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Experimental Study on Partial Replacement of Cement with Fly Ash & Fine Aggregate with Waste Foundry Sand for M25 Grade Concrete

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Abstract - *The infrastructure are developing day by day so demand is more for concrete. The construction activity is readily depend on concrete directly or indirectly. By this significant demand for natural resources like sand etc., are depleting day by day and heavy release of carbon dioxide gas in cement manufacturing process, destruction of environment taking place. To overcome these problems, partially use of industrial waste in place of cement and sand are necessary in the production of concrete. In this study an attempt has been made with a M25 mix proportion. Experimental study is conducted to evaluate the strength characteristics 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 The cement has been replaced by Fly-Ash in the range of 0%, 10%, 20% and 25% by weight of cement. The sand has been replaced by Waste foundry sand in the range of 0%, 10%, 20%, 25% and 30% by weight of sand. Concrete cubes were casted and tested after 7 days and 28 days of curing for compressive strength and compared the results with the control cube specimens. The optimum mix of Fly-Ash and Waste foundry sand are determined.*

***Key Words*: industrial waste, Fly Ash, Waste Foundry Sand, Sand, Compressive strength.**

1. INTRODUCTION

Concrete is one of the significantly accepted construction material in the development of infrastructure. It is perfectly matches with several requirements such as strength, durability, impermeability and fire resistant. The current consumption of concrete is approximately 500 million tons per annum and demand is expected to reach one billitons in next decade. Concrete is a heterogeneousmix of cement, aggregates and water. Cement is an artificial material manufactured with naturally available limestone, silica and gypsum. Aggregates are considered to be one of main constituents of concrete since they occupy more than 70% of concrete matrix. In the recent years, green concrete has draws serious attention of researchers and investigators because a concept of eco-friendly. The contribution of ordinary Portland cement production worldwide to greenhouse gas emissions is estimated to be approximately 1.35 billion tons per year. To keep the global environment safe from the consequence of cement production, it is essential to explore the alternative materials than can at least partially eliminate the use of cement in concrete and no environment destruction.

2. MATERIALS AND METHODOLOGY

1. Cement: Ordinary Portland cement (OPC) of 43 Grade (Ultratech) with respect to IS 8112-1989 was considered for present study.

Table 1: Physical properties of cement

SI No	Parameter	Value
1	Specific gravity	3.11
2	Normal Consistency	30%
3	Initial setting time	48min
4	Final setting time	355min
5	Fineness	4%
6	3days compressive strength	25.5Mpa
7	7days compressive strength	36.4Mpa

2. Fly Ash: Fly Ash is a waste industrial bi-product from the thermal power plant use to make power generation. It can be used as a cementations material. For our research work Fly Ash used is brought from Raichur Thermal Power Station. The properties of Fly Ash are tabulated below.

Table- 2: properties of Fly ash

Colour	Dark Gray
Fineness	3%
Specific gravity	1.91

3. Fine aggregate: Locally available natural river sand is used. Sand having fineness modulus 3.17 and confirmed to grading zone-I as per IS: 383-1970 recommendation.

Table-3: Test Results of Fine Aggregate

Grade zone as per IS: 383-1970	zone -1
Fineness Modulus	3.13
Specific Gravity	2.547

4. Coarse aggregate: The crushed stone aggregates were collected from the local quarry. 20mm down and 12.5mm down size are used as coarse aggregates in this this experiment. Both 20mm down and 12.5mm down size aggregates are blended in equal proportion and tested as per IS:383-1970 to from 20mm well graded aggregates.

Table-4: Test Results of coarse Aggregate

Shape	Angular
Size	20mm and 12.5mm
Specific Gravity	2.609

5. Waste Foundry Sand (WFS): Waste foundry sand is bi-product obtained from ferrousand non-ferrous metal from casting industry and was obtained from Pradeep industry Ltd, Hrihara industrial area, Davanagere Dist.

Table 5: Test results of waste foundry sand

Colour	Black
Fineness modulus	3.2
Specific Gravity	2.40

6. Water:

Fresh and clean water is used for casting the specimens in the present study. The water is relative1y free from organic matter, silt, oi1, sugar, chloride and acidic materia1 etc. As per Indian standard. The PH value not less than 6. The water used for casting and curing should satisfy as per IS 456-2000.

7. Super plasticizer:

In the present experimental work Conplast SP430 is used obtained from Fosroc Chemicals (India) pvt. Ltd. Its advantage is improved workability, increased strength, and higher cohesion and free from Chloride. Its SG is 1.220 to 1.225 at 30°C.

METHODOLOGY:

In this work partial replacement of cement with Fly ash and Fine aggregate with waste foundry sand taken. Experimental investigation is carried out to find the strength characteristics of hardened concrete. The cement is replaced by Fly ash in the range of 0%, 10%, 20% and 25% by weight of cement. The Sand is replaced by Waste Foundry sand in the range of 0%, 10%, 20%, 25% and 30% by weight of fine aggregate for M25 grade mix. Concrete cubes were casted and tested after 7days and 28 days curing for compressive strength and compared with normal concrete specimens. So that optimum percentage of Fly ash and Waste foundry sand are to be determined. The experimental work is divided in to 5 trials. Each trials has constant fly ash replacement for cement and varying waste foundry sand replacement for fine aggregate in the range 0%, 10%, 20%, 25% & 30%. Different combination of replacement ratios of Fly ash and waste foundry sand are tabulated below.

Table 6: Combination of replacement ratios of Fly ash and Waste foundry sand

Fly Ash % replacement for cement	Waste foundry sand % replacement for fine aggregate				
0	0	10	20	25	30
10	0	10	20	25	30
20	0	10	20	25	30
25	0	10	20	25	30

For each trials, two sets of cubes (6 specimens) were casted. One set of cubes were tested for compressive strength after 7 days of curing and other set of cubes were tested after 28 days of curing.

Mix design: The M25 grade concrete is adopted for the present work. Detailed mix proportion is obtained as per code IS: 10262-2009.

Table 7: Mix proportion

Ingredients	Water in litres	Cement in kg	River sand in kg	Coarse aggregates in kg	
				20mm (50%)	12.5mm (50%)
Quantity	166.47	350.46	605.24	603.63	603.63
Mix ratio by weight	w/c=0.475	1	1.726	1.722	1.722

3. RESULTS AND DISCUSSIONS

The concrete cubes of different replacement proportion were subjected to compressive strength test and results obtained from test are tabulated and the corresponding graphs were plotted to finding the variation of strength.

Compressive strength of concrete – 0%, 10%, 20%, & 25% Replacement for cement by Fly ash is restricted with varying % Replacement of sand by Waste foundry sand.

Table 8: Compressive strength of concrete

SI.N0	Mix (Flyash% + Waste foundry sand %)	Compressive Strength (Mpa)	
		7days	28days
1	**Conventional**	**27.40**	**34.81**
2	0+10	28	36
3	**0+20**	**29.19**	**37.33**
4	0+25	25.77	31.70
5	0+30	23.85	27.40
6	10+0	26.66	32.88
7	10+10	27.40	34.81
8	**10+20**	**29.33**	**35.40**
9	10+25	24.592	32.148
10	10+30	22.66	28.296
11	20+0	26.814	34.66
12	20+10	27.55	35.55
13	**20+20**	**31.68**	**39.11**
14	20+25	24.74	31.25
15	20+30	22.07	28.74
16	**25+0**	**26.96**	**32.44**
17	25+10	25.18	29.03
18	25+20	24.29	28
19	25+25	23.85	27.11
20	25+30	19.11	23.55

Optimum Compressive strength of concrete: The results of compressive strength of concrete cubes for 7 days & 28 days are tabulated for varying %of replacement of cement by fly ash and varying %of replacement of fine aggregate (river sand) by waste foundry sand for optimum mix. It is observed that the optimum compressive strength for 7 day & 28 days are observed for 20% replacement of cement by Fly ash and 20% replacement of Fine aggregate by Waste foundry sand.

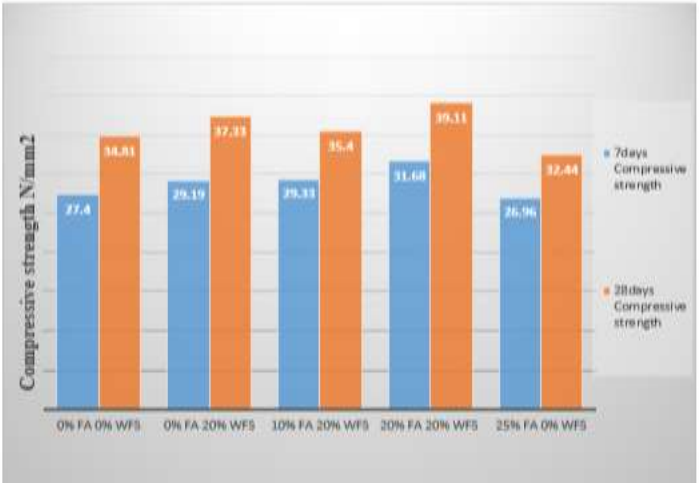

Figure 1: graph shows the optimum Compressive strength of concrete.

4. CONCLUSIONS

Based on the experimental study undertaken the following conclusion are drawn.

1. In this study, the mean target strength of M25 grade concrete is achieved with the combined effect of using Fly ash and Waste foundry sand as a partial replacement for cement and sand respectively.

2. By this experimental work, the optimum replacement ratio for M25 grade concrete mix are 20% replacement of cement by Fly ash and 20% replacement of sand by Waste foundry sand, which gives nearly 15% more Compressive strength than results of conventional concrete of M25 mix.

3. Compressive strength decreases on increases in percentage of fly ash and Waste foundry sand.

4. Fly ash and Waste foundry sand replacements greater than 20% (M25) had lower strength than normal concrete.

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