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Use of Fire Clay as a Partial Replacement in Concrete

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Abstract : **Utilization of industrial waste products in the industry has been the focus of research for economic, environmental and technical reasons. Huge quantity of fire clay which is a waste product available at very negligible rate. In this paper, fire clay can be utilized by replacing it with sand. Trial mixes were tested with different proportions of 0 % to 40% with the replacement of fire clay and also with the addition of chemical admixtures. This study is aimed to evaluate the strength of high performance concrete by performing tests like compressive strength, split tensile strength and flexural strength at the age of 7days, 14days and 28days and physical properties test were also conducted and compared with the conventional concrete and durability test and water permeability test are also conducted at the age of 28days. The aim of this research is to make economical and light weight concrete and to avoid problem of clay disposal.**

KEYWORDS: Fire clay, Chemical admixtures, Durability, Compressive strength.

I. INTRODUCTION

Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. Industrial wastes, such as fly ash and silica fume are being used as supplementary cement replacement materials. Currently, there has been an attempt to utilize the large amount of fire clay, the residue from an industry. Therefore it is possible to use fire
clay as a sand replacement material to improve quality and reduce the cost of construction materials. Recycling in concrete has advantages since it is widely used and has a long service life, which means that the waste is being removed from the waste stream for a long period.On the other hand, the modern technological society is generating substantially high amounts of solid wastes both in municipal and industrial sectors; posing an engineering challenging task for this effective and efficient disposal. Hence, partial or full replacement of cement by the other compatible materials like sintered fly ash, crushed rock dust, quarry dust, glass powder, recycled concrete dust, and others are being researched from past two decades, in view of conserving the ecological balance. Even though, use of several types of industrial solid wastes like metallurgical waste, glass pieces, fly ash, quarry dust, tyre and rubber waste, crushed concrete waste, sludges and others in making good field concrete is being effectively done at European countries, U.S.A., U.K., and Australia; Asian countries could not gear up to that level to match with those countries . Therefore, resource exploitation and waste disposal problems are currently rocking the sustainable development in those countries (including India).

This will not only provide new material for construction but also will help the preservation of the environment and can also help the economy by providing new use for the fire clay. Concrete is generally composed of aggregates, cement and water. The aggregates are usually coarse and fine aggregates. The aggregates should have good mechanical properties in terms shape, density, grading, hardness, purity to achieve the required strength and durability.

II. MATERIALS PROPERTIES

A. *Cement*

The ordinary pozzalona cement conforming used for the preparation of test specimens. The properties of cement as shown in table 1.

Table 1.Properties of Cement

PROPERTY	VALUE
Specific Gravity	3.14
Fineness	97.56
Initial Setting Time	30mins
Final Setting Time	600mins
Compressive Strength	42N/mm^2
Consistency	29%

B. *Coarse Aggregate*:

The crushed aggregates used were 25mm and 12.5mm of nominal size are tested as per Indian Standards and results are within the permissible limit.

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Table 2.Properties of Coarse aggregate

PROPERTY	VALUE
Specific Gravitry	2.70
Fineness	3.2
Aggregate crushing value	20.04%
Aggregate impact value	19.87%
Aggregate abrasion value	20.42%
Flakiness and elongation index	19% & 20%

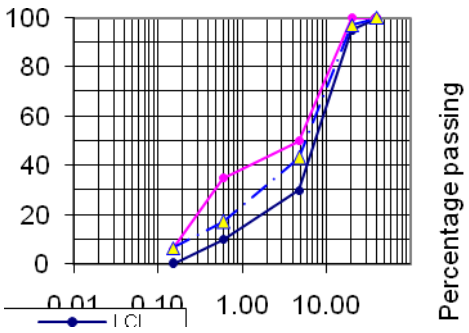
C. Fine Aggregate:

Crusher sand is used as fine aggregate. The specific gravity and fineness modulus were found to be 2.75 and 3.20 respectively. The properties are tested as per IS 381:1970.Fire clay is used for utilization of fine aggregate upto partial replacement. Specific gravity and fineness modulus

Fig 1 Crusher Sand

Table 3.Sieve Analysis for Crusher sand

SIEVE SIZE	QTY RETAINED	% QTY	CUMULATIVE %	% OF PASSING
4.75mm	56g	5.6	5.6	94.4
2.36mm	204g	20.4	26	74
1.18mm	263g	26.3	52.3	47.7
600µm	64g	6.4	58.7	41.3
300µm	221g	22.1	80.8	19.2
150 µm	155g	15.5	96.3	3.7
75 µm	35g	3.5	99.8	0.2
Pan	2g	0.2	100	0



Water absorption for both coarse and fine aggregate

Table 4.Water Absorption

MATERIALS	WATER ABSORPTION
Coarse aggregate (25mm)	0.20%
Coarse aggregate (12.5mm)	0.50%
Crusher sand	2.7%
Fire clay	4.7%

D. Fire clay chemical composition

Table 5.Chemical Composition

CHEMICAL	% Of COMPOSITION
SiO_2	57.32
Fe_2O_3	0.86
Cao	0.27
K_2O	1.25
Loss on Ignition	10.10
Carbon	0.20
MgO	0.34
Na_2O	0.08
Al_2O_3	30.80
TiO_2	1.05
Plasticity by hand feel	Good
Atterbergs number	"13"

III. RESULTS AND DISCUSSION

A. Mix Proportions

The concrete mix is designed as per IS 10262 – 2009 [8] and IS 456-2000 [9] for the normal concrete. The grade of concrete which we adopted was M30 with the water cement ratio of 0.45.

B. Test Specimens

Cubes of size 150mm X150mm X150 mm, prisms of size100mmX100mmX500 mm and cylinders of size 300mm x 150mm were prepared using the standard moulds. The samples are casted using the different proportions of fireclay. The samples are demoulded after 24 hours from casting and kept in a water tank for 7,14 and 28 days curing. The specimens are casted for testing the properties such as compressive strength, flexural strength and split tensile strength

Fig 4 Tested Specimen

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Table.6.Compressive Strength Test for Cubes

Days	Mix1 (CM) N/mm^2	Mix2 (10%) N/mm^2	Mix3 20% N/mm^2	Mix4 30% N/mm^2	Mix5 40% N/mm^2
7 days	42.33	34.65	33.67	31.67	20.63
14days	50.2	38.67	34.44	32.18	25.1
28days	56.44	46.22	44.89	42.22	27.51

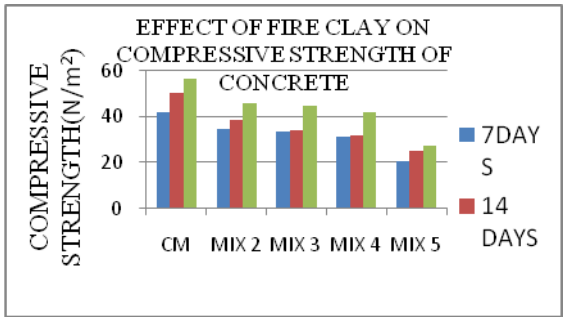

Fig 5 Graph for Compressive Strength

a) Result for Flexural strength

Table.7 Flexural Strength Test for beams

Days	Mix 1 (CM) N/mm^2	Mix 2 (10%) N/mm^2	Mix 3 (20%) N/mm^2	Mix 4 (30%) N/mm^2	Mix 5 (40%) N/mm^2
7days	2.4	2.05	1.78	1.74	1.62
14days	3.6	3.08	2.67	2.61	2.43
28days	5.4	4.62	4	3.91	3.644

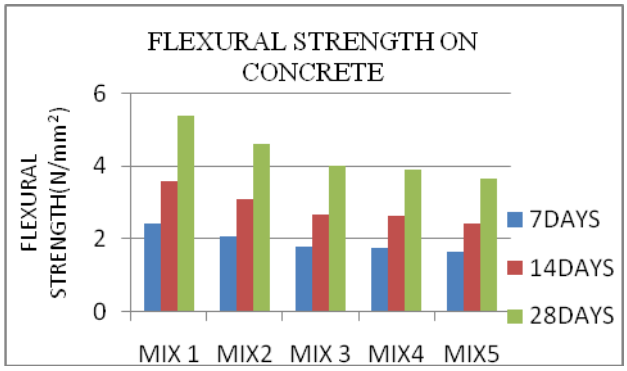

Fig 5 Graph for flexural Strength

a) Study on Split Tensile Strength

Table.8 Split Tensile Strength Test for Cylinders

Days	Mix 1 (CM) N/mm^2	Mix 2 (10%) N/mm^2	Mix 3 (20%) N/mm^2	Mix 4 (30%) N/mm^2	Mix 5 (40%) N/mm^2
7days	2.4	2.05	1.78	1.74	1.62
14days	3.6	3.08	2.87	2.61	2.43
28days	5.4	4.62	4.28	3.91	3.644

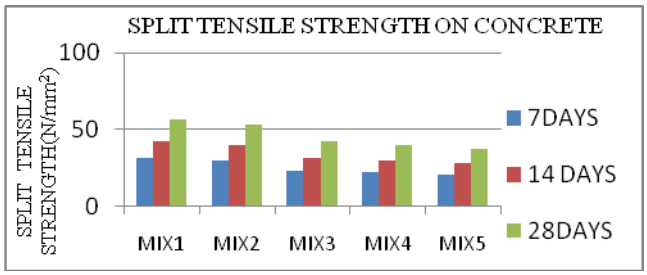

Fig 6 Graph for split tensile Strength

C. *Water Permeability*

The specimens has been accommodated in the holder into the seats of the test set-up and secured therein using rosin to avoid any seepage of water through sides. The water pressure is raised to 0.5 N/mm^2, holding the pressure until the end of the test. Three cubes are casted and tested for the determination of water permeability. The size of the specimen was 150mm cube. The pressure as specified was applied and held for 72 hours and the pressure was released at the end of test. Then the cubes is tested under compressive strength test then the water traces were measured for the depth of penetration. The permeability has been measured as the average of maximum depth of penetration is calculated at the age of 28 days and tabulated in table no.7

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Fig 7. WPT Apparatus

Table.9 Summary of water permeability values

Age	Mix1 (CM)	Mix 2 (10%)	Mix 3 (20%)	Mix 4 (30%)	Mix 5 (40%)
28 days	1mm	2mm	3mm	4mm	5mm

D. Rapid chloride penetration test

This test method covers the determination of the electrical conductance of concrete to provide a rapid indication of its resistance to the penetration of chloride ion. Bring sample to SSD condition and apply sealer on the outer surface and allow the sealer to dry. Keep the sample in the vaccum chamber in vertical position. Pour water in the vaccum chamber till the sample submerges in water. Switch on the vaccum pump and condition for 1 hr. Release vaccum after conditioning and keep water in sample for 18 + - 2hr. Prepare NaCl solution (30 grams of NaCl + 970 ml water) and NaOH solution (12 grams in 1 litre of water). Fix the sample in the test apparatus and seal the edges with sealent and pour NaCl in (-ive) and NaOH (+ve) terminals. Connect the terminals to the unit. Set the current to 60V + - 0.1V. Note the initial reading and continue to take reading in every 30 min interval for 6 hours.

Fig 8 Specimen for RCPT

Table.10 Rapid chloride penetration test (coloumbs)

Age	Mix 1 (CM)	Mix 2 (10%)	Mix 3 (20%)	Mix 4 (30%)	Mix 5 (40%)
28 days	1237.2	1949.4	2219.4	2785.7	3307.5

CONCLUSION

Compressive strength of control mix at the age of 28 days is 56.44 N/mm^2. More over the compressive strength of 10%,20% ,30% are reached the target strength of M30 grade mix. Similarly the flexural strength and the split tensile strength are to be higher than the design targeted strength. Then the water permeability is also found to be lower than the limited value (25mm) and the rapid chloride penetration test results are within the moderate range. The penetration of water and chloride ion is lower in the specimens tested and hence the causes of corrosion will be low.

[1] Based on the findings from the study the partial replacement of fireclay with upto 30% replacement is recommended for use in concrete production for use in construction where crushed sand and fireclay is in abundance and river sand is scarce.

[2] Unit weight of fireclay is higher than that of river sand aggregate in dense condition which in turn , contributes to the increase in the fireclay as a fine aggregate.

[3] Concrete specimens were prepared with proportions of 10% ,20%,30%, and 40% for M30 grade concrete mix. The test results shows clearly that fire clay as a partial sand replacement has beneficial effects of the mechanical properties of high performance concrete of the proportions upto 30% were considered and the cost of concrete is also reduced and hence it becomes more economical without compromising concrete strength than the conventional concrete.

REFERENCES

(1) Abdelmaseeh Bakos Keryou (2013), 'Effect of Using Windows Waste Glass as Coarse Aggregate on some Properties of Concrete', Engg & tech journal,Vol32, No.6.

(2) Aggarwal.P, Aggarwal.Y and Gupta.S.M (2007) **'**Effect of Bottom Ash as Replacement of Fine Aggregates in Concrete', Asian Journal of Civil Engineering, Vol. 8, No.1, PP49-62.

(3) Apata A.O. and Alhassan A. Y (2012) 'Evaluating Locally Available Materials as Partial Replacement for Cement', Journal of Emerging Trends in Engineering and Applied Sciences, Vol. 3 (4),pp 725-728.

(4) Concrete Technology Book by M.S.Shetty.

(5) Felix Kala.T (2013) 'Effect of Granite Powder on Strength Properties of Concrete', International Journal Of Engineering And Science, Vol.2, Issue 12, Pp 36-50.

(6) IS 10262 -1981 IS Method of Mix Design, Bureau of Indian Standards, New Delhi.

(7) IS 383 -1970 Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standards, New Delhi.

(8) IS 456 -2000 Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.

(9) Ishak Waleed Esmail.M (2009) 'Investigating the effect of partial replacement of aggregates by clay waste products in concrete', University of Nairobi, Vol. 11(1), pp 33-40.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

(10) Keerthinarayana.S and Srinivasan.R (2010) 'Study on Strength and Durability of Concrete by Partial Replacement of Fine Aggregate Using Crushed Spent Fire Bricks', Buletinul Institutului, VI (Lx), Fasc. 2,pp 51-63.
(11) Mageswari.M and Vidivelli.B (2010) 'The Use of Sheet Glass Powder as Fine Aggregate Replacement in Concrete', The Open Civil Engineering Journal, Volume-4, pp. 65-71
(12) .Manasseh JOEL (2010) 'Use of Crushed Granite Fine as Replacement to River Sand in Concrete Production', Leonardo Electronic Journal of Practices and Technologies, Issue 17, pp. 85-96.
(13) Murali.G (2012) 'Experimental Investigation on Concrete with Different Waste Stone as a Aggregate', International Journal of Engineering Research and Applications, Vol. 2, Issue 3, pp. 253-256.
(14) Odero B.J,Mutuku R.N and Kabubo C.K (2013) 'A Review On Mechanical Characteristics of Normal Concrete Partially Replaced With Recycled Ceramics Aggregates', Engg & tech journal, ISSN 1065-3662.
(15) Shafana.T and Venkatasubrama.R (2014) 'A study on the Mechanical Properties of Concrete with partial replacement of Fine aggregate with Sugarcane bagasse ash', International Journal of Advanced Structures and Geotechnical Engineering, Vol. 03, No. 01, pp 34-39.
(16) Tiwari Darshita and Patel Anoop (2013) 'Study of Strength and Workability of Different Grades of Concrete by Partial Replacement of Fine Aggregate by Crushed Brick and Recycled Glass Powder', International Journal of Science and Research, Volume 3, Issue 6,ISSN 2319-7064.
(17) Topçu.B.N and Canbaz.M (2007) 'Utilization of Crushed Tile as Aggregate in Concrete', Iranian Journal Of Science & Technology, Vol. 31, No. B5, pp 561-565
(18) Veera Reddy.M (2010) 'Investigations on stone dust and ceramic scrap as aggregate replacement in concrete', International journal of civil and structural Engineering, Vol.1, No. 3, ISSN 0976 – 4399.
(19) Vishnumanohar.A (2014) 'Performance of Normal Concrete with Eco Sand (Finely Graded Silica) As Fine Aggregate', International Journal of Engineering Science Invention, Volume 3,PP 27-35.

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