EXPERIMENTAL STUDY OF NON- AUTOCLAVED LIGHTWEIGHT CONCRETE PREPARED BY BAGASSE ASH

NISHANT KUMAR¹ & SUNEHA DHIMAN²

¹Post Graduate Student, Department of Civil Engineering, Chandigarh University, Mohali, Punjab, 140413, India

²Assistant Professor, Department of Civil Engineering, Chandigarh University, Mohali, Punjab, 140413, India

ABSTRACT

This experimental study is mainly focused on the production of lightweight concrete using bagasse ash as the partial replacement of the cement in the non autoclaved concrete. The dead load of the building also consists of a load of partition walls and normal mortars. Bagasse Ash has a low density which also reduces the weight of concrete. The introduction of bagasse ash makes increment in compressive strength by 10% and split tensile Strength by 10.5%. it also decreases the cost of lightweight concrete by 12%. The prepared concrete has 20 percent more water absorption but 5% lesser dense.

KEYWORDS: Aluminium Powder, Lightweight Concrete, Non-Autoclaved, Bagasse Ash

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INTRODUCTION

The primary structural material utilized in concrete applied for different structure components, both for auxiliary and non-basic, just as for building components. Concrete has a few points of interest, for example, simple to set up, high compressive quality, customizable quality, and locally accessible material. In any case, concrete likewise has a weakness as far as its weight. This is a significant burden when it is applied to tremor inclined regions like Indonesia. Lightweight frothed concrete is an elective structure material to diminish the danger of building harm because of seismic tremor catastrophe. Non autoclaved circulated air through cement (AAC) as a structural material has been mechanically delivered since the start of the twentieth century. It is a type of cement with lightweight, got by consistently dispersed, shut air bubbles. Since AAC ordinarily has one-6th to 33% the thickness of traditional cement, and about a similar proportion of compressive quality, it is valuable for cladding and infills, and forbearing divider segments of low-to-medium-ascent structures. Besides, because its warm conductivity is one-6th or not as much as that of solid, it can give financially savvy structure arrangements when utilized in low-vitality structures. The material has incredible fire rating properties, and its imperviousness to fire is marginally longer than that of traditional cement of a similar thickness. It isn't vulnerable to form development, and as a result of its inner porosity, it has an exceptionally low solid transmission and is acoustically extremely powerful for a material of its weight. Lightweight frothed concrete is made by presenting air through the exclusive froth procedure to control the thickness of the solid. The thickness of frothed solid extents from 300 to 1800 kg/m³, which is fundamentally lower than that of ordinary cement (2400 kg/m³). Impervious to disappointment because of bacterial, creepy crawly and fire harms. Cell concrete (or circulated air through cement or froth concrete) in which air-voids are entangled in the mortar lattice by methods for a reasonable frothing specialist is created from concrete, lime, silica sand, and once in awhile pozzolanic material. In light of the strategy for pore development, it is characterized into three gatherings:

Air-entraining technique (gas concrete – utilizing compound response in glue for gas creation), frothing technique (frothed concrete – bringing air into the glue with including bubble stabilizer) and joined strategy (bringing air into the glue utilizing concoction response and balancing out it with gas stabilizer). Because of the relieving temperature, cell cement can be separated into two gatherings: one that is restored at surrounding or marginally raised temperatures, and the difference comprises precast brickwork items that are non autoclaved at a temperature fundamentally higher than 100 C in a pressurized and steam warmed condition. The pore framework in the concrete-based material is routinely delegated gel pores, slender pores, and macropores because of intentionally entrained air, and macropores because of lacking compaction. Contrasted with gel pores, fine pores and other huge pores are liable for any decrease in the quality. The kind of pores can be recognized by examination techniques, for example, nitrogen gas assimilation, mercury porosimetry, optical microscopy with picture handling and X-beam registered tomography with picture preparation. The pore arrangement of autoclaved circulated air through cement is delegated (i) fake air pores, intercluster and interparticle pores, (ii) macropores framed because of the development of the mass brought about by air circulation and micropores which show up in the dividers between the macropores and (iii) smaller scale vessels (50 nm to 50 μ m) and counterfeit air pores (>50 μ m)). Circulated air through cement is generally comprised of lime, concrete, gypsum, and sand (or pozzolanic materials) with hints of aluminum powder as a pore-shaping specialist. The aluminum responds with lime, which discharges hydrogen gas and structures a lot of little air pockets conveyed consistently in the framework [9,10]. After the set, all in all, circulated air through cement was cut into exact dimensional units and afterward restored in an autoclave where the best fix pressure is 1.0–1.2 MPa for 5–8 h. Contrasted and the conventional autoclaved circulated air through cement (AAC), non-autoclaved circulated air through cement (NAAC) has a considerable bit of leeway in encouraging the assembling procedure and diminishing the expense of items. During the NAAC creation, steam restoring was directed lower than 100 C for 8–24 h in the wake of being cut. Along these lines, the NAAC has the element of security in the item process with low vitality utilization contrasted and AAC. In most worldwide markets, AAC is fabricated and showcased as a brickwork unit. It can frequently be utilized to substitute different types of stonework material, but since the material is solid, yet lightweight, it is regularly utilized in a thickness that is a lot more noteworthy than for different materials. Also, AAC can be utilized to make daintily fortified story stature components or all the more intensely strengthened components for floorboards, rooftop boards, divider boards, lintels, pillars, and other exceptional shapes. These components can be utilized in an assortment of utilizations, including private, business, and modern development. Strengthened divider boards can be utilized as cladding frameworks just as burden-bearing and non-load-bearing outside and inside divider frameworks. Fortified floor and rooftop boards can be effectively used to give the flat stomach framework while supporting the important gravity loads. One of the key properties of AAC fabricate is the adaptability in the process as far as item attributes and item sizes. Therefore, there are numerous conceivable various organizations in which the items can be produced.

METHODOLOGY

For the study of lightweight concrete, the various proportions of sand and cement with a water-cement ratio of 0.55 is taken for the considerations. And results are derived on the basis of compressive strength, split tensile strength, water absorption, and cost per cubic meter

Table 1:Content of Light Weight Concrete with Different Proportions of Cement and Sand

Mix Designation	Ratio of Cement and Sand	Water Cement Ratio	Cement Kg/m ³	Sand Kg/m ³	Water Kg/m ³
N1	1:1	0.55	625.000	625.000	343.750
N2	1:2	0.55	416.667	833.333	229.167
N3	1:3	0.55	312.500	937.500	171.875
N4	1:4	0.55	250.000	1000.000	137.500
N5	1:5	0.55	208.333	1041.667	114.583
N6	1:6	0.55	178.571	1071.429	98.214
N7	2:1	0.55	833.333	416.667	458.333
N8	2:3	0.55	500.000	750.000	275.000
N9	2:5	0.55	357.143	892.857	196.429

After selecting the proper ratio, the mix was tested with the water-cement ratio of 0.45, 0.5, 0.6, and 0.65. because lightweight concrete needs more water to react with the aluminum to initiate the aeration process

Table 2: Content of Light Weight Concrete with Different Water Cement Ratios

Mix Designation	Ratio of Cement and Sand	Water Cement Ratio	Cement Kg/m ³	Sand Kg/m ³	Water Kg/m ³
N3	1:3	0.55	312.500	937.500	171.875
N10	1:3	0.45	312.500	937.500	140.625
N11	1:3	0.5	312.500	937.500	156.250
N12	1:3	0.6	312.500	937.500	187.500
N13	1:3	0.65	312.500	937.500	203.125

For non-autoclaved aerated concrete, the design mix quantities should be reduced to 60%, and the dosage of alumina powder is to be tested. The dosage of alumina powder is 0.1%, 0.2%, 0.3% and 0.4%. alumina powder on reaction with water produces air which helps to produce aerated concrete when mixed with water. So the different addition of alumina is tested.

Table 3: Content of Light Weight Concrete with Different Dosage of Alumina Powder

Mix Designation	The Ratio of Cement and Sand	Water Cement Ratio	Cement	Sand	Water	Aluminum Dosage	
			Kg/m ³	Kg/m ³	Kg/m ³		Kg/m ³
N3A0	1:3	0.55	187.500	562.500	103.125	0	0
N3A1	1:3	0.55	187.500	562.500	103.125	0.10%	0.187
N3A2	1:3	0.55	187.500	562.500	103.125	0.20%	0.374
N3A3	1:3	0.55	187.500	562.500	103.125	0.30%	0.561
N3A4	1:3	0.55	187.500	562.500	103.125	0.40%	0.748

As per the experimental study the bagasse ash to be introduced in the composite mix hence it contents pozzolanic properties it will help reduce environmental waste and emission of CO₂ from the concrete.

Table 4: Content of Light Weight Concrete with Different Proportions of Bagasse Ash

Mix designation	Ratio of cement and sand	Water cement ratio	Cement	Sand	Water	Bagasse ash	
			Kg/m ³	Kg/m ³	Kg/m ³	%	Kg/m ³
N3A3	1:3	0.55	187.500	562.500	103.125	0	0.000
N3B4	1:3	0.55	180.000	562.500	103.125	4	7.500
N3B8	1:3	0.55	172.500	562.500	103.125	8	15.000
N3B12	1:3	0.55	165.000	562.500	103.125	12	22.500
N3B16	1:3	0.55	157.500	562.500	103.125	16	30.000
N3B20	1:3	0.55	150.000	562.500	103.125	20	37.500
N3B24	1:3	0.55	140.625	562.500	103.125	24	46.875

Figure 1: Dry Mix of Light Weight Concrete.

RESULTS

Table 5: Results of Light Weight Concrete with Different Proportions of Cement and Sand

Mix Designation	Ratio of Cement and Sand	Compressive Strength	Split Tensile Strength	Water Absorption	Cost	Density
N1	1:1	4.740	1.524	190	5937.5	1406
N2	1:2	4.400	1.468	210	4583.3	1476
N3	1:3	4.000	1.400	225	3906.3	1525
N4	1:4	3.500	1.310	235	3500.0	1570
N5	1:5	2.900	1.192	247	3229.2	1593
N6	1:6	2.400	1.084	263	3035.7	1608
N7	2:1	5.200	1.596	150	7291.7	1650
N8	2:3	4.500	1.485	202	5125.0	1450
N9	2:5	4.250	1.443	217	4196.4	1500

In the experimental study of various ratios, 1:3 is found to be very effective in terms of strength, cost, density, and water absorption. The ratio 1:1, 1:2, 2:1 and 2:3 have higher cement content which has two problems, first is the heat of hydration as the higher the cement content higher will be the heat of hydration. Second economy higher cement content is not an economic friendly. As the cement content increases the density of concrete increases. As the cement content increases the pores in the concrete fills which increase the strength of concrete but decreases the water absorption.

Figure 2: Strength Chart for Aerated Concrete.

Figure 3: Water Absorption and Density for Aerated Mix.

Figure 4: Cost Analysis for Aerated Mix.

Table 6: Results of Light Weight Concrete with Different Water-Cement Ratios

Mix Designation	Water Cement Ratio	Compressive Strength	Split Tensile Strength	Water Absorption	Cost	Density
		N/m ²	N/m ²			Kg/m ³
N3W0	0.55	4.0	1.400	225	3906.3	1525
N3W1	0.45	3.5	1.310	235	3906.3	1523
N3W2	0.5	3.7	1.346	230	3906.3	1520
N3W3	0.6	3.9	1.382	225	3906.3	1532
N3W4	0.65	3.8	1.365	217	3906.3	1538

The experiment shows that at w/c ratio 0.55 gives optimum results in terms of strength. As the water content in concrete increases, the water demand negligibly changes due to less formation of the heat of hydration and cement paste with extra water fills the pores in the concrete so it also absorbs less water means changing the water content does not affect the water absorption of concrete. But the water content makes a negligible effect on the density of concrete.

Figure 5: Strength Chart for Aerated Concrete with different Water Cement Ratios.

Figure 6: Water Absorption and Density Chart of Different w/c Ratio.

Table 7: Results of Light Weight Concrete with Different Dosage of Alumina Powder

Mix Designation	Alumina Powder Dosage	Water Cement Ratio	Dry Volume of Material Taken	Volume After B24 hrs	Increase in Cost due to Alumina Powder
N3A0	0	0.55	60%	60%	0
N3A1	0.10%	0.55	60%	75%	140.25
N3A2	0.20%	0.55	60%	92%	280.5
N3A3	0.30%	0.55	60%	102%	420.75
N3A4	0.40%	0.55	60%	120%	561

Figure 7: Mix MN3A4 with 120% Casting Volume.

Figure 8: Mix NM3A0 with 100% Casting Volume.

Alumina powder on reaction with water forms air bubbles which create pores in the concrete so different proportions are tried to check the exact dosage of the alumina powder for the formation of lightweight concrete.

Table 8: Results of Light Weight Concrete with Different Proportions of Bagasse Ash

Mix designation	Ratio of cement and sand	Water Cement Ratio	Compressive Strength	Split Tensile Strength	Water Absorption	Cost (Excluding the cost of alumina powder which is 750 rs per kg)	Density
			N/m ²	N/m ²	Kg/m ³	RS (main+Al Cost)	Kg/m ³
N3A3	1:3	0.55	3.2	1.400	225	2343.8+420	1290
N3B4	1:3	0.55	3.3	1.435	230	2283.8+420	1281
N3B8	1:3	0.55	3.8	1.501	245	2223.8+420	1250
N3B12	1:3	0.55	4.1	1.534	263	2163.8+420	1235
N3B16	1:3	0.55	4.3	1.550	270	2103.8+420	1220
N3B20	1:3	0.55	3.7	1.501	290	2043.8+420	1150
N3B24	1:3	0.55	3.6	1.382	350	1968.8+420	1050

An increase in bagasse ash content increases the strength parameters due to its pozzolanic actions but it also increases the water absorption capacity of concrete because bagasse ash is water-binding ash and it easily absorbs water. Use of bagasse ash can decrease the density of concrete i.e. reduction in weight and use of bagasse ash can result in the reduction in cost also.

Figure 9: Strength Chart for Aerated Concrete with Varying Bagasse Ash Content.

Figure 10: Water Absorption and Density Chart of Different Bagasse Ash Content.

CONCLUSIONS

- Bagasse ash can be easily replaced cement up to 16% due to its pozzolanic action
- For the particular ratio, bagasse ash can reduce the cost of lightweight concrete up to 12%.
- Bagasse ash also reduces the weight of concrete up to 6%
- An increase in the strength due to bagasse ash can be seen up to 30%.
- Due to the use of bagasse ash water absorption of concrete increases up to 18%.

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