Experimental Studies on Marble Powder used for Concrete

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***Abstract*- The availability of coarse aggregate i.e., Stone is reducing day by day. So, in order to replace the stone aggregate, we used tiles which are also wasted 30% in Indian industry. We used M20 grade concrete with different % of tiles which are 20%, 40%, 60% and 80% Compressive strength, splitting tensile strength, flexural strength and modulus of elasticity test has been conducted on concrete specimens which are cured for 28 days, 54 days, and 90 days. We also used 150mm cubes for testing compressive strength, 150mm diameter and 300mm length for tensile strength and for modulus of elasticity, a prism of size 500mm length 100mm wide 100mm thickness for flexural strength.**

***Keywords*- Recycled aggregate and Glass aggregate, Ordinary Portland cement (OPC), Low-cost, Eco-friendly, Compressive strength, Split tensile strength, Flexural Strength.**

INTRODUCTION

The availability of coarse aggregate i.e., Stone is reducing day by day. So, in order to replace the stone aggregate, we used tiles which are also wasted 30% in Indian industry. We used M20 grade concrete with different % of tiles which are 20%, 40%, 60% and 80% Compressive strength, splitting tensile strength, flexural strength and modulus of elasticity test has been conducted on concrete specimens which are cured for 28 days, 54 days, and 90 days. We also used 150mm cubes for testing compressive strength, 150mm diameter and 300mm length for tensile strength and for modulus of elasticity, a prism of size 500mm length 100mm wide 100mm thickness for flexural strength. And we compared with conventional concrete of grade M20 of same days of curing which is 28 days, 54 days and 90 days. Finally, we got the safe value.

1.2 TYPES OF TILES-

There are several types of tiles used for residential and commercial applications, they are:

a) Ceramic tile
b) Quarry tile
c) Porcelain tile
d) Mosaic tile
e) Marble tile

Marble tile: - The word marble is derived from the ancient Greek (ma′rmaron) from (ma′rmaros) “crystalline rock, shining stone, perhaps from the verb “to flash, sparkle, gleam, R.S.P Beeks has suggested that a “Pre-Greek origin is probable”. Marble is a rock resulting from metamorphism of sedimentary carbonate rocks, most commonly limestone or dolomite. Metamorphism causes variable recrystallization of original carbonate crystals. Pure white marble is result of metamorphism of very pure limestone or dolomite protolith.

1.2 MATERIALS AND MIX PROPORTION

1.2.1 Aggregates

1.2.1.1 Ceramic tile aggregate

The ceramic tiles are collected and then break into pieces by hammering. The pieces tiles are sieved to get a 20 mm size.

1.2.1.2 Stone aggregate

A crushed granite stone of size 20mm are used for all the specimens.

1.2.1.3 Fine Aggregate

The fine aggregate used for the entire specimen were natural river sand complying with the requirement of IS383:1970.

1.2.1.4 Water:

Locally available potable water is used for mixing the concrete.

Fig:1 Marble powder

1.2.2 Mix proportion: -

Grade of concrete	**M30**
Cement	**362 Kg/cum**
F. A	**682.6 Kg/cum**
C.A	**1184.4 Kg/cum**
Water	**162.9 Kg/cum**

1.3 DURABILITY OF CONCRETE-

A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service. The materials and mix proportions specified and used should be such as to maintain its integrity and, if applicable, to protect embedded metal from corrosion. One of the main characteristics influencing the durability of concrete is its permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other potentially deleterious substances. Impermeability is governed by the constituents and workmanship used in making the concrete. With normal-weight aggregates a low permeable concrete is achieved by having adequate cement content, sufficiently low water/cement ratio, by ensuring complete compaction of the concrete, and by adequate curing.

The factors influencing durability include:

- The environment;
- The cover to embedded steel
- The type and quality of constituent materials
- The cement content and water/cement ratio of the concrete
- Workmanship, to obtain full compaction and efficient curing
- The shape and size of the member.

The degree of exposure anticipated for the concrete during its service life together with other relevant factors relating to mix composition, workmanship, design and detailing should be considered. The concrete mix to provide adequate durability under these conditions should be chosen taking account of the accuracy of current testing regimes for control and compliance as described in IS 456.

1.4 NEED FOR STUDY

Nowadays M-sand is commonly used in the production of concrete due to the scarcity of natural river sand. The use of manufactured sand in concrete as fine aggregate may alter the strength and durability. Hence, an experimental investigation is necessary to predict the strength and durability of concrete made of manufactured sand.

1.5 REVIEW OF LITERATURE

1.5.1 General

About 30% productions go as waste, which is not recycling at present. The workability of ceramic waste coarse aggregate concrete is good and the strength characteristics are comparable to those of the conventional concrete.

1.5.2 STUDIES ON EXPERIMENTAL INVESTIGATION

S. KUMAR, R. KUMAR (2006)- Innovative methodologies for utilization of waste from metallurgical and allied industries

SA. MANGI, MS. RAZA (2022)- Recycling of ceramic tiles waste and marble waste in sustainable production of concrete.

S. RAY, M. HAQUE- Use of ceramic waste as aggregate in concrete production.

CHAPTER 2

AIM AND SCOPE

The main scope of the project is to find out the strength variation of concrete on addition of different % of tiles in different tests they are: -
1) Compressive strength test
2) Tensile strength test
3) Modulus of elasticity test
4) Flexural strength test.
The main objective is to find out the exact % of tiles to replace stone aggregate.

EXPERIMENTAL INVESTIGATION

3.1 MATERIALS USED

The quality of material plays a vital role in the manufacture of High Strength Concrete. The various materials used to produce the HSC are:
I. Cement (PPC)
ii. R-Sand
iii. Coarse aggregate
iv. Water
v. Tiles

3.2 MATERIAL PROPERTIES

The properties of each materials used to produce High Strength Concrete are discussed below in the following sub-section.

3.2.1 Cement

The Portland pozzolana cement is a kind of blended cement which is produced by either intergrading of OPC clinker along with gypsum and pozzolanic materials separately or thoroughly blending them in a certain proportions. Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous and aluminous material which in itself possesses little or no cementations properties, but it chemically reacts with calcium hydroxide at ordinary temperature to form compounds possessing cementations properties. Portland pozzolana cement produces less heat of hydration and offers greater resistance to attack of aggressive waters than ordinary Portland pozzolana cement shall comply the requirements of IS 1489. 53 grade Portland pozzolana cement with brand name Shankar Cement was used in this project and is shown in Fig. 3.1. Cement was purchased from Shakti Enterprisers in Vijayanagar at Erode. The properties of cement used are given in table3.1.

Fig: 3.1 Cement

Property	Value
Initial setting time	35 minutes
Final setting time	8 hours
Specific gravity	3.15
Consistency	30%

Table 3.1 Properties of cement

3.2.2 River sand

The sand from river due to natural process attrition tends to possess smoother surface texture and better shape. It also carries moisture that is trapped in between the particles. These characters make concrete workability better. However, silt and clay carried by river sand can be harmful to the concrete. Another issue associated with river sand is that of obtaining required grading with a fineness modulus of 3.8. It has been verified and found, at various locations across south India, that it has become increasingly difficult to get river sand of consistent quality in terms of grading requirements and limited silt/clay content. It is because we do not have any control over the natural process. The river sand used in this project is shown in Fig. 3.2. River sand was purchased from a sand quarry in Bhavani River at Erode. The properties of cement used are given in table3.2.

Fig: 3.2 River sand

Property	Value
Specific gravity	2.68
Water absorption	1%
Free moisture content	0.9%
Fine modulus	3.89

Table: 3.2 Properties of R-sand

3.2.3 Coarse aggregate

Aggregate shall comply the requirements of IS 383. As far as possible preference shall be given to natural aggregates. The nominal size of coarse aggregate should be large as possible within the limits specified but in no case greater than one-fourth of the minimum thickness of the member. However, for most of the work 20mm and 12mm sizes in the combination of 70% :30% respectively were selected as coarse aggregate because this particular combination had minimum voids. The coarse aggregate used in this project is shown in Fig.3.4. Coarse aggregate was purchased from Aayana rock quarry at Kumarapalayam in Namakkal. The properties of coarse aggregate used are given in table3.4

Fig: 3.3 Coarse aggregates

Property	Value
Specific gravity	2.78
Water absorption	0.5%
Free moisture content	0
Fine modulus	0.5225

Table: 3.3 Properties of coarse aggregates

3.2.4 Water

Water used for mixing and curing shall be clean and free from oils, acids, alkalis, salt, sugar, organic or other substance that may be deleterious to concrete. Portable water generally considered satisfactory for mixing and curing. Tests will be performed to find the various physical& chemical properties of all the materials. Portable water available in the laboratory was used in this project for mixing and curing of HSC.

3.2.5 Tiles

Marble tiles-

The word marble is derived from the ancient Greek (ma′rmaron) from (ma′rmaros) “crystalline rock, shining stone, perhaps from the verb “to flash, sparkle, gleam, R.S.P Beeks has suggested that a “Pre-Greek origin is probable”. Marble is a rock resulting from metamorphism of sedimentary carbonate rocks, most commonly limestone or dolomite. Metamorphism causes variable recrystallization of original carbonate crystals. Pure white marble is result of metamorphism of very pure limestone or dolomite protolith

Fig: 3.5 Marble tile

Property	Value
Specific gravity	2.72
Maximum size (mm)	24 inches
Fineness modulus	0.91
Water absorption	0.2%

3.3 MIX PROPORTION

Trial no	% Replacement	Cement (Kg)	C.A (kg)	F. A (Kg)	Marble powder (Kg)	W/C
1	**0%**	**369.780**	**1221**	**547**	**0.0**	**192.10**
2	**5%**	**351.291**	**1221**	**547**	**18.489**	**192.10**
3	**10%**	**332.800**	**1221**	**547**	**36.987**	**192.10**
4	**15%**	**314.313**	**1221**	**547**	**55.467**	**192.10**

Table: 3.5 Mix proportion of M30 grade.

3.3.1 Mixes Adopted

Mix ratio as per IS method is adopted for the design mix. Plain concrete cubes cylinders prism was cast, cured and tested in UTM. M20 Grade of Concrete is chosen and the design mix adopted for the Test Specimens is 1:1.8:2.8, water cement ratio is 0.5.

3.4 SPECIMEN CASTING

Table: 3.6 Number of specimens cast for the experimental program

Sr no	Test	Specimen size	Sample numbers
1	Compressive	150mm x150mmx150mm	39
2	Tensile	150mmx150mm x150mm	39
3	Flexure	500mmx100mmx100mm	39
		Total	**87**

3.4.1 Casting of concrete

150 mm molds should be filled in three approximately equal layers (50 mm deep). A compacting bar is provided for compacting the concrete. It is a 380 mm long steel bar, weighs 1.8 kg and has a 25 mm square end for ramming. During the compaction of each layer with the compacting bar, the strokes should be distributed in a uniform manner over the surface of the concrete and each layer should be compacted to its full depth. During the compaction of the first layer, the compacting bar should not forcibly strike the bottom of the mold. For subsequent layers, the compacting bar should pass into the layer immediately below. The minimum number of strokes per layer required to produce full compaction will depend upon the workability of the concrete, but at least 35 strokes will be necessary except in the case of very high workability concrete. After the top layer has been compacted, a trowel should be used to finish off the surface level with the top of the mold, and the outside of the mold should be wiped clean

3.4.2 Testing of concrete

3.2.4.1 Compression Test

The Compression Test is a laboratory test to determine the compressive strength of the concrete.

3.2.4.2 Tensile Test

The splitting tensile test is a much used method to determine the tensile strength of concrete. The conventional test procedure is known to have a number of limitations related to size effect and boundary conditions

3.2.4.4 Flexural strength test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

Fig: 3.5 Casting

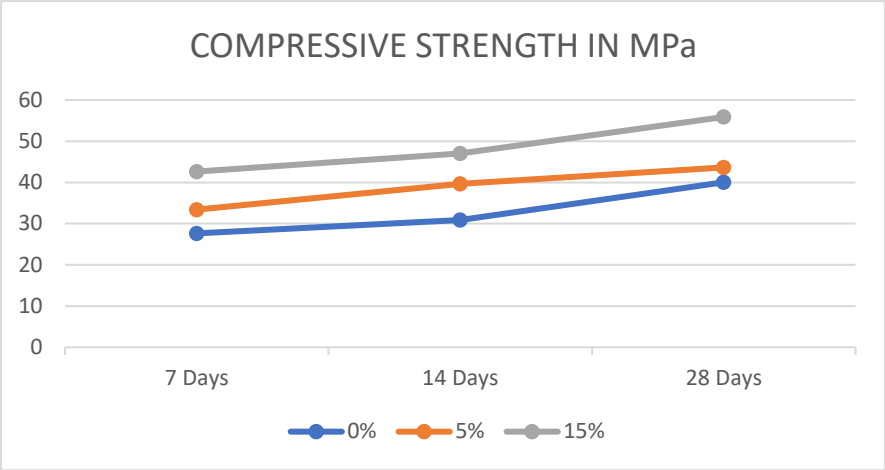
Fig: 3.5.1 Curing

3.5 RESULTS AND DISCUSSION

Various tests are conducted to find the properties of hardened concrete. Compressive strength, Flexure strength, Cylinder split tensile test were obtained in the laboratory. Test result obtained were presented in this section.

Sr. No	Code	% Replaced	Breaking load @ 7 days			Breaking load @ 28 days			Average Breaking load		Average flexural Strength @ 7 days	Average flexural Strength @ 28 days
			Specimen no.			Specimen no.						
			1	2	3	1	2	3	7 days	28 days		
1	CM	0%	14	12	13	17	14	16	3	15.6	5.67	7.44
2	HSI	5%	12	12.5	9.5	16.5	14.4	15	11.3	15.3	5.82	7.52
3	HSII	10%	11.5	12	11.5	17.5	14	16	11.66	15.83	6.42	7.87
4	HSIII	15%	5.1	6.3	5.4	6	8	5.5	5.6	6.5	2.52	7.2
5	HSIV	20%	7.5	7	6	7.5	7	7	6.83	7.14	2.11	7.45

Table: 3.5



Graph 3.5 Compression test

Days	Percentage of marble powder in concrete		
	0%	*5%*	*15%*
7 Days	27.63MPa	33.4MPa	42.63MPa
14 Days	30.9MPa	39.63MPa	47.03MPa
28 Days	40.03MPa	43.64MPa	55.87MPa

Table: 3.5.1 Final Result

IV. CONCLUSION

1. Due to marble dust, it proved to be very effective in assuring very good cohesiveness of mortar and concrete.
2. From the above study, it is concluded that the marble dust can be used as a replacement material for cement; and 10% replacement of marble dust given an excellent result in strength aspect and quality aspect and it better than the control concrete.
3. The result showed that the substitution of 10% of the cement content by marble dust induced higher compressive strength, higher splitting tensile strength, flexural strength and improvement of properties related to durability.
4. Test result show that this industrial waste is capable improving hardened concrete performance up to 15%, enhancing fresh concrete behavior and can used in plain concrete.

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