International Research Journal of Engineering and Technology (IRJET) **e-ISSN: 2395-0056**
Volume: 10 Issue: 03 | Mar 2023 **www.irjet.net** **p-ISSN: 2395-0072**

PERFORMANCE OF LIGHT WEIGHT AGGREGATE CONCRETE- A REVIEW

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Abstract - *The main constituents of concrete are cement, aggregates, and water. The need for concrete increases as infrastructure expands. A rise in demand for concrete's constituents has resulted from the continued expansion of its use. One of the most mined materials in the world is coarse aggregate. Total demand has reached an all-time high due to rising building and urbanisation. This necessitates a global increase in the number of quarries. This illness is highly detrimental to the environment. Moreover, it has expedited the depletion of our natural resources. In an effort to decrease environmental damage and the depletion of natural resources, researchers are investigating viable substitutes for regularly used combinations. Environmental conservation, including waste reduction and the judicious use of natural resources, was a top focus for construction and building materials. By blending different types of waste, new materials, such as eco-concrete, specialty concrete, etc., have been produced. In nontraditional concretes, fly ash, crushed granulated blast furnace slag, silica fume, building demolition debris, plastics, and glass were utilised in place of cement or aggregates. Furthermore, wastes can be utilised to generate lightweight concretes. In this article, a variety of studies conducted by researchers to develop lightweight concrete by employing a variety of feasible light weight aggregates are addressed..*

Key Words: light weight concrete, fly ash, eco concrete, industrial waste materials

1.INTRODUCTION

Concrete is among the most extensively employed building materials in the world. The qualities of concrete are altering as a result of technical advancements, material substitution, and the development of the building industry. The world of concrete technology has progressed greatly to accommodate special criteria. The traditional method of manufacturing standard concrete consisted of only four components: cement, water, coarse and fine aggregates. A significant and adaptable material, structural lightweight aggregate concrete is expected to take centre stage in the new millennium owing to its numerous technological, financial, and environmental advantages. It is used in a broad variety of structures, including as multi-story building frames and floors, curtain walls, shell roofs, folding plates, bridges, and various prestressed and pre-cast parts. Because earthquake forces will be proportional to the mass of civil engineering structures and buildings, structural lightweight aggregate concrete is frequently utilised to minimise a structure's dead weight as well as the danger of earthquake damage to a structure. In order to diminish the likelihood of an earthquake's acceleration, a structure or building must minimize its mass. Moreover, lowering the dead weight of a building may cause the cross-section of its foundation, beams, plates, and columns to be smaller. A greater strength/weight ratio, stronger tensile strain capacity, a lower coefficient of thermal expansion, and good heat and sound isolation qualities are all benefits of structural lightweight aggregate concrete because of the air gaps in the lightweight aggregates.

1.1 Light weight concrete (LWC)

A form of concrete known as "lightweight concrete" is one that contains an expanding agent, which increases the mixture's volume while enhancing its strength and reducing its dead weight. The development of Light Weight Concrete (LWC) in concrete technology is quite recent. It is not a novel building material, but it was created in Sweden in the 1920s as a result of the expanding need for timber supply. For more than 70 years in Europe, 40 years in the Middle East, and around 20 years in South America and Australia, the LWC has been employed in a range of commercial, industrial, and residential applications. Manufacturing claims that LWC currently makes up more than 40% of all building in the UK and more than 60% in Germany. It is lighter than standard concrete and has a dry density ranging from 300 kg/m3 to 1850 kg/m^3.

LWC is often created either by adding chemicals that create air voids in the cured concrete or by utilising natural or synthetic lightweight aggregates **[Cheng et al., 2012]**. However, in the past, natural or man-made aggregates were used to make lightweight concrete for structural applications **[Felicetti et al., 2013; Yang et al., 2012]**

The construction industry tends to favor lightweight concrete (LWC) over normal weight concrete (NWC) because of LWC's many benefits, such as NWC's relatively higher thermal conductivity and LWC's lower costs in these areas: transportation costs, lifting equipment costs, and self-weight **[Abdelrahman et al. 1993, Ahmad and Hadhrami 2009].**

1.2 Advantages of light weight concrete

As comparison to steel, the low strength-to-weight ratio of normal-weight concrete is one of the material's most significant drawbacks. This problem of concrete can be alleviated proportionally by the production of lightweight concrete, especially lightweight concrete with a high strength. Structural lightweight concrete is classified as a unique form of concrete **[Kostmatka et al., 2002]**

PROPERTIES OF LIGHT WEIGHT CONCRETE

Zhao et al [2012] have investigated the influence of initial water curing on the compressive strength of light weight aggregate (self-compacting) concrete. They showed that specimens subjected to air drying exhibited greater compressive strength at 28 days than those subjected to wet curing. In addition, they determined that 7-day initial water curing and subsequent room exposure are more advantageous for the development of compressive strength in self-compacting concrete than 3, 14, and 28-day initial water curing.

Twenty-one distinct forms of artificial aggregates were produced from industrial by-products by **[Shaiksha vali et al. 2020]**, with the inclusion of glass fibres and a pelletization period of 17 minutes, coupled with a water content of 28%.After being made, the fresh pellets were let to air dry for 24 hours before the aggregates were hardened using a cold-bonding procedure (Water Curing) at room temperature for 28 days. According to the research, 12mm F21 aggregate has the greatest individual aggregate compressive strength at 48.1MPa. The F16 aggregate has the worst impact strength, at only 13%. Similarly, F14 aggregate had the lowest water absorption at 16.3%. It has been recognised that the interaction of binders with fibres during aggregate production is crucial to the production of artificial aggregates with high strength. Coarse aggregates for structural concrete may be produced using the pelletization procedures developed by **Rajamane et al. (2004)** using fly ash. Also, the group of specialists calculated the aggregate's bulk density, relative density, water permeability, and crushing value. When made using bonded fly ash coarse aggregate, this concrete has a considerable slump, is relatively light, and satisfies the requirements of IS 456-2000 for structural grade minimum concrete. A battery of tests, including permeability to water and chloride, as well as a high rate of water absorption, demonstrate the material's remarkable resilience.

The effects of utilizing varied coarse aggregates were studied by **Kayali O. (2008).** Granite, dacite, commercially available pelletized fly ash aggregates (SP), and synthetic fly ash aggregates fabricated from fly ash were all used as coarse aggregates in the study (FAA). Using the aforementioned coarse particles, four unique concrete mixtures were produced. Concrete made using industrial fly ash pellets (SP concrete) and concrete made with synthetic fly ash aggregates (FAA concrete) were given different names.

Using a slump cone, the quality of all four concrete recipes was evaluated. Slump in concrete made with SP and FAA was much higher than in concrete made with granite aggregates. There was a noticeable drop in concrete density to the use of fly ash aggregates. The consequence was that both SP and FAA concrete were less dense than regular concrete.

Priyadharshini et al. (2011) developed artificial coarse aggregates by partially replacing fly ash and cement for natural coarse aggregates. The pelltization process is used to recover the natural resources of artificial aggregates from room-temperature-dried, fresh aggregates. The curing was completed utilising a cold-bonded technique that will be used as an aggregate additive in concrete. Nonetheless, it meets the minimal requirements for structural lightweight concrete while having 48% less compressive strength than ordinary concrete. Crushed fly ash aggregates with a rounded shape were easier to manipulate than crushed aggregates with sharp angles. It was determined that fly ash concrete is 15% less dense than conventional concrete.

Geetha, et al (2011) studied the characteristics of fly-ash sintered aggregates. To enhance the properties of these aggregates, a variety of clay binders were used. In order to enhance the characteristics of the aggregates, the dose of the binder and the sintering temperature were increased. Kaolinite & metakaolin binders resulted in a greater than 10% fine aggregate. It was found that the characteristics of aggregate depend greatly on the binder type.

Yaşar et al. (2003) studied lightweight structural ideas. Concrete benefiting from the use of basaltic pumice the second objective is to build a structure that is more cost-effective. After the addition of fly ash, the SLWC mixture become greener. The density of the projected quantity of Portland cement was 500 kg/m^3. The fly ash SLWC mixture was made by substituting 20% of the Portland cement with fly ash. 1860 kg/m3 was the weight of the atmospheric dry unit. In addition, it contains 28 MPa and 29 MPa, respectively. 3.4 mpa. They indicated that SLWC with a cylinder must use a lightweight aggregate to attain 25 MPa compressive strength. Using fly ash enables for the creation of cost-effective SLWC over time.

Ramadan et al. (2007) created a lightweight tetrapod aggregate from calcium-rich fly ash, which exhibited low weight, strength, high penetration, and interlocking properties. In addition, the physico-mechanical properties of the created normal fly ash aggregate were determined. It was also determined that increasing the amount of lime improved the mixture's performance.

The features of fly ash aggregates suitable for use as coarse aggregates were examined by **Nadesan and Dinakar (2017**). The following conclusions were reached as a result of their review: Noting that the fineness of the fly ash has a considerable effect on the aggregate's physical properties is important. The aggregates of fly ash exhibited a spherical shape and a specific gravity ranging from 1.33 to 2.35. The permeability and chloride penetration of fly ash aggregates are lower than those of conventional aggregates. In terms of corrosion resistance, concrete with fly ash aggregate beat conventional concrete.

Vasugi and Ramamurthy (2014) produced coal pond ash aggregates using two different types of binder. As binder and $Ca(OH)_2$ doses were raised, the efficiency of palletisation improved. By increasing binder kaolinite/local clay and 5–12 bentonite and a sintering temperature of 900–1100 Celsius , bulk density and 10% fines value rose. The TPFV of clay aggregate was much more than that of bentonite, which was 4.5 tonnes. It was ideal for large-pond ash ingestion, with an up to 88 percent consumption rate. Sintering improves pore structure and binder binding capabilities, hence enhancing the aggregate strength of sintered pond ash. By increasing the quantity of binder and borax, open porosity and water absorption were decreased. The bituminous pond ash aggregate was denser and more durable.

The two classes of F fly ash aggregate was explored by **Acar et al (2013)**. Both the sintering temperature and time were played about with. Bulk, water permeability, shrinkage, and elastic modulus were used as indicators of sintering effectiveness. Microstructural and phase changes caused by sintering were also analysed by scanning electron microscopy (SEM) and x-ray diffraction (XRD). Fly ash is favoured because of its superior microcrystalline structure, higher density and strength, and lower porosity, water permeability, and drying shrinkage values.

Anja Terzic, et al (2015) developed four different variants of LWA. Mechanical activated or non-activated reduced fly ash and water glass pellets joined and sintered in cold. Strength of concrete, flexural strength, permeability, shrinkage, and young's modulus tests were used to compare the lightweight concrete's performance to that of conventional concrete. This LWC had behaviour similar to ordinary concrete.

Zhang and Poon (2015) conducted a thorough analysis of the characteristics of lightweight aggregate concrete. In order to achieve the desired 28-day compressive strength of 30 MPa, six different concrete mixtures were developed: a control mix using only normal-weight aggregates and a w/c of 0.6, and five light-weight aggregate concrete mixes using either zero, 25%, 50%, 75%, or 100% Furnace Bottom Ash (FBA) in place of natural fine aggregate, all at a w/c of 0.39. A 28-day oven-dried density of about 1500 kg/m^3 was attained for the light weight aggregate concrete employing 100% FBA to substitute crushed fine stone, as shown by the results of the hardened concrete characteristics testing. As can be seen from the results of the tests, the light weight aggregate concrete is weaker and less rigid than the conventional aggregate concrete. The heat insulation property test showed that the thermal conductivity could be reduced to around 70% of the control by employing the porous lightweight aggregate.

Muthusamy et al. (2015) looked into the effect of varying levels of ash replacement on the compressive strength of oil palm shell light weight mixed concrete by adjusting variables such as the water-cement ratio, super plasticizer, sand content, and cement content. At this early stage of the study, ash with varying levels of replacement were created and evaluated for their compressive strength. After that, experiments were conducted with 20% POFA substitution, since this amount yields the maximum compressive strength result. Experiments were carried out with two distinct mixes to determine the impact of varying the water percentage, super plasticizer percentage, sand percentage, and cement quantity. Cubes of concrete made from plain oil palm shell light weight aggregate (0% Palm Oil Fuel Ash; POFA) were made as a control, and cubes of concrete made from oil palm shell light weight aggregate containing 20% POFA; POFA were also made. All samples were cured in water until the day of testing.

Physical and mechanical features of high-strength, light-weight aggregate concrete made using expanded clay aggregate were tested by **Serkan Subasi (2009).** There was a significant increase in strength when employing a cement concentration of 450 Kg/m^3 among concrete mixes, and the mechanical qualities may be improved by adding 10% fly ash. It may be possible to reduce the cement load and thus the cement expenditure.

Josef Hadi Pramana et al. (2010) found that light weight concrete can be used as a coarse aggregate instead of regular concrete. Energy may be absorbed by using either aerated concrete or lightweight aggregate concrete. Depending on the materials employed, aerated concrete's homogenised microstructure of its aerated component and air space entrapment in cement contribute to its effective energy absorption. To mitigate localised damage from ballistic loading, lightweight aggregate concrete is strengthened. Lighter concrete has higher impact resistance than regular concrete because of its lower modulus of elasticity and higher tensile strain capacity.

Rajamane et al. (2006) have reported the specifics of an experiment into the usage of fly ash-based lightweight aggregate as coarse aggregate in polymer concrete using sand fly ash and polyester resin as additional components. They found that the ratio of tensile strength to compressive strength for such polymer concrete was significantly higher than that of traditional concrete, and that the density of polymer concrete was reduced when lightweight aggregate was incorporated.

Kockalan and Ozturan (2010) investigated the impact of two types of lightweight fly ash aggregates on the structural behaviour of concrete mixtures. Using cube compressive strength, Young's modulus, and tensile strength, the mechanical strength parameters of LWC specimens and NWC specimens were examined. Chloride permeability were used to evaluate the durability of concrete. When oven-dried density improved, then the compressive strength increased. The 28-day and 56-day concrete samples did not fail since their durability factors were more than the needed 85 or 90 to withstand freezing and thawing.

3. CONCLUSION

Based on a review of the literature, the following findings may be drawn:

a. Concrete's density might be decreased. When lightweight aggregates were included in the concrete blend

b. Light weight concrete has higher impact resistance than regular concrete because of its lower modulus of elasticity and higher tensile strain capacity.

c. Light weight aggregates made from fly ash exhibited low weight, strength, high penetration, and interlocking properties.

d. The heat insulation property test revealed that the thermal conductivity of the porous lightweight aggregate may be lowered to around 70% of the control level.

e. Lightweight concrete exhibited similar characteristics to standard concrete. Hence, lightweight aggregates may be used in place of natural stone aggregate.

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