# AERATED CONCRETE INCORPORATING QUARRY DUST

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**Abstract -** *The use of LWC (Lightweight concrete) has been a feature in the construction industry for centuries, but like other materials the expectations of the performance have raised and now we are expecting a consistent, reliable material and predictable characteristics. The use of aluminum powder to make aerated concrete seems to be a viable option. In this study an investigation is done to reduce the density without significantly reduce compressive strength. Recycled aggregates such as quarry dust can be used as a replacement to sand, further reducing the cost and environmental impact. This mix is to be made into a concrete block of target strength within the range of 5- 10 MPa with minimum density, i.e.: develop light weight masonry blocks.*

***Key Words*: Aluminum Powder, Fly Ash, Quarry Dust, Aerated Concrete**

## 1. INTRODUCTION

Light weight concrete is an important and versatile material in modern construction. Light weight concrete has strengths comparable to normal weight concrete yet is typically 25% to 35% lighter. Structural lightweight concrete offers design flexibility and substantial cost savings by providing: less dead load, improved seismic structural response, longer spans, better fire ratings, thinner sections, decreased storey height, smaller size structural members, less reinforcing steel, and lower foundation costs. E.K. KunhanandanNambiaret.al. (2006) [3] Study the influence of filler type (i.e., sand and fly ash) and the particle size of sand on the properties of moist cured foam concrete. Kunhanandan Nambiar et.al. (2007) [4] found that volume, size and spacing of air voids have influence on strength and density. Narayanan et al(2000 )[7]investigations on the properties of aerated concrete in terms of physical (microstructure, density), chemical, mechanical (compressive and tensile strengths, modulus of elasticity, drying shrinkage) and functional (thermal insulation, moisture transport, durability, fire resistance and acoustic insulation) characteristics. Narayanan et al (2000) [8] studied the influence of composition on the drying shrinkage of non-autoclaved and autoclaved aerated concrete. Muthu Kumar et al (2015)[5]studied on the effect of fineness and dosage of aluminum powder on the properties of moist-cured aerated concrete. Ali. J. Hamad (2014) [2] investigated the materials, production, properties and application of aerated lightweight concrete and classified of aerated lightweight concrete into foamed concrete and autoclaved concrete. Rostislav Drochytka et al (2015) [9] studied on the development of microstructure and changes in compressive strength, density and coefficient of thermal conductivity of the fly ash aerated concrete in time. Siong Kang Limet.al. (2017), [10] investigates the feasible utilization of quarry dust as an alternative to river sand in the production of lightweight foamed concrete and found that the use of high volume quarry dust could reduce the fluidity and increase the compressive strength. A.Sivakumar and Prakash.M (2011),[1] investigated the hardened and durable properties of concrete using quarry dust. G.Balamuruganand, Dr.P.Perumal(2013),[6]replaced sand by quarry dust in steps of 10% and found that maximum compressive strength is obtained at 50% replacement. Lohani T.K et.al. (2012) [11] states that replacement of sand with quarry dust is an economic alternative.

### 1.1 Aerated Concrete

The usual methods of aeration are by mixing in stabilized foam or by whipping air in with the aid of an air entraining agent. The precast products are usually made by the addition of aluminum powder to the mix which reacts with alkaline substances in the binder forming hydrogen bubbles. Air-cured aerated concrete is used where little strength is required. Full strength development depends upon the reaction of lime with the siliceous aggregates, and for the equal densities the strength of high pressure steam cured concrete is about twice that of air-cured concrete, and shrinkage is only one third or less. It is made by either a physical or a chemical process during which either air or gas is introduced into a slurry, which generally contains no coarse material. Aerated concrete used as a structural material is usually high-pressure steam-cured

### 1.2 Advantages of Using LWC

Reduced dead load of wet concrete allows longer span to be poured unpropped. This saved both labor and circle time for each floor. Reduction of dead load, faster building rates and lower haulage and handling costs is another advantage. Another important characteristic of LWC is its relatively low thermal conductivity, a property which improves with decreasing density in recent years, with the increasing cost and scarcity of energy sources, more attention has been given the formerly to the need for reducing fuel consumption while maintaining, and indeed improving, comfort conditions buildings

## 2. MATERIALS USED

The cement used for this project work is Ordinary Portland Cement of 53 grade. The fine aggregate to be used in the study is quarry dust. For the production of light weight concrete, sieved sand (600μm) is used and for the production of the aerated light weight mortar mix. Class F fly ash i s preferred for the study. Aluminum powder provides the porous properties that are required to create a lightweight concrete. The Aluminum powder used for the study is manufactured by NICE CHEMICALS Pvt Ltd, Kerala. The recommended super plasticizer is MasterGlenium SKY 8233

## 3. EXPERIMENTAL PROGRAM

### 3.1. Fresh Concrete

The spread test gives the quick assessment of the fluidity of high slump concrete mixes. Equipment for the spread test comprises of a suitable base, a standard slump cone, metal scoop and a metric rule. The base should be clean, flat, smooth surfaced, and rigid and non-absorbent with a lateral dimension of not less than 600mm. It should be level and free from vibration during the test. Here a leveled ceramic tile is used as a base surface. Standard slump apparatus, a mini slump cone mould was used.

### 3.2. Hardened Concrete

As per IS: 516-1959 ,70.7mm × 70.7mm × 70.7mm moulds were used to cast mortar cubes to determine the compressive strength of concrete. The tests to be conducted include compressive strength test at 7 and 28 days of curing

For finding compressive strength place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Apply the load gradually without shock and continuously at the specified rate till the specimen fails. Record the maximum load and note any unusual features in the type of failure.

wet densities and dry densities of each mix containing different proportions of aluminum powder was found out and compared. The wet density is found out by weighing each mould filled with the mortar mix and dividing the value by the volume of mould. The cube specimens shall be dried to constant mass and then cured for 7 days and 28 days. The overall volume is computed in cubic meters. The blocks shall then be weighted in kilograms to the nearest 10gm.Thus dry densities is found out by weighing the dried cube specimens and the same is repeated at 7 and 28 days of curing of mortar cubes

## 4. RESULTS AND DISCUSSIONS

### 4.1. Percentage Variation of Aluminum Powder for Cement-Fly Ash Paste (W-C Ratio 0.45)

In this step optimum percentage aluminum content at lowest percentage rate i.e.: 0.5%, 1%, 1.5% to get reasonable compressive strength with minimum density, keeping Fly Ash at 20 %( As per IS: 2185(Part 3)-1984 the maximum permissible limit of fly ash in cement is 20 %.), w/c at 0.45

**Table -1:** $7^{th}$ and $28^{th}$ day densities of Specimens with Various % of aluminum powder

| Al powder (%) | $7^{th}$ day density | $28^{th}$ day density |
|---|---|---|
| **0.5** | 913.06 | 1001.72 |
| **1** | 594.23 | 687.62 |
| **1.5** | 460.28 | 500.86 |

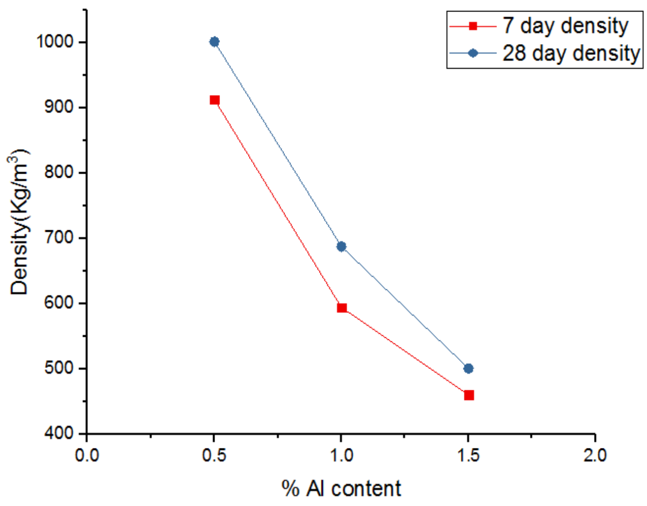


**Chart -1**: $7^{th}$ and $28^{th}$ day densities of Specimens with Various % of aluminium powder

As the percentage of aluminum powder addition increases the weight of concrete also get decreased. 1% and 1.5% cubes float on water

As the various percentage of aluminum powder for cement fly ash paste increases, the compressive strength of concrete decreases. Maximum compressive strength is at 0.5% aluminum content and its value is above 5MPa (6.7MPa) with low density (1001.72 Kg/m$^3$). So, the optimum aluminum content suitable for light weight masonry block is 0.5%

**Table -2:** Compressive strength of various percentage of aluminum powder

| Al powder (%) | $7^{th}$ day strength(MPa) | $28^{th}$ day strength(MPa) |
|---|---|---|
| **0.5** | 4.4 | 6.7 |
| **1** | 1.12 | 1.4 |
| **1.5** | 1 | 1.1 |

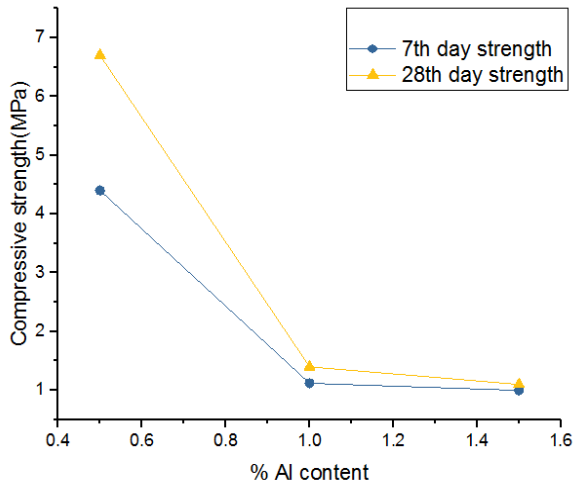


**Chart-2**: Compressive strength of various percentage of Al

### 4.2. OPTIMIZATION OF QUARRY DUST: BINDER KEEPING FLYASH 20% WITHOUT M. SAND

Taking aluminum powder content as 0.5% and specimens are casted with different ratio of quarry dust: binder , keeping Fly Ash at 20% ,w/c at 0.45

**Table -3:** 7th and 28th day densities of Specimens with Various Proportion of Quarry dust: Binder

| Binder: Quarry dust | 7th day density(Kg/m³) | 28th day density(Kg/m³) |
|---|---|---|
| **1:0.25** | 1085.54 | 1109.703 |
| **1:0.50** | 1246.107 | 1270.262 |
| **1:0.75** | 1251.79 | 1312.88 |
| **1:1** | 1263.157 | 1398.14 |

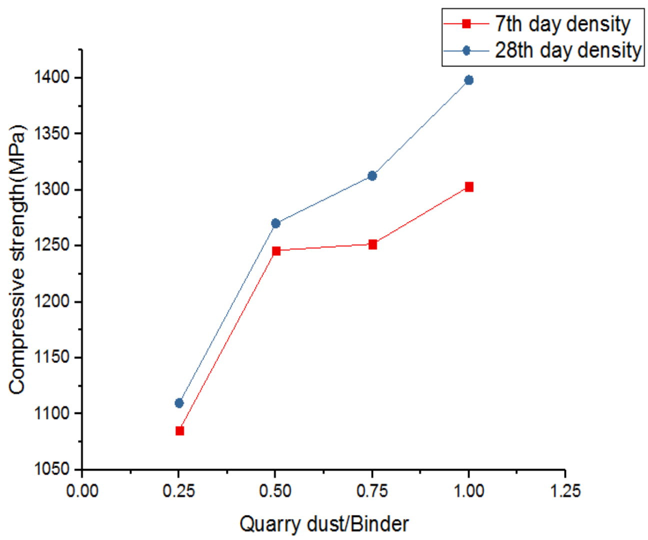


**Chart -3**:7th and 28th day densities of Specimens with Various Proportion of Quarry dust: Binder

It is noticed that, with various Proportion of Binder : Quarry dust at constant Fly Ash and aluminum powder percentage, there is a variation in density. As the percentage of quarry dust increases, the density of concrete increases.

7th and 28th day compressive strength obtained for Fly Ash at 20%, w/c at 0.45 and aluminum at 0.5% with various proportions of binder: quarry dust is as shown

**Table -4:** Compressive strength of various proportion of binder: quarry dust

| Binder: Quarry dust | 7th day strength(MPa) | 28th day strength(MPa) |
|---|---|---|
| **1:0.25** | 3.54 | 4.625 |
| **1:0.50** | 4.625 | 6.068 |
| **1:0.75** | 4.034 | 5.252 |
| **1:1** | 3.149 | 4.133 |

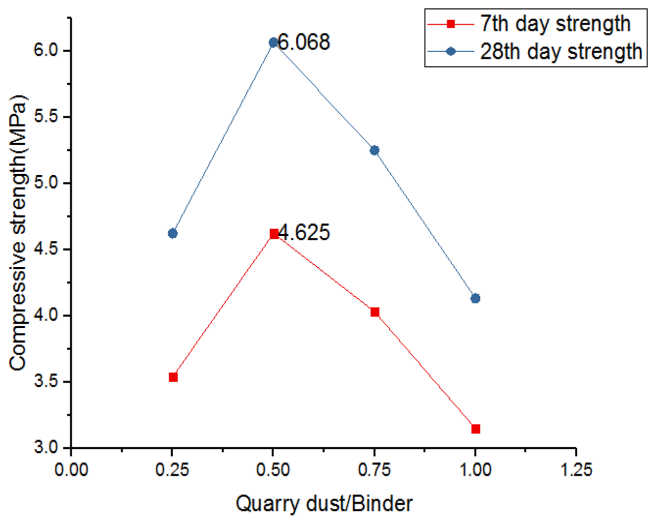


**Chart -4**:Compressive strength of various proportions of binder: quarry dust

As the Various Proportion of Binder: Quarry dust increases, the compressive strength of concrete increases and then decreases. Maximum compressive strength at 1:0.5 binder : quarry dust ratio.

## 3. CONCLUSION

The optimum percentages of aluminum powder and binder : quarry dust ratio were obtained separately for lightweight masonry block. It is to be noted that the optimum percentages were based on factors such as compressive strength and density. It is seen that optimum aluminum content, which is suitable for lightweight masonry block is 0.5%. Target strength and density for light weight masonry block was obtained at cement: quarry dust ratio of 1:0.5

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