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EFFECT OF ELEVATED TEMPERATURE ON MECHANICAL PROPERTIES OF CONCRETE PRODUCED WITH PALM OIL FUEL ASH

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Abstract: In this paper, Palm Oil Fuel Ash Concrete developed using palm oil fuel ash (POFA) as a partial replacement for ordinary Portland cement by 0, 10, 20 and 30% by weight. POFA concrete samples are subjected to high temperatures of 200 and 400ºC for a period of 2 and 4 hours. The results indicate that the compressive strength is improved by the use of POFA in concrete. At high temperature, POFA concrete showed higher strength than conventional concrete. From the experimental results, it can be seen that 20% POFA performed well.

Keywords: Concrete, Elevated Temperature, Palm oil fuel ash, Sustainable concrete, compressive strength.

1. INTRODUCTION

The most part, the surrounding temperature of substantial designs is relied upon to be at room esteems during development and during their administration life. Current plan and development codes deal with well being of these constructions comparable to room temperature esteems. On occasion the natural temperature might increment amazingly or vacillate intermittently, and frequently the plan strength of the design is essentially influenced. It has become basic for specialists to be keen on the lingering plan strength of cement exposed to high temperatures to frame information base for execution at these raised temperatures for down to earth research applications. Albeit experimental methodologies of applying least substantial cover to deal with imperviousness to fire has been the standard, a more same methodology emerging from measurable proof isn't awkward. An initial step is to subject delegate substantial 3D square blends to a scope of temperature varieties above room temperature and notice the adjustment of compressive strength accomplished at different substantial ages.

Concrete is generally utilized as an essential primary material in development because of various benefits like strength toughness, simplicity of creation and non-instability properties, it has over other development materials. Concrete primary individuals when utilized in structures need to fulfil suitable fire security necessities determined in construction laws. This is on the grounds that fire addresses one of the most severe natural conditions to which designs might be oppressed; thusly, arrangement of fitting fire well being measures for underlying individuals is a significant part of building plan. Fire security measures to primary individuals are estimated as far as imperviousness to fire which is the span during which a primary part displays obstruction regarding underlying respectability, dependability and temperature transmission. Concrete by and large gives the best imperviousness to fire properties of any structure material.

Although concrete is considered a non-combustible material, its constituents will be affected by higher temperatures or flames, resulting in loss of its qualities and performance. The amount of the mixture, the size and shape of the elements, the thermal compatibility of the constituents and the type of aggregate, as well as the exposure period to the target temperature, all influence the performance of concrete at high temperatures.

2. OBJECTIVE

i. Tooptimize the POFA with 0%, 10%, 20% and 30% as a partial substitute for OPC cement.

ii. To evaluate the compressive and split tensile strength of POFA concrete at 7 and 28 days.

iii. To determine the temperature effects of using optimum POFA with 0, 2 and 4 hours interval.

3. MATERIALS PROPERTIES

3.1 Cement

The locally available cement utilized for this research and its physical properties are presented in below table

Table 1. Properties of cement

S.No.	Property	Cement (53 grade)
1	Specific gravity	3.15
2	Consistency	36%
3	Initial setting time	48 min
4	Final setting time	587 min

3.2 Fine aggregate

The material which passes through 4.75 mm sieve and its properties are presented in below table

Table 2: Physical properties of fine aggregates

S.No.	Characteristics	Value
1	Specific gravity	2.58
2	Fineness modulus	2.77
3	Grading zone	Zone II

3.3 Aggregate

The physical properties of natural and recycled coarse aggregate are presented in below table

Table 3: Physical properties of the recycled and natural coarse aggregate

S. No	Properties	Aggregates
1	Specific gravity	2.38
2	Water absorption (%)	1.85
3	Fineness modulus (%)	7.50

3.4 Water

Potable water was used in the manufacture of concrete.

3.5 Palm Oil Fuel Ash

Palm oil fuel ash (POFA), a by-product of the palm oil industry, is disposed of as waste in landfills. The collected ash was dried in an oven and passed through a 90 micron sieve and used to replace the cement.

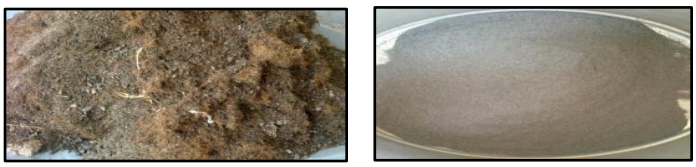

Fig.1 Palm oil fuel ash

3.6 Master gleniumsky8233

Superplasticizer is added to increase the workability since ash added and as a result the strength is increased.

4. METHODOLOGY

OPC 53 grade cement is used for the production of the concrete mix. Sand from the Krishna River and coarse aggregates up to a size of 20mm are used to mix the concrete. The concrete mix of grade M30 (control concrete: P0) is 1: 1.59: 3.27. The OPC has been partially replaced by weight by POFA (20% P20, 40% P40 and 60% P60) for M30. The water / binder ratio considered is 0.4 are cast and then cured for 28 days. Control concrete (0% POFA) and POFA concrete are left free in the laboratory for 7 days, then heated to target temperatures using an electrically controlled furnace (capacity of 1200 ^{o}C) to achieve resistance to

heat. The high temperatures considered are 200ºC, 400ºC and the exposure time is 2 hours The heating rate of the target temperatures is maintained at 10°C/min to maintain the thermal stability of the exterior parts of the concrete specimens. The electrical supply to the electric oven is cut off after reaching 2 hours of exposure time and then the samples are left to stand for 24 hours. Figure 2 shows a view of the POFA used for the experimental study.

POFA used for the study

Muffle Furnace se

Compression strength test setup

5. RESULTS & DISCUSSIONS

Compressive strength of POFA concrete:

The cube specimens of size 150mmx150mmx150mm are tested. Cube specimens were removed from the curing tank after 28 days of curing and cleaned to eliminate surface water. The compressive strength of concretes with varied sizes of coarse aggregate for M40 grade was tested at 7 and 28 days in the current experiment. Table 4 represents compressive strength at 7 and 28 days. Table 5 shows the 20% optimum POFA with 0, 2 and 4 hours interval.

Table 4: Compressive strength of concrete POFA for 7 days and 28 days

Sl.No.	POFA	7 days	28 days
1	0%	34.34	49.21
2	10%	35.01	51.19
3	20%	37.77	52.9
4	30%	36.27	51.97

Table 5: Temperature effects of POFA concrete optimum (20%)

POFA	Temperature	0 Hours	2 Hours	4 Hours
0%	AT	49.21	--	--
0%	ROOMTEMPERATURE	--	--	--
0%	200	--	--	--
	400			
20%	AT	52.9	--	--
20%	ROOMTEMPERATURE	--	49.99	48.39
20%	200	--	43.94	41.91
	400			

Figure 5. Temperature effects of POFA concrete 200°C

Figure 6. Temperature effects of POFA concrete 400ºC.

Splitting tensile strength test

This test method measures the splitting tensile strength of concrete by the application of a diametral compressive force on a cylindrical concrete specimen placed with its axis horizontal between the platens of a testing machine.

Table 6: Split tensile strength of concrete POFA for 7 days and 28 days.

SPLIT TENSILE STRENGTH, N/mm²			
Sl.No	**POFA**	**7 days**	**28DAYS**
1	0%	3.32	4.77
2	10%	3.4	5.01
3	20%	4.07	5.71
4	30%	3.58	5.14

6. CONCLUSIONS

From the results of POFA concrete, the following conclusions are drawn:

1. The compressive strength of conventional concrete at 7 and 28 days are 34.34 and 49.21N/mm^2.
2. The optimum 20% of POFA compressive strength of concrete at 7 and 28 days are 37.77 and 52.90N/mm^2.
3. The split tensile strength of conventional concrete at 7 and 28 days are 3.32 and 4.77N/mm^2.
4. The optimum 20% of POFA compressive strength of concrete at 7 and 28 days are 4.07 and 5.71N/mm^2.
5. The use of POFA with 0%, 10%, 20% and 30% as a partial substitute for OPC cement in the production of concrete has shown a slight reduction of 1.05% and 1.09% for 200ºC and 1.2% and 1.26% for 400ºC in resistance to compression strength.
6. The POFA at 20% performed well at 2 hours at 200 and 400°C.
7. The loss of strength could be due to the change in the chemical composition of POFA concrete at targeted elevated temperatures.
8. POFA used as cement replacement enables the large utilization of waste product.

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