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Partial Replacement of Cement with Marble Powder and Fine Aggregate with Copper Slag

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ABSTRACT: Concrete is the biggest utilized material around the world. With the expanding pace of populace development, framework to should be grown quickly to satisfy the necessities of individuals and for all these an enormous measure of assets are required. The significant one of them is total. In any case, the inordinate utilization of these assets will make an ecological awkwardness. Hence, we have chosen to supplant these significant element of the development business with marble powder and copper slag individually. As we know Concrete is the largest material after food and water. The main constituents of concrete are Cement and Fine aggregate. Many studies have been done to know the environmental impact of cement and concrete. Seeking the adverse effect of high production of cement on environment, we have thought of partial replacement of cement with marble dust and fine aggregate with copper slag in this research.

KEYWORDS: Concrete, Cement, copper slag, marble dust.

I. INTRODUCTION

Today concrete is the most consumed material, with three tons per year used for every person in the world. Plain concrete is good in compression but weak in tensile strength with very limited ductility and little resistance to cracking. The production of concrete is said to be responsible for 8% of the world's carbon dioxide with Portland cement being a major contributor. The cement or particularly Portland cement in concrete, releases concrete dust when building is demolished or by the action of natural disasters, this is a major source of air pollution. The workers who cut and grind or polish the concrete are at risk of inhaling airborne silica, which can cause silicosis after a long period of time. Hence a solution to partially replace cement can reduce its effect. Concrete is the largest used material worldwide. With the increasing rate of population growth, infrastructure too needs to be developed rapidly to fulfill the needs of the people and for all these a huge amount of resources are required. The major one of them is cement and sand. But the excessive consumption of these resources will create environmental imbalance. Therefore, we have decided to replace these two major ingredients of the construction industry with marble dust and copper slag respectively.

1.1 Marble Powder

Since ancient times, marble has been widely used as a construction material. In practice, marble waste produced as a by-product, is a vital material that requires proper environmental disposal else it causes landfill issues. Furthermore, waste recycling that isn't properly managed is a waste. During the cutting process, a large quantity of powder is produced. As a result, nearly 25% of the marble by weight is reduced and converted to form waste marble dust (WMD).



Fig 1 Marble Powder

Table 1 Properties of Marble Powder and Cement

Properties	Marble Powder	Cement
Bulk density (kg/m ³)	1118.01	1440
Specific gravity	2.5	3.15

1.2 Copper Slag

The term sand as used in the building and construction industry is synonymous with fine aggregate which is the material with a particle size less than 5mm. Coarse sand is defined as the material comprising particles of size less than 5mm and with less than 10% being finer than 0.15mm. Fine sand is generally regarded as the material finer than 1.0mm. The particle size distribution of the sand determines its particular use such as roofing tile sand, plaster sand, concrete fine sand, concrete coarse sand, masonry sand, fill sand, grout sand, bedding sand, filter sand and so on Sand is used all over the world in the construction industry and is an essential raw material for providing infrastructure and shelter.



Fig 2 Copper Slag

Table 2 Properties of Copper Slag and Sand

Properties	Copper Slag	Sand
Particle shape	Irregular	Irregular
Density (kg/m ³)	3016–3870	1602
Specific gravity	3.40	2.63-2.67

II. PROBLEM STATEMENT

Experimental investigation was carried out to check suitability and veracity of the Plain concrete mix with marble powder for 5, 10, 15, 20% with cement and copper slag for 5, 10, 15, 20% with fine aggregate on performance of concrete. They were,

- Mix A: Plain Concrete
- Mix B: Plain Concrete + Marble Powder
- Mix C: Plain Concrete + Copper Slag
- Mix D: Plain Concrete + Marble Powder + Copper Slag

Table 3 Plain Concrete - Marble Powder + Copper Slag

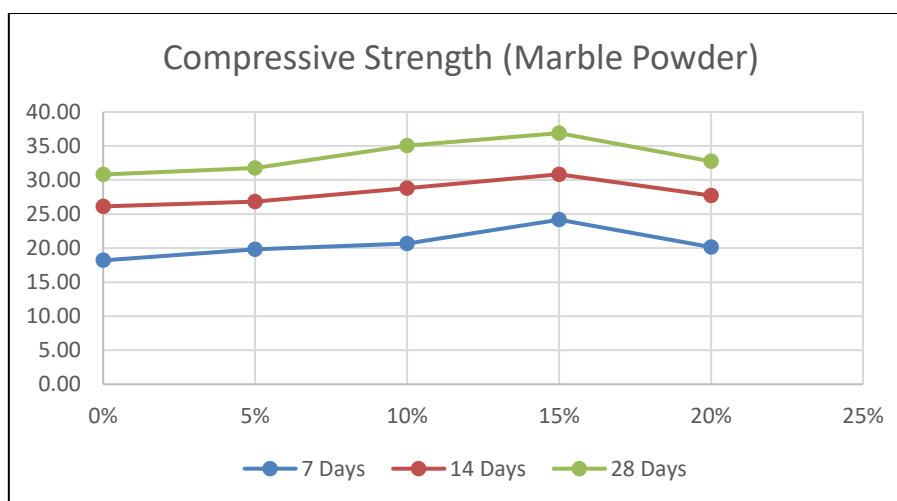
Material	% Replaced	Compressive Strength			Split Tensile Strength		
		7 Day	14 Day	28 Day	7 Day	14 Day	28 Day
Marble Powder	0	3	3	3	3	3	3
	5	3	3	3	3	3	3
	10	3	3	3	3	3	3
	15	3	3	3	3	3	3
	20	3	3	3	3	3	3
Copper Slag	0	3	3	3	3	3	3
	5	3	3	3	3	3	3
	10	3	3	3	3	3	3
	15	3	3	3	3	3	3
	20	3	3	3	3	3	3
Marble Powder + Copper Slag	5+5%	3	3	3	3	3	3
	10+10%	3	3	3	3	3	3
	15+15%	3	3	3	3	3	3
	20+20%	3	3	3	3	3	3

III. RESULTS AND ANALYSIS

3.1 Results for Marble Powder

Table 4 Summary of Compressive Strength (Marble Powder)

Compressive Strength (Marble Powder)			
Percentage	7 Days	14 Days	28 Days
0%	18.20	26.13	30.806
5%	19.83	26.81	31.783
10%	20.67	28.82	35.075
15%	24.17	30.84	36.887
20%	20.16	27.72	32.762



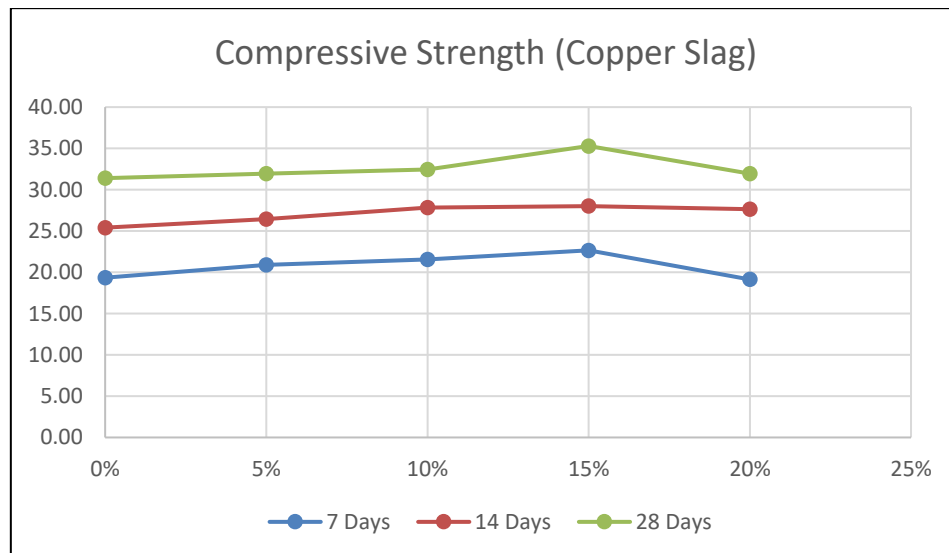
Graph 1 Compressive Strength (Marble Powder)

Above Results show that there is a marginal increase in Compressive strength in replacement of Marble Powder up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

3.2 Results for Copper Slag

Table 5 Summary of Compressive Strength (Copper Slag)

Compressive Strength (Copper Slag)			
Percentage	7 Days	14 Days	28 Days
0%	19.36	25.41	31.39
5%	20.90	26.44	31.933
10%	21.54	27.83	32.437
15%	22.66	28.01	35.293
20%	19.13	27.66	31.96



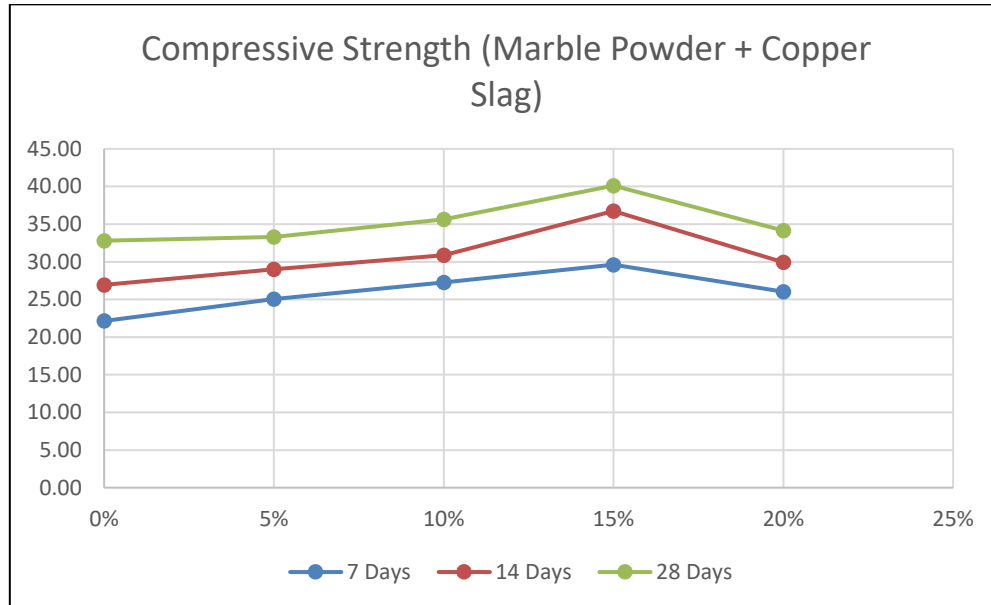
Graph 2 Compressive Strength (Copper Slag)

Above Results show that there is a marginal increase in Compressive strength in replacement of Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

3.3 Results For Marble Powder + Copper Slag

Table 6 Summary of Compressive Strength (Marble Powder + Copper Slag)

Compressive Strength (Marble Powder + Copper Slag)			
Percentage	7 Days	14 Days	28 Days
0%	22.14	26.94	32.81
5%	25.05	29.01	33.293
10%	27.27	30.89	35.650
15%	29.62	36.74	40.117
20%	26.03	29.94	34.15



Graph 4.5 Compressive Strength (Marble Powder + Copper Slag)

Above Results show that there is a marginal increase in Compressive strength in replacement of Marble Powder + Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.

IV. CONCLUSION

A detailed study has been carried out on the Compressive and tensile strength of concrete with varying the various percentage of Marble Powder and Copper Slag. Experimental investigation was carried out to check suitability and veracity of the Plain concrete mix with marble powder for 5, 10, 15, 20% with cement and copper slag for 5, 10, 15, 20% with fine aggregate on performance of concrete. Inclusion of marble powder for cement performs better up to 15%, and similarly, inclusion of copper slag for fine aggregate also performs better up to 15%, but adding both together gives excellent performance results up to 15% of replacement. Hence the following conclusion is considered based on the results and observations are following.

- Inclusion of Marble Powder and Copper Slag for cement and fine aggregate reduces the slump values. This is due to the resistance for the free flow of concrete.
- From the test results obtained during the experiment work it is clear that the strength of Marble Powder and Copper Slag concrete significantly higher than the normal concrete. The crack formation is also very small in mix specimen compared to normal specimen
- There is a marginal increase in Compressive strength in replacement of Marble Powder + Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%.
- There is a marginal increase in Split Tensile Strength in replacement of Marble Powder + Copper Slag up to 15% at the age of 7, 14, 28 days and gets slightly decreased at the 20%

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