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# AN EXPERIMENTAL STUDY ON SUSTAINABLE CONCRETE USING FLYASH AND FOUNDRY SAND

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***Abstract*— The infrastructure system is one of the main investment to every modern society for their economic and social development, so demand for concrete is more and it is extensively used material for all construction activities. There are different materials which are locally accessible and furthermore practical to acquire the best possible quality of the concrete in development. By this significant demand for natural resources like sand etc., are consuming day by day and heavy releases of carbon dioxide gas in cement manufacturing process, so in the recent years, global warming and ecological and economical issues have become major problems. There is a need to identify suitable alternatives for the production of Concrete. The use of industrial waste materials for concrete production has become the latest trend in the research and construction industry. In this study an attempt has been made with a M20 grade concrete. Experimental study is conducted to evaluate the mechanical properties of hardened concrete. Properties of concrete have been assessed by partially replacing cement with Fly-Ash and sand with waste foundry sand. The cement has been replaced by Fly-Ash in the range of 10%, 30% and 50% by weight of cement. The sand has been completely replaced by Waste foundry sand. Concrete cubes were casted and tested after 7 days and 28 days of curing period.***

***Keywords*— Sustainable concrete, Industrial Waste, Foundry Sand, Fly-Ash, Mechanical Properties**

## I. INTRODUCTION

Ordinary Portland cement (OPC) is a binder used in concrete and cement based materials. While OPC has served an important role in construction, its production is associated with environmental consequences including significant greenhouse gas emission. The production of one ton of OPC has been found to emit a ton of gaseous carbon dioxide and the cement industry is believed to cause approximately 6% of global emissions of carbon dioxide. Moreover carbon dioxide emissions are responsible for harmful effect on climate change. In such case, there is a need for more sustainable construction materials and production process. The use of industrial waste materials for concrete production has become the latest trend in the research and construction industry. The use of fly ash in concrete has been widely shown to be an effective way to minimize the cost of the concrete by means of partial cement replacement. Using fly ash as partial replacement of cement also reduces the proportional amounts of Green House Gas (GHG) production and other environmental effects of cement production. The use of fly ash as a cement replacement also improves the performance of concrete that is made with other recycled by-products. This paper will inspect the potential monetary and environmental savings of combining two by-products. In addition to using fly ash as a partial replacement of cement, the paper will examine the use of foundry sand as a complete replacement for fine aggregate.

## II. MATERIALS USED AND METHODOLOGY

### *A. Materials Used*

*1) Cement:* Ordinary Portland Cement (OPC) 53 grade (Coromandal King) confirming to IS-12269-1987used in this study, few tests are conducted on the cement in laboratory to check the quality of the cement. The results are tabulated in table 1.

TABLE 1
TEST RESULTS ON CEMENT

| | |
|---|---|
| Fineness | 4% |
| Specific Gravity | 3.17 |
| Standard Consistency | 28% |
| Initial Setting Tine | 35 min |
| Final Setting Time | 5 hr 50 min |

*2) Coarse Aggregate:* 20mm & 10mm size of coarse aggregates were used in concrete mix in dry condition. The results have been tabulated in table.2

TABLE 2
TEST RESULTS ON COARSE AGGREGATES

| | |
|---|---|
| Aggregate Impact Value | 7.10% |
| Aggregate Crushing Value | 14.21% |
| Shape | Angular |
| Elongation Index | 61% |
| Specific gravity | 2.88 |
| Water Absorption of 20mm size aggregates | 0.97% |
| Water Absorption of 10mm size aggregates | 0.83% |

*3) Foundry Sand:* The sand has been completely replaced by Waste foundry sand in the present work. It is a by product obtained from ferrous and non-ferrous metal from casting industry, Foundry sand is brought from Vamshi Krishna Chemicals and Materials Suppliers, Vijaywada Dist. The results have been tabulated in table.3

TABLE 3
TEST RESULTS ON FINE AGGREGATES

| | |
|---|---|
| Specific Gravity | 2.48 |
| Porosity | Low |

*4) Fly Ash:* In this experimental work class F fly ash was used as complete replacement of cement. Cement is replaced with Fly ash by 10%, 30%, and 50%. Fly ash used is brought from Kothagudam thermal power station. The results have been tabulated in table.4

TABLE 4
TEST RESULTS ON FINE AGGREGATES

| | |
|---|---|
| Specific Gravity | 2.1 |
| Fineness | 4% |

*5) Water*: Water plays an important role in the concrete mix. Clean water which is accessible in our college ground is utilized. The water used for casting and curing should satisfy as per IS 456-2000.

*6) Super plasticizer:* In this present investigation, a superplasticizer namely SP 430 has been used for obtaining workable concrete at low w/fiyash ratio. POLYHEED complies with BIS: 9103-1999 and BS: 5075 part 3.

*B. Methodology*

The mix proportions of concrete are modified for using Fly ash and foundry sand as a partial replacement of cement and fine aggregates respectively. The cubes were cast by replacing cement completely with Fly ash similarly fine aggregate with 10%, 30%, 50% Foundry sand. Specimens are cast as per mix design (M20), detailed mix proportion is obtained as per code IS: 10262-2009. Samples were cast and put in water curing for 7 and 28 days at room temperature after curing period compressive strength tests is conducted. In each trail, two sets of cubes were casted. One set of cubes were tested at 7 days of curing and other set of cubes were tested at 28 days of curing.

TABLE 7
MIX PROPORTION

| **Materials** | **Water** | **Cement (Partially Replaced with Flyash)** | **Rivers Sand (Completely replaced with Foundry Sand)** | **Coarse Aggregates** | |
|---|---|---|---|---|---|
| | | | | **20mm** | **10mm** |
| Quantity ($Kg/m^3$) | 145 | 290 | 696 | 1029 | 400 |

## III. RESULTS AND DISCUSSION

The findings gathered from the visual observations and test results for all the mixes are detailed here.

**Cube Compressive Strength**

The cube compressive strength test results at the various ages such as 3 days, 7 days, 14 days and 28 days were carried out. Compressive strengths of various mixes are given in below.

TABLE 8
COMPRESSIVE STRENGTH AT VARIOUS AGES

| **S.No** | **Mix (FA+FS) in %** | **Compressive Strength in MPa** | | | |
|---|---|---|---|---|---|
| | | **3 days** | **7 days** | **14 days** | **28 days** |
| 1. | 10% + 100% | 8.45 | 12 | 14 | 15.555 |
| 2. | 30% + 100% | 7.78 | 9.77 | 12.66 | 14.222 |
| 3. | 50% + 100% | 6.30 | 8.88 | 10.23 | 11.555 |

The results of Compressive strength of concrete cubes for 3,7,14 days & 28 days are tabulated for varying % of replacement of cement by fly ash and complete replacement of Fine aggregate (river sand) by Foundry sand for optimum

mix. It is observed that the compressive strength of concrete at 3, 7, 14 days & 28 days is decreases with an increasing the flyash percentage.

TABLE 9
VARIATION OF COMPRESSIVE STRENGTH WITH FLYASH PERCENTAGE

| S.No | % of Flyash Replacement with cement | Compressive Strength in MPa (28 Days) |
|---|---|---|
| 1. | 10% | 15.555 |
| 2. | 30% | 14.222 |
| 3. | 50% | 11.555 |

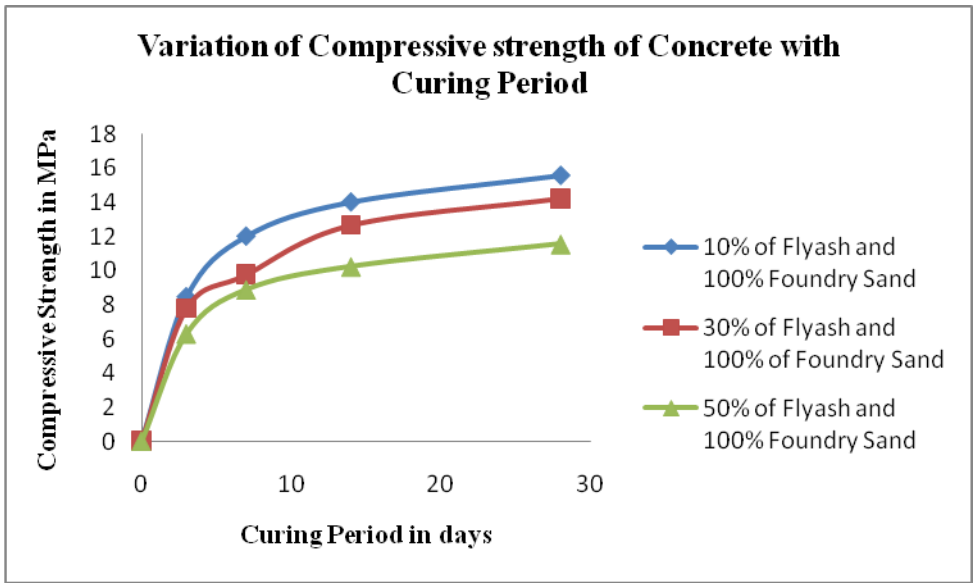


*Fig. 1 Variation of compressive strength of Concrete with Curing Period*

From the graph it is clear that the compressive strength of concrte decreases with an increasing the Flyash percentage, reduction in strength due to decrease in the w/c ratio.

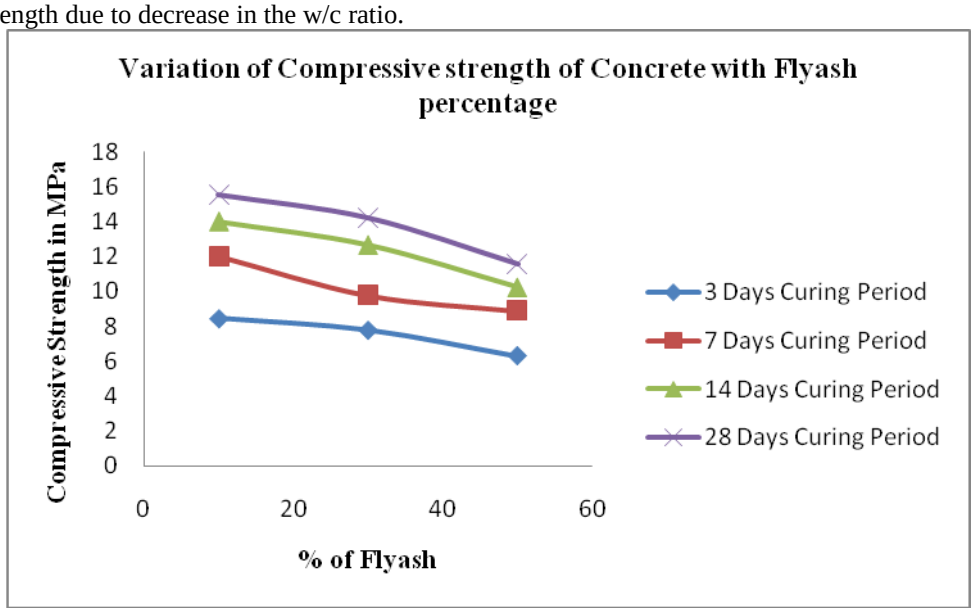


*Fig. 2 Variation of compressive strength of Concrete with flyash Percentage*

From the graph it is clear that the compressive strength of concrete increases with an increasing the curing period

## IV. CONCLUSIONS

1. The compressive strengths at various curing ages (3, 7, 14, 28 days) for percentage replacement of fly ash with cement and complete replacement of foundry sand is less compare to conventional concrete.
2. The compressive strength at 28 days concrete decreases by 1.3% and 2.6% for 10%, 30% and 50% replacement of fly ash with complete replacement of foundry sand respectively when compared with the normal concrete mix.
3. Compared to normal mix of M20 grade concrete and replacement of fly ash with cement (10%,30%,50%) and complete replacement of foundry sand the compressive strength decreases by replacement and increases by ages.

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