

A Comparative Study on Partial Replacement of Cement With Fly ash & Granite Powder

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Abstract: The study emphasis on the use of pozzolanic waste materials as a partial substitute of OPC cement leading to enhance compressive strength of cement. Thus providing a new gateway to utilise these waste materials and also reducing the quantity of CO₂ emission from the manufacturing process of cement, as a result of which environment impact is reduced.

The aim of this study is to find maximum proportion in which different pozzolanic materials can be used as a substitute of OPC cement while giving higher strength as compared to conventional cement mortar mix. In this research OPC cement is replaced by different pozzolanic materials (fly ash & granite powder) accordingly in the range of 5%, 10%, 15% & 20% by weight for OPC-43 grade mortar. Mortar mixtures were produced, tested and compared in terms of strength to the conventional cement mortar mix. The compressive strength test is carried out to evaluate the strength for 7 days, 28 days & 56 days. As a result, the compressive strength is increased by 10% replacing of fly ash, 10% replacing of granite powder. Keeping all this view, the aim of the investigation is the behaviour of cement mortar while replacing OPC cement with different proportions of pozzolanic materials by performing the compressive strength test.

Keywords: Pozzolanic Waste Materials, Eco-friendly, Feasibility, Compressive strength test, OPC-43.

I. INTRODUCTION

The increase in global warming has resulted a wide range of change in earth's temperature, the source being emission of CO₂ gas from the production process of cement. Use of naturally available pozzolanic waste materials (fly ash & granite powder) as a partial substitute of OPC cement in mortar mix has seen a wide potential in the utilization of these waste material and also enhancing the properties of mortar mix and thus reducing the environment impact caused by manufacturing of cement. In this study the effect of using fly ash & granite powder is used as a partial substitute of ordinary portland cement.

II. MATERIALS USED

1. CEMENT (OPC – 43 grade):

This is the most commonly type of cement used in those construction works where there is no special requirement of high strength. It is produced by grinding clinkers of portland cement (greater than 40%) with a restricted quantity of calcium sulphate (responsible for setting time) and about 5% other constituent as per standards of European Standard EN197-1. In this study ordinary portland cement of 43 grade which resembles to IS 8112: 2013 is being used.

2. SAND/MOORUM:

Moorum is used as a fine aggregate. Fine aggregate is used in mortar mix for the reduction of cost as using pure cement for masonry work is an expensive task. Moorum used in this study is air-dried and sieved through 4.75mm sieve to eliminate foreign particles before mixing.

3. FLY ASH:

Fly ash is the by-product obtained by the combustion of coal. Fly ash of class F is used in our study, and is brought from Panki Thermal Power Station located at Panki in Kanpur district, Uttar Pradesh INDIA.

4. GRANITE POWDER:

Granite is an igneous rock which is majorly used as a construction material in various forms. Granite powder obtained from cutting and polishing of granite is disposed in environment producing health hazards.

III. METHODOLOGY

1. PREPARATION OF MORTAR:

Cement is first replaced partially by pozzolanic materials (fly ash / granite powder) in given proportions along with the fine aggregates in the ratio 1:3 and mixed for about 3 to 4 minutes. Water is then

added according to the formula given and mixed for about 4 minutes.

$$\text{water content} = \left(\frac{P}{4} + 3\right)$$

Here, P is the consistency of cement replaced by pozzolanic materials and is obtained by using vicat apparatus. The mixture can be handled for about 40 minutes. Tables below shows the consistency of cement when replaced by pozzolanic materials and corresponding water content at different proportions of replacement.

Table 1: Consistency & water content for fly ash proportions.

% replacement with fly ash	Consistency (%)	Water Content (%)
5%	22	8.5
10%	25	9.25
15%	25	9.25
20%	26	9.5

Table 2: Consistency & water content for Granite powder.

% replacement with GP	Consistency (%)	Water Content (%)
5%	24	9
10%	24	9
15%	25	9.25
20%	26	9.5

2. CASTING & CURING:

A total of 48 cubes, 24 for each material (i.e. fly ash and granite powder) and 6 for each percentage of replacement were casted in 70.6 mm³ mould and exposed to room temperature for 1 day. After 1 day of exposure to room temperature when cubes has gain sufficient strength to withstand their self load samples were kept for curing in fresh clean water until testing days (i.e. 7 day, 28 day & 56 day).

3. TESTING:

Samples were subjected to compressive strength test in accordance with BS 1881-116:1983 with the help of automatic mechanical machine (Instron 5569, USA) to determine maximum strength of mortar samples. The cubes were tested to a load of 5000 KN at 5.00 mm/min of rate of loading.

IV. RESULT & DISCUSSION

Compressive Strength Test:

Compressive strength test was done on the samples at 7 days, 28 days & 56 days and results were obtained as shown in figures below. Average of two cubes were taken as the strength of sample at that proportion. It was concluded that on partial replacement of OPC by 10% of granite powder maximum compressive strength of 46.65 N/mm² is achieved at 28 days.

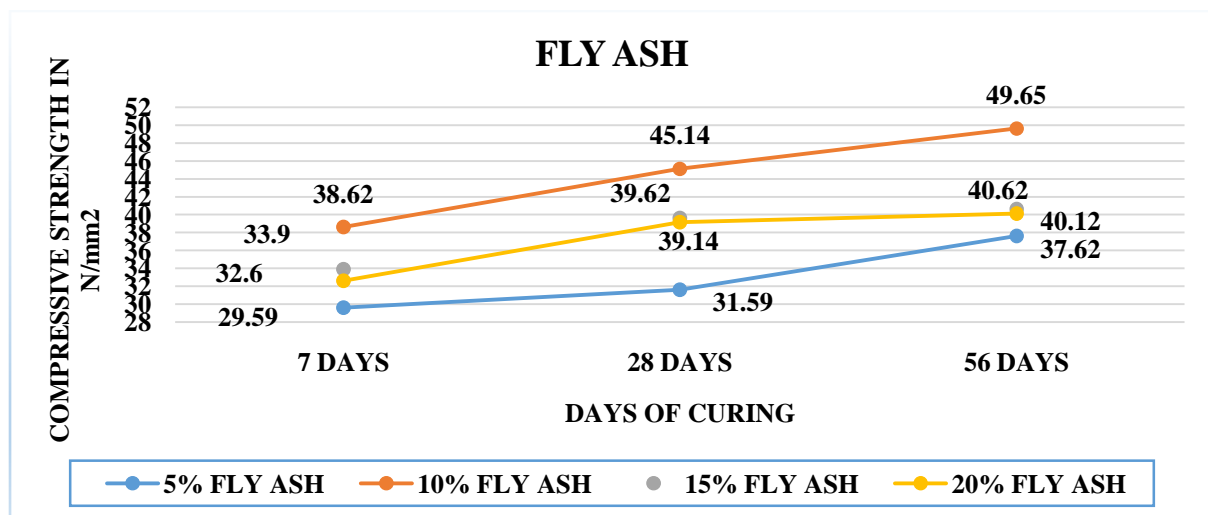


Figure 1: Graphical representation of compressive strength for Fly Ash.

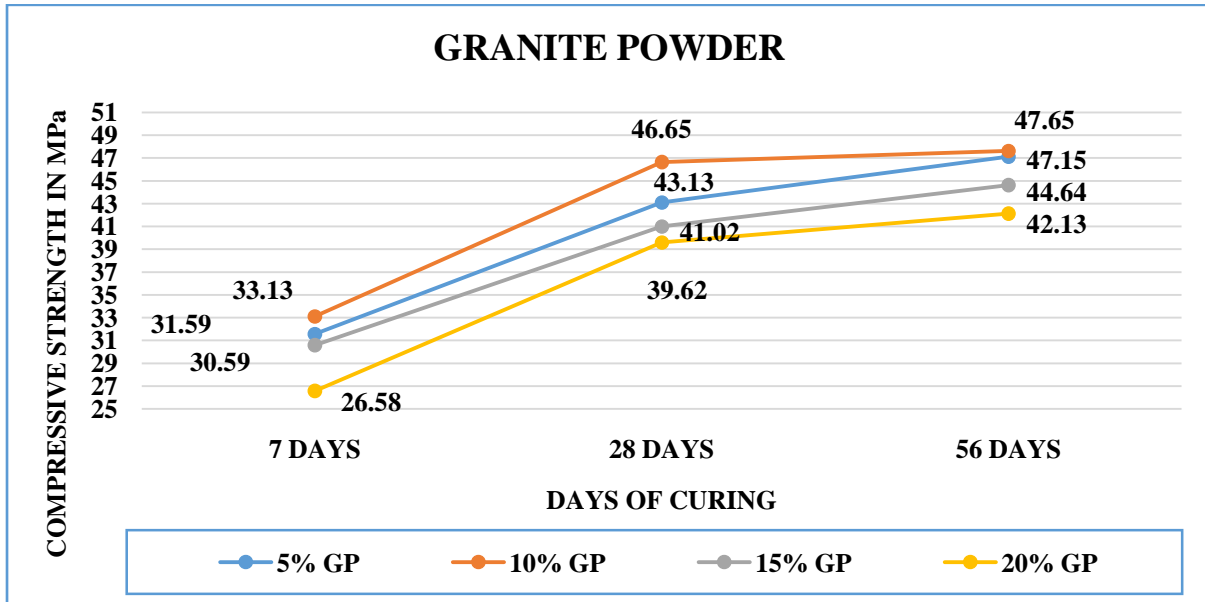


Figure 2: Graphical Representation of Compressive Strength for Granite Powder.

V. CONCLUSION

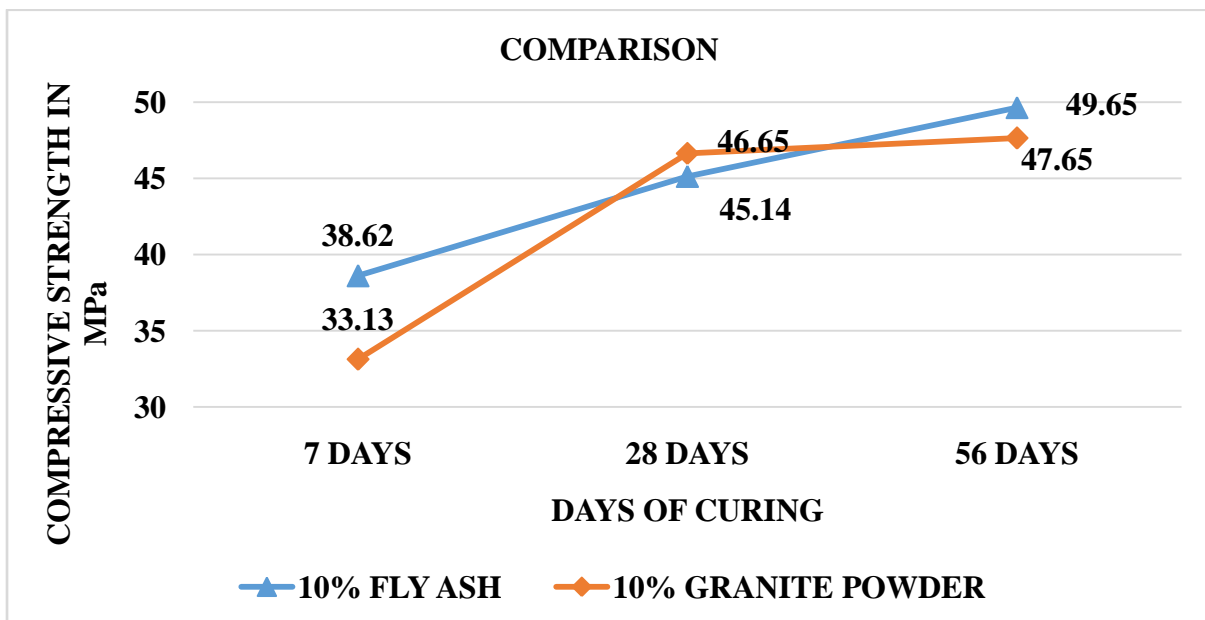


Figure 3: Comparative Analysis to Determine Optimum Mix Proportion.

1. For fly ash optimum level of replacement is up to 10% by weight.
2. For granite powder optimum level of replacement is up to 10% by weight.
3. On addition of different pozzolanic materials (fly ash and granite powder) as a partial replacement of OPC cement the water content required to accomplish the reaction mechanism of cement increases on increasing the percentage of replacement.
4. Maximum compressive strength is obtained when OPC cement is mixed with 10% of granite powder.
5. Test results shows that replacement of OPC cement with 10% of Fly Ash by weight gives high strength at early days i.e. 7 days of curing and also improves strength of OPC cement with other properties with a considerable replacement quantity.
6. To obtain high compressive strength, the order of material used as a replacement of OPC cement can be concluded as:

10% Granite Powder > 10% Fly Ash

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