IJERMS

International Journal of Engineering Researches and Management Studies

EXPERIMENTAL STUDY OF SELF COMPACTING CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH MARBLE POWDER

Rohit Kumar*[1] & Ravi Kumar[2]
[*1]Student at Sddiet Panchkula
[2]Assistant Professor in Sddiet Panchkula

ABSTRACT
The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. In INDIA, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. Slump and air content of fresh concrete and absorption and compressive strength of hardened concrete were also investigated. Test results show that this industrial bi product is capable of improving hardened concrete performance up to 10%. In the present work A series of laboratory experiments was conducted to find the fresh properties of concrete like flow ability and passing ability 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 marble powder on these properties are studied with the partial replacement of cement in 0%, 5%, 10%, 15%, 20% and 25%.

1. INTRODUCTION

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, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as conventionally vibrated concrete (CVC). Self Compacting Concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction. Marble is a metamorphic rock composed of recrystallized carbonate minerals most commonly calcite or dolomite. Marble may be foliated. Geoygists use the term marble to refer to metamorphosed limestone. Marble is commonly used for sculpture and as a building material. marble powder was collected from the dressing and processing unit . It was initially in wet from after that it is dried by exposing in the sun and finally sieved by IS -90 micron sieve before mixing in concrete. These day marbles are widely used in construction work. A large amount of waste is generated during sawing, grinding and polishing process. The result is that the marble waste which is 20% of total marble quarried has reached as high millions of tons. Generally the marble wastes are being dumped in any nearby pit or vacant space near the marble processing industries, although notified areas have been marked for dumping the same. This leads to increased environmental risks as dust pollution spreads alongside for a large area. In the dry season, the dust dries up, floats in the air, flies and deposits on crops and vegetation. In addition, the deposition of such generated huge amount of fine wastes certainly creates necrotic ecological conditions for flora and fauna changing landscapes and habitats. The accumulated waste also contaminates the surface and underground water reserves. Now a day's marble waste is one of the causes of environmental problems around the world. Therefore, max. Utilization of marble waste in various industrial sectors, especially the construction, agriculture, glass and paper industries would help to protect the environment. Concrete is the most widely used construction material in the civil construction work because of its high structural strength and stability.

IJERMS
International Journal of Engineering Researches and Management Studies

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.

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.

Marble Powder
Marble is a metamorphic rock which results from the transformation of a pure limestone. The purity of the marble is responsible for its colour and appearance. Marble powder is produced from the marble processing plants during the cutting, shaping and polishing. It is white if the limestone is composed solely of calcite (100% $CaCO_3$). Marble is used for construction and decoration. Marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. The specific gravity of marble is 2.52. Local available Marble powder used as Partial replacement of fine aggregate in concrete.

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

IJERMS
International Journal of Engineering Researches and Management Studies

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.
- 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.

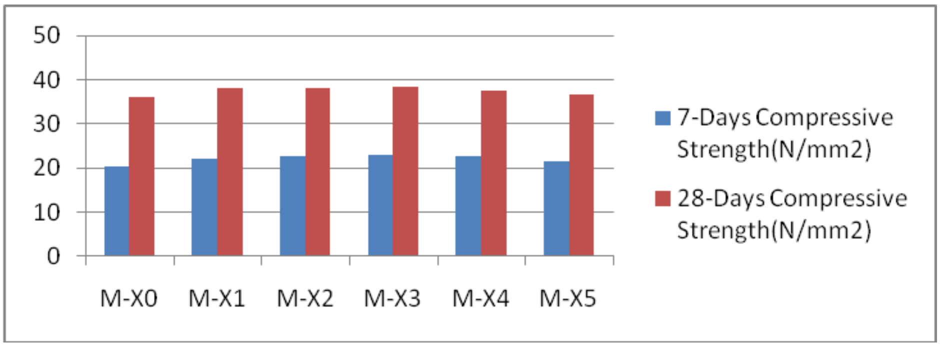
IJERMS
International Journal of Engineering Researches and Management Studies

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

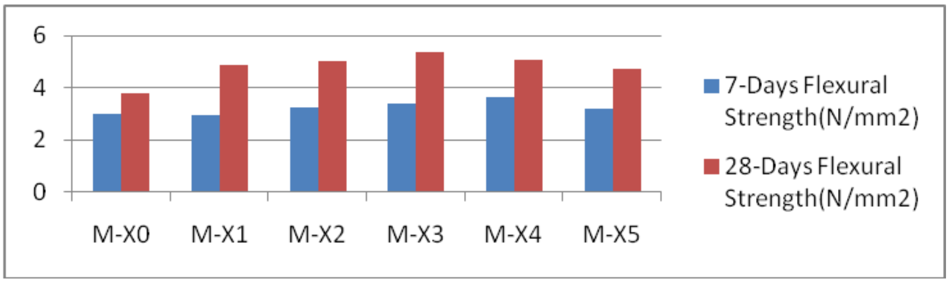


Compressive strength comparison of 7days and 28 days

- **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

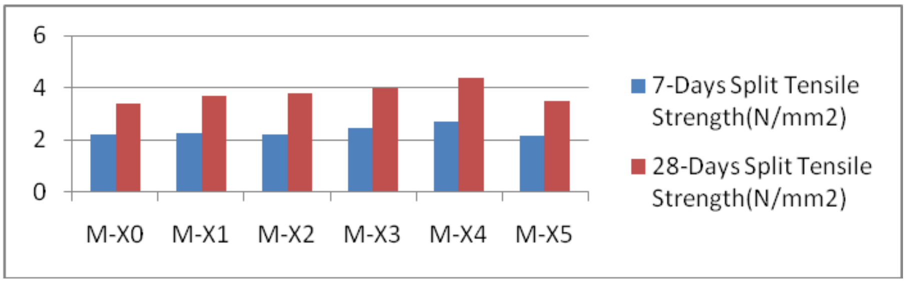
IJERMS
International Journal of Engineering Researches and Management Studies



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. CONCLUSION

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%.

IJERMS
International Journal of Engineering Researches and Management Studies

- 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%.

REFERENCES

1. *Arivalagan S, 2013, "Experimental analysis of self- compacting concrete incorporating different ranges of High- volumes of class F fly ash" Scholars Journal of Engineering and Technology(SJET) 1(3); 104-111, ISSN 2321-435X.*
2. *Gaywala N R and Raijiwala D B, 2011, "Self compacting concrete: A concrete of next decade" Journal of engineering Research and Studies, E-ISSN 0976-7916, Issue IV/ October-December,2011/ 213-218.*
3. *Zoran Grdic et.al., 2008, "Properties of self compacting concrete with different types of additives" FACTA UNIVERSITATIS, Series: Architecture and civil engineering vol. 6, N 2, pp. 173-177*
4. *Aggarwal Paratibha et.al., 2005, "Properties of self compacting concrete- An overview" 30th Conference on our world in concrete & Structures" 23-24 August 2005, Singapore, Article online id: 100030011.*
5. *Mahajan Sumit and Singh Dilraj, 2013, " Fresh and hardened properties of self compacting concrete Incorporating different binder materials" International Journal of emerging Technology and Advanced Engineering, ISSN 2250-2459,Volume 3, Issue 12, December 2013.*
6. *Goodier C I, 2003, "Development study on self compacting concrete" Proceedings of the ICE-Structures and buildings, 2003, 156(4), pp. 405-414.*
7. *Pai B.H.V. et.al., 2014, "Experimental study on self compacting concrete containing Industrial by-products" European Journal April 2014 edition vol.10, no. 12, ISSN: 1857-7881(Print) e-ISSN: 1857-7431.*
8. *IS: 8112-1989, "43 grade ordinary Portland cement- Specifications"*
9. *IS: 383-1970, "Specifications for Coarse and Fine aggregates from natural sources for concrete (Second Revision)"*
10. *Okamura H. and Ouchi M., "Self compacting concrete" Journal of Advanced concrete Technology vol. 1, 5-15 April 2003.*
11. *EFNARC 2002, "Specifications and Guidelines for self compacting concrete" EFNARC publication 2002, 1-32.*
12. *S.Suresh and ShaktinathDas"Green cement for sustainable concrete using marble dust" Department of ChemicalEngineering,MaulanaAzad NationalInstituteof Technology. International conference on global scenario in environment and energy March 2013.*
13. *Sachin2010:" Effect of the lime content in marble powder for producing high strength concrete" Vol. 8, No. 4, April 2013*
14. *AkbulutH andGürerC(2007)." Useofaggregates produced frommarble quarry waste in asphalt pavements". Build. Environment, 42(5): 1921-1930.*
15. *Baboo Rai , Khan Naushad H , Abhishek Kr , Tabin Rushad S , Duggal S.K, Volume 1, No 4, 2011, Influence of Marble powder/granules in Concrete mix"*
16. *IS: 3831970, Specification for Coarse and Fine Aggregate from Natural Sources for Concrete—Bureau of Indian Standards, New Delhi.*
17. *IS: 102621982, Recommended Guidelines for Concrete Mix Design—Bureau of Indian Standards, New Delhi*