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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF COARSE AND FINE AGGREGATE WITH BROKEN TILES AND POND ASH

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Abstract--The industrial or constructional waste containing many hazards, inorganic and toxic substances beyond the acceptable limit cause impact to living life. To overcome these issues the waste can be recycled and to reduce the burden on environment also use of alternative is required. This study presents the results of an experimental study on the partial replacement of the fine aggregate and coarse aggregate with pond ash and broken tiles with different combinations of both the materials 10% and 20% in the interval of 5% of fine aggregate and 10% of coarse aggregate in M_{25} grade of concrete. In this study broken tiles and pond ash are collected from various places for the partial replacement of coarse and fine aggregates. These replacements will reduce the cost of the structure at greater percentage because aggregates are more costly in cement for concrete production. Fine aggregate is the major component of concrete which is naturally available and hence limited in availability percentages of replacements towards compressive strengths, split tensile and flexural strength of concrete and cubes were cast and tested for 7 and 28 days and the test results are compared with the conventional concrete.

Key words: Pond ash, broken tiles, Compressive strength, Split Tensile Strength, Flexural strength of concrete.

1. INTRODUCTION

Pond ash is a waste product generated by thermal power stations. It is usually much cheaper than sand in India. On using pond ash and broken tiles as partial replacement for fine aggregate and coarse aggregate, it can reduce the environmental hazards and also we can partially overcome the waste disposal crisis. Cost of pond ash as compared to the sand will be very less. Hence the overall cost of concrete with pond ash and broken tiles as partial replacement for fine aggregate and coarse aggregate will be very much less compared to normal concrete. Partial replacement of coarse aggregate by waste ceramic tile increases the strength and durability where as partial replacement of fine aggregate by pond ash increases the strength of concrete, we are aiming at achieving increasing strength and durability properties. Then various properties different mixes of mix design with 0%, 5%, 10% and 15% of partial replacements of fine aggregate and coarse aggregate with 0%, 10% and 20% of pond ash and broken tiles respectively are compared and the ideal percentage replacement is determined.

2. MATERIALS USED

Cement:- Cement is the binding ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the Cement content and chemical composition of cement. The cement used in this work is Ordinary Portland cement 53 grade confirming to IS 12269- 1987.

Table 1

Physical Properties of Cement

Property	Result
Specific gravity of cement	3.12
Fineness of cement	92.50%
Normal consistency of cement	33%
Initial setting time	36 minutes

Fine Aggregate:- The natural sand which obtained from Zone-II and which is passed through 4.75mm sieve is used as a fine aggregate. Test on aggregate are conforming to IS 383 specifications.

Coarse Aggregate:- Aggregate of size more than 4.75mm are generally considered as Coarse aggregate used in this experiment work is 20mm and 12mm. A good quality of Coarse Aggregate is obtained from stone crusher unit. The Coarse aggregate is selected as per IS : 383 specifications.

Table 2 Physical Properties of Fine Aggregate and Coarse Aggregates

Fine Aggregate	
Property	**Results**
Specific gravity	2.67
Fineness Modulus	2.78
Bulking of sand	25 at 4% moisture content

Coarse Aggregates	
Property	**Results**
Specific gravity	2.76
Fineness modulus	7.14
Water absorption	0.6

Broken Tiles:-The waste tiles were broken into little pieces by hand-operations and by using mechanically. The compulsory size of crushed tile aggregate was independent to use them as partial replacement to the natural coarse aggregate. The broken tile waste which is not greater than 4.75 mm size was neglected. The broken tile aggregate passing through the 20mm sieve and retained on 12mm sieve are used.

Table 3 Physical and Chemical properties of Broken Tiles

Property	Results
Specific gravity	2.32
Fineness modulus	6.82
Water absorption	19.67%
Impact value	20%
Crushing value	27%

Compounds(%)	Broken Tiles
SiO_2	64.3
Al_2O_3	19.2
Fe_2O_3	2.51
Cao	1.85
Na2o	0.23
K_2O	1.8
P_2O_5	0.05
TiO_2	0.81
Mgo	2.15

Pond ash:- Coal ash mixtures of fly ash and bottom ash that accumulate into one because of the process of disposal of power plant can be termed as pond ash. By these conditions, in this study try to find a solution by utilizing industrial waste pond ash materials for the concrete manufacturing.

Table 4 Physical and Chemical properties of pond ash

Property	Results
Specific gravity	1.692
Fineness modulus	2.79
Bulking of sand	22 at 6% moisture content

Compounds(%)	Pond ash
SiO_2	61.85
Al_2O_3	30.48
Fe_2O_3	3.23
$SiO_2+Al_2O_3+Fe_2O_3$	95.56
TiO_2	2.19
Cao	0.72
K_2O	0.9
P_2O_5	0.64
LOI	1.27

Water: Water is virtal ingredient that once mixed with cement forms a paste that blinds the aggregate along. There is not a lot of limitations for water except that the water should not severely contaminated. In this study, normal tap water was used.

3. METHODOLOGY

The evaluation of broken tiles and pond ash for use as a partial replacement of coarse and fine aggregate. The study and behavior of compressive strength, split tensile strength and flexural strength of concrete when the base materials three samples per different proportions were tested with the average strength values reported in this paper. The combination of broken tiles and pond ash for use as a partial replacement of coarse aggregates constant at 10%, 20% and 30% and fine aggregate at different proportions 5%, 10%, 15% by weight fine aggregate of M 25 grade concrete. Here examined and results were analyzed after 7 days and 28 days. Information get from the replacement is compared with data from a Conventional concrete.

4. M IXING PROCEDURE

The mixing procedures divided into three stages. In the first stage, all the binder (cement) were weighted accordingly and mixed until all the constituents mixed uniformly. This was make sure that all the binders were mixed thoroughly to produce a homogeneous mix. The second stage involves mixed in the binders with aggregates and for about five minutes. At the final stage, water was added into the concrete mix. The step was decisive important make sure that water was distributed evenly so that concrete we have similar water binder ratios for every specimen. After that concrete can be placed in cubes, cylinders, beams as per recommended dimensions.

Table 5

Percentages and weights of ingredients of concrete

Mix Proportion	Cement		Fine Aggregate				Coarse Aggregate			
	Cement	Cement	Sand	Sand	Pond ash	Pond ash	Aggregate	Aggregate	Broken tiles	Broken tiles
	%	Weight	%	Weight	%	Weight	%	Weight	%	Weight
A0	100	1.283	100	2.35	0	0	100	3.9	0	0
A1	100	1.283	95	2.23	5	0.12	90	3.51	10	0.39
A2	100	1.283	90	2.1	10	0.24	90	3.51	10	0.39
A3	100	1.283	85	2	15	0.36	90	3.51	10	0.39
A4	100	1.283	95	2.23	5	0.12	80	3.12	20	0.78
A5	100	1.283	90	2.1	10	0.24	80	3.12	20	0.78
A6	100	1.283	85	2	15	0.36	80	3.12	20	0.78
A7	100	1.283	95	2.23	5	0.12	70	2.73	30	1.17
A8	100	1.283	90	2.1	10	0.24	70	2.73	30	1.17
A9	100	1.283	85	2	15	0.36	70	2.73	30	1.17

5. TESTS ON CONCRETE

The tests to be conducted on hardened concrete is

- Compressive strength test
- Split tensile strength test
- Flexural strength test

Compressive Strength Test:-

- Compressive strength test was conducted on concrete cubes of size 150 x 150 x 150 mm casted by obtaining the 7 and 28 days in order to determine the compressive strength of the cubes.
- The maximum compressive load on the specimen was recorded as the load at which the specimen failed to take any further increase in the load.
- The compressive strength is determined by dividing the maximum of failure load of the specimen during the test by the cross sectional area of the specimen The average of these samples+ was taken as the representative value of compressive strength

Compressive Strength = Load/Area

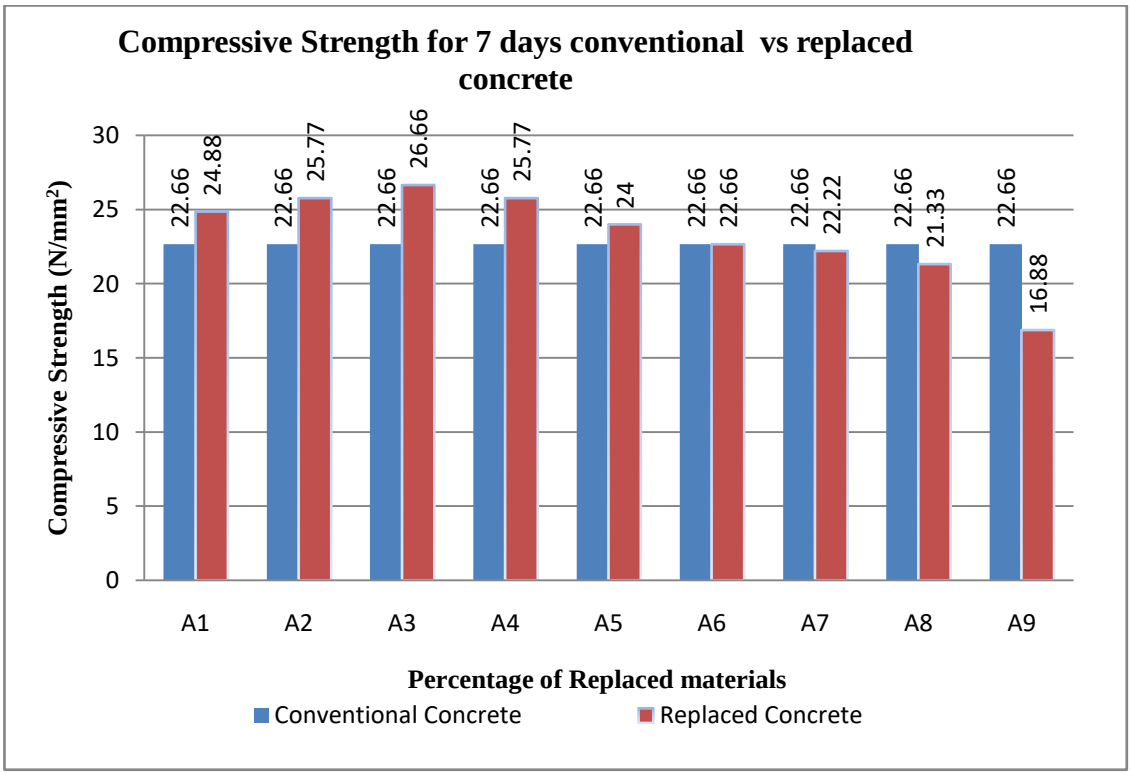
Table 6

Compressive strength conventional vs replaced concrete for 7 Days & 28 Days

S.No	Sample	Cement (%)	Fine Aggregate (%)	Pond Ash (%)	Coarse Aggregate (%)	Broken Tiles (%)	Compressive Strength (N/Mm^2)	
							7 Days	28 Days
1	A0	100	100	0	100	0	22.66	32
2	A1	100	95	5	90	10	24.88	28
3	A2	100	90	10	90	10	25.77	28
4	A3	100	85	15	90	10	26.66	40.88
5	A4	100	95	5	80	20	25.77	34.22
6	A5	100	90	10	80	20	24	32.44
7	A6	100	85	15	80	20	22.66	28.88
8	A7	100	95	5	70	30	22.22	25.33
9	A8	100	90	10	70	30	21.33	24.44
10	A9	100	85	15	70	30	16.88	23.55

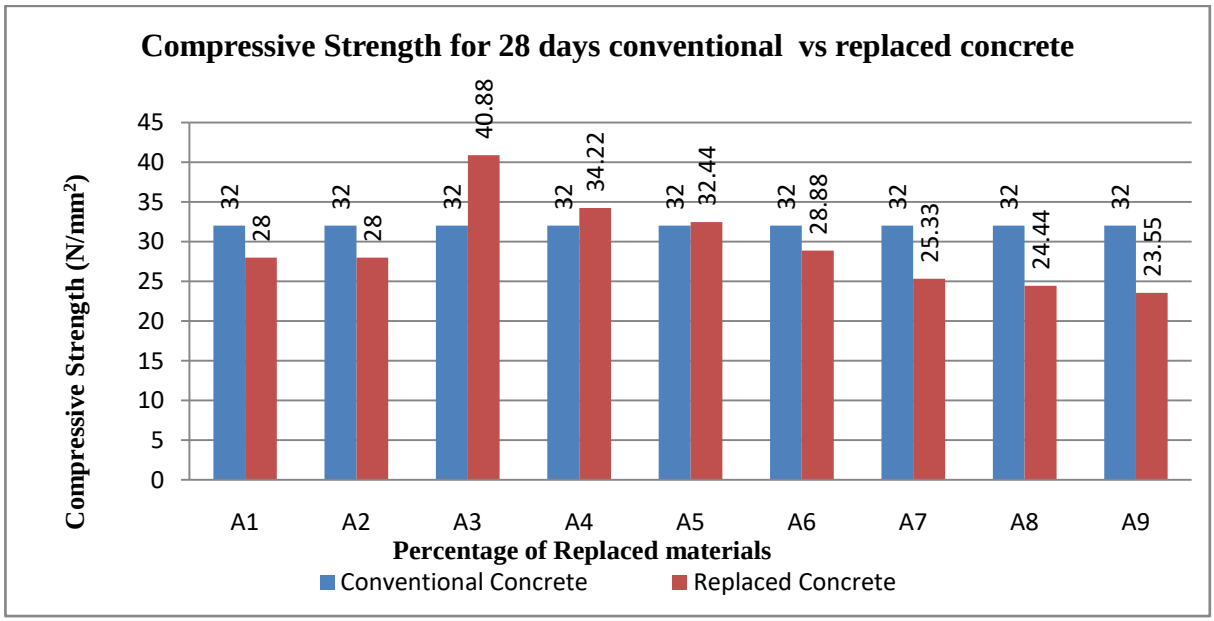
Graph 1

Compressive Strength for 7 days conventional vs replaced concrete



Graph 2

Compressive Strength for 28 days conventional vs replaced concrete



Split Tensile Strength Test:-

- Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150mm x 300 mm specimen used to determine the split tensile strength. After curing, the specimens were tested for split tensile strength using a calibrated compression testing machine of 2000kN capacity.
- The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs. Here d , h of specimen are 150, 300.

Split Tensile Strength = 2P/πdh

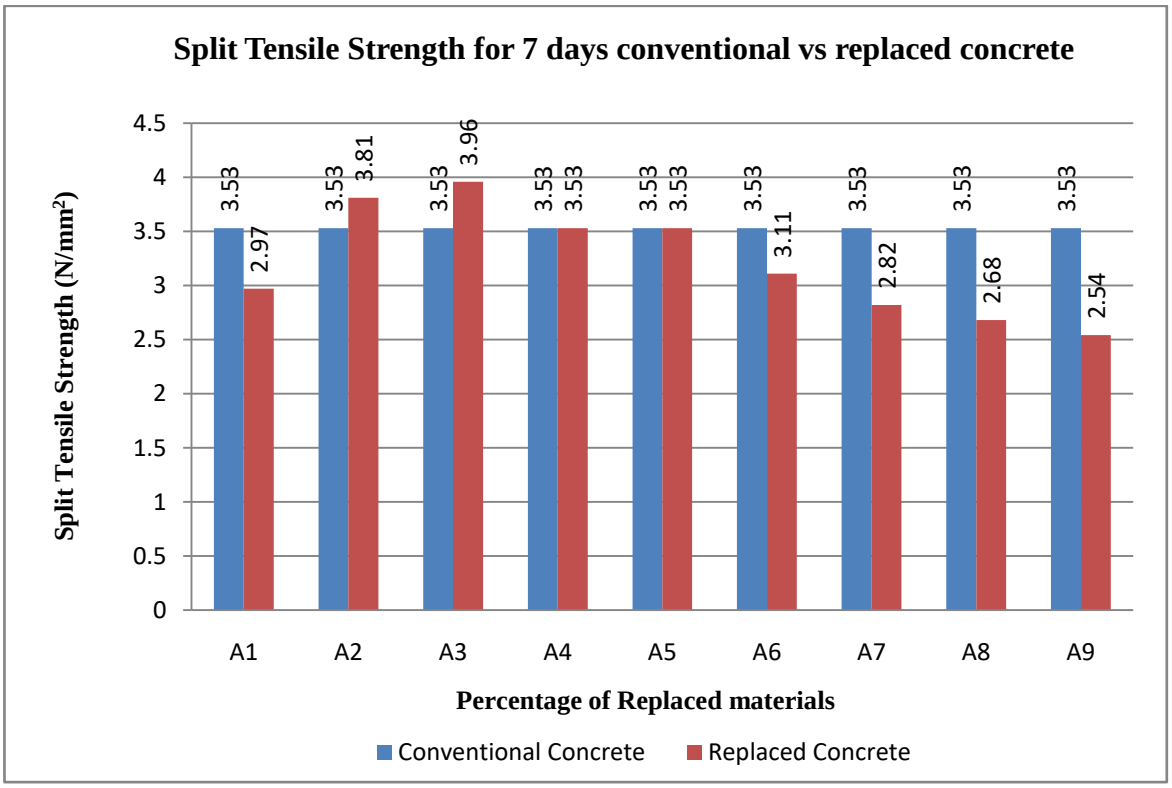
Table 7

Split tensile strength for conventional vs replaced concrete for 7 Days & 28 Days

S.No	Sample	Cement (%)	Fine Aggregate (%)	Pond Ash (%)	Coarse Aggregate (%)	Broken Tiles (%)	Split Tensile Strength (N/Mm^2)	
							7 Days	28 Days
1	A0	100	100	0	100	0	3.53	4.24
2	A1	100	95	5	90	10	2.97	3.11
3	A2	100	90	10	90	10	3.81	4.52
4	A3	100	85	15	90	10	3.96	4.66
5	A4	100	95	5	80	20	3.53	3.81
6	A5	100	90	10	80	20	3.53	3.81
7	A6	100	85	15	80	20	3.11	3.67
8	A7	100	95	5	70	30	2.82	3.53
9	A8	100	90	10	70	30	2.68	3.39
10	A9	100	85	15	70	30	2.54	2.97

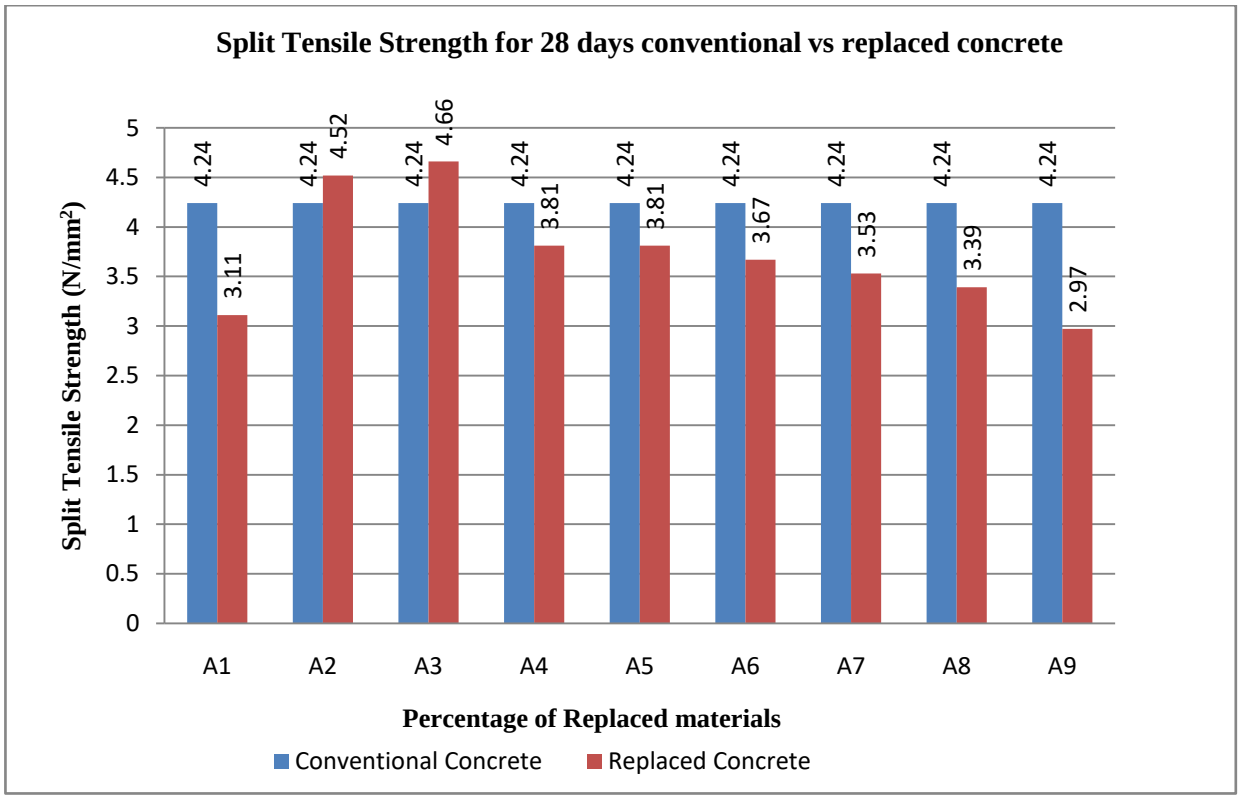
Graph 3

Split tensile strength for 7 Days conventional vs replaced concrete



Graph 4

Split tensile strength for 28 Days conventional vs replaced concrete



Flexural Strength Test:-

- For this test the beams of dimension 100mmX100mmX500mm were casted. Flexural strength also known as modulus of rupture.
- The value of the modulus of rupture depends on the dimensions of the beam and manner of loading. In this study, to find the flexural strength by using third point loading. L, b, d values of the specimen are500, 100, 100

Flexural Strength = PL/bd^2

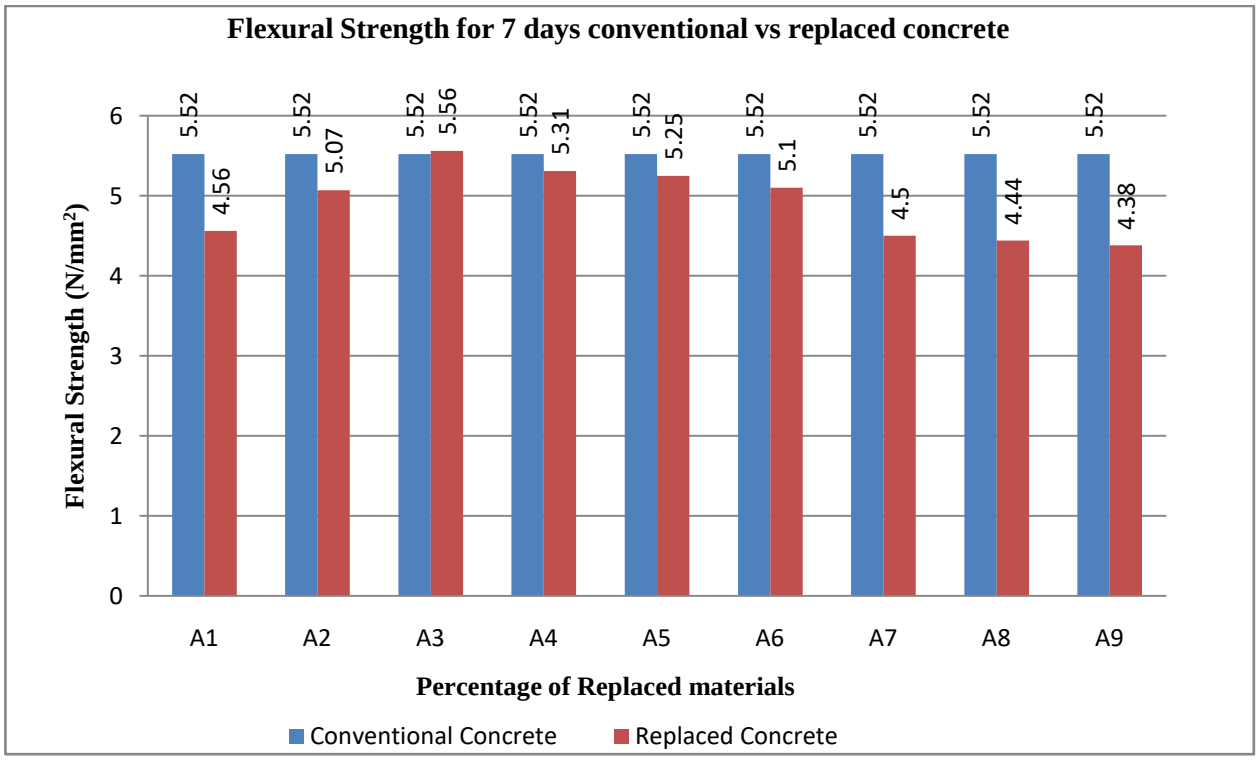
Table 8

Flexural strength for conventional vs replaced concrete for 7 Days & 28 Days

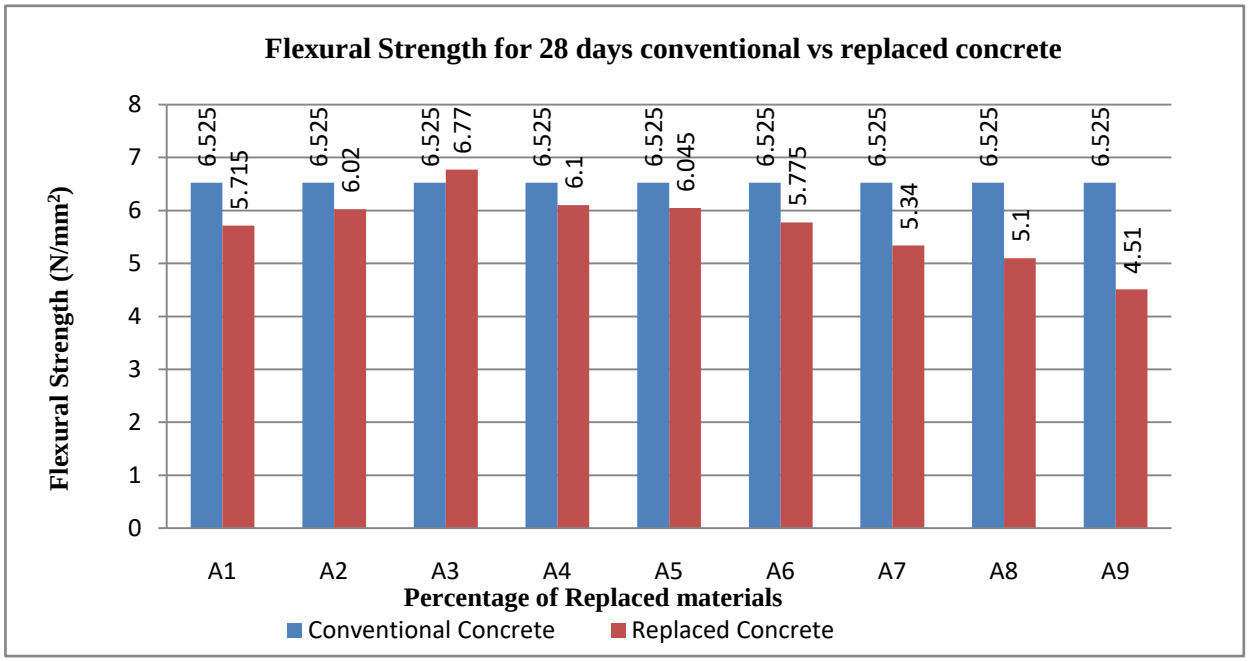
S.No	Sample	Cement (%)	Fine Aggregate (%)	Pond Ash (%)	Coarse Aggregate (%)	Broken Tiles (%)	Flexural Strength (N/Mm^2)	
							7 Days	28 Days
1	A0	100	100	0	100	0	5.52	6.52
2	A1	100	95	5	90	10	4.56	5.71
3	A2	100	90	10	90	10	5.07	6.02
4	A3	100	85	15	90	10	5.56	6.77
5	A4	100	95	5	80	20	5.31	6.1
6	A5	100	90	10	80	20	5.25	6.04
7	A6	100	85	15	80	20	5.1	5.77
8	A7	100	95	5	70	30	4.5	5.34
9	A8	100	90	10	70	30	4.44	5.1
10	A9	100	85	15	70	30	4.38	4.51

Graph 5

Flexural strength for 7 Days conventional vs replaced concrete



Graph 6
Flexural strength for 28 Days conventional vs replaced concrete



8. CONCLUSION

- After the completion of all experimental tests, this study is concluded that the broken tiles and pond ash can be used as a partial replacement of coarse aggregate and fine aggregate in concrete mix.
- The Compressive, Split tensile and Flexural strengths of M25 grade concrete increases when the coarse aggregate and fine aggregate is replaced with broken tiles and pond ash up to a combination of 15% pond ash and 10% broken tiles.
- By increasing the proportions in the mix leads to the increasing the strength of the concrete upto A3(15% , 10%) and after increasing the proportions in the mix leads to the decreasing the strength of the concrete increasing.
- Minimize the solid waste disposed from the tile industry and also pond ash from the thermal power plants as a waste material.

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