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# Effect of Alccofine and Foundry Slag on Compressive Strength of High Strength Concrete

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**Abstract:** ***This paper presents the results of an experimental investigation carried out for M-60 grade of concrete and evaluates the effect of Alccofine on compressive strength of concrete. High strength concrete is made by the partial replacement of sand with that of foundry slag and addition of Alccofine with cement. In this study, concrete of M60 grade is considered for a W/C ratio of 0.27 with the targeted slump of 170 mm for the replacement of 10%, 20%, 30% of aggregates (fine) with that of slag aggregate and adding of 3%, 6%, 9%, 12% of Alccofine respectively. This concrete mixed is studied for compressive strength.***

**Keywords: High strength, concrete, Compressive, strength, Alccofine, Foundry, slag.**

## INTRODUCTION

In India, as there is a rapid growth of industry so the waste produced from the industry is growing day by day. The rapid growth of industrialization has raised the economy of India but it also produces numerous types of waste or by products which are hazard to the environment and are creating a storage problem of such hazardous by product [1]. Over the period of time, waste management has become one of the typical problems which effect the environment. The construction industry is continuously contributing in the utilization of these waste products in one form or other. Foundry Slag is a by product of the steel manufacturing process. The consumption of such product in the concrete industry had not only reduces their effect on the environment but also help in solving the problem of land utilization for the decomposition of such non degradable products. During the production of steel and iron, large size of fluxes made up of limestone and/or dolomite are charged into the blast furnace along with coke or wood as a fuel. The burning of fuel raises temperature which produces carbon monoxide and reduces iron ore into molten iron product. Fluxing agents separate impurities from the molten iron and slag is produced during separation of molten steel.

Alccofine is a ultrafine slag having optimum particle size distribution and is a mineral admixture produce by Ambuja Cement Ltd [2]. It's a one type of super-pozolanic material which reduces the permeability in concrete and creates dense packing effect in concrete and ultimately reduces the water content and increases the compressive strength of the concrete.

Experimental program has been designed to study the effect of Alccofine with the partial replacement of foundry slag with fine aggregate on the compressive strength of high strength concrete (M-60). The investigation has been carried out as to study the effect of alccofine on the mix prepared by partial replacement of fine aggregate.

**Material Used**

1) **Cement: -** Portland Pozzolana Cement (PPC) of Ultra Tech Cement Ltd from a single lot was used throughout the course of the investigation. It was fresh and without any lumps. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 1489:1991[3] are listed in Table 1.

2) **Fine aggregates**:- In this experimental program**,** natural river sand from the crusher at Khizrabad and conformed to Indian Standard Specifications IS: 383-1970 are listed in Table 2

3) **Coarse Aggregate: -** Crushed aggregate confirming to IS: 383-1987 has been used. Aggregates of size 20 mm and 10 mm of specific gravity 2.86 and fineness modulus 7.674 for 20 mm and 6.30 for 10 mm were used.

4) **Alccofine:-** In this experiment Alccofine of 1200 series (1203) from Ambuja Private Ltd. has been used [2]. The physical and chemical properties of Alccofine are shown in Table 3 and 4 respectively.

5) **Foundry Slag:-** For the experimental work, the foundry slag from the local steel making plant located at Mandi Gobindgarh, Punjab. It is black in colour. The Fineness Modulus of foundry slag is 3.19 and grinding of slag is done to conform the size as Zone II as per Indian Standard Specifications IS: 383-1970.

**Mix Design:-** The mix design is done as per IS : 10262-1982 for the grade M-60 [4]. The Table 5 shows the various proportions of the ingredients.

## EXPERIMENTAL PROGRAM:

**Experimental Process:** Test specimens of size 150 × 150 × 150 mm were prepared for testing the compressive strength concrete [5]. The mixes for 0%, 5%, 10% and 15% partial sand replacement percentages of foundry slag and variation of Alccofine 0%, 3%, 6%, 9%, 12% were cast into cubes for testing.

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**Table 1.** Properties of PPC

| **Sr. No.** | **Characteristics** | **Values Obtained Experimentally** | **Values Specified By IS 1489:1991** |
|---|---|---|---|
| 1. | Specific Gravity | 3.1 | - |
| 2. | Standard Consistency, percent | 3.1 | - |
| 3. | Initial Setting Time | 110 minutes | 30 min |
| 4. | Final Setting Time | 254 minutes | 600 max |
| 5. | Compressive Strength | | |
| | 3 days | 24 | 16 |
| | 7 days | 38 | 22 |
| | 28 days | 49 | 33 |

**Table 2.** Physical Properties of Fine Aggregates

| Characteristics | Value |
|---|---|
| Specific gravity | 2.59 |
| Bulk density, | 1.2 |
| Fineness modulus | 2.988 |
| Water absorption, % | 1.82 |
| Zone | II |

**Table 3.** Physical Parameters of Alccofine 1203

| **Specific Gravity** | **Bulk Density ($kg/m^3$)** | **Particle Size Distribution (μ )** | | |
|---|---|---|---|---|
| | | d 10 | d 50 | d90 |
| 2.9 | 600-700 | 1-2 | 4-5 | 8-9 |

**Table 4.** Chemical Parameters of Alccofine 1203

| **CaO** | **$Al_2O_2$** | **$SIO_2$** | **Glass content** |
|---|---|---|---|
| 31-33 % | 23-25 % | 33-35 % | >90% |

In this study, to make concrete mix, cement and fine aggregate were first mixed dry to uniform color and then coarse aggregate were added and mixed with the mixture of Cement, Alccofine with variation and fine aggregates. Then water was added and the whole mass mixed. The interior surface of the testing and the base plate were properly oiled before concrete was placed. After this the specimens were removed from the moulds and placed in clean fresh water at a temperature of $27^0 \pm 2^0$C for 28 days curing.

**RESULTS & DISCUSSION:**

The result of the compressive test are listed in Table 6.

**Compressive Strength:** Below Figure 1 shows the %age increase in comprssive strength (MPA) with different %age of foundry slag and %age of alccofine. By plotting the result data the maximum %age increase can be seen as 26.63%, for 15% of foundry slag and 12% of alccofine in 7 days.

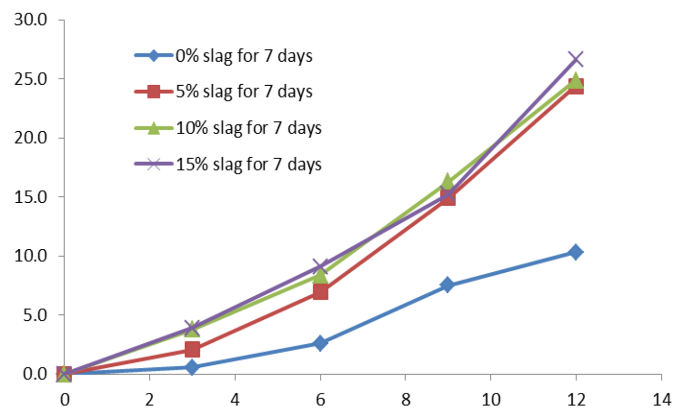


**Fig. 1** Percentage Variation for 7 days

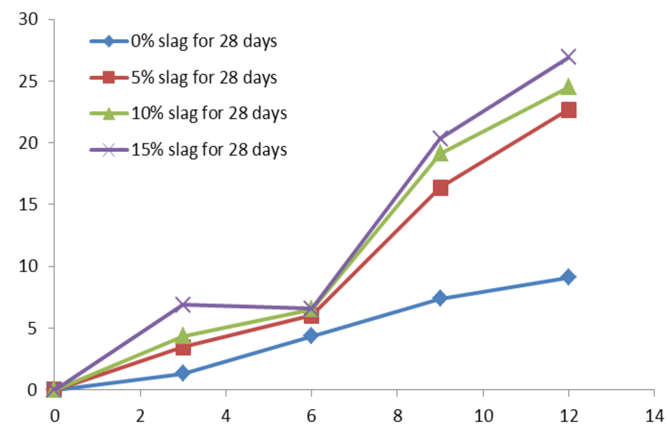


**Fig. 2** Percentage Variation for 28 days

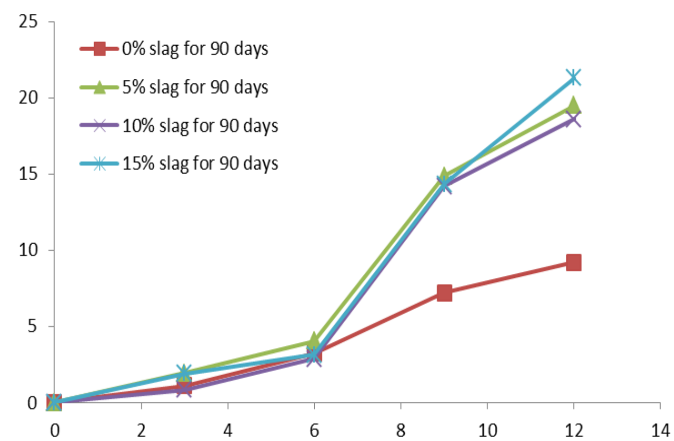


**Fig. 3** Percentage Variation for 90 days

Figure 2 shows the %age increase in comprssive strength (MPA) with different %age of foundry slag and %age of alccofine. By plotting the result data the maximum %age increase can be seen as 26.92%, for 15% of foundry slag and 12% of alccofine in 28 days.

Figure 3 shows the %age increase in comprssive strength (MPA) with different %age of foundry slag and %age of alccofine. By plotting the result data the maximum %age increase can be seen as 21.30%, for 15% of foundry slag and 12% of alccofine in 90 days.

**Table 5.** Mix Proportion of Control Mix Ingredients (Kg/m$^3$)

| Material | Control mix 0% Alccofine (M0)Kg/m$^3$ | 3% Alccofine (M1)Kg/m$^3$ | 6% Alccofine (M2) Kg/m$^3$ | 9% Alccofine (M3) Kg/m$^3$ | 12% Alccofine (M4) Kg/m$^3$ |
|---|---|---|---|---|---|
| Cement PPC | 440 | 440 | 440 | 440 | 440 |
| Alccofine1203 | 0 | 13.20 | 26.40 | 39.60 | 52.8 |
| W/C ratio | .30 | .30 | .30 | .30 | .30 |
| Water content | 132 | 132 | 132 | 132 | 132 |
| Mass of 10mm coarse aggregate | 413 | 413 | 413 | 413 | 413 |
| Mass of 20mm coarse aggregate | 674 | 674 | 674 | 674 | 674 |
| Mass of slag ( 0%) | 0 | 0 | 0 | 0 | 0 |
| Mass of fine aggregate | 724 | 724 | 724 | 724 | 724 |
| Mass of slag( 5%) | 36.2 | 36.2 | 36.2 | 36.2 | 36.2 |
| Mass of fine aggregate | 687.8 | 687.8 | 687.8 | 687.8 | 687.8 |
| Mass of slag( 10% | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 |
| Mass of fine aggregate | 651.6 | 651.6 | 651.6 | 651.6 | 651.6 |
| Mass of slag( 15% | 108.6 | 108.6 | 108.6 | 108.6 | 108.6 |
| Mass of fine aggregate | 615.4 | 615.4 | 615.4 | 615.4 | 615.4 |
| Super plasticizer@ 1.4% | 6.16 | 6.16 | 6.16 | 6.16 | 6.16 |

**Table 6.** Compressive strength of concrete mixes of specimen size 150 × 150 × 150

| %age of Alccofine | 0% slag | | | 5% slag | | | 10% slag | | | 15% slag | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 days | 28 days | 90 days | 7 days | 28 days | 90 days | 7 days | 28 days | 90 days | 7 days | 28 days | 90 days |
| **0** | 59.04 | 63.46 | 65.21 | 60.22 | 65.39 | 68.11 | 61.35 | 65.46 | 69.91 | 63.49 | 65.90 | 70.31 |
| **3** | 59.38 | 64.29 | 65.93 | 61.45 | 67.65 | 69.44 | 63.66 | 68.30 | 69.33 | 65.95 | 70.44 | 71.66 |
| **6** | 60.58 | 66.22 | 67.32 | 64.39 | 69.32 | 70.86 | 66.48 | 69.74 | 71.32 | 69.26 | 70.22 | 72.51 |
| **9** | 63.48 | 68.15 | 69.90 | 69.20 | 76.11 | 78.24 | 71.34 | 77.98 | 79.18 | 73.15 | 79.31 | 80.38 |
| **12** | 65.12 | 69.23 | 71.20 | 74.90 | 80.21 | 81.39 | 76.60 | 81.49 | 82.22 | 80.40 | 83.64 | 85.29 |

**CONCLUSION:**

From the above discussion it can be observed that with the increase in the percentage of Alccofine and Foundry Slag the compressive strength of the concrete mix also increases. The maximum percentage increased for the variation of 0, 3, 6, 9 and 12 % of Alccofine and 0, 5, 10 and 15 % of Foundry slag for 7, 28, 90 days is 26.63, 26.92 and 21.30 % respectively. The results shows that there is a drastically increase in the Compressive Strength. This Concrete mix is Environment Friendly as it is prepared by using the byproduct such as Foundy Slag and Alccofine for the development of High Strength Concrete.

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