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STUDY OF UTILIZATION OF WASTE MATERIALS TO ENHANCE THE PERMEABILITY OF HIGH STRENGTH CONCRETE

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ABSTRACT

HSC is a relative term, the definition of which may vary between two cities in the same country. In USA during 1950s concrete with a compressive strength of 34MPa was considered high strength. While recently concrete having compressive strength has high as 110MPa are used frequently.The advantage of HSC is small cross-section of structural elements resulting into reduction in cost and use of more space and improved engineering properties.

The present work is done to study the water permeability of HSC using IS code method. Fly ash (F.A.) and silica fume (S.F.) were added individually and collectively to the cement by weight basis. The contents of silica fume and fly ash were varied from 5 to 15% when used individually and 10 to 20% when used collectively. The water to cement plus binder materials ratio wa varied from 0.35 to 0.39. In order to maintain a desired degree of workability of concrete, expressed in terms of compaction factor, a superplasticizer (Sulphonated Naphthalene Formaldehyde-SNF) was used @ 2% by weight of cement. The two types of aggregates viz. Crushed sand stone and granite were used. The specimens were tested for compressive and split tensile strengths and water permeability after 28 days of curing.

The percent inclusion of fly ash, silica fume and fly ash plus silica fume by weight of cement and types of aggregate were the main parameters of the study.

1. INTRODUCTION

Concrete is most widely used man made construction material, commonly obtained by mixing Portland cement, sand, crushed rock and water. The total world consumption of concrete is estimated to be about one ton for every human being per year. Man consumes no material except water in such tremendous quantities. Concrete is neither as strong nor as touch as steel, so why is it the most widely used engineering construction material? The reason for its wide spread use can be summerised as - the ease with which concrete can be formed into a variety of shapes and sizes and cheapest and most readily available material on the job. The next reason which is most relevant to the present work is that the concrete possesses excellent resistance to water without serious deterioration. The use of concrete in many kinds of hydraulic structures, sub-structures, under water marine structures and chemical industries now-a-days is well known. In such structures many times the water tightness of concrete is of greater importance than strength. In concrete, water is present as a necessary requirement for the cement hydration reactions and as a plasticizing agent. With due course of time, depending on the environmental conditions and thickness of concrete element, all the capillary water and a part of adsorbed water is lost, leaving the pores unsaturated or empty. Since it is the evaporable water, a concrete will not be vulnerable to water-related destructive phenomena, provided the subsequent exposure of concrete to the environment does not lead to re-saturation of pores. To a large extent it depends on permeability of concrete.

2. CONSTITUENT MATERIALS USED

The constituent materials used are cement, fine aggregate, coarse aggregate, stone dust and water. The recommended materials have been described below.

Cement

Various types of cement can be used in concrete with stone dust. The cement should be fresh, free from foreign matters and of uniform consistency. Usually ordinary Portland cement is used in normal conditions.

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Fine Aggregate

The most common fine aggregate used in concrete is sand. The sand should be clean, hard, strong and free from organic impurities and deleterious substances. It should be capable of producing a sufficiently workable mix with a minimum water-cement ratio.

Coarse Aggregate

The aggregates are formed due to natural disintegration of rocks or by artificial crushing of the rock or gravels. The properties of coarse aggregate are chemical and mineral composition, spectrographic description, specific gravity, hardness, strength, physical and chemical stability, pore structure and color. Some other properties of the aggregate not possessed by the parent rocks are particle size and shape, surface texture and absorption etc. All these properties may have a considerable effect on the quality of concrete in fresh and hardened states.

Silica Fume

The silica fume used was obtained from silica supplier jaguar infra. Sol. lmtd. Chandigarh. The chemical composition and physical properties of silica fume are given in Table.

Fly Ash

The fly ash used was obtained from Panipat Thermal Power Station. The chemical and physical composition of fly ash are given in Table

Water

Mixing water should be fresh, clean and potable. Water should be free from impurities like clay, loam, soluble salts which lead to deterioration in the properties of concrete. Potable water is fit for mixing or curing of concrete.

3. MIX DESIGN

Mix proportion of concrete mix

S. No.	Mix Designation	Percentage replacement	W/P ratio	Total Binder (kg/cum)	Cement (kg/cum)	Marble powder (kg/cum)	Coarse aggregate (kg/cum)	Fine aggregate (kg/cum)	Water (liter/cum)	S.P.(1.5 %) (kg/cum)
1	M-X0	0	0.36	500	375	0	741.69	955.12	180	5.62
2	M-X1	5	0.36	500	350	25	741.69	955.12	180	5.25
3	M-X2	10	0.36	500	325	50	741.69	955.12	180	4.87
4	M-X3	15	0.36	500	300	75	741.69	955.12	180	4.5
5	M-X4	20	0.36	500	275	100	741.69	955.12	180	4.125
6	M-X5	25	0.36	500	250	125	741.69	955.12	180	3.75

4. TESTING OF SPECIMENS

- Fresh properties test conducted are Slump flow test(Total spread and T50 time), L-Box Test, J-Ring Test and V-Funnel Test
- The cubes were tested in compression testing machine after 7 and 28 days with uniformly increasing loads capacity compression testing machine. The loading was transmitted from loading machine to the specimen by rigid steel plates placed on both above and below the specimen. The load was applied until needle started deflecting backward after crushing of the specimen and the last reading was noted.

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- The beams were tested in a frame having varying capacity with two point load test. The specimens were divided in three parts equally and two point loads were kept at the end of middle third part of specimen and the load was applied through cylindrical iron piece kept below the dial gauge.
- The cylinders were tested in compression testing machine with uniformly increasing capacity compression testing machine. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens

5. RESULT ANAYLSIS

Acceptance criteria of Self-compacting concrete

Method	Unit	Typical range of values	
		Mini mum	**Maxi mum**
Slump Flow by Abram Cone	Mm	650	800
T50cm Slump Flow	Sec	2	5
J-Ring	Mm	0	10
V- Funnel	Sec	6	12
Time increase at V-funnel at T5minuts	Sec	0	3
L-box	(h1/h2)	0.8	1.0
U-box	(h1-h2)mm	0	30

- **Slump flow and T_{50} test:** It has been observed that, on addition of waste marble powder, the filling ability of SCC by Slump flow test, T50cm test found to be increasing with increase in percentage of waste marble powder.

Slump flow and T_{50} test

Sr. No.	Mix Designation	Type of Mix	Slump (mm)	T50cm Slump Flow (sec)
			600-750 mm	<6 sec.
1	M-X0	M-30(0% MP)	655	4.5
2	M-X1	M-30(5%MP)	660	4.1
3	M-X2	M-30(10%MP)	675	3.7
4	M-X3	M-30(15%MP)	695	3.2
5	M-X4	M-30(20%MP)	702	3.1
6	M-X5	M-30(25%MP)	705	3.0

- **Passing ability Test:** The passing ability of SCC by V-Funnel, J-Ring test and L-Box test also found to be increasing with increase in percentage of waste marble powder.

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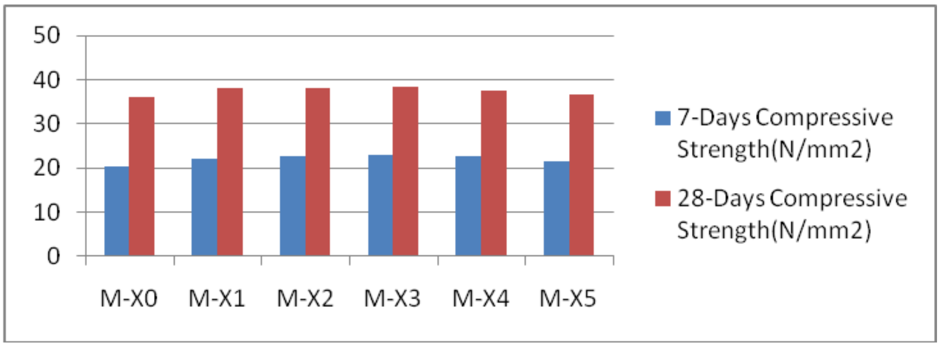
V-funnel, L-box and J-ring Test

Sr. No.	Mix Designation	Type of Mix	V-Funnel (sec)	L- Box {h2/h1)	J-Ring
			8-12 sec.	0.8-1	3-10 (mm)
1	M-X0	M-30(0% MP)	10.8	0.82	9.5
2	M-X1	M-30(5%MP)	9.6	0.85	8.8
3	M-X2	M-30(10%MP)	8.7	0.88	8.1
4	M-X3	M-30(15%MP)	8.2	0.90	7.2
5	M-X4	M-30(20%MP)	7.9	0.92	6.3
6	M-X5	M-30(25%MP)	7.5	0.92	5.8

- **Compressive Strength Tests:** The compressive strength was conducted on various specimens as per the guidelines given in IS 516-1959.Compressive strength of cube at 7 days and 28 days are shown in table

Mix Designation	7-Days Compressive Strength(N/mm^2)	28-Days Compressive Strength(N/mm^2)
M-X0	20.49	36.12
M-X1	22.2	38.1
M-X2	22.68	38.18
M-X3	23.05	38.35
M-X4	22.69	37.43
M-X5	21.48	36.595



Compressive strength comparison of 7days and 28 days

- **Flexure Strength Test:** Although the concrete is not designed to resist tension, the knowledge of tensile strength of concrete is of value in assessing the load at which crack will start appearing in concrete. Flexural Strength of specimen at 7 Days, 14 days and 28 days are shown in Table

Mix Designation	7-Days Flexural Strength(N/mm^2)	28-Days Flexural Strength(N/mm^2)
M-X0	3	3.77
M-X1	2.94	4.88
M-X2	3.24	5.04
M-X3	3.37	5.35
M-X4	3.62	5.09
M-X5	3.22	4.72

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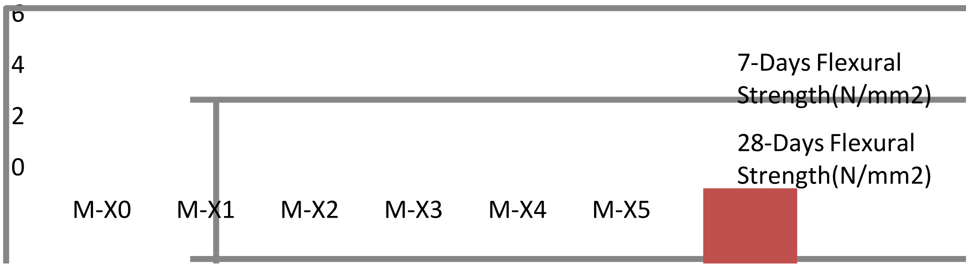
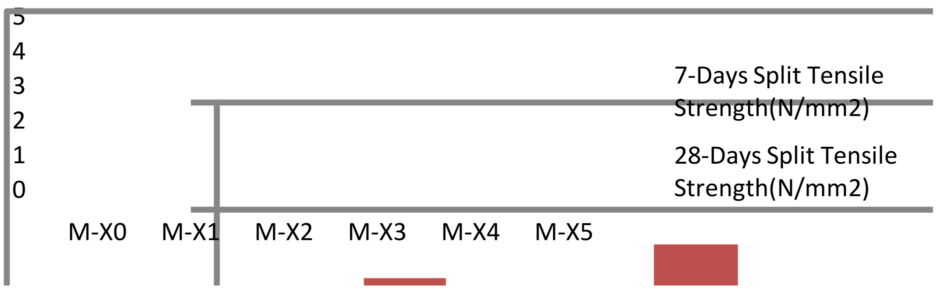


Flexural Strength Test Graph of 7days and 28 days

- **Split Tensile Strength Test :** The split tensile strength of concrete was conducted on various mixes as per guidelines of IS 516-1970.Split Tensile strength of 7 and 28 days are shown in Table

Mix Designation	7-Days Split Tensile Strength(N/mm^2)	28-Days Split Tensile Strength(N/mm^2)
M-X0	2.2	3.37
M-X1	2.24	3.67
M-X2	2.23	3.8
M-X3	2.45	3.98
M-X4	2.71	4.36
M-X5	2.15	3.48



Split Tensile Strength Test Graph of 7days and 28 days

6. CONCLUSIONS

A series of laboratory experiments was conducted to find the fresh properties of concrete like Workability and also the testing on hardened concrete is also done to find compressive strength, split tensile strength, and flexural strength of concrete with several percentage of marble powder. The effects of red mud and quarry stone on these properties are studied. The following are the conclusions that can be drawn from the experimental investigation:

- It has been observed that, on addition of waste marble powder, the filling ability of SCC by Slump flow test, T50cm test found to be increasing with increase in percentage of waste marble powder.
- The passing ability of SCC by V-Funnel, J-Ring test and L-Box test also found to be increasing with increase in percentage of waste marble powder.
- As shown per the results the values of strength in compressive strength test for 7 days, 14 days and 28 days are increases for the marble powder content 0%, 5%, 10% , 15% and 20% but it is then decreased for the marble content of 25%.
- As shown per the results the values of strength in flexural strength test for 7 days and 28 days are increases for the powder content 0%, 5%, 10% , 15% and 20% but it is then decreased for the marble content of 25%.

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- As shown per the results the values of strength in Split Tensile strength test for 7 days and 28 days are increases for the powder content 0%, 5%, 10% , 15% and 20% but it is then decreased for the marble content of 25%.

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