EFFECT OF WASTE MARBLE POWDER REPLACEMENT ON WORKABILITY OF SELF-COMPACTING CONCRETE

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Abstract - *Self-Compacting concrete (SCC) is defined as a highly flowable, non-segregating concrete mix that can be placed even in the most congested reinforcement by means of its own weight, with little or no vibrations. An experimental study was undertaken to study the properties of self-compacting concrete (SCC) in plastic state. In the present study, the waste marble powder (WMP), finer than 4.75 mm were used for the replacement of fine-aggregate. The replacement is done partially in the proportion of 0%, 10%, 20%, 30%, 40%, 50% and its effect on workability of self-compacting concrete were investigated. The workability tests of self-compacting concrete used in this research were the slump flow test, T_{50cm} slump flow, V-funnel test, J-ring test, L-box test and Orimet test. Slump flow test, T_{50cm} slump flow, v-funnel test and Orimet test are used to evaluate the filling ability of SCC while j-ring test and L-box test are used to evaluate the passing ability of SCC. A comparative study of self-compacting concrete mix is carried out to find the effect on workability of self-compacting concrete replaced with waste marble powder.*

Key Words*: *Self-compacting concrete (SCC), Waste marble powder (WMP), Workability, flowable, congested reinforcement

1. INTRODUCTION

Self-compacting concrete has ability involves not only high deformability of paste or mortar, but also resistance to segregation between coarse aggregate and mortar when the concrete flows through the confined zone of reinforcing bars **[1]**. Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight completely filling formwork and achieving full compaction **[2]**. Self-compacting concrete is one of "the most revolutionary development' in concrete research, this concrete is able to flow and to fill the most restacted places of the form work without vibration **[3]**. Self-compacting concrete (SCC) is a new category of high performance charactererized by its ability to spread into a heavily reinforced area under its own weight without the need of vibration and has excellent deformability and high resistance to segregation. The use of SCC in considered having a number of advantages as- (i) Faster placement. (ii) Better consolidation around reinforcement.(iii) Easily placed in thin walled elements with limited access. (iv) Improves the quality, durability and reliability of concrete structures. (v) Ease of placement results in cost saving through reduced equipment and labor requirement. **[4]**. Self compacting concrete (SCC) is an innovative development of conventional concrete, which requires high binder content to increase its segregation resistance **[5]**. Self compacting concrete (SCC) can be defined as a fresh concrete which possesses superior flowability under maintained stability (i.e. no segregation), thus allowing self-compaction – that is, material consolidation without addition of energy. SCC was first developed in Japan in 1988 in order to achieve durable concrete structures by improving quality in the construction process **[6]**. Self compacting concrete (SCC) is a type of concrete that has the capacity to consolidate under its own weight **[7]**.

2. MATERIALS AND METHODS

Cement: ordinary Portland cement (OPC) of 43 grade conforming to IS- 8112-1989 was used throughout the investigation. The Normal consistency of cement was 28%. Physical properties of cement are given in table-1.

Fine aggregate: Locally available, Ramganga river sand conforming to IS: 383-1970, Zone-II was used throughout the investigation. Specific gravity, Bulk density and Fineness modulus were 2.6, 1774 kg/m^3 and 3.18 respectively.

Coarse aggregate: Locally available crushed stone aggregates conforming to IS: 383-1970, of 10 mm nominal maximum size was used throughout the investigation. Specific gravity, bulk density and Fineness modulus were 2.7, 1483 kg/m^3 and 6.45 respectively.

Waste marble powder: Waste marble powder was collected from the locally available manufacturing unit in

Moradabad (U.P.). 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 (Fig-1). Physical properties of waste marble powder are given in table-2.

Water: Potable water for mixing and curing of concrete specimens was used throughout the investigation.

Superplasticizer: Sika viscocrete 20-HE was used in present experimental research. It is a revolutionary high range water content reducer based on polycarboxylate ether (PCE). It has been developed for the production of concrete with high early strength and excellent workability requirements.

SCC MIX DESIGN: Okamura method (Rational mix design method) was used for mix design of self compacting concrete. Okamura and Ozawa (1995) have proposed a simple mix proportioning system assuming general supply from ready mixed concrete plants. The coarse and fine aggregate contents are fixed so that self compactibility can be achieved easily by adjusting the water powder ratio and super-plasticizer dosage only. The coarse aggregate content in concrete is fixed at 50 % of the solid volume. The fine aggregate content is fixed at 40% of the mortar volume. The water power ratio in volume is assumed at 0.9 to 1.0 depending on the properties of the power. The super-plasticizer dosage and the final water-power ratio are determined so as to ensure self compactibility **[10].**

.In the present study, M-30 grade of SCC was used for all experimental work. All the test of Self-compacting concrete (SCC) in fresh state, performed in present study as per EFNARC specifications and guidelines **[11].** The acceptance criteria of SCC as per EFNARC are given in table-3.

Table -1: Physical properties of cement

S. No.	Characteristic	Experimental values	Codal Requirement (IS: 8112-1989, OPC 43 grade specifications)
a	Fineness of cement(% retained on IS 90 micron sieve)	4.83%	10%
b	Soundness of cement(By Le-Chatelier method)	0.9 mm	Not more than 10 mm
c	Initial setting time	65 min	Not less than 30 min
d	Final setting time	224 min	Not more than 600 min
e	Compressive strength (7 days)	23.5 N/mm²	16.0 N/mm²
f	Compressive strength (14 days)	34.8 N/mm²	22 N/mm²
g	Compressive strength (28 days)	45.0 N/mm²	43 N/mm²

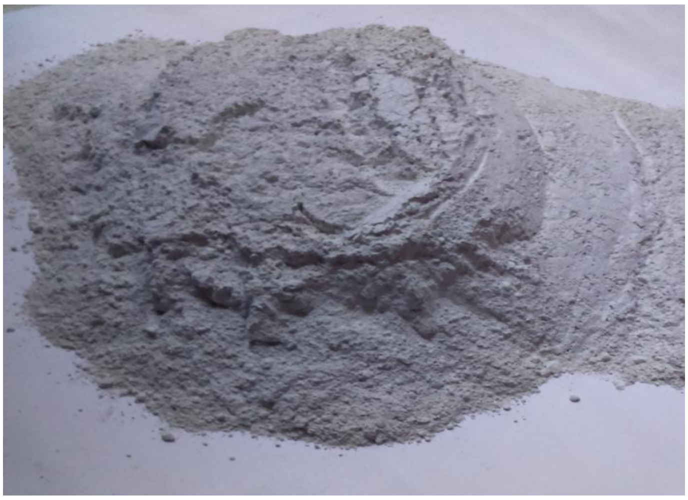

Fig -1: **Waste marble powder**

Table-2: Physical properties of waste marble powder

S. No.	Characteristic	Result
a	Colour	White
b	Form	Powder
c	Odour	Odourless
d	Specific gravity	2.68

Table-3: Acceptance criteria of Self-compacting concrete (EFNARC, 2002)

Method	Unit	Typical range of values	
		Minimum	Maximum
Slump Flow by Abram Cone	mm	650	800
T_{50cm} Slump Flow	sec	2	5
J-Ring	mm	0	10
V- Funnel	sec	6	12
Time increase at V-funnel at $T_{5minuts}$	sec	0	3
L-box	(h_1/h_2)	0.8	1.0
U-box	(h_1-h_2)mm	0	30
Fill box	%	90	100
GTM screen stability test	%	0	15
Orimet	sec	0	5

3. RESULTS AND DISCUSSION

In the present study, fresh properties of self-compacting concrete were investigated by using waste marble powder at six replacement rates of fine aggregate. The investigations were carried out according to appropriate criteria given by European standards. Several tests such as slump flow test, T_{50cm} slump flow test, V-funnel test, J-ring test, L-box test and orimet test were carried out to determine the properties of fresh SCC. It can be seen from table-4, In all the mixes of self-compacting concrete (SCC) with waste marble powder the slump flow test, T_{50cm} slump flow test, V-funnel test, J-ring test, L-box test and orimet test were carried out under limiting values. The graphical representations of all the tests are shown in Fig-2, Fig-3, Fig-4, Fig-5, Fig-6 and Fig-7. The results shows increase in workability of SCC with increase in proportion of waste marble powder.

Table-4: 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%	670	4.5	10.5	9.5	.902	5
SCC 2	10%	682	4	9.5	8.8	.915	4.8
SCC 3	20%	695	3.6	10.3	8.1	.923	4.2
SCC 4	30%	712	3.2	9.2	7.2	.935	3.5
SCC 5	40%	725	2.6	8.5	6.3	.946	3
SCC 6	50%	732	2	8.1	5.8	.962	2.6

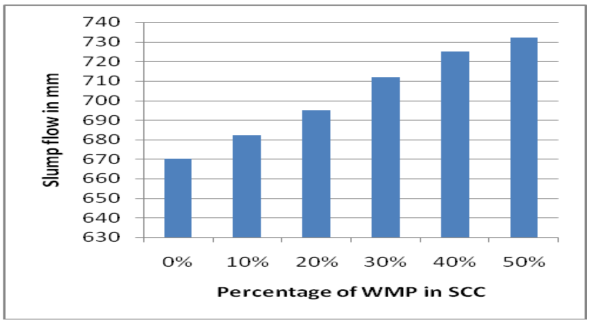

Fig-2: Slump flow test with different mixes of WMP

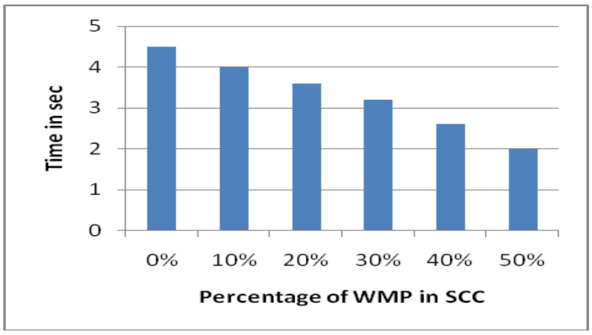

Fig-3: T_{50cm} Slump flow test with different mixes of WMP

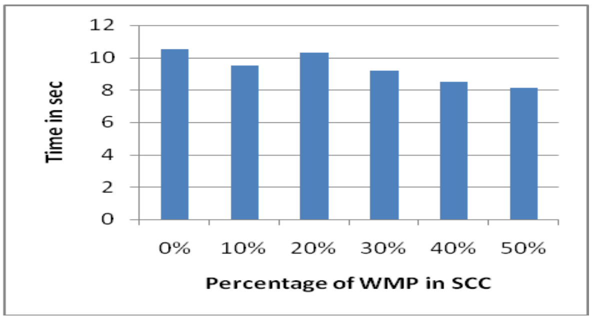

Fig-4: V-Funnel test with different mixes of WMP

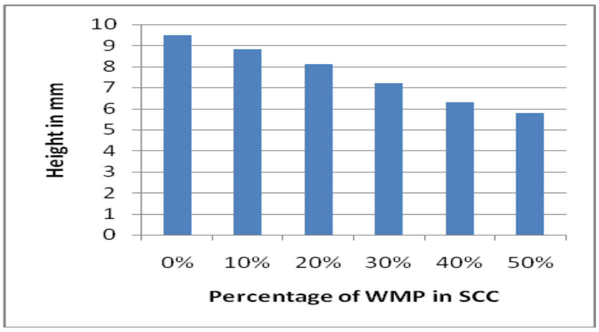

Fig-5: J-ring test with different mixes of WMP

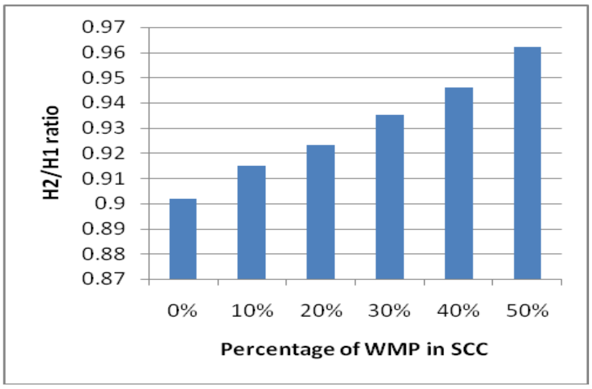

Fig-6: L-box test with different mixes of WMP

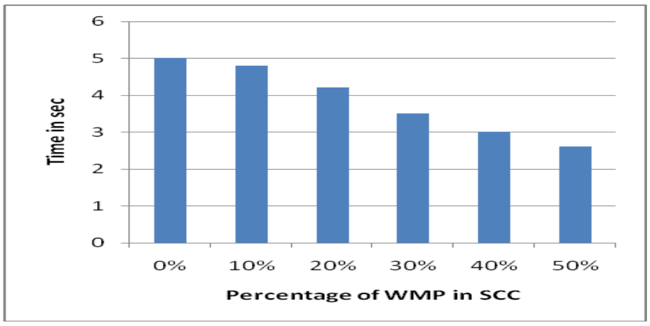

Fig-7: Orimet test with different mixes of WMP

3. CONCLUSIONS

From the present study, following conclusions may be drawn:

1. It has been observed that, on addition of waste marble powder, the filling ability of SCC by Slump flow test, T50cm test, V-Funnel test and Orimet test found to be increasing with increase in percentage of waste marble powder.
2. The passing ability of SCC by J-Ring test and L-Box test also found to be increasing with increase in percentage of waste marble powder.

The workability of SCC found to be increasing with increase in waste marble powder percentage. So, the required values fulfilling the criteria of EFNARC can be obtained.

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