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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OFCEMENT WITH FLY ASH

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ABSTRACT

In today's world the main emphasis is on green and sustainable development. Presently large amount of fly ash is generated in thermal power plants as a waste material with an improper impact on environment and humans. Fly ash a waste generated by thermal power plants is as such a big environmental concern. The use of fly ash concrete formulations as a supplementary cementitious material was tested as an alternative to traditional concrete. The cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 5%, 10%, 15% & 20% by weight of cementfor M-25 and M-40 mix. These tests are carried out to evaluate the mechanical properties for the test results for compressive strength up to 28 days and split strength for 56 days are taken.

Key words: Fly Ash, Compressive strength, Split strength, Thermal Industry Waste.

INTRODUCTION

Fly ash, **flue ash**, **coal ash**, or **pulverized fuel ash** (in the UK) – plural: **coal combustion residuals** (**CCRs**): Is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler's combustion chamber (commonly called a firebox) is called bottom ash. In modern coal-fired power plants, fly ashis generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as**coal ash**.

Depending upon the source and composition of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminum oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

The use of fly ash as a lightweight aggregate (LWA)offers a valuable opportunity to recycle one of thelargest waste streams in the US. In addition, fly ashcan offer many benefits, both economically andenvironmentally when

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utilized as a LWA. The minor constituents of fly ash depend upon the specific coal bed composition but may include one ormore of the following elements or compounds foundin trace concentrations (up to hundreds ppm): gallium, arsenic, beryllium, boron, cadmium, chromium,hexavalent

1. LITERATURE REVIEW

Atul Uniyal, Karan Singh (2019), "Partial Replacement of Cement in Concrete using Ceramic Waste" Waste and find the solution of resulting it the most serious problem of the word today. Waste utilization has become an attractive alternative to disposal now days. There are number of researches, for use of waste in industry most of them related to use these waste in construction are or use of waste in concrete to develop new type of concrete.

Use of waste producing is not only makes it economical but also a very good and attractive solution of disposal problem. Ceramic waste from ceramic industry is used to produce a new type of concrete by replacing the cement.

According a report in India 30% of the daily production goes on waste during the manufacturing, usages and transportation. Ceramic waste increases day by day because of its usages in construction, so it is necessary for ceramic industry for diminishing the waste dump at ceramic industries is recycling, reusing and substitution of concrete ingredients. Ceramic waste produce from industry is durable, hard, and highly resistant to biological, chemical and physical degradation forces. Ceramic waste powder can be used to produce lightweight concrete, without affecting. The compressive strength of concrete of the concrete improved by the use of optimal dosage of ceramic tile powder. This study was carried to obtain the results, The most optimal dosage for the partial alternative of cement by ceramic tile powder is 15 %. The compressive strength of concrete decreases, when the addition of dosage is more than 15%. The results show if20% replacement of cement by ceramic tile powder will affect the strength of concrete.

2. METHODOLOGY

The methodology will be adopted for the projectwork.

- Literature Survey
- Material Collection
- Mix Proportions
- Casting of Specimens
- Testing of Results
- Conclusion

METERIALS AND METHODS

The raw material utilized in concrete is subjectedto several experiments to determine their properties and to decide their usability in concrete. Concrete is asynthetic material, whichis made up of cement, coarseaggregates, fine aggregate andwater. In this experiment additionally I have added an artificial admixture (super plasticizer) to enhance some of the properties of concrete. The material utilized are cement, M-sand, recycled aggregate, coarse aggregate and artificial admixture. In order to check the use of demolished waste as coarse aggregates in concrete in recently constructed project, the mechanical properties for the recycle aggregate were determined, with specific gravity, water absorption, abrasion

resistance, Aggregate Impact Value and Aggregate Crushing Value.

Cement

Fine aggregate Coarse aggregate Recycled aggregate Admixture – Super plasticizer Conplast SP 430Water

In this analysis, control mix was designed as per IS10262:1986 to reach a target compressive strength of 30 MPa.

The casted cubes are test for7,14, 28 days Compressive strength, Split tensile strength and 14, 21, 28 days Flexural strength test. The wet mixture was filled into the mould in 3 layers with the help of solve the mix iscompacted with twenty-five blows of 4.5 kg rammer on level and rigid platform. The number and size of samples are determined by the specific of the tests. The excess mixture was scraped off and also the mouldleveled using a straight edge. The mould and itscontent were left for twenty four hours before the removal of the mould. Identification marks were inscribed on the specimen for simple referencing.

Cement

A cement is a binder, a chemical substance used for construction that sets, hardens, andadheres toother materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together

Fine aggregate

Fine aggregates are essentially any natural sandparticles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4"' minus as it refers to the size, or grading, of thisparticular aggregate.

Coarse aggregate

Coarse aggregates are any particles greater than 0.19 inch, but generally range between3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stonemaking up most of the remainder.

Recycled aggregate

Recycled concrete aggregate is the term used to describe the material produced from crushed construction and demolition waste, primarily consisting of concrete but also including aggregate materials such as sand, gravel, slag, and crushed stones.

3. METERIAL PROPERTIES

Cement

Table 2. Properties of Cement.

S. No.	Property	Cement
1.	Initial setting time	44 minutes
2.	Final setting time	620 minutes
3.	Consistency	33 %
4.	Specific Gravity	3.15

Fine Aggregate.

Natural river sand (Zone II) is used as a FineAggregate. It is passes through the 4.75 mm IS sieve and then used for making of Concrete.

Table 3. Properties of Fine Aggregate.

S. No.	Property	Fine Aggregate

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1.	Fineness modulus	2.52
2.	Specific gravity	2.70

Coarse Aggregate.

S. No.	Property	DCA
1.	Specific gravity	2.66
2.	Water absorption	1.6 %

The Course Aggregate is properly sieved and 12.5 mm , 20 mm aggregates were used for Concrete.

Table 4. Properties of Coarse Aggregate.

S. No.	Property	Coarse Aggregate
1.	Fineness modulus	2.52
2.	Specific gravity	2.7

Table 4. Properties of Coarse Aggregate.

Fly-Ash

SNO	part	Values
1	Specific gravity	2.3
2	Moisture content	19.75%
3	Fineness	0.001 -0.6 mm
4	Maximum dry density	1.53 g/ cm
5	Permeability	$4.87x10^{-7}$ cm/s
6	Angle of internal friction	23°-41 °
7	Cohesion	3-34 Kpa
8	Compression of index	0.15
9	Coefficient of consolidation	0.1 -0.5 m2 per year

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5 .CONCRETE TESTINGSLUMP TEST

Concrete slump test or slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction siteduring the progress of the work. Concrete slump test iscarried out from batch to batch to check the uniform quality of concrete during construction.

Compressive Strength Formula

Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied.

Compressive Strength = Load / Cross-sectional Area Procedure: Compressive Strength Test of Concrete Cubes

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For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. For most of the works cubical molds of size15cm x 15cm x 15cm are commonly used.

SPLIT TENSILE STRENGTH TEST

Testing machine shall meet the followingrequirements:

- Firstly, it shall conform to the requirements of Test Method C 39/C 39M.
- Secondly, testing machine should be able to apply theload continuously and without shock.
- Thirdly, it should be able to apply loads at a constant rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999) splitting tensile stress until the specimen fails

Fig.1:Split cylinder testing machine

Plate or Supplementary Bearing Bar

Sampling of Concrete Cylinders
Concrete specimen moulds

- It shall be made of steel, and 3 mm thick.

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- The mould shall be capable of being opened longitudinally to facilitate the removal of the specimen and is provided with a means of keeping it closed while in use.
- The mean internal diameter of the mould is 15 cm ± mm and the height is 30 +/- 0.1cm.
- The moulds are provided with a metal base plate mould.
- Moulds need to be coated with a thin film of mould oil before use, in order to prevent adhesion of concrete.

Curing of Specimen

- Casted specimen should be stored in a place at a temperature of 27° +/- 2°C for 24 +/- 0.5 hrs from the time addition of water to the dry ingredients.
- After that, the specimen should be marked and removed from the mould and immediately submerged in clean fresh water or saturated lime solution and kept there until taken out just prior to the test.
- The water or solution in which the specimens are keptshould be renewed every seven days and should be maintained at a temperature of 27° +/- 2°c.

Fig.7:curing concrete specimen

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FLEXURAL STRENGTH TEST

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending. The results of flexural test on concrete expressed as a modulus of rupture which denotes as (*MR*) in MPa or psi. The flexural test on concrete can be conducted using either three point load test (ASTM C78) or center point load test (ASTM C293). The configuration of each test is shown in Figure-2 and Figure-3, respectively. Test method described in this article is according to ASTM C78.

4	15	21mm
5	20	18mm
6	30	12mm

HARDENED CONCRETE TEST COMPRESSIVE STRENGTH TEST

It has performed on standard compression testing machine of **2000KN capacity,** as per IS :516-1959 and the casting of concrete cubes of **size 150mm x 150mm x 150mm** of compressive strength for 7days and 14 days.

TESTING OF CONCRETE CUBES

The concrete cubes after casting is allowed

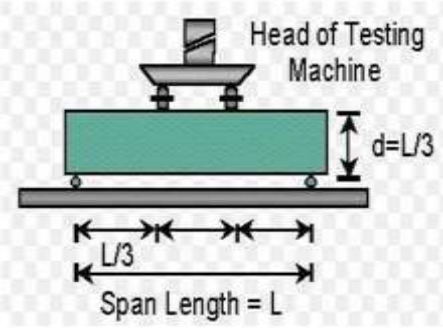

Fig.2: Three-Point Load Test (ASTM C78)

7 .RESULTS

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for 7days and 14 days curing. After curing, to determine the ultimate compressive load by using Compression Testing Machine (CTM).

From the ultimate load, the compressive strength is obtained by the following formula,

Compressive strength = Ultimate load/Area (N/mm^2)

SLUMP TEST

To determine the workability of concrete mix by slump test conducted by as per IS 1199-1959.This allows the concrete to subside and the slump shall be measured immediately bydetermining the difference between the height of the mould and highest point of the specimen being tested. The test results are given in the table.

SL .NO	DMC%	SLUMP (mm)
1	0	32mm
2	5	29mm
3	10	25mm

DMC%	DAYS OF TESTING	COMPRESSIVE STRENGTH OF CONCRETE (N/mm^2)		
0	7	13.56	13.95	13.75
	14	19.26	19.02	18.95
5	7	14.02	14.25	14.36
	14	19.85	19.65	19.88
10	7	14.55	14.95	14.78
	14	19.88	20.55	20.75
15	7	10.55	10.35	10.12
	14	14.80	15.25	15.15

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SPLIT TENSILE STRENGTH TEST

It has performed on standard compression testingmachine of **2000KN capacity,** as per IS :516-1959 and the casting of concrete cylinder of **size 150mm dia and 300mm length** of splittensile strength for 7days and 14 days.

TESTING OF CYLINDER

The concrete cylinders after casting are allowed for 7days and 14 days curing. After curing, to determine the ultimate tensile load by using Compression Testing Machine (CTM). From the

SL .NO	DMC%	DAYSOF TESTING	4DAYSOF TESTING
1	0	2.77	2.91
2	5	2.32	3.15
3	10	2.01	2.36
4	15	2.12	2.52
5	20	2.16	2.35

Split tensile strength = $2P/(\pi DL)$ (N/mm^2)FLEXTURAL STRENGTH TEST

TESTING OF BEAM

The concrete beams after casting is allowed for 7days and 14 days curing. After curing, to determine the ultimate flexural strength by using Flexural Testing Machine (FTM).

From the ultimate load, the flexural strength is obtained by the following formula,

Flexural strength =PL/BD^2

CONCLUSION

Based on experiments and test results on fresh & hardened concrete the following conclusions are drawn

1. Fly ash content increased in the concrete mix workability of concrete is¬ also increased and FA+GF combination mixes reduces the workability of mixes compared to the fly ash concrete mixes.

2. The rate of gain in strength of fly ash concrete specimens is observed to¬ be higher than the corresponding conventional concrete at 28 and 56 days.

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3. In 7 days strength there is no increased in compressive strength than¬ control mix.

4. Fly ash concrete having various cement replacement level up to 15%¬ exhibited satisfactory results for both compressive, flexural and tensile strength.

5. 10% FA and 0.17% GF combination gives good flexural strength than¬ corresponding control mix and fly ash concrete mixes.

6. 15% FA and 0.17% GF combination gives good tensile strength than¬ corresponding control mix and fly ash concrete mixes.

7. Use of fly ash reduces the amount of cement content as well as heat of¬ hydration in a concrete mix. Thus, the construction work with fly ash concrete becomes environmentally safe and also economical

SL. NO	DMC%	7 DAYSOF TESTING	14 DAYS OF TESTING
1	0	7.1	7.86
2	5	6.6	6.9
3	10	5.78	6.46
4	15	5.18	5.51
5	20	4.98	4.90

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