ISSN: 2454-9940

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

E-Mail :
editor.ijasem@gmail.com
editor@ijasem.org

www.ijasem.org

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN2454-9940

www.ijasem.org

Vol 17, Issue 1, 2023

Exploration of Ultra-Lightweight Aggregate Concrete with Minimal Nano-Si Clay

Mr. A. Ramkumar, Mr. C. Jegadeeswaran, Mrs. R. Keerthana, Mr. A. Venkateshan

Assistant Professor [1,2,3,4]

ramkumar.a@actechnology.in, cjegadeseswaran@actechnology.in, keerthana.r@actechnology.in, venkateshan.k@actechnology.in

Department of CIVIL ENGINEERING, Arjun College of Technology, Thamaraikulam, Coimbatore-Pollachi Highway, Coimbatore, Tamilnadu-642 120

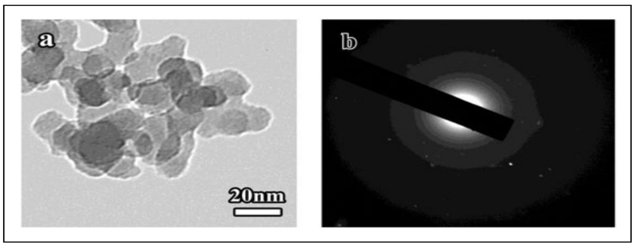
ABSTRACT

Although nano-modification of cement-based concrete has been hailed as a practical method to enhance its mechanical qualities, there has been a dearth of research on low-dose nano-modification of lightweight cement-based concrete. This study examined low dosages of lightweight cement treated with nano-silica particles. The lightweight concrete samples were prepared using two different methods: prewetting and non-wetting. Lightweight concrete's compressive and flexural strengths were examined to determine the effect of low-dose Nano silica on these properties. The modification of the hydration process by incorporation of Nano-silica into the cementitious matrix led to the discovery of a new hydration product. The advent of novel hydration products has made the use of nano-silica to enhance the cement paste's adherence to lightweight aggregates a realistic possibility. Incorporating substantial amounts of Nano-silica into the mix decreases the volume expansion of the new hydration products when light aggregates and cement paste come into contact. There is potential for the creation of new high-performance lightweight concrete products due to the fact that low-dose Nano modification may enhance the mechanical properties of lightweight concrete.
Keywords: Lightweight concrete, low dosage, nano modification, reinforcement mechanism, microstructure characterization

1.INTRODUCTION

The internal curing effect, for instance, lessens early age shrinkage, which in turn lessens dead loads, improves thermal insulation, increases fire resistance, decreases the cost of shipping precast units on site, and saves money on foundations and reinforcement. 8 In other words, LWAC's versatility makes it a promising material for a variety of uses, such as thermal isolation structures and light bridge decking.

The many potential applications of LWAC are exciting, but there is still a problem that needs fixing: their low density, high strength and stiffness, and weak bonding strength with cement paste. There a number of factors that are believed to affect the stiffness of lightweight concrete, including the kind of stress as well as the size, shape, and aggregate type of the specimen.



“Figure 1. TEM morphology of nano-SiO2addition to strengths, the interfacial transition zone (ITZ)”

Fundamental issues such as impact, bleeding, and segregation must be addressed prior to any field applications. Fiber and fine particle reinforcement, for example, have been used to enhance the qualities of lightweight concrete.

The conventional wisdom was that using a combination of fibres as reinforcements would enhance the mechanical properties of LWAC. Throughout its existence, this LWAC has been fortified with steel fibre. The researchers found that compressive and flexural strengths of LWAC were significantly increased when steel fibre was added to the material. The use of steel fibres increases the toughness and strengthens the material. The flexural toughness might be significantly enhanced by using steel fibres. Research has shown that a 2.0% steel fibre content is optimal for performance enhancement. The function of the volume fraction

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN2454-9940
www.ijasem.org
Vol 17, Issue 1, 2023

and aspect ratio of the steel fibres in reinforcing is crucial. The study found that although the low volume % had no effect on compressive strength, it significantly affected flexural strength and toughness. In order to solve the strength problem that LWAC had in its applications, it was constructed using a variety of fibres, not just steel. These included polymers, glass, carbon, and hybrid fibres.

"Experimental program: Materials and methods"

With a pH of 42.5, it was found that the optimal densities for expanded ceramsite were 0.45 g/cm² and an absorption ratio of 2.5%. Modi-Fire was made possible by nano-silica (SiO2) that was commercially accessible from the Hefei Liangziyuan Co. in Anhui Province. Among the materials tested, nano-SiO2 exhibited the highest density of surface area per unit weight, with a surface area of 80m2/g. In Figure 1 (SAED), we can see that SiO2 was subjected to transmission electron microscopy and electron diffraction at a specific location.We used a water/cement ratio of 0.45 and nano-SiO2 doses between 0 and 5 ppb.Approximately 0.01% of the whole mass is cement. Table 1 displays the mix design for the nano modified concrete. There were two methods for preparing the LWAC. The non-prewetting method included sonicating nano-SiO2 at 40 kHz and 200 kHz in order to create nano-SiO2.

Results and discussion

Referring to Figure 2, we can see that non-prewetting LWAC samples exhibit both compression and flexibility when Compression strength measurements performed across materials with and without nano-SiO2 concentrations ranging from 0.05 to 0.01 weight percent (25.2 MPa) showed no statistically significant changes. Similar to the control sample, this one has a flexural strength of 3.5 MPa. Both the compressive and flexural strengths reached their maximum levels with nano-SiO2 additions of 0.1%. When compared to the control sample, we found that flexural strength increased by 18% and compressive strength jumped by 40% after 7 days.

Increasing the dosage of nano-SiO2 increased compressive and flexural strength by 0.2 to 0.5 percent, whereas adding nano-SiO2 reduced the correlation by 1 percent. [% of body mass] Even at a dosage of just 0.2%, flexural and 7-day compression strengths were 24% and 6% higher than in the control samples, respectively. They both saw an approximately 11% decrease in efficacy when administered the 0.1wt% dosage. The 7-day compressive and flexural strengths were measured at 32.4 and 3.6 MPa, respectively, using a weight-percentage dosage increment of 0.5. The compression and flexural strengths were found to be significantly lower after the dose reached 1%. Comparing these findings to the control groups revealed very identical outcomes.

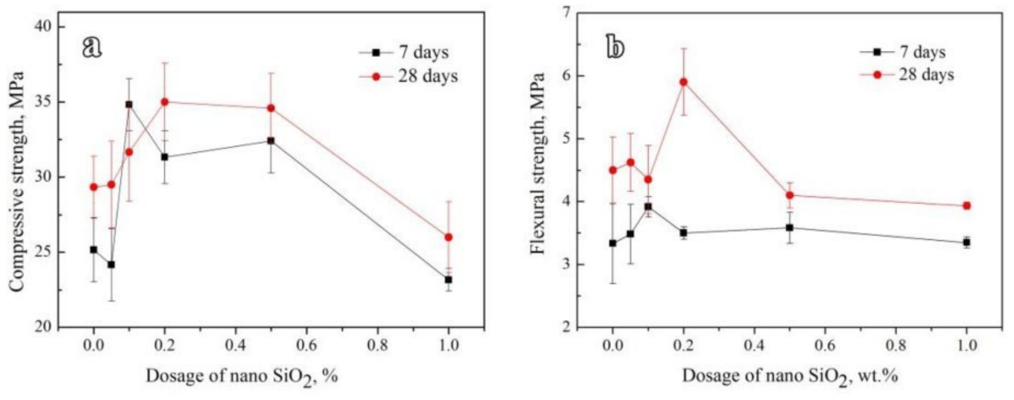


Figure 2. "Properties of non-prewetting lightweight concrete (7 and 28 days) as a function of nano-SiO2 dose (a) compression strength and (b) flexural strength." SiO2:

Compression and flexural strength were 30 and 4.5 MPa when the dose was raised to 0.05 weight percent. "Highest compression and flexibility strengths, with values of 35 and 5.9 MPa, could be achieved at 0.2 percent dose. The compressive and flexural strengths of the 28-day specimens were significantly reduced when the dosage was increased from 0.5 to 1%, respectively."

"Prewetting LWAC samples' compressive and flexural strengths after 7 and 28 days of curing can be shown in Figure 3.

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN2454-9940

www.ijasem.org

Vol 17, Issue 1, 2023

A similar trend may be found in the compressive and flexural strengths of samples that have not been pre-soaked in water, as illustrated by this figure Increases in nano-SiO2 dosage did not result in a linear increase in compressive or flexural strength." After seven days, the nano-SiO2 sample's compressive strength was 23.1 MPa, the same as the control sample's (25.2 MPa). A flexural strength of 3.0 MPa makes it ideal (2.9 MPa). Compression and flexural strength peaks were also detected at 0.1 weight percent throughout the course of seven days. These specimens had 40% and 41% greater compressive and flexural strengths, respectively, than the control sample after 7 days.

The compressive and flexural strengths of the samples treated with nano-SiO2 presetting at concentrations of 0.2% and 0.5% wt percent show no discernible variation after seven days when compared to the control samples. Although there was a great deal of volatility in this region, 1% was the final outcome. Pressure resulted in a 24% rise in compressive and flexural strengths after seven days compared to the control group, but a 14% drop after a 0.1% dose reduction. Two examples. The 7-day cumulative and flexural strengths increased by an additional 31.4% and 3.8%, respectively, with a dosage increase of 0.5 weight percent from the original dosage level. "The samples' compressive and flexural strengths were reduced by around 2.5 MPa each after seven days, bringing them to a level where they were similar to the control samples when the dose reached 1%.

Figure 3 displays the relationship between the dose of nano-SiO2 and the compressive and flexural strengths of prewetted LWAC samples after 28 days. Figure 3a (a) shows that when the dose of nano-SiO2 is raised, the control sample's average compressive strength increases from 26.8MPa to 30.3MPa and 37.3MPa, respectively."The percentages are below 1% in both instances. After raising the dose of nano-SiO2 from 0.2 percent to 0.5 percent, the compressive strength was found to be 34.8 MPa, which is lower than before. By raising the dose of nano-SiO2 to 1.0 percent, the compressive strength was decreased to 31.2 MPa. The flexural strength varies when the dose of nano-SiO2 is increased over time. We dosed nano-modified materials at a rate of 0.5 percent weight percent to produce flexural strengths of approximately 4.4 MPa, and at a rate of 0.1 percent weight percent, we achieved flexural strengths of around 5.1 MPa. The control sample had a flexural strength of 3.7MPa.At a nano SiO2 dosage of 1%, the desired reduction in flexural strength was achieved.

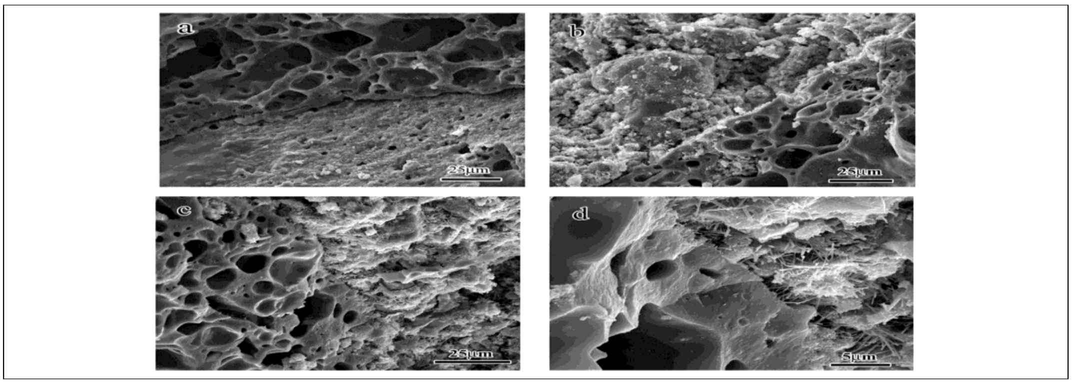


Figure 4. Scanning electron microscopy

Figure 4. Scanning electron microscopy of interface sections between aggregates and cement pastes in the LWAC has been used to investigate fracture surfaces. Whatever the situation may be: (a) without any nano alteration, (b) with little nano modification,high magnification picture of nano modification (c) with a reasonably large dose of nano modification and (d) high magnification. Lightweight aggregate concrete (LWAC) is made using a scanning electron microscope (SEM).

CONCLUSIONS

The mechanical characteristics of LWAC materials were examined in this study using low dose nano SiO2 as a test. Researchers discovered that adding low dosagenano-SiO2 to LWAC significantly improved its mechanical characteristics. At a concentration of 0.1 wt percent, the nano-SiO2 modification effect may be achieved with just a modest quantity of material. At the LWAC's interaction with lightweight aggregates and cement paste, Nano-SiO2 modifies its toughness by producing fiber-shaped hydration products.

REFERENCES

ISSN2454-9940
www.ijasem.org
Vol 17, Issue 1, 2023

1. Ferrara L, Cortesi L and Ligabue O. Internal curing of con-crete with presaturated LWA: a preliminary investigation.*ACISpecialPublication*2015;305:12.1–12.12.

2. Bentur A, Igarashi S-I and Kovler K. Prevention of autoge-nous shrinkage in high-strength concrete by internal curingusingwetlightweightaggregates.*CemConcrRes*2001;31(11):1587–1591.

3. Ferrara L, Caverzan A and Peled A. “Collapsible” light-weight aggregate concrete. Part I: material concept and pre-liminary characterization under static loadings. *Mater Struct*2016;49(5):1733–1745.

4. Ferrara L, Caverzan A, Nahum L, et al. “Collapsible” light-weight aggregate concrete. Part II: characterization understaticanddynamicloadings.*MaterStruct*2016;49(5):1747–1760.

5. ÜnalO,UygunoğluTandYildizA.Investigationofproper-ties of low-strength lightweight concrete for thermal insula-tion.*BuildEnv*2007;42(2):584–590.

6. SayadiAA,TapiaJV,NeitzertTR,etal.Effectsofexpandedpolystyrene (EPS) particles on fire resistance, thermal con-ductivityandcompressivestrengthoffoamedconcrete.*ConstrBuildMater*2016;112:716–724.

7. SenaratneS,GeraceD,MirzaO,etal.Thecostsandbenefitsof combining recycled aggregate with steel fibres as a sus-tainable,structuralmaterial.*JCleanProd*2016;112:2318–2327.

8. Suzuki M, Meddah MS and Sato R. Use of porous ceramicwasteaggregatesforinternalcuringofhigh-performanceconcrete.*CemConcrRes*2009;39(5):373–381.

9. RaithbyKDandLydonFD.Lightweightconcreteinhighwaybridges. *Int J Cem Compos Lightweight Concr*1981; 3(2):133–146.

10. Nair H, Ozyildirim C and Sprinkel MM. *Use of LightweightConcrete for Reducing Cracks in Bridge Decks*. No. FHWA/VTRC16-R14.2016.Hensher DA. *Fiber-reinforced-plastic (FRP) rein forcement forconcrete structures: properties and applications*. Vol. 42.PA,USA:ElsevierPublishing,2016.

11. RanjbarMMandMousaviSY.Strengthanddurabilityassessment of self-compacted lightweight concrete contain-ingexpandedpolystyrene.*MaterStruct*2015;48(4):1001–1011.