An Experimental Study of Mechanical Properties on Fibre Reinforced Concrete using Polypropylene and Marble Powder

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Abstract

Normal or conventional concrete uses more of the raw material like sand, gravels, fly ash etc. Its usage has been increased to an enormous amount where there are likely chances of meeting with the demand of such construction materials. It may also lead to increase the cost of the materials drastically. To overcome such situations, alternate building materials were emerging now-a-days. This study has been made as an attempt in improvising the technological ailment by using recycled materials for construction. Marble dusts and Fibres, the abundantly available materials were selected for partially replacements in concrete. Marble powder being a residual content is used in concrete with various proportions as a partial replacement of sand in the proportion of 15% and 20% by weight. Polypropylene fibre being used for the post cracking purposes in concrete is used here for increasing the mechanical properties of the concrete along with the addition of Marble powder. The fibre is added at the proportion of 0.2% of total volume of the concrete. This experimental investigation is carried out to evaluate the ability to increase the mechanical properties of the concrete by using Marble powder and polypropylene fibre and to determine the optimum dosage of those ingredients.

Keywords: Conventional Concrete, Marble dusts, Optimum dosage, Partial replacement, Polypropylene Fibre

I. INTRODUCTION

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. The construction materials which have been using till now may create a huge demand in the future due to lack of availability. It is effective that those wastes can be used in concrete as a replacement for normal construction materials such as sand and cement. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project also describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. The marble and granite stone processing is one of the most thriving industry, wherein the effect changes on the physical and mechanical properties of fresh and hardened concrete based on the content of the material added. Polypropylene fibre and marble powder has been increasingly used for increasing the characteristic strength in concrete.

II. OBJECTIVE OF THE STUDY

In this project our main objective is to study the influence of marble powder and polypropylene fibre in partial replacement of sand and to compare it with the mechanical properties of ordinary M25 concrete. The study has also been carried out to determine the optimum percentage of marble powder and Polypropylene fibre added in concrete that achieves the maximum strength without compromising the workability.

III. MATERIAL USED

The marble waste originally discharged from the marble processing factories in slurry form is dried manually by sun light for more than 15 days (due to the winter season) until its water content is completely dried. After grinding, the fineness of the four marble waste powder samples was tested for fineness by Blaine air permeability apparatus. And it was found that one sample had a Blaine fineness of 3571 cm^2/gm whereas the three samples had Blaine fineness of 4843 cm^2/gm.

A good concrete must possess high strength and low permeability. To improve the post cracking behaviour, short discontinuous and discrete fibres are added to the plain concrete. Addition of fibres improves the post peak ductility performance, pre-crack tensile strength, fracture strength, toughness, impact resistance, flexural Strength resistance, fatigue performance etc. Polypropylene is a synthetic hydrocarbon polymer, the fibre of which is made using extrusion processes by hot drawing the material through a die. Its use enables reliable and effective utilization of intrinsic tensile and flexural strength of the material along with significant reduction of plastic shrinkage cracking and minimizing of thermal cracking.

Preliminary tests were carried out to determine the particle size distribution of fine and coarse aggregate. Standard sieve analysis was done to understand the distribution pattern of the samples and the observations are tabulated below:

Table – 1
Particle size distribution for fine aggregate

Size of Sieve	*Empty weight of sieve (grams)*	*Empty weight Retained (grams)*	*Weight Retained (grams)*	*Cumulative weight Retained (grams)*	*Cumulative % retained (grams)*	*% finer*
4.75mm	*413*	*452*	*39*	*39*	*3.60*	*96.40*
2.36mm	*392*	*433*	*41*	*80*	*8.00*	*92.00*
1.18mm	*358*	*463*	*105*	*185*	*18.50*	*81.50*
600µ	*341*	*527*	*186*	*371*	*37.50*	*62.50*
300µ	*372*	*725*	*353*	*724*	*72.40*	*27.60*
75µ	*308*	*393*	*85*	*809*	*80.90*	*19.10*
Pan	*330*	*521*	*191*	*1000*	*100*	*0*

Table – 2
Particle size distribution for coarse aggregate

Size of Sieve	*Empty weight of sieve (grams)*	*Empty weight Retained (grams)*	*Weight Retained (grams)*	*Cumulative weight retained (grams)*	*Cumulative % retained (grams)*	*% finer*
20mm	*858*	*1394*	*536*	*536*	*17.87*	*82.13*
16mm	*818*	*2281*	*1463*	*1999*	*66.63*	*33.37*
12.5mm	*857*	*1495*	*638*	*2637*	*87.90*	*12.10*
8mm	*883*	*1225*	*342*	*2979*	*99.30*	*0.70*
6.3mm	*823*	*837*	*14*	*2993*	*99.77*	*0.23*
Pan	*902*	*909*	*7*	*3000*	*100*	*0.00*

IV. MIX PROPORTION

The experimental investigation was carried out to study the mechanical properties of concrete of M25 grade. The following table lists out the various proportions of concrete ingredients and its design mix ratio.

Table – 3
Mix proportion of concrete ingredients

Cement (kg/m3)	*F.A (kg/m3)*	*C.A (kg/m3)*	*Water (lit/m3)*
438.133	*658.1746*	*1129.0388*	*1129.0388*
1.0	*1.5*	*2.58*	*0.45*

V. RESULTS AND DISCUSSION

The mechanical properties of the M25 Grade concrete with sand partially replaced by marble powder and along with the addition of Polypropylene fibre are ascertained. From the results, it is observed that strength has been increasing at various ranges for different mixes.

The Compressive strength, Split tensile strength and flexural strength of concrete partially replaced by marble powder and polypropylene fibre for sand exhibited a significant increase in the mechanical properties also ensuring zero compromise in the workability of concrete.

Fig. 1: Slump cone Test showing workability

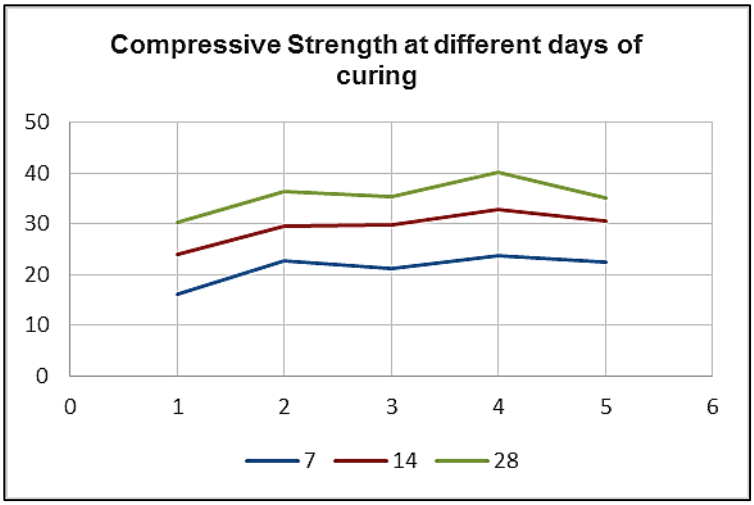

Fig. 2: Sample result of Compressive strength

The comparative results of Flexural strength, Split tensile strength and Compressive strength of concrete specimens are shown in the graph below:

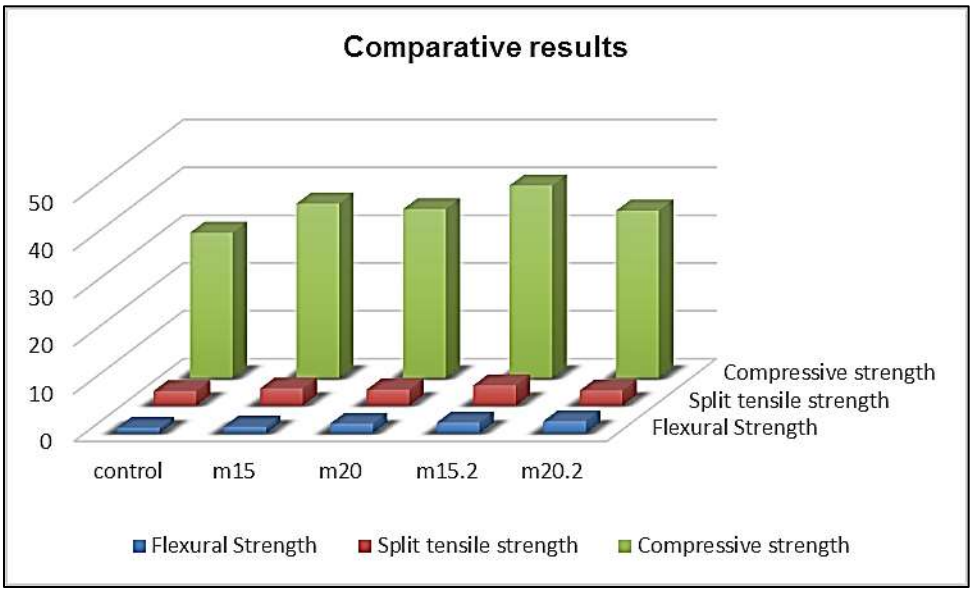

Fig. 3: Comparative results of various strengths

Based on the compressive strength of concrete specimens at different curing periods, the Mix of Marble 15% and PP gives 32% greater compressive strength than the conventional M25 Grade concrete. The Mix of Marble 15% and PP gives 38% greater Split Tensile strength than the conventional M25 Grade concrete. The Mix of Marble 20% gives 56% greater Flexural strength than the conventional M25 Grade concrete.

VI. CONCLUSION

Based on the Replacement of Standard construction materials, Marble powder and Polypropylene fibres are added to the standard M25 Grade concrete at the rate of 15% and 20% of total weight of Sand in concrete and Polypropylene fibres is added at the proportion of 0.2% of total volume of concrete. Based on the Indian Standard (IS: 10262 - 1982), design mix for M25 grade of concrete by partially replacing fine aggregate by marble and polypropylene fibre evidently resulted in increase of workability and compressive strengths in concrete.

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