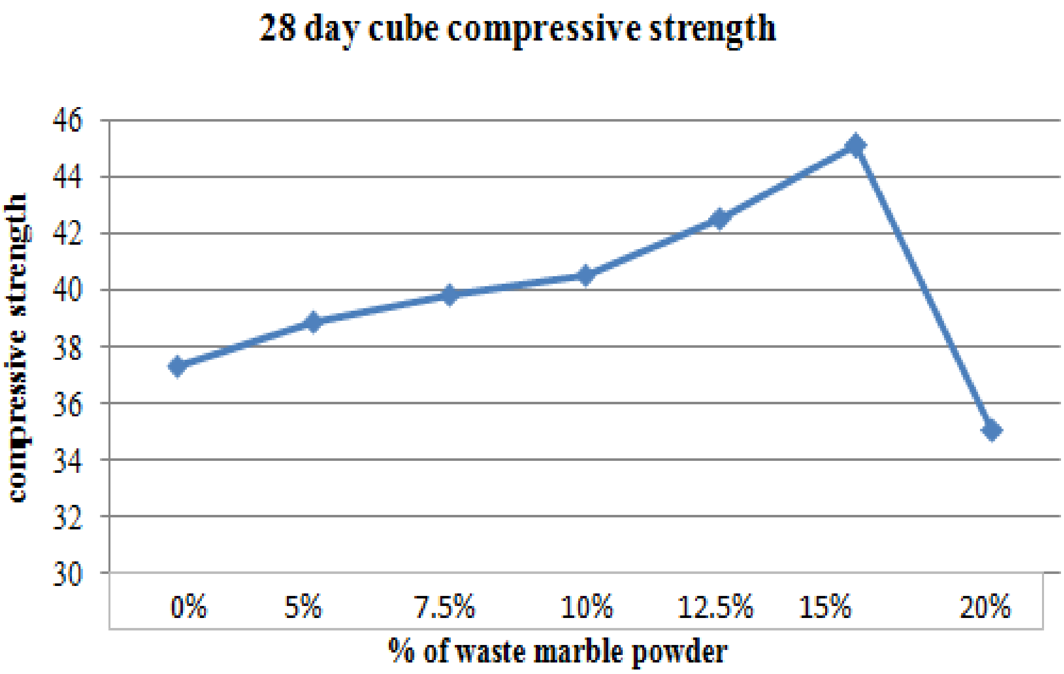

Figure: Comparison of compressive strength at 28 days between all the samples of SCC with waste marble powder

IV.CONCLUSION

From this study, the following conclusion can be drawn:

(i) With the increase of waste marble powder (WMP) dosage, the workability of SCC is increased. So, the required slump flow value fulfilling the criteria of EFNARC can be obtained.

(ii) For the 30% waste marble powder replacement, the fresh properties observed were good as compared to 0%, 10%, and 20% and 40% waste marble powder replacement.

(iii) The results of compressive strength (hardened properties) have shown significant performance difference and the higher compressive strength has been obtained for waste marble powder replacement. The highest compressive strength has been found at 30% waste marble powder replacement as compared to other mixes at 7 days age.

(iv) The highest compressive strength has been also found at 30% waste marble powder replacement as compared to other mixes at 28 days age.

So, finally we can say that we can obtain maximum workability and compressive strength with the increase of the percentage of waste marble powder up to 30%.

REFERENCES

[1.] Jashandeep Singh and Er. R.S. Bansal (2015). "Partial replacement of cement with waste marble powder with M25 grade"International Journal of technical Research and Applications (IJTRA) e-ISSN: 2320-8163, www.ijtra.com Volume 3, Issue 2 (march-apr 2015) PP. 202-205.

[2.] Gulden CaginUlubeyli, RecepArtir (2015). "Properties of Hardened Concrete Produced by Waste Marble Powder." www.sciencedirect.com

[3.] Kishan P Pala et.al (2015). "Use of Marble Powder and Fly Ash in Self Compacting Concrete", IJIRST – International Journal for Innovative Research in Science & Technology ISSN (online): 2349-6010

[4.] A.Krishnamoorthy al. (2014): "Experimental study on self-compacting concrete containing industrial by-products", European Scientific Journal April 2014 edition vol.10, No.12 ISSN: 1857 – 7881.

[5.] Aalok D. sakalkale, G. D. dhawale, R. S. kedar, "Experimental study on use of waste marble dust in concrete", journal of engineering Research and Applications" ISSN: 2248-9622, vol 4, issue 10(part-6), October 2014

[6.] PrajapatiKrishnapal et al. (2013): "Strength Characteristics of Self Compacting Concrete Containing Fly ash"**,** Research Journal of Engineering Sciences ISSN 2278 – 9472 Vol. **2(6),** 1-5, June (2013).

[7.] Er.Ranjodh Singh, et.al. "Study of Self Compacting Concrete Using Brick Dust and Marble Powder". International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com

[8.] M. ShahulHameed, et.al (2012). "Self-Compacting Concrete Using Marble Sludge Powder and Crushed Rock Dust". KSCE Journal of Civil Engineering (2012) 16(6):980-988 DOI 10.1007/s12205-012-1171-y

[9.] BouzianiTayebet. al, (2011) "Effect of Marble Powder on the Properties of Self-Compacting Sand Concrete", The Open Construction and Building Technology Journal, 2011, 5, 25-29

[10.] Ergun, A. (2011), "Effects of the usage of diatomite and waste marble powder as partial replacement of cement on the mechanical properties of concrete". Construction and Building Materials, 25, 806–812.

[11.] H.J.H. Brouwers, H.J. Radix (2005). "Self-Compacting Concrete: Theoretical and Experimental Study", Cement and Concrete Research 35 (2005) 2116 – 2136