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Experimental Study on Lightweight Concrete Using Pumice Aggregate

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ABSTRACT—

This review paper synthesizes experimental studies on the use of pumice aggregate in the production of lightweight concrete. Pumice, a volcanic rock, is characterized by its low density and high porosity, making it a suitable aggregate for lightweight concrete. In the recent times due to tremendous benefits in terms of low density, high thermal conductivity, design flexibility and less cost, the use of light weight aggregate concrete for structural applications has gained a lot of interest. Light weight aggregate concrete is obtained by mixing cement with light weight aggregates having lesser densities. This paper discusses the physical and mechanical properties of pumice aggregate, the mix design of lightweight concrete using pumice, and the resultant properties of the concrete. The environmental benefits and potential applications of pumice aggregate lightweight concrete (PALWC) are also explored.

Keywords: - Density, Light Weight Concrete, Aggregate, Pumice Aggregate

INTRODUCTION :

Lightweight concrete (LWC) is an important material in modern construction due to its reduced weight, which offers advantages such as lower dead load, reduced seismic forces, and improved thermal insulation. Pumice, a naturally occurring volcanic material, has been identified as a promising aggregate for LWC due to its low density and availability. This review aims to compile and analyze experimental research on the properties and performance of lightweight concrete using pumice aggregate. Light weight concrete is an amazing human invention which is used in several fields of construction in the recent times due to its lesser densities and thermal conductivities. The strength of LWC is 25 to 35 % lesser as compared to conventional concrete. Light weight concrete is a blend of light weight coarse aggregate such as shale, clay (or) slate giving it low density which range from 1440 -1840kg/m³. The main advantage of LWC is its low density, reduction of dead load, faster building rates and handling costs. Since eighteenth century, the Romans have used lightweight concrete. In Europe priority of utilization of LWAC happened around a long time back when the Roman constructed the pantheon and water systems in Rome. In light weight aggregate they are two types one is natural light weight aggregate and other one is artificial light weight aggregate. Natural lightweight aggregate includes pumice, diatomite, expanded clay aggregate and rice husk. Day by day the industrial usage is increasing and waste generated will be obtained in more quantities from the industries. To usage the industrial waste they are using cinders, palm oil shells, and fly ash. Usage of this natural and artificial light weight aggregates in making concrete results is achieving lesser densities and high thermal conductivities. Cinder absorbs water at a rate of about 1.5%. This discrepancy is assumed to be the primary cause of the decreased strength and durability of cinder-based concrete. Due to their high porosity and porous structure, pumice aggregates may be used as an alternative to aggregate in porous concrete to increase porosity without significantly lowering concrete strength. Expanded clay aggregate is one of the materials among light weight aggregate which gives the highest compressive strength.

REVIEWS OF LITERATURE :

1. Arundhathi S 1, Elanchezhian M 2, Balan G 3, Dhanush Ram M 4, Dr .S Sundari 5 “Experimental Study on a Light Weight Concrete with Partial Replacement of Pumice Stone in Aggregates” (2023): One of the most commonly available natural lightweight aggregate called pumice aggregate is used as a replacement for coarse aggregate. Pumice aggregate is used because of its low density than conventional coarse aggregate, and it is easily available. Lightweight concrete is prepared by partially replacing the coarse aggregate with pumice aggregate by 50%, 70% & 100%. The conventional concrete and pumice lightweight aggregate concrete is made by using mix M25 with SLES (sodium lauryl ether sulphate) admixture. The mechanical properties of conventional concrete and pumice lightweight aggregate concrete are compared by conducting various destructive and non-destructive tests and favorable replacement is found.

2. Chiru K S, Manjesha G, “Experimental Study on Light Weight Concrete by using LECA and Fly ash” (2022): Main intention of carrying out this project is to compare the weight of concrete and strength properties viz. cube compressive strength, split tensile stremgth and flexural strength of light weight concrete against conventional concrete by partially replacing natural aggregates by LECA by 25 percentage, 35 percentage and replacing cement by flyash by 20 percentage. Lightweight aggregate has been effectively utilized for well more than two millennia and use of lightweight total adds to the maintainable advancement by moderating energy. Bringing down transportation prerequisites, boosting outline and construction proficiency and expanding the service life of the item it is utilized as a part of with

expanding concern over the intemperate abuse of common aggregates, lightweight aggregate delivered artificially is a feasible new resource of structural aggregate objects.

3. G. Senthil Raj 1, M. Aravindhan2, M. Hariprasad3, K. Seenuvasan4, K. Sarathi5 "An Experimental Study on Light Weight Concrete Using Pumice and Partial replacement of cement using GGBS and Metakaolin" (2021): In Light weight concrete pumice plays a role as coarse aggregate. In our concrete we are using M-sand and partial replacement of cement using GGBS and Metakaolin. The ratio we are (40% Cement ,50% GGBS), (50% Cement, 40% GGBS), (60% Cement,30% GGBS), (70% Cement, 20% GGBS), (80% Cement, 10% GGBS) and 10% Metakaolin is kept constant in our concrete. As we are using this ratio to get the strength and hardness of the concrete. It reduces the permeability. Cement is major constituent material of the concrete which produced by natural raw material like lime and silica. Once situation may occur there will be no lime on earth for production. This situation leads to think all people working in construction industry to do research work on cement replacing material and use of it. Industrial wastes like Ground Granulated Blast Furnace Slag (GGBS) show chemical properties similar to cement.

4. RishikSarkar, Ridul Saud "Experimental Study on the use of Pumice as Coarse Aggregate in Structural Concrete" (2021): In this investigation, an attempt has been undertaken to find out whether pumice lightweight concrete can be used as structural concrete. This is carried out by comparing conventional concrete and lightweight aggregate concrete using the M30 mix [1]. Lightweight concrete is prepared by partial replacement of coarse aggregate with various percentages of pumice, viz., 25%, 50%, 75% and 100%. This project is undertaken to determine the mechanical and durability properties of lightweight aggregate concrete, i.e., Compressive Strength, Split Tensile Strength and Acid Resistance, after 7 and 28 days of curing and hence find the suitable replacement concerning the above-mentioned replacement percentages [4]. The results indicate reduced mass without significant change in acid resistance, whilst maintaining adequate strength. The different engineering properties of pumice aggregate concrete were compared to that of conventional concrete.

5. Manoj V1, Sridhar R2, Ajey Kumar V G3 "Study on Effects of Pumice in High Performance Light Weight Concrete by Replacing Coarse Aggregates" (2021): quantity and Nano Silica replaced in 1-3% for different mixes to predict three output parameters such as compressive strength (Mpa), split tensile strength (Mpa), flexural strength (Mpa). The addition of pumice to CA concrete decreases density while also lowering all mechanical properties, according to test results. This is because pumice has a smooth surface texture and has a lower density than CA. On the other hand, lightweight concrete containing more than 20% pumice changes into structural lightweight concrete with excellent strength. Several studies demonstrated an overall gain in strength as well as weight loss. As a result, light-weight concrete is equal to heavy-weight concrete in terms of strength.

6. Akshay Suresh Lad1 Exploratory Investigation on Light Weight Concrete with Pumice Stone as a Partial Substitution of Coarse Aggregate (2020): Lightweight concrete in today's world has a high number of applications as the structural demands are increasing it has many applications in the concrete and construction industry nowadays. In this experimental study, an attempt has been made to compare the conventional concrete with the lightweight concrete which is made by partially replacing the coarse aggregate with Pumice aggregate using a mix of M30. The lightweight concrete has been made by partial replacement of coarse aggregate with the varying percentage of pumice aggregate from 8%, 16%, and 24%. This experiment is focused to determine the strength parameters of the newly designed concrete, to find the most favorable replacement from the above-mentioned replacements and the results are compared with that of the conventional concrete.

7. MammanAdamu Idi1, AgboolaShamsudeen Abdulazeez2, Shu'aibu Ahmed Usman3, Tapgun Justin4 "Strength Properties of Concrete Using Pumice Aggregate as Partial Replacement of Coarse Aggregate" (2020): The study established that with pumice aggregate content the result shows slightly reduced compressive, tensile and flexural strengths as compared to the control concrete. Concrete produced with pumice as coarse aggregate meet the required strength at 28 days. Control concrete had higher compressive strength at 28 days of 1.05% compared to 5% pumice aggregate. Also control concrete had higher tensile strength at 28 days of 0.59% compared to 5% pumice aggregate in addition control concrete had higher flexural strength at 28 days of 4.41% compared to 5% pumice aggregate Concrete with pumice as coarse aggregate is optimum at 5% for all curing days which meet the required strength at 28 days but can be replaced up-to 15% aggregate replacement. This study recommends the use of admixture to improve in general the properties of concrete.

8. R.B. Karthika ⇑, V. Vidyapriya, K.V. Nandhini Sri, K. Merlin Grace Beaula, R. Harini, MithraSriram "Experimental study on lightweight concrete using pumice aggregate" (2020): Concrete is the commonly used manufactured building material in the world, owing to its usefulness and relatively low cost. One of the disadvantages of conventional concrete is its high self-weight. This heavy self-weight of concrete will result in uneconomical structural material. To decrease the self-weight of concrete, the coarse aggregate is replaced partially by lightweight aggregate. This is known as lightweight concrete having low density, reduction of dead load and to increase thermal insulation. There are two types of lightweight aggregate - natural lightweight aggregate and artificial lightweight aggregate. One of the most commonly available natural lightweight aggregate called pumice aggregate is used as a replacement for coarse aggregate. Pumice aggregate is used because of its low density than conventional coarse aggregate, and it is easily available. Lightweight concrete is prepared by partially replacing the coarse aggregate with pumice aggregate by 50%, 80% & 100%. The conventional concrete and pumice lightweight aggregate concrete is made by using mix M30 with Conplast SP430 admixture. The mechanical and durability properties of conventional concrete and pumice lightweight aggregate concrete are compared by conducting various destructive and non-destructive tests and favorable replacement is found.

9. Ashuvendrasingh "Experimental Study on Light Weight Fiber Concrete Using Pumice Stone as Partial Replacement of Coarse Aggregate" (2019): In this experimental work an attempt has been made to study and compare the structural properties of light weight concrete of M40 grade using the light weight aggregate Pumice stone as a partial replacement to natural coarse aggregate and mineral admixture materials like GGBFS and with some percent of Recron 3s. This study has been done by varying 10% - 50% pumice stone on partial replacement. Compressive strength, flexural strength and split tensile strength were evaluated for this study and comparison was made with that of conventional concrete. All these concrete specimens were cured for 7 days and 28 days in water tank on normal 27 ± 2 0C atmospheric temperatures.

10. SuriBabu, P. Padma Rao, Dr. T. Chandra ShekarRao, R. VenkataRamana "AN Experimental Study on Mechanical Properties of Light Weight Aggregate (Pumice Stone &Leca) Concrete" (2018): mechanical properties of light weight aggregate concrete. Light Weight Aggregate Concrete offers wide range of advantages than the conventional concrete. One such basic advantage is its reduction of dead load of structural components which is a special attractive property in the construction of multi-storied buildings. In this study, an attempt has been made to improve the lowered mechanical properties and young's modulus of light weight aggregate concrete by the usage of mineral admixture Silica Fume 10% by weight of cement (from literature) to the structural grade light weight aggregate concrete. The study concludes that the usage of light weight aggregates (Pumice Stone & LECA) in concrete decreases the dead weight of concrete, but a significant decrease in mechanical properties also. So as to attain both strength and reduction in dead weight the influence of silica fume was found to be predominant.

CONCLUSION :

Based on the above literature and numerous experiments conducted by several authors with a variety of objectives to generate lightweight concrete with similar physical and mechanical qualities as that of conventional concrete it is concluded that when replaced with fine or coarse particles, the workability of the concrete had varied trends depending on which aggregates were used. Pumice aggregate lightweight concrete (PALWC) presents a viable alternative to conventional concrete in various construction applications, offering benefits such as reduced weight, improved thermal insulation, and environmental sustainability. Continued research and development in mix design and performance optimization will further enhance its applicability and performance in the construction industry.

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