Experimental Study on Partial Replacement of Cement with Marble Powder and Fine Aggregate with Quarry Dust and with Addition of Polypropylene Fiber

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Abstract : **Concrete is the most important component used in the construction industry. Due to urbanization, the use of cement in the construction industry gets increased rapidly. Due to the increasing demand for cement, marble powder is used as a partial replacement for cement. Marble waste is a solid waste material generated from the marble processing and can be used as a filler material in cement while preparing concrete. The amount of waste marble powder generated at the site every year is in the range of 250-400 tones. The series of tests are conducted to study the effect of 5%, 10% and 15% replacement of cement with marble powder on compressive strength and split tensile strength and compare it with the conventional concrete and also to find the optimum replacement of marble powder between 10% to 14%.With the optimum replacement of marble powder, quarry dust is replaced for fine aggregate at 10%,20%,30% and tested for compressive strength and split tensile strength. With these optimum results polypropylene fiber is added for further improvement in strength.**

Keywords—Compressive strength, Split tensile strength, Marble powder, Quarry dust, Polypropylene fiber.

I. Introduction

Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. The secret of its popularity lies in the simple fact that except cement, all other ingredients of concrete are commonly available local materials like aggregate and water. Earlier we knew only about the conventional ingredients of concrete like cement, aggregate and water, but today we are well conversant of the importance of admixtures too. The concrete industry is constantly looking for supplementary material with the objective of reducing the solid waste disposal problem. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size.

II. Objectives

- To investigate the effects of using marble powder and quarry dust as a partial replacement of cement and fine aggregate in concrete.
- To study the physical and chemical properties of marble powder and quarry dust.
- To investigate and compare the strength of hardened concrete for various polypropylene fiber mixes with optimum percentages of marble powder and quarry dust obtained.

III. Literature Review

Anitha selva sofia S D et al., (2013), describes the Experimental Investigation on Quarry dust concrete with chemical admixture . The main objective of this investigation is to evaluate the possibilities of using quarry dust as a replacement to fine aggregate along with super plasticizer. The chemical admixture used for the investigation is super plasticizer conplast sp430. 0%, 10%, 20%, 30%, 40%, 50% and 100% of traditional fine aggregate was replaced with quarry dust.They concluded that the conventional fine aggregate is completely replaced with quarry dust along with 1 % dosage of super plasticizer increase in the compressive strength is around 85%.

Ahsana Fathima K M, et al (2014), describes the Behavioural study of Steel fiber and Polypropylene fiber. The main aim of this experiment is to study the strength properties of steel fibre and polypropylene fibre reinforced concrete of M30 grade with 0%, 0.25%, 0.5%, and 0.75% by volume of concrete. They showed the results that the polypropylene fibre reinforced concrete yield higher flexural strength with addition of 0.5% polypropylene fibre by volume of concrete.

Prof. Veena G. Pathan, et al(2014), studied the Feasibility and Need of use of Waste Marble Powder in Concrete Production. This paper presents the feasibility of the substitution of marble waste for cement to achieve economy and environment saving. In this paper, only some basic study of using marble waste in cement and concrete production is investigated. They concluded that the marble dust can be used as a replacement for cement. Test results indicate that the 10% of marble dust in the cement concrete gives the best results. And also increase in curing days will increase the strength of marble dust concrete when compared from 14 days to 28 days.

IV. MATERIALS USED

A. *Cement*

OPC (43 grade) cement is used throughout the course of project work. The properties of the cement used are shown in the Table 1 below

TABLE I PROPERTIES OF CEMENT

Sl.No	Physical property	Value
1	Specific gravity	3.15
2	Fineness	3.3
3	Initial setting time	38 min
4	Final setting time	520min
5	Standard consistency	31%

B. *Aggregates*

Aggregates are those chemically inert materials which when bonded by cement paste form concrete. Aggregates constitute the bulk of the total volume of concrete and hence they influence the strength of concrete to great extent.

1)Fine Aggregates: The material which passed through I.S. Sieve No. 480 (4.75mm)is termed as fine aggregates. The source for fine aggregate used is from natural river bed. The fine aggregate used which have fineness modulus of 3.1, specific gravity of 2.6.

2)*Coarse Aggregates:* The material whose particles are of such size as are retained on I.S. Sieve No. 480 (4.75mm) is used as coarse aggregates. The aggregate used which have specific gravity of 2.73 and fineness modulus of 7.5.

C. *Marble Powder*

Marble dust which is used in this investigation was obtained during polishing and cutting of marble. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. We can reduce the environmental pollution by utilizing this marble powder.

TABLE II PROPERTIES OF MARBLE POWDER

Sl.No	Properties	Value
1.	Color	White
2.	Form	Powder
3.	Specific Gravity	2.66

Fig. 1 Marble Powder

D. *Quarry Dust*

It is the residue material which is the extraction of rocks to form the fine particles less than 4.75mm through the IS sieve. Locally available quarry dust was used in the present study for replacement of fine aggregate.

TABLE III PROPERTIES OF QUARRY DUST

Sl.No	Property	Values
1	Specific gravity	2.6
2	Water Absorption (%)	1.3
4	Fineness modulus	3.6

Fig. 2 Quarry Dust

E.*Polypropylene Fiber*

Polypropylene fibres are tough but with low tensile strength and modulus of elasticity. Fibres are intended to improve tensile strength, flexural strength, toughness and impact strength, to change failure mode by means of improving post-cracking ductility, and to control cracking .These fibers have low density of 0.9 g/cc. The sufficient quantities of

polypropylene fibres with suitable characteristics may prevent spalling of a concrete

TABLE IV PROPERTIES OF POLYPROPYLENE FIBER

Sl.No	Property	Values
1	Length	12mm
2	Aspect ratio	6
3	Diameter	2 mm
4	Appearance and form	Clear, bright and white in colour

Fig. 3 Polypropylene Fiber

F. Chemical Admixture

The use of water reducing admixture in concrete production helps to reduce the amount of fresh water used when making concrete. Super plasticizer by trade name **Techmix 550**, Sulphonated Naphthalene Polymers manufactured at Chennai, was used as water reducing admixture to achieve the required workability.

V.EXPERIMENTAL INVESTIGATION

The experimental investigation consisted of making M30 concrete with various proportions of marble powder as a replacement to cement. With the optimum results quarry dust is added to the mix as partial replacement for fine aggregate and polypropylene fiber is added as 0.5%,1%,and 1.5% and determining the Compressive strength of concrete.

M30 mix was designed as per IS 10262:2009 and its mix ratio was found to be 1: 2.02:3.6:0.40.The required materials were weighed and mixing of concrete was carried out manually. Cube specimens of size 150 mm x150 mm x 150 mm is casted. The specimens are de moulded after 24 hours of casting and the specimens are cured in tank for 7 and 28 days. Cylinder specimens of size 150mm x 300 mm is also casted and cured in tank for 28 days.

VI. RESULTS & DISCUSSION

A. *Tests for Compressive Strength:* The compressive strength of concrete for cubes, all mixes at 7 and 28 days of curing. Three cubes were casted for various percentage replacements of cement by MP. The result shows that the Compressive strength increased with addition of waste marble powder up to 12% replace by weight of cement and further addition of marble powder, the compressive strength decreases. With the 12% replacement of cement with marble powder, different percentages (10%, 20%,30%) of quarry dust was replaced for fine aggregate. There is increase in compressive strength at 12% replacement of marble powder for cement with 30% replacement of quarry dust for fine aggregate. Polypropylene fiber was added as 0.5%,1%,1.5%.The compressive strength is increased at 0.5% of polypropylene fiber

TABLE V AVERAGE COMPRESSIVE STRENGTH OF MARBLE POWDER

Mix	Average Compressive Strength (N/mm^2)	
	7 days	***28 days***
C	22.31	33.81
M1(5%)	22.1	34
M2(10%)	23.82	34.53
M3(15%)	21.86	32.64

TABLE VI AVERAGE COMPRESSIVE STRENGTH OF MARBLE POWDER (BETWEEN 11% TO 14%)

Mix	Average Compressive Strength (N/mm^2)	
	7 days	***28 days***
M4(11%)	22.68	34.9
M5(12%)	24.08	35.42
M6(13%)	22.41	34.49
M7(14%)	21.79	33.03

TABLE VII AVERAGE COMPRESSIVE STRENGTH OF QUARRY DUST WITH OPTIMUM PERCENTAGE OF MARBLE POWDER

Mix	Average Compressive Strength (N/mm^2)	
	7 days	***28 days***
M5(12%)&Q1(10%)	23.77	35.48
M5(12%)&Q2(20%)	24.34	35.8
M5(12%)&Q3(30%)	25.32	36.7

TABLE VIII AVERAGE COMPRESSIVE STRENGTH OF POLYPROPYLENE FIBER WITH OPTIMUM PERCENTAGE OF MARBLE POWDER AND QUARRY DUST

Mix	Average Compressive Strength (N/mm^2)	
	7 days	***28 days***
P1 (0.5%)	26.18	38.5
P2 (1%)	25.02	37.8
P3 (1.5%)	23.71	35.4

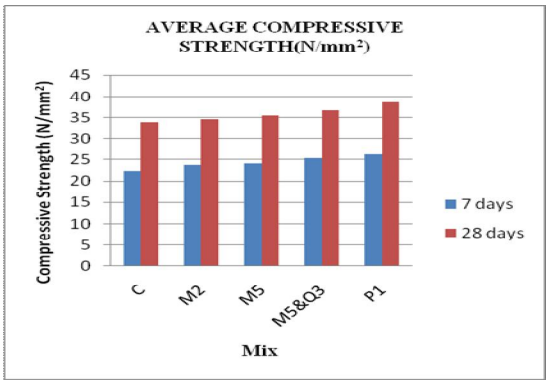

Fig. 4 Average Compressive Strength

***B**. Tests for Split Tensile Strength:* This is an indirect test to determine the tensile strength of cylindrical specimens. Splitting tensile strength tests were carried out on cylindrical specimens of size 150 mm diameter and 300 mm length at the age of 28 days curing, using compression testing machine The load was applied gradually till the specimens split and readings were noted.

TABLE IX AVERAGE SPLIT TENSILE STRENGTH

Mix	Average Split tensile strength for 28 days
C	3.38
M5	3.54
M5&Q3	3.67
P1	3.89

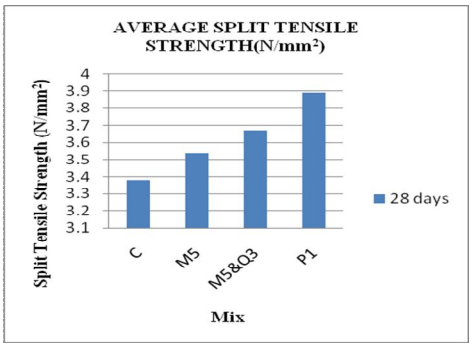

Fig. 5 Average Split Tensile Strength

V. CONCLUSION

Based on the results presented above, the following conclusion can be drawn:

1. The Compressive strength of Cubes are increased with the addition of marble powder up to 12% replace by weight of cement.
2. Optimum percentage replacement of cement with Marble powder and fine aggregate with quarry dust is 12% and 30%.The compressive strength is increased about 8.5% and split tensile strength is increased about 8.57% when compared to conventional concrete.
3. There is a decrease in workability as the replacement level increases, and hence the super plastizer is used.
4. The compressive strength of concrete increased about 13.87% and split tensile strength is increased about 15.08% with the further addition of 0.5% polypropylene fibre by weight of cement to the concrete.

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