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Explorations into the Expanded Clay Aggregate Concrete Bricks Strength Properties

S. Anka Rao[1], N. Priyanka[2], D Kavitha[3] and G Malleswara rao[4], T. Raghu Vamsi[5]

[1,2,3,4] Assistant Professor, Pace Institute of Technology and Sciences, Ongole, Andhra Pradesh, India
[5]B. Tech Scholar, Pace Institute of Technology and Sciences, Ongole, Andhra Pradesh, India

Correspondence should be addressed to S. Anka Rao; ankaraos@pace.ac.in

ABSTRACT- This experiment aims to examine the strength characteristics of structural light weight concrete generated by substituting light weight aggregates like Cinder (class-F) and ECA for coarse aggregate in M30 grade concrete. Lightweight concrete is created from cinder and ECA, with cement and coarse aggregate substituted at 40%, 50%, 60%, and 100%. The mix design for the project is 1:1.24:0.63. Using the aforementioned mix percentage, we cast 15 brick specimens measuring 0.61x0.20x0.10m and cylindrical moulds measuring 0.15x0.3m. a whole of 7,14,28 days. Concrete that is lighter by 25% to 35% has the same strength as concrete that is heavier by weight.

KEYWORDS- Compressive Strength, Expanded Clay Aggregate, Flexural Strength, Fly Ash, Tensile Strength.

I. INTRODUCTION

The light weight concrete aids in load reduction since the density is lowered significantly from 2400kg/cubic metre to 1800kg/cubic metre. Light weight concrete is an improved variety of concrete that has a lower density. When structural problems necessitate a low dead load, light weight concrete is employed. Because it is low in weight, it is simple to lift and carry, which is a significant advantage of light weight concrete.[1] It also has slower temperature transmission rates than conventional concrete. When compared to standard conventional concrete, the connection between the cement and particles in light weight concrete is stronger. Because of its low density and better strength, light weight concrete is becoming more popular. [2]

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II. MATERIALS &PROPERTIES

A. Concrete

Concrete is a building material made of Portland cement and water, as well as sand, gravel, crushed stone, or other inert material such expanded slag or vermiculite. The cement and water combine to produce a paste that hardens chemically into a solid, stone-like lump.

B. Cement

Cement is a binder that sets and hardens on its own and may bind other materials together. Cement is composed of four major constituents: tricalcium silicate (3CaO SiO2), dicalcium silicate (2CaO SiO2), tricalcium acuminate (3CaO Al2O3), [5] and tetracalcium aluminoferrite (4caco Al2O3 Fe2O3). aluminoferrite tetracalcium (4CaO Al2O3 Fe2O3). Such substances be labelled as C3S, C2S, C3A, and C4AF in a shortened terminology that differs from the standard atomic symbols, where C stands for calcium oxide (lime), S for silica, A for alumina, and F for iron oxide. There are also trace quantities of uncombined lime and magnesia, as well as alkalis and trace amounts of other metals (see table 1 to 3).

Table 1: Properties of cement

S.NO	Physical property	Test result
1	Compressive Strength(Mpa)	48.35
2	Fineness (%)	6
3	Specific Gravity	3.06

Table 2: Fly ash Chemical properties

Chemical compound	Low calcium fly ash Class F	High calcium fly ash Class C
Silicon dioxide	54.90	39.90
Aluminum oxide	25.80	16.70
Calcium oxide	8.70	24.30

Magnesium oxide	1.80	4.60
Sulfur trioxide	0.60	3.30
Sodium oxide and potassium oxide	0.60	1.30
Iron oxide	6.90	5.80

Table 3: Fly ash physical Properties

Flyash	Properties
Specific gravity	2.3
Moisture content	19.75%
Fineness	0.001-0.6mm
Maximum dry density	1.53
Cohesion	3- 34 Kpa
Compression index	0.15

C. Aggregates

Aggregates are essential components of concrete. These provide the concrete structure, prevent shrinkage, and have an economic impact. Previously, aggregates were considered.
Aggregates with a size greater than 4.75 mm are classified as coarse aggregates, whereas aggregates with a size just under 4.75 mm are classified as fine aggregates.

- Fine aggregates
- Expanded clay aggregates

D. Fine aggregates

Fine aggregates, often known as sand, are an aggregation of mineral matter grains formed by the dissolution of rocks (see table 4).
Sands that have been preserved and isolated from organic material by the operation of strong currents or breezes over dry terrain are often fairly consistent in grain size. Typically, industrial landforms are generated by the action of winds.

Table 4: Physical properties of fine aggregates

S.N0.	Physical property	Test result
1.	Fineness modulus	2.45
2.	Specific Gravity	2.56
3.	Bulk Density(kg/m3)	1530-1600
4.	Water Absorption (%)	0.80

E. Expanded Clay Aggregates

Light expanded clay aggregates. It is a kind of aggregates created by the pyroclastic procedure in a rotating kiln at a very elevated temp of 1,200 °C (2,190 °F). Because the organic chemicals burn when exposed to high temperatures, the pellets expand and develop a honeycombed structure. In contrast, the exterior surface of each granule melts and sinters. Ceramic pellets produced as a result are lightweight, porous, and have a high crushing resistance. It is environmentally benign, fully natural, and provides the same benefits as tile in brick form. LECA is non-destructible, non-combustible, and resistant to dry-rot, wet-rot, and insect assault.it shows that fig 1.Expanding clay aggegate.
Before choosing on a material to be utilized as aggregate, it must meet the IS: 1343 criteria. Because we are concerned with the mix design, basic tests were carried out and the findings were decided(see table 5).

Figure 1: Expanded Clay Aggregate

Table 5: Physical properties of ECA

S.NO	Physical property	Test result
1	Maximum Size (mm)	20
2	Fineness modulus	7.25
3	Specific Gravity	2.70
4	Bulk Density(kg/m3)	1480-1610
5	Water Absorption (%)	0.12
6	Aggregate Crushing Value (%)	16.60
7	Aggregate Impact Value (%)	11.01

F. Water

Water quality is critical because pollutants can reduce concrete strength and induce corrosion of steel reinforcing. Water used in the production and curing of concrete should be relatively clean and devoid of harmful chemicals such as oil, acid, alkali, salt, sugar, silt, organic matter, and other materials that are harmful to the concrete or steel. If the water is drinkable, it is deemed adequate for concrete production. As a result, drinkable tap water was employed in this investigation for mixing and curing.
As per IS 456 -2000, the PH value of water should range from 6.0 to 8.0.

G. Workability Tests

- Compaction Factor Test
- Slump cone Test

H. Compaction Factor Test

The compacting factor test of fresh concrete is used to measure the workability of fresh concrete(see table 6).

Table 6: Compaction factor values

Fly ash%	ECA %	Compaction Factor Values
40	100	0.82
50	100	0.79
60	100	0.8

I. Slump Cone Test

The phrase "workability" has a considerably broader and deeper meaning than the other term "consistency," which is sometimes employed interchangeably with workability (see table 7).

Table 7: Slump Test Results

Fly ash%	ECA %	Slump Values
40	100	132
50	100	129
60	100	127

J. Compressive Strength Test

The compressive strength of any material is defined as its resistance to failure when subjected to compressive pressures. The compressive strength of concrete is determined at batching plants in labs for each batch in order to preserve the required quality of concrete throughout casting. After 7, 14, and 28 days of curing, compressive strength is determined by dividing the failure load by the area of applied load (see figure 2).

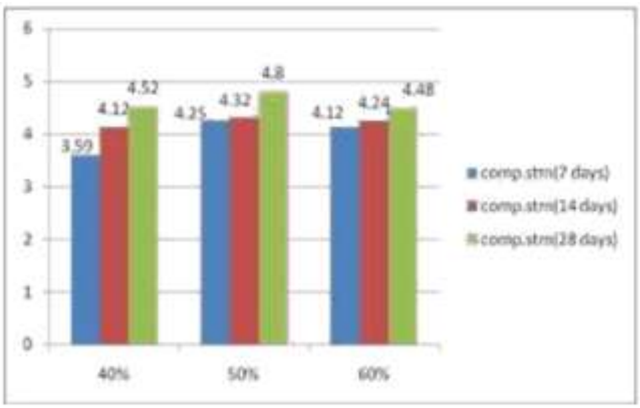

Figure 2: Compression Testing Machine

K. Compression Test Results

Compressive strength is defined as its resilience to axial loading. Cubes are loaded into the machine, and after tightening its wheel, the start button is pressed as pressure is applied. When fractures appear on cubes, the meters reading is recorded. The test result to analyze the figure 3 comparission Testing Machine.

Compressive strength is calculated by following formula: Compressive Strength = P/A

Where P = load

A = area of cube.

Table 8: Compression strength test values

Fly ash%	ECA%	7 days	14days	28days
40	100	3.59	4.12	4.52
50	100	4.25	4.32	4.80
60	100	4.12	4.24	4.48

Figure 3: Compressive strength (x- Axis: - Fly ash proportions and Y-Axis:- Compressive Strength Values (N/mm2))

L. Flexural Strength Test

Flexural strength is defined as the stress at failure in bending. It is the same as, or slightly more than, the failure stress in tension. As we all know, concrete is reasonably strong in compression but weak in tension. Tensile stresses are likely to form in concrete as a result of drying shrinkage, corrosion of steel reinforcing, temperature gradient, and a variety of other factors.in that fig 4 shows that flexural Strength (see table 8).

Figure 4: Flexural Strength

M. Test Flexural Strength Values

Flexural test beams with dimensions of 150X150X700 mm3 were used. The force was applied without shock and increased until the specimen failed, and the highest load delivered to the prism throughout the test was recorded on the metre. The indications of concrete failure broken faces were detected. The flexural strength of Coconut Shell Aggregate Concrete was determined using the three-point load technique. The prisms' flexural strength was determined using the provided equation. Table 5 and 6 shows the test flexural strength vales(see table 9)..

Modulus of rupture, fb = PL/bd2 Where P = Maximum load applied, N

L = Supported length of the specimen, mm
b = Measured width of the specimen, mm

Table 9: Flexural strength values

Fly ash%	ECA %	7 days	14days	28days
40	100	1.05	1.26	1.12
50	100	1.12	1.32	1.20
60	100	1.17	1.38	1.24

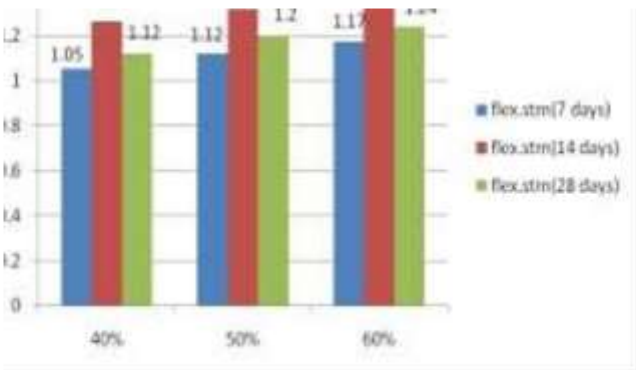

Figure 5: Flexural Strength (X- Axis:- Fly ash proportions Y-Axis :- Flexural Strength Values (N/mm2)

The usual compressive strength was attained using 40% FA and 100% ECA as a substitute for cement CA.
The greatest compressive strength was reached by replacing coarse aggregate with 50% FA and 100% ECA.
For 28 days, the compressive strength of 60% FA and 100% ECA as replacements for either cement or coarse aggregate was lower than that of conventional concrete.
The statistics demonstrate that ECA and FA may be used instead of cement. However, the percentage of ECA and fly ash replacement has an effect on the characteristics of the concrete. At 7 and 28 days of cure, 100% ECA and 50% FA replacement had greater compressive strength than control concrete.

III. CONCLUSION

Because of the fineness and spherical form of its particles, the addition of fly ash and ECA has increased the workability of a concrete regardless of the replacement level for all mixes. Because of the pozzolanic activity of the ash, using fly ash as a replacement for cement or fine aggregate in a concrete mix boosts its compressive strength. Because fly ash slows the hydration process of cement, the compressive strength of fly ash and ECA concrete increases over time, whereas regular concrete reaches its maximum compressive strength after around 28 days.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

[1] Mr. Anil Kumar R Assistant, Dr. P Prakash, 2015 Studies on Structural Light Weight Concrete by Blending Light Weight Aggregates, International Journal of Innovative Research in Engineering & Management (IJIREM) ISSN: 2350-0557, Volume-2, Issue-4, July-2015

[2] Andro genis. J, M.S.Dinesh kumar, D.Praveen, A.S.Arun Prawin, Anekar Mohammed Uzair,2018 Flexural Behaviour of Light Weight Clay Aggregate Concrete Beam Reinforced With Geogrid, Volume 118 No. 20 2018, 3537-3545 ISSN: 1314-3395 (on-line version) url: http://www.ijpam.eu

[3] Lenka Bodnarova, Rudolf Hela, Michala Hubertova, Iveta Novakova, 2014 Behaviour of Lightweight Expanded Clay Aggregate Concrete Exposed to High Temperatures, World Academy of Science, Engineering and Technology International Journal of Civil and Environmental Engineering Vol:8, No:12, 2014

[4] Manu S. Nadesan, P. Dinakar, 2017 Mix design and properties of fly ash waste lightweight aggregates in structural lightweight concrete,Case Studies in Construction Materials 7 (2017) 336–347 journal homepage: www.elsevier.com/locate/cscm

[5] Obada Kayali, 2005 Flashag – New Light Weight Aggregate For High Strength And Durable Concrete, 2005 World Of Coal Ash (WOCA) April 11-15,2005, Lexington,Kentucky,USA http://www.flyash.info

[6] R.N. Raj Prakash, A.Krishnamoorthi, 2017 Experimental Study On Light Weight Concrete Using Leca, International Journal of ChemTech Research CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555 Vol.10 No.8, pp 98-109, 2017

[7] Jos_e Alexandre Bogas*, Jorge de Brito, Jos_e M. Figueiredo, 2015 Mechanical characterization of concrete produced with recycled lightweight expanded clayaggregate concrete , journal homepage:www.elsevier.com/ locate/jclepro

[8] P.Matysek ,2004 Compressive Tests On Masonary Made Of Expanded Clay Aggregate Concrete Units, 13th International Brick and Block Masonry Conference Amsterdam, July 4-7, 2004

[9] Etaveni Madhavi, D. Rahul Naik , Koneti Maheshwari, Addagatla Mahesh Kumar, Choehan Jagadeeshmohan , Bollepally Swathi, 2017 Strength Properties Expandable Clay Aggregates Concrete, Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue- 5, 2017 SSN: 2454-1362, http://www.onlinejournal.in

[10] R.Gopi, V.Revathi, R.Ramya, K.Ramesh, 2015 Saturated Light Expanded Clay Aggregate and Fly Ash Aggregate, As Internal Curing Agents In Self Compacting Concrete, Australian Journal of Basic and Applied Sciences, 9(31) September 2015, Pages: 226-233 ISSN:1991-8178

[11] Vishal Gadgihalli, MeenaY.R , Abrar Khan , Raghavendra Prasad Havanje Dinakar , S. C. Sharma, 2017 Analysis Of Properties Of Concrete Using Expanded Clay Pebbles As Fine Aggregate , [Gadgihalli et. al., Vol.5 (Iss.11): November, 2017] ISSN- 2350- 0530(O), ISSN- 2394-3629(P) DOI: 10.5281/zenodo.1117175

[12] Lena Johansson Westholm, 1998 The use of leca (light expanded clay aggregrates) for the removal of phosphorus from wastewater, Water Science and Technology Volume 35, Issue 5, 1997, Pages 87–93 Wetland Systems for Water Pollution Control 1996

[13] Girts Bumanis, Diana Bajare, Aleksandrs Korjakins, 2013 Mechanical and Thermal Properties of Lightweight Concrete Made from Expanded Glass,*Corresponding author:

girts.bumanis@rtu.lv
http://dx.doi.org/10.5755/j01.sace.2.3.2790

[14] Michal Hora a, Radek Štefan a, Jaroslav Procházka,2013 Temperature Analysis Of Lightweight Aggregate Concrete Slab Members At Elevated Temperatures For Predicting Fire Resistance,

[15] Diana Bajare, Janis Kazjonovs*, Aleksandrs Korjakins,2013 Lightweight Concrete with Aggregates Made by Using Industrial Waste, *Corresponding author :janis.kazjonovs@rtu.lv
http://dx.doi.org/10.5755/j01.sace.4.5.4188*

[16] R. Vijayalakshmi and S. Ramanagopal,2018 Structural Concrete using Expanded Clay Aggregate: A Review, Indian Journal of Science and Technology, Vol 11(16), DOI:10.17485/ijst/2018/v11i16/121888, April 2018

[17] Michala Hubertova, Rudolf Hela, 2013 Durability of Light Weight Expanded Clay Aggregate Concrete, Available online at www.sciencedirect.com

[18] M.shankar, 2016 Experimental Investigation on Self Compacting Concrete Using Light