Effect of Marble Waste and Copper Slag in Concrete

Malar Vannan S[1], Dr.T.Murugesan[2]
[1]*PG Scholar, Department of Civil Engineering, Government college of Engineering – Salem-11, Tamilnadu, India*
[2]*Assistant Professor, Department of Civil Engineering, Government college of Engineering – Salem-11, Tamilnadu, India*

Abstract: Concrete is one of the most widely used construction materials in the world. It can be cast in diverse shapes. Concrete is a composite material forming by the combination of cement, sand, coarse aggregate and water in a particular proportion in such a way that the concrete produced meets the needs as regards its workability, strength, durability and economically. Portland cement is normally an essential binder ingredient used in concrete. Cement production consumes a considerable amount of raw material and energy and releases a large quantity of CO2. Several researchers have made efforts to utilize industrial and agricultural by-products or waste materials for mixed cement production to reduce costs, save resources, reduce energy consumption, and decrease the amount of CO2 generated during OPC production. To reduce carbon emissions, attempts have been made to find substitutes for cement to minimize the environmental impact of the concrete industry. With rapid industrial and agricultural development, large quantities of industrial and agricultural waste have been generated. Disposal of these wastes is a serious environmental problem, as most final wastes go to landfills, which not only reduces useful land area but also pollutes the environment.

Keywords: **Marble waste powder, Copper slag Compressive strength, Split tensile strength, paver block.**

1. INTRODUCTION

1.1 GENERAL

Concrete is a commonly used building material due to its strength, durability, and affordability. However, it is not immune to cracking and damage over time, which can lead to structural weakness and the need for costly repairs.

Self-healing concrete offers a promising solution to this problem by incorporating healing agents within the concrete mixture.

When cracks form, these agents are activated and repair the damage, effectively closing the crack and restoring the concrete's strength. This technology has the potential to significantly extend the lifespan of concrete structures and reduce maintenance costs, making it a valuable advancement in the construction industry.

2. MATERIAL PROPERTIES

2.1 MATERIALS USED

- Cement (OPC 53)
- Fine Aggregate
- Coarse Aggregate
- Water
- Marble waste powder (MWP).
- Copper slag(CS)

2.1.1 COPPER SLAG

copper slag has a high Fe content and has been used as an iron adjustment material during the cement clinker production (Huang, 2001). Since the main composition of copper slag is vitreous FeSiO3, it has low melting point and could reduce the calcination temperature for cement clinker. Thus, the use of copper slag to replace iron powder as iron adjusting materials facilitates cement production, reduces or eliminates the need of mineralizer. However, the use of iron powder does not show this advantage. The performance testing results indicated that cement produced by using copper slag performed even better than using iron powder. In another publication, it was reported that copper slag was successfully used as an iron adjustment material in cement clinker production. In another study, researchers used the tailings from Mo ores and copper slag to produce cement clinker. In addition, CaF was used as a mineralizer. The performance of the cement was even better than that produced using traditional clay, limestone and mill scale.

PHYSICAL PROPERTIES

Table 1. Properties of copper slag

Particle shape	Irregular
Appearance	Black, glassy, more vesicular.
Water absorption (%)	0.15–0.55
Hardness	6–7

Fig 1. COPPER SLAG

2.1.2 MARBLE WASTE POWDER

Marble waste powder can be partially replaced as fine aggregate in concrete.

Fig 2. Marble waste powder

2.2 MATERIAL TEST

2.2.1 TEST ON CEMENT

- Consistency test
- Specific gravity test
- Finesse test
- Initial setting time test

Ordinary Portland cement of 53 grade was used in the study. The properties of cement were shown in Table.

Table 2. Test result on cement

Property of cement	Values
Specific gravity	3.15
Fineness	8.3%
Consistency	29%
Initial setting time	45 mins

2.2.2 TEST ON FINE AGGREGATE

- Sieve analysis
- Specific Gravity

Table 2. Test result on Fine Aggregate

Property of fine aggregate	Values
Specific gravity	2.62
Fineness Modulus	2.71

2.2.3 TEST ON COARSE AGGREGATE

- Specific Gravity
- Water absorption

Table 3. Test result on Coarse Aggregate

Property of coarse aggregate	Values
Specific gravity	2.78

3.2 CASTING OF MARBLE WASTE POWDER

Table 3.mix identifications

S.NO	MIX ID	DEFINITIONS
1	MW1	10% MWP replace of fine aggregate
2	MW2	20% MWP replace of fine aggregate
3	MW3	30%MWP replace of fine aggregate
4	MW4	40%MWP replace of fine aggregate

Figure5. casting of marble waste powder

MWP CUBE TEST ON COMPRESSIVE STRENGTH

Table 4 compressive strength

Curing period	Mix id	Compressive strength (N/mm^2)
28 days	MW1	50.97
	MW2	34.66
	MW3	31.72
	MW4	36.29
56 days	MW1	39.33
	MW2	34.33
	MW3	27.66
	MW4	20.00

4. MIX DESIGN

Table 4. MIX DESIGN

Grade	Cement Kg/m³	Fine aggregate Kg/m³	Coarse aggregate Kg/m³	Water Cement ratio Lit/m³
M40	383	606	1293	153

Mix Ratio

1 : 1.58 : 3.37

w/c = 0.4

5. TESTING RESULT CONVENTIONAL CONCRETE

5.1 CASTING OF CONVENTIONAL CONCRETE

Fig 3. Casting of conventional concrete

5.1.1 CONVENTIONAL CONCRETE CYLINDER TEST FOR SPLIT TENSILE STRENGTH

The split tensile strength of concrete at the age of 7days. Cylinder were casted in the size 150mm diameter and 300mm height. The concrete was prepared in M40 Mix proportions.

CASTING OF CONVENTIONAL CONCRETE CUBE

Table 4. Concrete cylinder test for compressive strength

Curing period	Samples	Tensile strength (N/mm^2)
7days	1 2 3	2.63 3.19 3.19

5.1.2 CONVENTIONAL CONCRETE CUBE TEST FOR COMPRESSIVE STRENGTH

The compressive strength of concrete at the age of 28days. Cubes were casted in the size 150mm X 150mm X 150mm. The concrete was prepared in M40 Mix proportions.

5.1.3 CONVENTIONAL CONCRETE CUBE TEST FOR COMPRESIVE STRENGTH

Table 7. Conventional concrete cube test for compressive strength

Curing period	samples	Compressive Strength
28 days	1 2 3	47.08 47.55 47.96

6. CASTING OF CUBE BY USING COPPER SLAG

6.1 SPECIMEN IDENTIFICATION

Table 8. Specimen identification

S.NO	MIX ID	DEFINITIONS
1	CS1	10% CS replaced in fine aggregate
2	CS2	20% CS replaced in fine aggregate
3	CS3	30% CS replaced in fine aggregate
4	CS4	40% CS replaced in fine aggregate

Fig 6. casting of cube by using cs

6.3 COPPER SLAG CUBE TEST ON COMPRESIVE STRENGTH

CURING PERIOD	MIX ID	COMPRESIVE STRENGTH (N/mm^2)
28 Days	CS1	
	CS2	28.00
	CS3	28.00
	CS4	29.33
56 Days	CS1	40.00
	CS2	38.66
	CS3	27.33
	CS4	37.33

6.4 CASTING A CUBE OF BY ADDING MARBLE WASTE POWDER AND COPPER SLAG

Curing period	No Samples	Average compressive strength (N/mm^2)
28 days	1 2 3	39.24 39.67 39.67

6.5 CASTING A CYLINDER BY USING MARBLE WASTE POWDER AND COPPER SLAG

Table 11. MWP and CS test for split tensile strength

Curing period	No Samples	Tensile strength (N/mm^2)
7 days	1 2 3	2.63 3.19 3.19

7. CASTING A CONVENTIONAL PAVER BLOCK

Figure 7 casting a paver block

7.1 CONVENTIONAL PAVER BLOCK TEST ON COMPRESIVE STRENGTH

Curing period	No of samples	Compressive strength (N/mm^2)
28 days	1	40.50
	2	41.66
	3	40.97

7.2 CONVENTIONAL PAVER BLOCK TEST ON FLEXURAL STRENGTH

Curing period	No of samples	Flexural strength (N/mm^2)
28 days	1	3.01
	2	3.10
	3	3.46

8. CONCLUSIONS

- The conventional concrete cube M40 can attain the compressive strength of 28 days 47.53 $N/mm^{2.}$
- The marble waste powder can be replaced as fine aggregate 10% 20% 30% 40% the 10% of MWP can attain the compressive strength of 28 days and 56 days 50.97 N/mm^2 and 40 N/mm^2
- The copper slag can be replaced as fine aggregate 10% 20% 30% 40% the 10% CS can attain the compressive strength of 28 days and 56 days 29.33 N/mm^2 and 40 N/mm^2
- The conventional paver block M40 can attain the compressive strength of 28 days 41.04 N/mm^2
- The flexural strength of paver block can be determined 28 days 3.19 N/mm^2
- The conventional concrete cylinder M40 can attain the split tensile strength of 7 days 3 N/mm^2.
- The blended concrete cylinder can attain the split tensile strength of 7 days 2.72N/mm^2.
- The blended concrete cube can attain the compressive strength of 28 days 39.53 N/mm^2

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