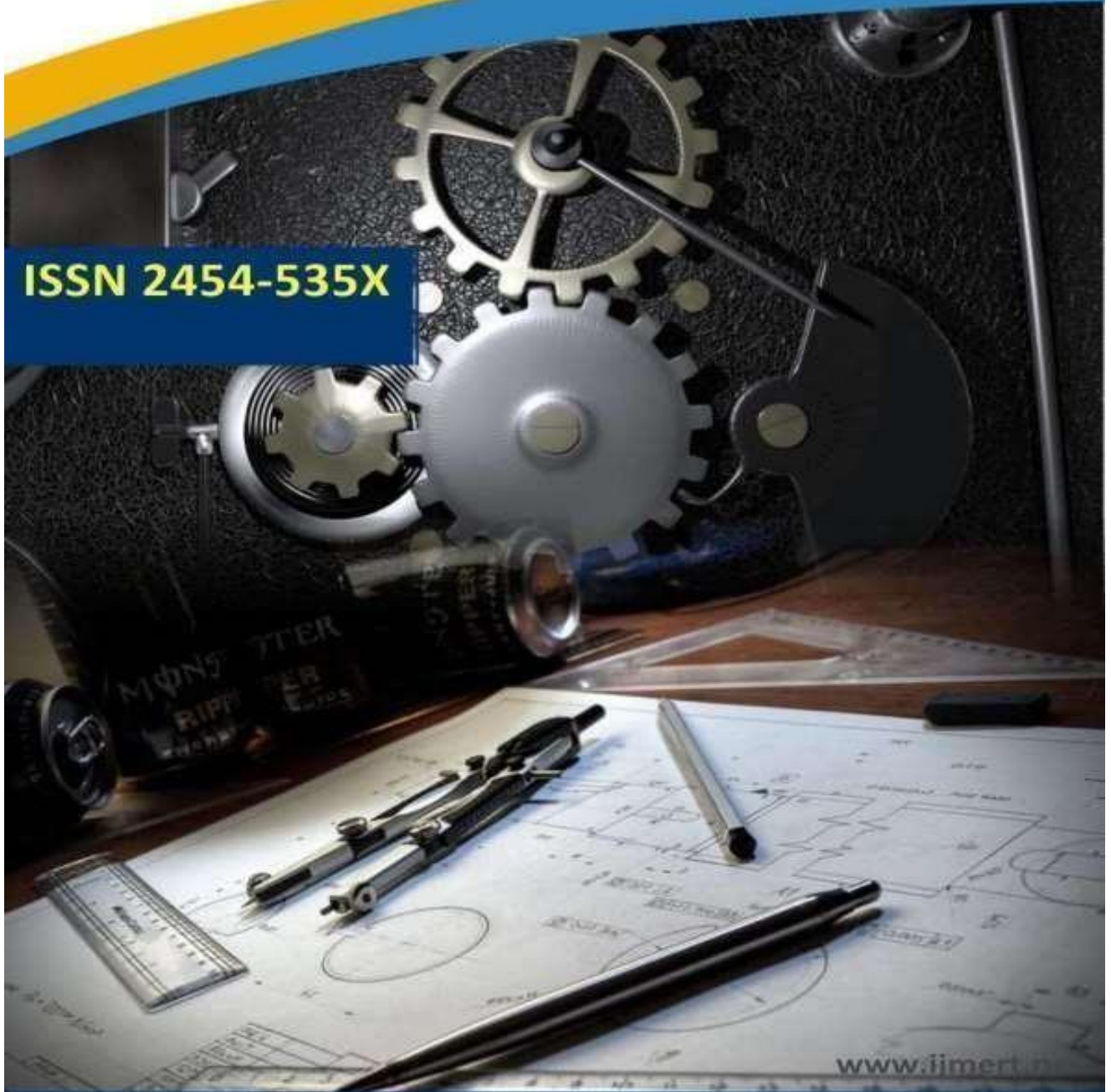




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Research on the Axial compressive stress-strain relationship and the behavior of structural lightweight aggregate concrete

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ABSTRACT

When compared to regular concrete, the lightweight aggregate-only concrete has significantly reduced mechanical characteristics and is thus unsuitable for structural purposes. By substituting some of the natural crushed stone with synthetic lightweight aggregate, a hybrid aggregate system may be used to improve the performance of concrete. “The stress-strain relationship and the Poisson effect in concrete were examined in the previous work using expanded shale as the artificial lightweight aggregate. The experiment employed four different volumes of shale aggregate, and the mechanical characteristics of concrete were studied as a result of the volume content. When shale aggregate volume was increased, peak stress and modulus of elasticity decreased. However, as the shale aggregate volume percentage increases, so do the axial and lateral stresses associated with the peak stress. The more the shale aggregate concentration in the concrete, the greater the Poisson effect was seen in the lateral strain to axial strain ratio. The stress-strain connection between lightweight concrete and lightweight aggregate may now be analytically defined.

1.INTRODUCTION

More than 10 billion tons of concrete are produced each year, making it the most significant building material in the world. Even if this practice has a harmful impact on the environment, it is true that it is becoming more and more popular. [1] Approximately ten to eleven billion tons of aggregate are used every year across the world, and the availability of high-quality natural aggregates is gradually diminishing.” To satisfy environmental and sustainable development demands, concrete is being made using synthetic aggregate instead of natural crushed stone [2–9].

The lightweight aggregate (LWA) has a porous structure, which makes it weaker and more prone to deformation than natural aggregate. The mechanical characteristics of concrete will be significantly reduced in all respects if LWA is used in its entirety as the aggregate. Natural crushed stone and synthetic aggregate are often used together in a hybrid aggregate system, which is common. “Previous studies have demonstrated that LWA strength and content have a substantial impact on the mechanical characteristics of concrete [10–11]. The addition of low-strength LWA weakens the mechanical qualities of lightweight aggregate concrete (LWAC) [13], as it is well acknowledged to be the weakest component of the material.” Concrete's mechanical properties do not suffer much when LWA strength is greater than that of the mortar matrix, as has been shown in many studies

2.Experimental study

2.1 Materials and mix proportion



Cement with a compressive strength of 42.5 MPa according to Chinese standard GB175-2007 was utilized. The fine aggregate consisted of manufactured sand. At 5–20 millimeters in diameter, the natural coarse material used in the construction of this project is crushed granite. It was the expanded shale, which had an 8.5 Mpa cylinder compressive strength, a 5 percent water absorption capacity and a diameter of 5–20 mm. It was necessary to soak the shale in water for 12 hours before to mixing to prevent it from affecting the water-to-cement ratio. A superplasticizer based on aphthalene was used to increase the material's workability. Table 1 lists solid materials by their bulk density or apparent density. The mix % is determined by Chinese standard JGJ 55-2011. As a consequence of water absorption by the samples, their observed density was slightly greater than the predicted density, which was achieved by using different proportions of expanded shale to create four unique volume containers. Figure 3(b) shows that LWAC with a 20% LWA volume fraction has a lower compressive strength than regular concrete. There is no change in the compressive strength when the volume fraction is increased In the experiments of Chi et al. and Ke et al., similar findings were found.

Table 3: Mechanical and physical properties of concrete.

Groups	Density(kg/m ³)	Cubic compressive strength f_{cu} (MPa)	Compressive strength f_c (MPa)	Modulus of elasticity E_c (GPa)
CC	2520	52.4	41.8	34.3
LWAC-20	2400	50.7	35.1	28.7
LWAC-40	2300	48.1	37.3	28.3
LWAC-60	2240	50.6	40.0	26.3

For example, peak strains grow with increasing volume percentage of LWA, and the lateral peak strain is more important. The lateral and axial peak stresses rise by around 75% and 8%, respectively, when the LWA volume content is 60%. In this experiment, the Poisson ratio of typical concrete ranged from 0.08 to 0.16, as seen in the figure. When the load is mild, LWAC's Poisson ratio is almost identical to that of regular concrete. The Poisson ratio of LWAC increases as the stress level increases, compared to the Poisson ratio of regular concrete. In LWAC-20, there is a rapid rise in the Poisson ratio as the stress ratio approaches 1.0. As compared to LWAC-20 at peak stress, the Poisson ratio increases gently when LWA has a volume percentage of 40% or more. According to the findings, the LWAC-60 group's Poisson ratio is the highest of the four. This may be observed in the Poisson ratio of LWAC-60, where the stress ratio can be altered from 0.66 to 1.0. As a result, it can be concluded that the lateral expansion ductility of LWA increases with the volume content of LWA. In order to improve the ductility of lateral expansion, the method described below must be used. As a result of its greater deformation, LWA has lower modulus of elasticity and a greater Poisson ratio than natural crushed stone. LWA, on the other hand, has an internal-curing process that reduces the transition between the two surfaces.

CONCLUSIONS

Researchers in this study are examining the mechanical properties of LWAC by compressing and expanding an enlarged shale to an average cylinder compressive strength of 8.8 MPa. There are four distinct volume sizes employed in the study. What we learned from this research may be summed up as follows. It is non-monotonic that LWA volume % influences concrete compression strength when LWA density and strength are similar. Experimentally, we found that when the LWA volume percent rose, compressive strength fell. At a volume percentage of 60%, the compressive strength of LWAC is approximately comparable to that of normal concrete. Compressive strength may be achieved with a suitable amount of natural aggregate and low-water-absorption (LWA).

A crucial component in the interaction between natural aggregate and LWA has long been recognized as deformation compatibility. "Because LWAC is more deformable than natural aggregate, the modulus of elasticity of LWAC is lower in our experiment than in previous study. It is our major goal to investigate the lateral deformation of LWAC under uniaxial



compression.” It is clear from the graph below that the LWA volume fracture causes the lateral peak strain to increase much faster than the axial peak strain. When it comes to lateral expansion, LWAC outperforms standard concrete hand-in-hand. A steel tube component that is subjected to compression may benefit from this property.

For the purpose of constructing LWAC's elasticity models based on the results of the experiments, the volume fraction of LWA is used as a model variable. These three characteristics may be used to describe the stress-strain curve of LWAC during uniaxial compression. The model's potential use in nonlinear analysis and design of LWAC structures may be advantageous. It is well accepted that the kind of LWA will have a substantial influence on the mechanical characteristics of concrete. To get a better understanding of the mechanical properties of LWAC, further experiments will be conducted using a variety of LWA types in the future.

References

1. C. Meyer, The greening of the concrete industry, *Cement Concr. Compos.* 31(2009) 601–605.
2. R.M. Senthamarai, P. DevadasManoharan, Concrete with ceramic wasteaggregate, *Cem. Concr. Compos.* 27 (2005) 910–913.
3. R.M. Senthamarai, P.D. Manoharan, D. Gobinath, Concrete made from ceramicindustry waste Durability properties, *Constr. Build. Mater.* 25 (2011) 2413–2419.
4. development of analytical model forpre-peak stress–strain curve ofstructural lightweight aggregate concrete, *Constr. Build. Mater.* 36 (2012)845–849.
5. S.B. Huda, M.S. Alam, Mechanical behavior of three generations of 100%repeated recycledcoarse aggregate concrete, *Constr. Build. Mater.* 65 (2014)574–582.
6. Y.W. Zhou, X.M. Liu, F. Xing, et al., Axial compressive behavior of FRP-confinedlightweight aggregate concrete: An experimental study and stress-strainrelation model, *Constr. Build. Mater.* 119 (2016) 1–15.
7. B. Da, H.F. Yu, H.Y. Ma, et al., Experimental investigation of whole stress-straincurves of coralconcrete, *Constr. Build. Mater.* 122 (2016) 81–89.
8. K.S. Youm, J. Moon, J.Y. Cho, et al., Experimental study on strength anddurability of lightweight aggregate concrete containing silica fume, *Constr.Build. Mater.* 114 (2016) 517–527.
9. X. Yun, Z. Tao, T.Y. Song, et al., Performance of concrete made with steel slagand waste glass, *Constr. Build. Mater.* 114 (2016) 737–746.
10. M.E. Dilli, H.N. Atahan, C. Sengül, A comparison of strength and elasticproperties between conventional and lightweight structural concretesdesigned with expanded clayaggregates, *Constr. Build. Mater.* 101 (2015)260–267.
11. M.H. Zhang, O.E. Gjorv, Characteristics of lightweight aggregates for highstrength concrete, *ACI Mater. J.* (1991) 150–158.