International Journal of Scientific & Engineering Research, Volume 6, Issue 1, %ÌÉÙÜÈÙà-2015
ISSN 2229-5518

Effect of Styrofoam Balls and Aluminium Oxide on Strength Properties of Cement Motor Cubes

Peerzada Danish, Shahid ul Islam

Abstract—In this study, light weight mortar cubes are prepared by Styrofoam balls and Aluminium oxide. Compressive strength and density of the mortar cubes were determined for 7 days, 14 days, and 28 days. The mixture is produced by replacing Portland cement with Styrofoam balls in the ratio of 0%, 0.5% and 1% by the weight of cement and aluminium oxide in the ratio of 0%, 0.5% and 1% by the weight of cement. Rate of deterioration was higher in normal mortar cubes when compared to light weight mortar cubes. Test results clearly show that there is a decrease in density and slight decrease in compressive strength. As per the test results, the density of the mortar cubes decreases by 40%-50% when compared to the control mix and the compressive strength attained is 15 MPa.

Index Terms— Styrofoam balls, Aluminium oxide, density, compressive strength. Motor Cubes, cement, light weight concrete

---

1 INTRODUCTION

Light weight mortar is a versatile material which consists primarily of a cement based mortar mixed with at least 20% of volume air. The material is now being used in an ever increasing number of applications, ranging from one step house casting to low density void fills. Light weight mortar has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material. There is evidence that the Romans used air entertainers to decrease density. Significant improvements over the past 20 years in production equipment and better quality surfactants has enabled the use of light weight mortar on a larger scale.Lightweight and free flowing, it is a material suitable fora wide range of purposes such as, but not limited to, panels and block production, floor and roofs, wall casting, complete house casting, sound barrier walls, floating homes, void in fills, slope protection, outdoor furniture and many more applications. From the earlier studies it was observed that normal mortar cubes has a density of 2,400 kg/m3 while in light weight mortar cubes densities range from 1,800, 1,700, 1,600 down to 300 kg/m3. This shows that the density can be decreased to a great extent in light weight mortar cubes with a slight decrease in compressive strength.

2 LITERATURE REVIEW

Styrofoam ball is a low density material and it does not absorb much water. When these Styrofoam balls are added to cement mortar cubes, these Styrofoam balls reduce the density of the cubes by replacing a certain quantity of mortar. As the density is reduced by Styrofoam balls there is some decrease in the strength properties of cement mortar cubes. When the proportion of cement in the mix is greater than 50%, even a small dosage of aluminium powder (0.1%) added by mass of cement is effective in reducing the density and compressive strength substantially compared to the control. A further increase in the dosage of aluminium powder to 0.2% by mass of cement causes only a further marginal drop. However, for mixes having 40–50% cement by mass, addition of aluminium powder as low as 0.1% by mass of cement can only cause a marginal drop in density and compressive strength, whereas 0.2% aluminium causes a pronounced drop in the above properties compared to the control. Thus, the dosage of aluminium powder required for causing changes to density and compressive strength of lightweight mixes is related to the cement content of the mix. This can be explained by the fact that the quantity of hydrogen gas evolved to form bubbles in the paste depends on the amount of hydrated lime liberated through hydration of cement[1]. Lightweight mortar is economical, environmentally friendly, cellular, lightweight, structural materials that provide thermal and acoustic insulation as well as fire resistance.

It is an energy-efficient choice for moderate to cold climates where outdoor temperature fluctuates frequently. Aluminium powder has been always used as aerating agent in the manufacturing process of light weight mixes. The reaction between aluminium powder and alkaline content in the mix can generate hydrogen gas which introduces macroporosity in the matrix made of cement, lime, sand and water. Therefore, the IBA with aluminium metal residue might have potential in manufacturing light weight mortar cubes under appropriate treatment. Expansion effects result from IBA is usually thought to be due to the presence of residual aluminium metal in the IBA that reacts with hydroxide ions under high pH conditions to produce hydrogen gas. The formed by this reaction is believed to react with calcium dissolved in the pore water to produce hydrated calcium aluminate phases, and these are normally associated with rapid setting cement systems[5].

3. MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Cement

- ***Peerzada Danish*** *is currently working as Assistant Professor in Lovely Professional Univertsity, Punjab, India E-mail:danishsopore@gmail.com*
- ***Shahid ul Islam*** *is currently working as Assistant Professor in Lovely Professional Univertsity, Punjab, India E-mail: shshidiitr@gmail.com*

International Journal of Scientific & Engineering Research Volume 6, Issue 1ÛÌ%ÌÉÙÜÈÙà-2015
ISSN 2229-5518

Portland cement (often referred to as OPC, from Ordinary Portland Cement) is the most common type of cement in general use around the world because it is a basic ingredient of concrete, mortar, stucco and most non-specialty grout. It is a fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulfate (which controls the set time) and up to 5% minor constituents as allowed by various standards. The cement used in this project was of 53 grade OPC (Zuari).

Table 3.1 Composition of cement (after (Ontoria))

3.1.2 Styrofoam balls

Chemical composition (%)	CaO	68.50
	Al_2O_3	7.00
	SiO_2	12.00
	Fe_2O_3	4.81
	TiO_2	0.18
	SO_2	1.60
	Cr_2O_3	-
	PbO	-
Physical properties	Specific gravity	3.15
	Surface area (m^2/g)	0.352 (Blaine)
Particle size (μm)	10%	3.33
	50%	16.92
	90%	45.48

Styrofoam balls or poly (1-phenylethene-1, 2-diyl)) also known as Thermocole, is an aromatic polymer made from the monomer styrene, a liquid hydrocarbon that is manufactured from petroleum by the chemical industry. Polystyrene is one of the most widely used plastics, the scale being several billion kilograms per year.Polystyrene can either be a thermoset or a thermoplastic. A thermoplastic polystyrene is in a solid (glassy) state at room temperature, but flows if heated above its glass transition temperature of about 100 °C (for moulding or extrusion), and becomes solid again when cooled. Pure solid polystyrene is a colourless, hard plastic with limited flexibility. It can be cast into moulds with fine detail. Polystyrene can be transparent or can be made to take on various colours.

3.1.3 Aluminium oxide Aluminium oxide is an amphoteric oxide with the chemical formula Al O . It is commonly 2 3 referred to as alumina (α-alumina), or corundum in its crystalline form, as well as many other names, reflecting its widespread occurrence in nature and industry. Its most significant use is in the production of aluminium metal, although it is also used as an abrasive owing to its hardness and as a refractory material owing to its high melting point. There is also a cubic γ-alumina with important technical applications.Aluminium hydroxide minerals are the main component of bauxite, the principal ore of aluminium. A mixture of the minerals comprise bauxite ore, including gibbsite (Al(OH)), boehmite (γ-AlO(OH)), and diaspore (α-AlO(OH)), along with impurities of iron oxides and hydroxides, quartz and clay minerals. Bauxites are found in late rites. Bauxite is purified by the Bayer process:

$$Al_2O_3 + 3\,H_2O \rightarrow 2\,Al\,(OH)_3$$

Except for SiO , the other components of bauxite do not dissolve in base. Upon filtering the basic mixture, Fe O is removed. When the Bayer liquor is cooled, Al (OH) precipitates, leaving the silicates in solution. The solid is then calcined (heated strongly) to give aluminium oxide:

$$2\,Al\,(OH)_3 \rightarrow Al_2O_3 + 3\,H_2O$$

3.2 METHODOLOGY

3.2.1 Quantity of materials used based on mix proportion 1:3

Materials	Quantity
Cement(OPC 53 grade)	16200
Sand	48900
Water(30 cubes)	6800
Aluminium oxide(12 cubes)	40.5
Styrofoam balls(12 cubes)	40.5

3.2.2 TEST PROGRAM

Size of the cement mortar mould used was 10x10x10cm. In the first step cement is replaced by aluminium oxide by 0%, 0.5% and 1% by weight of cement. Similarly in the second step cement is replaced by Styrofoam balls by 0%, 0.5% and 1% by weight of cement. Cubes were filled with this mix and compaction was done by using vibrator. Cubes were demould after one day and were left for curing. Testing was done after 7, 14 and 28 days of curing.

4. RESULTS AND DISCUSSION

4.1 Effect of aluminium oxide and Styrofoam balls on strength properties of cement mortar cubes:

Fig 1 shows the values of compressive strength for Styrofoam balls and aluminium oxide at 0.5% by weight of cement. From the figure, it was observed that compressive strength at 0.5% of Styrofoam balls is 9.1 MPa at 28 days and that to for 0.5% aluminium oxide is 14.8 MPa at 28 days.

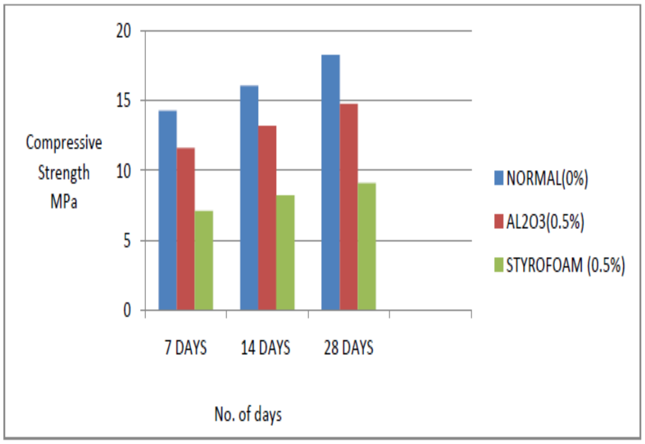

FIG 1: COMPRESSIVE STRENGTH VS TIME PERIOD

Fig 2 shows the values of compressive strength for Styrofoam balls and aluminium oxide at 1% by weight of cement. From the fig it was observed that compressive strength at 1% of Styrofoam balls is 7.2 MPa at 28 days and that to for 1% aluminium oxide is 9.5 MPa at 28 days.

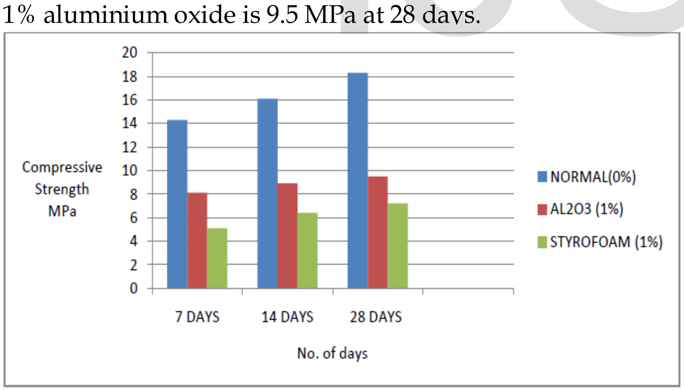

FIG 2: COMPRESSIVE STRENGTH VS TIME PERIOD

4.2 Comparison of densities of normal mix, aluminium oxide and Styrofoam balls:

Fig 3 shows the variation of density with time period for aluminium oxide and Styrofoam balls at 0%, 0.5%, and 1% (by weight of cement). From the test results it was observed that the density of the cement mortar cubes formed by Styrofoam balls is 40-50% less than that of normal mortar cubes and the cement mortar cubes formed by aluminium oxide is 30-40% less than that of normal mortar cubes.

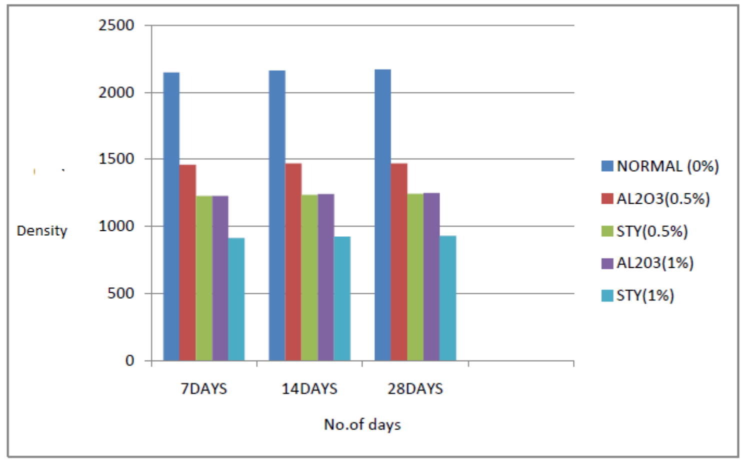

FIG 3: DENSITY VS TIME PERIOD

TABLE 4.1: Results of compressive strength and density for normal mix, aluminium oxide and Styrofoam balls

CUBES	DENSITY(g)			COMPRESSIVE STRENGTH (MPA)		
	7DAYS	14 DAYS	28 DAYS	7 DAYS	14 DAYS	28 DAYS
NORMAL MIX	2147	2161	2170	14.3	16..1	18.3
AL_2O_3 (0.5%)	1460	1469	1470	11.6	13.2	14.8
STY (0.5%)	1226	1234	1242	7.1	8.2	9.1
AL_2O_3 (1%)	1226	1240	1248	8.1	8.9	9.5
STY (1%)	913	923	929	5.1	6.4	7.2

5. CONCLUSIONS:

From the observations of the present study, the following conclusions were made

1. The density of the mortar cubes is reduced by 40 to 50% by addition of Styrofoam balls and aluminium oxide
2. The compressive strength of the mortar cubes is up to 8-15 Mpa by addition of Styrofoam balls and aluminium oxide
3. Cement mortar cubes formed by aluminium oxide gave more strength when compared to the cubes formed by Styrofoam balls.

International Journal of Scientific & Engineering Research Volume 6, Issue l0%ÌÉÙÜÈÙà-2015
ISSN 2229-5518

4. Cement mortar cubes formed by 0.5 % of aluminium oxide gave more strength when compared with the cubes formed by 1% of aluminium oxide, 1%, and 0.5% Styrofoam balls.

5. The density of mortar cubes formed by 1.0% aluminium oxide is less than mortar cubes formed by 0.5% aluminium oxide but the strength is also comparatively lower in the former case.

6. The other main objective is that the replacement of brick by this cement mortar cubes as weight will be less and strength will me much more than brick.

7. Light weight mortar cubes can be applied in architectural wall with high acoustic shielding

REFERENCES

[1] Arvind k Suryavanshi, R.Narayan Swamy (2002) "Development of light weight mixes using ceramic microspheres as fillers"; Cement and Concrete research vol 32, pp 1783-1789.

[2] Castrodale, R. W. and Harmon, K. S (May 2008) “Specifying Lightweight Concrete for Bridges,” Proceedings, 2008 Concrete Bridge Conference, St. Louis, MO, pp 12-14.

[3] M.S. Shetty Concrete Technology -third edition, Lakshmi Publishers

[4] Willowdale, Ontoria(2003)"Performance of hydrated high alumina cement";Cement and Concrete composites vol 21, pp 242

[5] X.C.Qiao, M.Tyrer, C.S.Poon, C.R.Cheeseman (2008) "Production of light weight mortar cubes using incinerator bottom as";Construction and Building Materials vol 22, pp 473-480

[6] Bijen, J. M. J. M., 1986, Manufacturing processes of artificial lightweight aggregates from fly ash, The International Journal of Cement Composites and Lightweight Concrete, 8, pp 191199.

[7] Cheeseman, C. R. and Virdi, G. S., 2005, Properties and microstructure of lightweight aggregate produced from sintered sewage sludge ash, Resources, Conservation and Recycling, 45, pp 1830.

[8] Chi, J. M., Huang, R., Yang, C. C., Yang, J. J., 2003, Effect of aggregate properties on the strength and stiffness of the lightweight concrete, Cement Concrete Composites, 25, pp 197 205.

[9] Garg, S. K., Khalid, M., Verma, C. L., 1995, Production of sintered fly ash lightweight aggregates for concrete building blocks and RCC roofs, Proceedings of the Eleventh National Convention of Chemical Engineers, Departments of Chemical Engineering, University of Roorkee, IV, pp 4044.

[10] Geetha, S., Ramamurthy, K., 2010, Reuse potential of low calcium bottom ashas aggregate through pelletization, Waste Management, 30, pp 1528–1535.

[11] Geetha, S., Ramamurthy, K., 2011, Properties of sintered low calcium bottom ash aggregate with clay binders, Construction and Building Materials, 25, pp 20022013

[12] Amor Ben Fraj, Mohamed Kismi, Pierre Mounanga (2010). Valorization of coarse Rigid 20. Polyurthane Foam Waste in Lightweight Aggregate Concrete. Constr. Build. Mater., 24: 1069-1077.

[13] Behera JP, Nayak BD, Ray HS, Sarangi B (2004). Lightweight Weight Concrete with Sintered Fly ash Aggregate: A Study on Partial Replacement to Normal Granite Aggregate. IE (I) Journal-CV., 85: 84-87.

[14] Bekir Ilker Topcu, Tayfun Uygunoglu (2007). Properties of Autoclaved Lightweight Aggregate Concrete. Build. Environ., 42: 4108-4116.

[15] Bijen JMJM (1986). Manufacturing processes of artificial lightweight aggregates from fly ash. Int. J. Cement Composite. Lightweight concrete. 8(3): 191-9