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UDC 691.327.3

STRENGTH AND DURABILITY OF LIGHTWEIGHT CONCRETE

Mohammad Mehdi Jamal
M.mehdijamal@gmail.com
Master student at L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
Advisor - Candidate of Technical Sciences, Associate Professor Kirgizbaev A.T

Abstract

This paper aims to discuss the strength and durability of lightweight concrete. Lightweight concrete is a versatile building material that is known for its ability to reduce the weight of structures and improve insulation. However, its strength and durability can be a concern. The paper explores the properties of lightweight concrete, such as its compressive strength, tensile strength, and durability, as well as factors that can affect its performance, including mix design, curing methods, and environmental conditions. The study also highlights various methods for improving the strength and durability of lightweight concrete, such as adding fibers, using admixtures, and incorporating recycled materials. The findings of this study will help engineers and builders design and construct more durable and resilient structures.

Keywords: lightweight concrete, strength, durability, mix design, fibers, Compressive strength, recycled materials

1. Introduction

Lightweight concrete is a building material that has gained popularity in recent years due to its many benefits. It is a type of concrete that has a lower density than traditional concrete, which makes it lighter and more manageable. This type of concrete can be used in a variety of applications, including building foundations, walls, and floors, as well as for precast structures. The use of lightweight concrete can help to reduce the weight of structures, which can be particularly useful in high-rise buildings, where the weight of the structure can become a significant issue [1].

Despite its many advantages, the strength and durability of lightweight concrete can be a concern. Lightweight concrete can have a lower compressive strength than traditional concrete, and it can be more susceptible to cracking and weathering. These issues can affect the overall performance and longevity of structures made from lightweight concrete [2].

2. Method

To investigate the strength and durability of lightweight concrete, this study will review relevant literature on the topic. The review will focus on the properties of lightweight concrete, including its compressive strength, tensile strength, and durability. It will also examine factors that can affect the performance of lightweight concrete, such as mix design, curing methods, and environmental conditions. The study will highlight various methods for improving the strength and durability of lightweight concrete, such as adding fibers, using admixtures, and incorporating recycled materials.

3. Literature Review

The strength of lightweight concrete, like that of heavy concrete, depends on the cement-water ratio, as it determines the properties of the cement stone that binds all the components of the concrete into a single monolith. However, porous fillers, due to the peculiarities of their structure, have a low strength, usually lower than the strength of the cement solution. Introducing them into concrete leads to a decrease in its strength compared to regular heavy concrete with strong, dense fillers, and this effect is greater, the higher the filler content and the lower its density. As a result, the strength curves of lightweight concrete as a function of the cement-water ratio are located below the curves for regular concrete, and concretes with fillers of different strengths have different curves [4]. The compressive strength of lightweight concrete is an important factor to consider when designing and constructing structures. Lightweight concrete can have a lower compressive strength than traditional concrete, which can affect the overall strength and stability of the structure. However, studies have shown that the compressive strength of lightweight concrete can be improved through various methods. One such method is the use of fibers, such as steel, glass, or synthetic fibers, which can improve the strength and durability of lightweight concrete. Another method is the use of admixtures, such as fly ash or silica fume, which can enhance the properties of lightweight concrete, such as its strength and durability [5].

3.1. Compressive strength

Table 1. Compressive strength of SLWC (MPa) after 1year

Curing	SLWC35		SLWC50	
	Age (days)		Age (days)	
	28	365	28	365
Full	38.0	48.0	49.5	64.5
1 SS	40.0	41.0	49.5	52.5
7 SS	42.5	47.0	57.0	62.5

Table 1. Presents compressive strength for the two concretes with various curing periods. To eliminate the possible variation in strength due to surface moisture, all strength specimens were tested in saturated surface dry condition. The compressive strength of SLWC50 control specimens at 28 days was 49.5 MPa and kept on increasing and reached 64.5 MPa at 365 days with a 26% increase. SLWC35 control specimens had a compressive strength of 48 MPa at 1 year. As shown in Table 1, as the period of initial curing of concrete in water increased compressive strength also increased for all testing ages. Seven days of initial water curing and subsequent exposure to uncontrolled predominantly hot-humid exposure conditions resulted in almost similar strength to those of the continuously water-cured cubes at the age of 12 months [7].

3.2. Splitting tensile strength

Tensile strength is another critical property to consider when evaluating the strength and durability of lightweight concrete. The tensile strength of lightweight concrete can be improved through the use of fibers, such as polypropylene or carbon fibers. These fibers can improve the tensile strength of lightweight concrete and make it more resistant to cracking and other types of damage. The split tensile strength of air-dried LWC Specimens was 8–9% of respective compressive strength. The split tensile strength of LWC made with foam and expanded clay aggregate reveals that air voids percentage increases with an increase in foam value with a significant decrement in strength and density properties. It was also noticed that tensile strength is directly related to compressive strength properties. LWC made with manufactured aggregate has demonstrated better ductility and flexural strength properties. Upon air drying, LWC made with OPBC exhibits lesser tensile strength properties than water curing and moist curing. In moist curing conditions splitting tensile strength is 6–7% of the compressive strength. Palm jiggery addition in the percentage of 0.05% and 0.1% as an admixture in the concrete illustrates promising split tensile strength properties. 12% strength of compressive strength was noticed in splitting tensile strength of LWC made with 15% OPS aggregate as coarse aggregate [7].

3.3. Flexural strength

The stiffness criterion was reduced when natural coarse aggregate (NCA) was replaced with coconut shell (CS), but the ductility factor increased. Additionally, it was observed that up to 50% replacement of NCA by CS aggregate exhibited the same flexural behavior as conventional concrete. Styrofoam aggregate with 15% NCA replacement possessed better flexural strength properties than the control mix. Concrete made with OPBC as aggregate had a flexural-to-compressive strength ratio of about 13%. A significant reduction in flexural strength was noticed when the concrete density was reduced. Fiber-incorporated LWC had a smooth flexural failure, whereas LWC without fibers had a brittle failure. Natural coarse aggregate replaced by OPS aggregate in a percentage of 15% had acceptable strength properties. The incorporation of fibers in concrete enhances the flexural carrying capacity of the members. Basalt Fiber Reinforced Polymer (BFRP) rebar has a lower density than conventional steel rebar, and the lower elastic modulus observed in BFRP boosts the load-carrying capacity of the members.

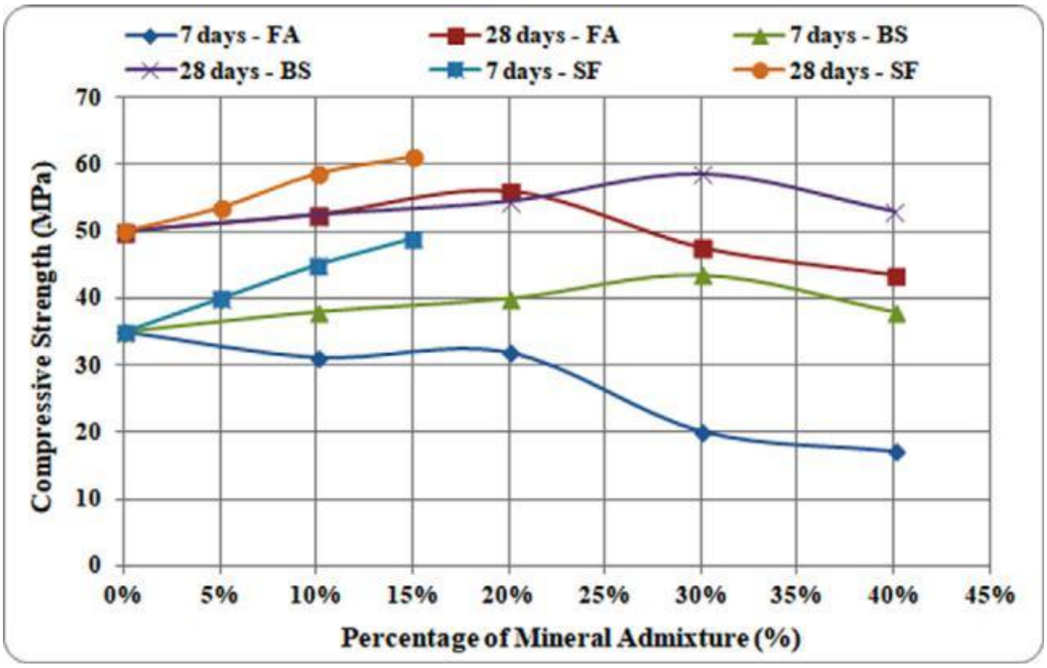

Fig. 1. Compressive strength of LWC with different MA.

3.4. Durability Durability is also an essential factor to consider when evaluating the strength and durability of lightweight concrete. Lightweight concrete can be more susceptible to weathering and other types of damage than traditional concrete. However, various methods can be used to improve the durability of lightweight concrete, such as adding admixtures or using curing methods that promote the formation of calcium silicate hydrates, which can enhance the durability of the concrete. Pre-wetted expanded clay aggregate performs good conditions for the hydration process that makes concrete impervious and results in water absorption about two times while compare to natural coarse aggregate concrete [6]. The shock absorption capacity of Styrofoam aggregate concrete is more than control specimens. This can be attributed to the fact that the disintegration of samples is lesser when compared to the control mix. Mix made with larger size aggregate has more number of voids that would result in higher porosity. During chemical exposure, ions such as chloride, sulfate, and acid may easily penetrate the concrete. Foamed concrete subjected to 15 numbers of freeze–thaw cycles has 15% lesser compressive strength than concrete which does not have freeze–thaw exposure. It was noticed that 15% replacement of Ficus exasperata Leaf Ash (FELA) as cementitious material shows potential durability properties. Pretreatment of Oil Palm Shell (OPS) aggregate with 20% polyvinyl alcohol in LWC has remarkable durability properties than LWC concrete made with untreated OPS and it has been noticed that LWC specimens using pretreated OPS aggregate with borate solution have whitish layer formation on its surface. SF percentage of about 10%, 20%, and 30% in LWC has shown good thermal conductivity properties [8].

4. Conclusion

In conclusion, the strength and durability of lightweight concrete can be a concern, but various methods can be used to improve these properties. The use of fibers, admixtures, and other additives can enhance the strength and durability of lightweight concrete, making it a viable option for a variety of construction applications. By understanding the properties and methods for improving the strength and durability of lightweight concrete, engineers and builders can design and construct more durable and resilient structures.

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УДК 691

ЗЫҒЫР НЕГІЗІНДЕГІ ЖЫЛУ ОҚШАУЛАҒЫШ МАТЕРИАЛДАРДЫ ӨНДІРУДІҢ ЭКОНОМИКАЛЫҚ НЕГІЗДЕМЕСІ

Ерсайын Анар Зайдоллақызы
anaryersaiyn@mail.ru
Л.Н. Гумилев атындағы Еуразия ұлттық университеті, «Өнеркәсіптік және азаматтық құрылыс технологиясы» кафедрасының магистранты, Астана, Қазақстан
Ғылыми жетекшісі – Аруова Ляззат Боранбаевна

Аңдатпа. Соңғы жылдары Қазақстан Республикасында майлы дақылдар егілетін алқаптардың айтарлықтай өсуі байқалды. Соның ішінде зығыр егілетін алқап 100 есеге өсті. Зығыр өндірісінің дамуы сәйкесінше өнім қалдықтарының көбеюіне