

Experimental Investigation of Partial Replacement of Fly Ash with Copper Slag in Cellular Light Weight Concrete

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ABSTRACT: In this experiment, is about the replacement of fly ash with copper slag for various proportions (20%, 40%, 60%) and it is compared with the conventional concrete blocks and conventional cellular light weight concrete block and it the bases of its compression strength and its cost.

KEYWORDS: Cellular Light weight concrete, Copper slag, Fly ash, Foaming Agent.

I. INTRODUCTION

India is second largest brick producing country next to china. During the manufacturing of brick the rate of Co₂ emission in the environment is very high this emission causes global warming in order to reduce the Co₂ emission use of burnt clay bricks should be reduced.

Brick ash is produced during burning of clay bricks and it is difficult to dispose it. Cellular light concrete blocks has been emerged as replacement for the conventional clay bricks. Cellular light concrete blocks is composed of cement, fly ash, water and foaming agent. In order to increase the strength of Cellular light concrete blocks, fly ash is replaced with copper slag.

Copper slag is a waste material that comes from the smelting process of copper extraction. For production of 1 tons of copper, 2-3 tonnes of copper slag is produced.

II. MATERIALS

A. Cement

Cement is powdery substance made by calcining lime and clay. Portland. Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. Cement and water form a paste that binds the other materials together as the concrete hardens. Ordinary Portland cement (OPC) is manufactured by the inter-grinding of OPC clinker with 10 to 25 per cent of pozzolanic material.

The pozzolanic materials generally used for manufacture of PPC are calcined clay or fly ash. PPC produces less heat of hydration and offers greater Resistance to the attack of aggressive waters than Ordinary Portland Cement. The reaction of cement when mixed with water is called hydration. Both C₃S and C₂S make up nearly 75% of cement.

The hydration of these compounds is responsible for the setting and hardening of cement. In the presence of water, the silicates and aluminates form produces of hydration which results in a hard mass over a period of time.

This hard mass is known as hydrated cement paste. The hydration surface reaction commences immediately once cement comes in contact with water. Ordinary Portland cement (OPC) Grade 53 was used for this experiment.

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The test results are tabulated below:

TABLE I. PROPERTIES OF CEMENT

Sl.No	Properties	Results
1.	Normal Consistency (%)	31
2.	Setting Time (minutes)	
	i) Initial setting time	32
	ii) Final setting time	200
3.	Specific gravity	3.15

B. Fly ash

It is a waste material obtained during the burning of the coals in the thermal power plants. Fly ash, also known as "pulverized fuel ash" in the United Kingdom, is one of the Coal combustion products, and is composed of the fine particles that are driven out of the boiler with the flue gases.

Ash that falls in the bottom of the boiler is called bottom ash. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the boiler is known as coal ash.

Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO₂) (both amorphous and crystalline), aluminium oxide (Al₂O₃) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

The test results on cement are tabulated below:

TABLE II. PROPERTIES OF FLY ASH

Sl.No	Properties	Results
1.	Normal Consistency (%)	32
2.	Setting Time (minutes)	
	i)Initial setting time	55
	ii) Final setting time	230
3.	Specific gravity	2.65

C. Copper slag

Copper slag is a waste material that comes from the smelting process of copper extraction and it is brought from the Sterlite Industries India Limited (SIIL), Tuticorin, Tamil Nadu, India. Currently, about 2600 tons of Copper slag is produced per day and a total accumulation of around 1.5 million tons.

It is a by-product obtained during the matte smelting and refining of copper. To produce every ton of copper, approximately 2.2–3.0 tons copper slag is generated as a by-product material.

Utilization of copper slag in applications such as Portland cement substitution and/or as aggregates has threefold advantages of eliminating the costs of dumping, reducing the cost of concrete, and minimizing air pollution problems.

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The test results are tabulated below:

TABLE III. PROPERTIES OF COPPER SLAG

Sl.no	Properties	Copper slag
1.	Specific gravity	3.56
2.	Water absorption %	0.15
3.	Fineness modulus	2.70
4.	Bulk density, g/cc	0.15
5.	Moisture content %	0.11
6.	Grading zone	Zone II

D. Foaming agent

It is the semi solid paste which is usually mixed with cement, Fly ash, and water to form the cellular light weight concrete. A foaming agent is a material that facilitates formation of foam such as a surfactant or a blowing agent. A surfactant, when present in small amounts, reduces surface tension of a liquid (reduces the work needed to create the foam) or increases its colloidal stability by inhibiting coalescence of bubbles.

A blowing agent is a gas that forms the gaseous part of the foam Foam generated is of two types: Protein Based and Synthetic Based. It depends upon the type of density concrete produced. It is generated using the foam generator.



Fig. 1. Foam Genertor

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III. METHODOLOGY

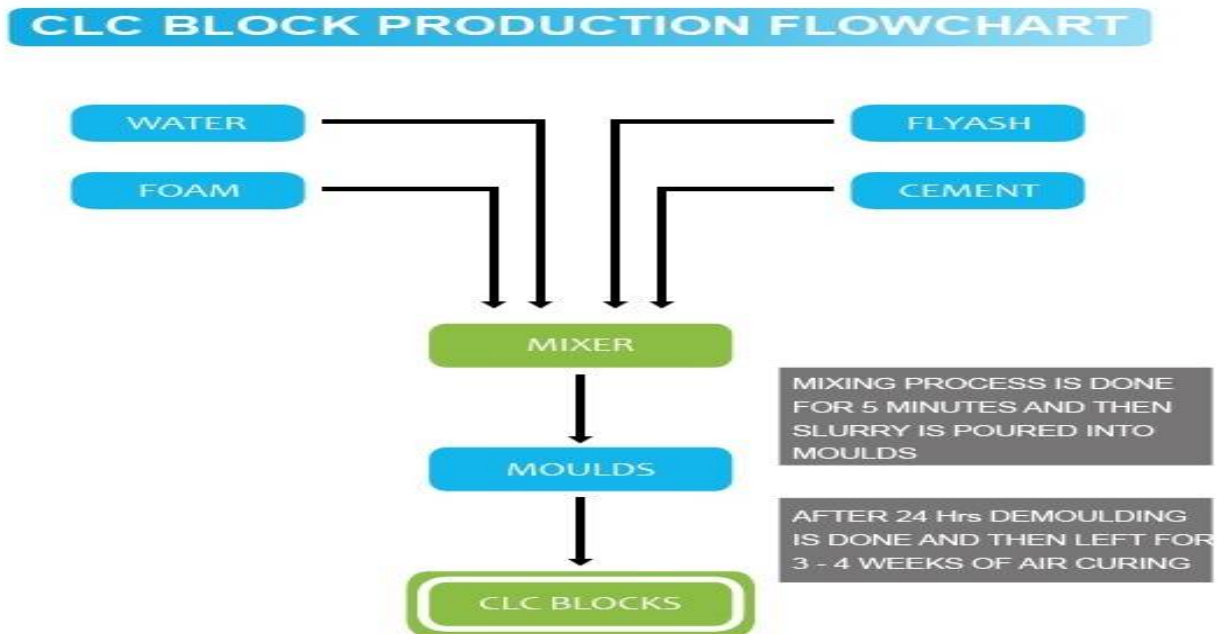


Fig. 2. Methodology

IV. MIX PROPORTIONS

TABLE IV. MIX PROPORTIONS FOR VARIOUS PERCENTAGES OF COPPER SLAG

	CEMENT (In Kg)	FLY ASH (In Kg)	COPPER SLAG (In Kg)	FOAMING AGENT (In Kg)	WATER (In Kg)
100% Fly Ash+0% Copper Slag	2.531	5.062	0.000	0.040	2.025
80% Fly Ash+20% Copper Slag	2.531	4.05	1.101	0.040	2.025
60% Fly Ash+40% Copper Slag	2.531	3.037	2.025	0.040	2.025
40% Fly Ash+60% Copper Slag	2.531	2.025	3.037	0.040	2.025

V. EXPERIMENTAL INVESTIGATION

In this experiment, Standard Size of 150 mm X 150 mm X 150 mm size bocks is used for casting the Cellular Light Weight Concrete blocks.

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TABLE V. COMPRESSIVE STRENGTH OF VARIOUS SAMPLES (N/MM²)

Mix	7th day	14th day
M0	7.42	13.72
M2	7.38	13.69
M4	8.24	14.73
M6	6.12	12.96

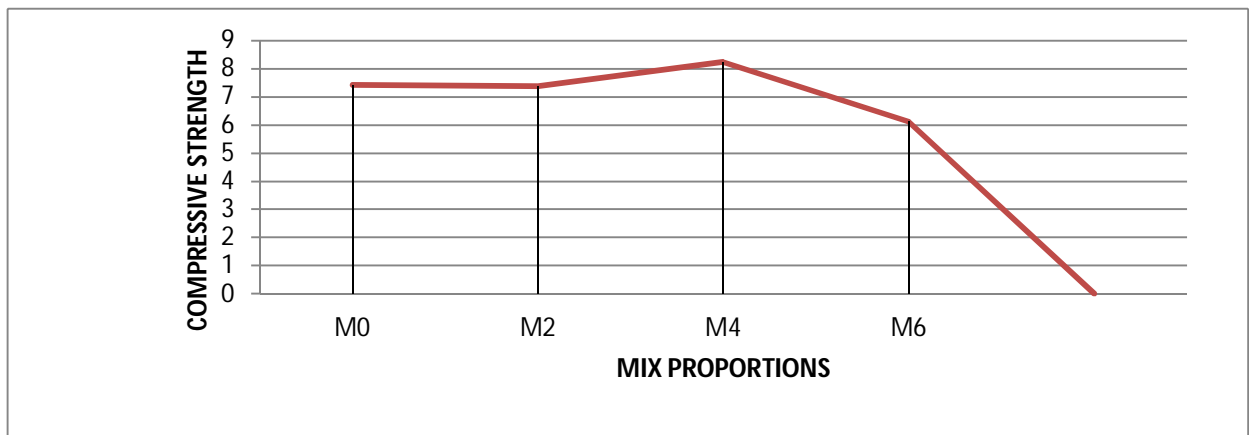


Fig. 3. Compressive Strength in 7th day

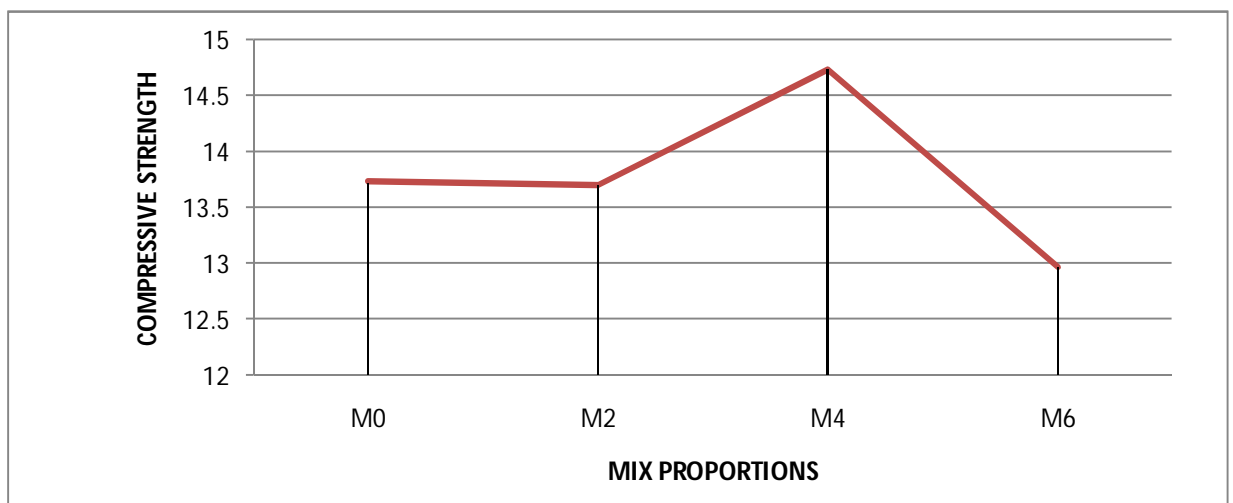


Fig. 4. Compressive Strength in 14th day

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VI. COST COMPARISON

TABLE VI. COST OF MATERIALS

Materials	Copper slag	Fly ash
Cost/ tonnes (Rs)	200	300

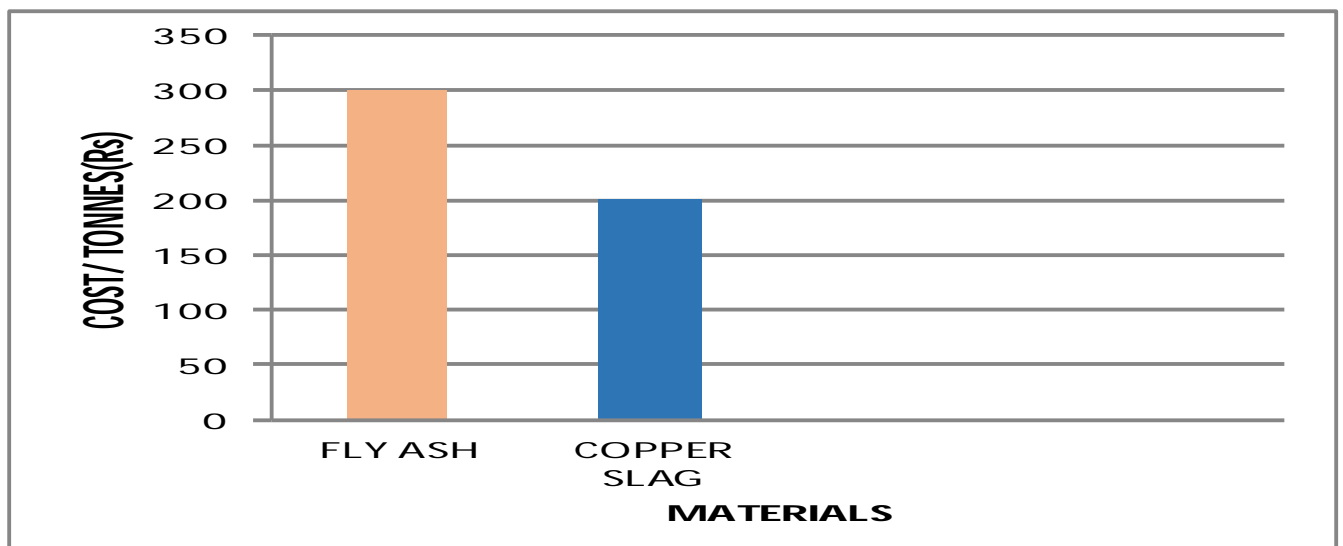


Fig. 5. Cost Comparison

VII. CONCLUSION

The compressive strength of the Cellular light weight concrete get increased when the Fly ash is replaced with copper slag up to 40% and decreasing gradually when copper slag exceeds 50%. The cost of copper slag is very cheap when compared to the cost of Fly Ash.

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