New and Mechanical Properties of Self-Compacting Elastic Lightweight Total Concrete and Comparing Mortar

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Abstract:

Waste tires have become a major environmental concern due to an increase in their volume over the last several years. Ingenious ways might be found to repurpose cement. The self-compacting elastic lightweight total cement (SCRLC) is manufactured by breaking piece tires into small particles and incorporating them into lightweight total cement. The effects of elastic particles on the properties of SCRLC and the corresponding mortar are the topic of extensive testing. When elastic particles are used in mortar, the yield pressure and the plastic thickness increase. A decrease in flowability, filling limit, and passing capacity is caused by an increase in the elastic particle replacement percentage of SCRLC. It was found that the SCRLC droop stream, shear pressure, and the SCRLC isolation percentage and plastic thickness of corresponding mortar glues were all closely linked. An upper limit of 231.7 Pa should be applied, with a lower cutoff of 3.72 Pa S, to the plastic thickness in elastic lightweight total cement, to guarantee that it can pack on its own. The compressive strength of SCRLC and the compressive strength of the matching mortar both decrease when the elastic particles replacement fraction increases. The 28-day compressive strength of SCRLC may meet the regulations of light weight total significant improvements up to a half swap percentage for elastic particles.

1. Introduction

Environmental difficulties arise when automobile sector waste, such as rubber waste, which has been rising in recent years is not properly handled [1]. There are a variety of ways to dispose of rubber trash. Using recycled rubber as an aggregate in concrete may be one of the best strategies to deal with discarded tires [2]. Concreting a huge quantity of rubber waste may be done in a sustainable way by using a lot of rubber in concrete [3,4].

As far as research is concerned, there have been many studies on how rubber particles affect concrete's physical qualities. There is evidence to suggest that the majority of recycling methods include crushing used rubber tires into different sized particles and then repurposing those particles for use in concrete. After that, we examined the workability [5–8], mechanical properties [9, 10], lifespan [11, 12], and application of standard concrete containing rubber particles as a material in more detail. Additionally, rubber particles were employed in lightweight aggregate concrete at this same period.

Rubber lightweight aggregate concrete (RLC), as opposed to standard rubber concrete, has been recommended in recent years because to its low unit weight, great flexibility, and adequate mechanical properties. In addition, a potential application future is in sight. However, since aggregate and rubber particles are so light, it is difficult to distribute them uniformly throughout the concrete. As a result, RLC's characteristics are not homogeneous. As with concrete, self-compacting technology may be used to correct RLC's uneven distribution of aggregate and rubber particles. In contrast, earlier research on self-compacting rubber lightweight aggregate concrete has been few or non-existent (SCRLC).

It was discovered that the properties of freshly formed concrete and those of hardened concrete are quite close indeed. It is thus necessary to investigate the physical properties of freshly placed concrete. Researchers have shown that the rheological properties of concrete's mortar are directly related to the concrete's workability [20]. As a result, the rheological properties of mortar may be used to predict the workability of a corresponding concrete. As a consequence, understanding the rheological characteristics of the matching mortar is an excellent way to prepare outstanding new SCRLC qualities. However, thus far, only a few references have reported on the impacts of rubber particles on the rheological properties of mortar and the link between the fresh qualities of SCRLC and the rheological features of related mortar. The mechanical properties of SCRLC and its corresponding mortar, on the other hand, have not been investigated.

The self-compacting technique was put to the test in this investigation to see whether it could be used to build RLC that performed exceptionally well. Several research tested the fresh and mechanical properties of SCRLC and the corresponding mortar to discover how rubber particles influenced the outcomes.Mixture configurations for the SCRLC feature six distinct mixtures. When replacing the fine aggregate, rubber particles of the same particle-size distribution were used in the 6 mixtures, with replacement volumes ranging from 0% to 50%. Compressive strength, plastic viscosity, and yield stress are some of the mortar's qualities. Slip flow, V-funnel and L box tests are among the methods used to evaluate the mechanical characteristics of SCRLC. The column segregation and compressive strength testing are among the other methods used to evaluate SCRLC's qualities. Also studied was the association between fresh SCRLC property findings and the respective mortar's rheological property characteristics Thus, a better knowledge of the elements that influence the characteristics of SCRLC was concluded.

2. ExperimentalProgram

Materials. It was found that fly debris and common Portland concrete were the primary components of the folios in this study. Elastic particles, a water-lessening specialist, a thickener, and water were all also used into the formulation of the solution. Examined was a concrete and fly debris mixture using an X-beam fluorescence spectrometer (Bruker D8 Advance X-beam dif-fractometer).

The product offering of the improvement organization has water retention limits of 2.3 percent, pounding strength of 8.82 MPa, free mass thickness of 842 kg/m3, and a molecule size range of 4.75 to 19 mm. The manufacturer instructed us to use elastic particles (shown in Figure 2) in place of sand to reduce the volume of the final product. To measure its free mass, it was calculated by multiplying its modulus of fineness (2.7) by its thickness (1.19) grams per cubic centimeter. Sizing of sand and elastic molecules is seen in Figure 3.

The water-reducing specialist was a polycarboxylate-based high-range water minimizer (HRWR) with a 40% strong ingredient. The thickening, hydroxypropyl methyl cellulose ether, was produced by National Starch Industry (Shanghai) Co., Ltd. The business offered a viscosity of 20000 MPa s. The water used in the mixing process was ordinary city water.

Reconciling Ratios and a Methodology. SCRLC and a corresponding mortar were examined for its fresh and mechanical characteristics correspondingly in this research project. SCRLC mixture proportions are presented in Table 2. There is a ratio of 1.00: 0.20:00.012.42 (cement; fly ash; FA; thickener; LWA; HRWR; water) in the control mix. Rubber particles were used to replace the sand in this work, with replacement percentages ranging from 10% to 50%. Thickener and water-reducing agent were used to retain SCRLC's working ability.SCRLC There was a 0.04 percent thickener and a 1 percent water-reducing agent in the formula (by weight of binding materials). Water to binding materials was set at a ratio of 0.42. Mixture proportions were derived from concrete compositions without lightweight aggregate.

FIgurE 1: Crushed shale ceramsite.

Seconds after mixing for 2 minutes, the thickening and water-reducing agent were added to the dry mixture, which had been kneaded for the first minute. Mortar paste's rheological properties were immediately tested at a temperature of 20 5°C after mixing. Cement, fly ash, rubber particles, sand, and light-weight aggregate were initially dry-mixed for one minute before being added to concrete. It took two additional minutes of mixing on high speed to incorporate both the thickening and thinner. Following the pre-tests, the slump flow, the L-box, the V-funnel, the U-box, and the column segregation were tested immediately in a controlled environment at 20 5°C. Molds were loaded with mastic paste and a self-compacting lightweight agglomerate, then baked for 24 hours to produce two distinct sets of parts: For 7, 28, and 90 days, samples were maintained at 20°C with a relative humidity of at least 95 percent before testing was conducted on them all. After that, the mechanical characteristics of hardening mortar and SCRLC were tested.

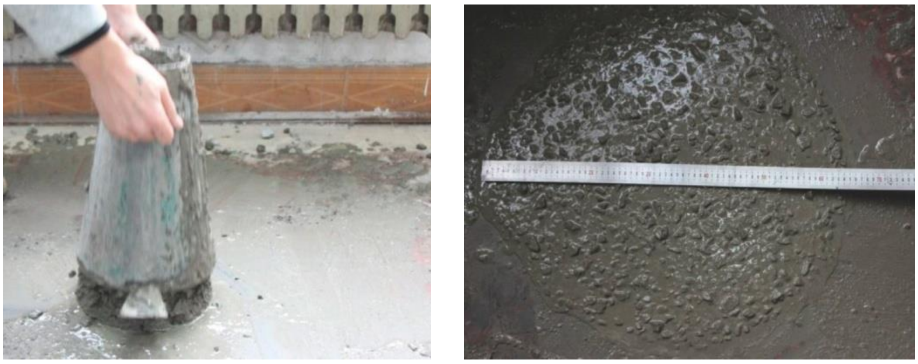
Tested using a rheological method, results showed a rise in shear rate and linear decline in shear rate between 0 S1 and 40 S1. The descending portion was used to analyze the flow curves' rheological properties. Rheological properties of a cement paste have previously been characterized using the Bingham model, which is based on prior research. Consequently, the Bingham model was used to investigate the rheological properties of mortar with rubber particles in the expectation that it would be a helpful tool. Use the Bingham model as follows to get the yield stress and plastic viscosities.

New SCRLC's resilience to segregation was evaluated in this study. The test's measure value may be computed as the segregation ratio (SR).

*2.5. Mechanical Properties Tests.*The mechanical characteristics of SCRLC hardening and a mortar were tested in this study. In a series of studies, SCRLC was tested for compressive, tensile, flexural and elastic modulus strengths. Compressive strength testing were performed on mortar at this time period. The compressive and splitting tensile strengths of the SCRLC were measured using 100 100 100 mm diameter cubic specimens. It was determined that SCRLC had an elastic modulus of 100 100 300 mm by measuring the elastic modulus of a prismatic specimen that satisfied the specifications of the GB/T 50081 standard.SCRLC's flexure strength was measured using prismatic specimens 100 100 400 mm in size. According to JGJ/T 70, the compressive strength of mortar was measured using three specimens each measuring 70,7,7,7,7 mm in cubical volume. Testing on mechanical characteristics required no compacting of any kind of specimens. We used a universal testing equipment that was operated by a computer to do these tests. Comprehending SCRLC's compressive, splitting-tensile, and flexural strengths, and comparing them to the compressive strengths of cor-

3. ResultsandDiscussion

Mortar Paste Rheological Properties. Mortar paste with different quantities of rubber particles is shown in Figure 10 by a rheological test. Using R2 values greater than 0.98%, Figure 10 indicates a strong linear relationship between shear rate and shear stress. Despite the existence of rubber particles in mortar pastes, the Bingham model may be used to fit shear rate and shear stress on varied re-placement levels of rubber particles. Using the flow curves, we may derive regression equations, as shown in Table 3.



(a) (b)

FigurE5:Slumpflowtest.

(a) (b)

FIgurE6:V-funneltest.

(a) (b)

FIgurE7:L-boxtest.

The V-Funnel design was put to the test. Time required for a V-funnel flow According to the rubber particle replacement ratio shown in Figure 15, the value of Tv varies. Rubber particles are replaced at a greater rate, as seen in the figure.According to the different rubber particles replacement ratio (0–50 percent), Tv increases from 14.7 to 24.3 seconds, which is around a 66% increase. It shows that when the rubber particle replacement ratio rises, the new SCRLC's filling capacity decreases. Rubber particles' lack of absorption means that they add more water to concrete mixtures, which increases the fluidity of the finished product.

Use an L-Box to do the test. T400 and h2/h1 findings were integrated in Figure 16, which shows the combined results. Increases in rubber particle replacement lead to an increase in T400, but decreases in h2/h1. Rubber particles diminish the h2/h1 ratio from 0.98 to 0.82 seconds, while increasing T400 from 7.7 to 10.9 seconds with a replacement ratio of 0 to 50 percent. The passage capacity of fresh SCRLC decreases as the replacement ratio of rubber particles increases, as shown by the T400 and h2/h1 variations. Rubber particles' shape and surface properties may also impact the passage capacity of fresh SCRLC.

Table4:TestresultsoffreshpropertiesofSCRLC.

Typeofconcrete	SF(mm)	T_{500}(s)	T_v(s)	T_{400}(s)	h_2/h_1(s)	Δh(mm)	SR(%)
SCLC	785	5.6	14.7	7.3	0.98	3	10.8
SCRLC10	770	5.8	15.6	7.5	0.97	4	9.7
SCRLC20	740	6.2	16.9	8.1	0.94	7	8.3
SCRLC30	710	6.7	18.5	8.5	0.92	9	7.5
SCRLC40	650	7.9	21.6	9.3	0.87	14	4.9
SCRLC50	580	9.4	24.3	10.9	0.82	18	3.2

4. Conclusions

Many trials were conducted to determine how SCRLC differed from a mortar of same composition in this study. The following are the results of our research.

Modeling shear rates and stresses may be done for mortar pastes with varying rubber particle replacement ratios by using the Bingham model. Mortar pastes may be considerably improved by increasing the percentage of rubber particles in the mortar. When the proportion of rubber particles in mortar increases, the molding properties of the finished product suffer.

Replacement of rubber particles in the SCRLC reduces the fresh characteristics of the SCRLC, such as the diameter of the slump flow and the h2/h1 ratio and segregation ratio. SCRLC's flowability, filling capacity, and passing ability decrease as the fraction of rubber replacement particles increases. SCRLC segregation resistance improves considerably as the rubber particle replacement ratio rises.

Rheological properties of mortar paste and the fresh features of SCRLC are clearly linked.

Both the shear tension and the plastic viscosity of the corresponding mortar pastes need to be less than 231.7 Pa and 3.72 Pas, respectively.

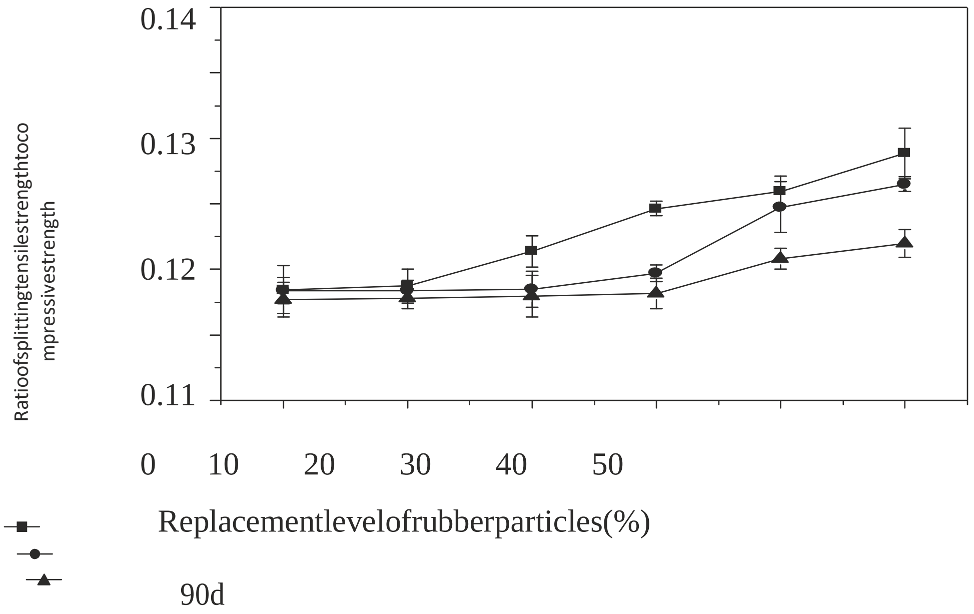


FIgurE23:Ratioofsplittingtensilestrengthtocompressionstrengthversusreplacementlevelofrubberparticles.

FIgurE24:Fracturedsurfaceinthetest.

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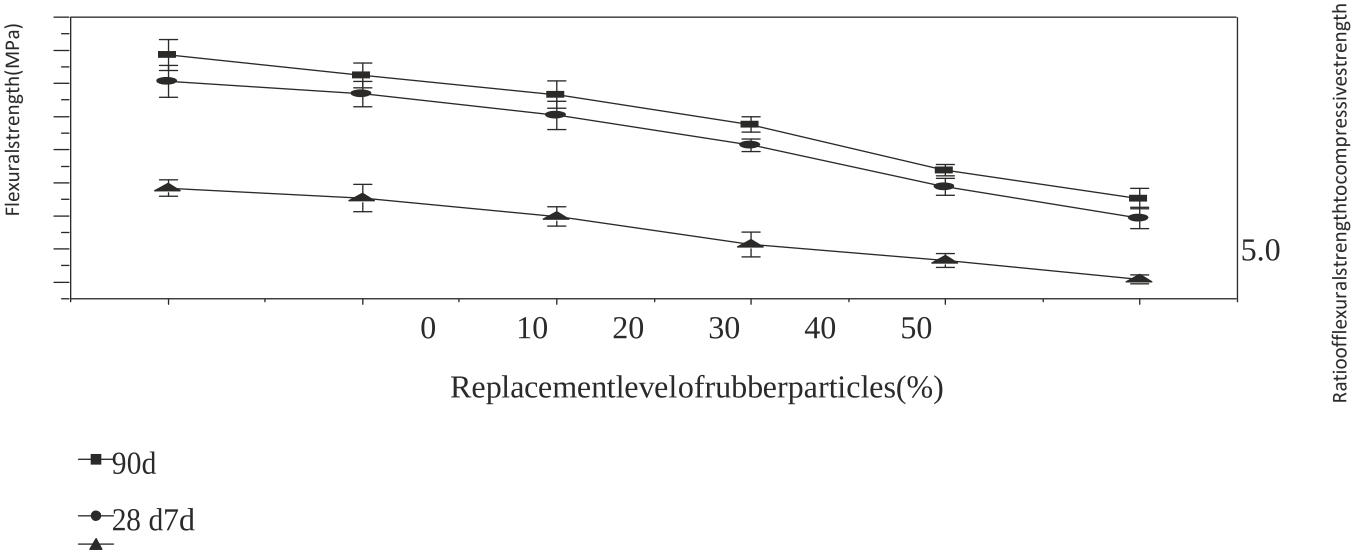

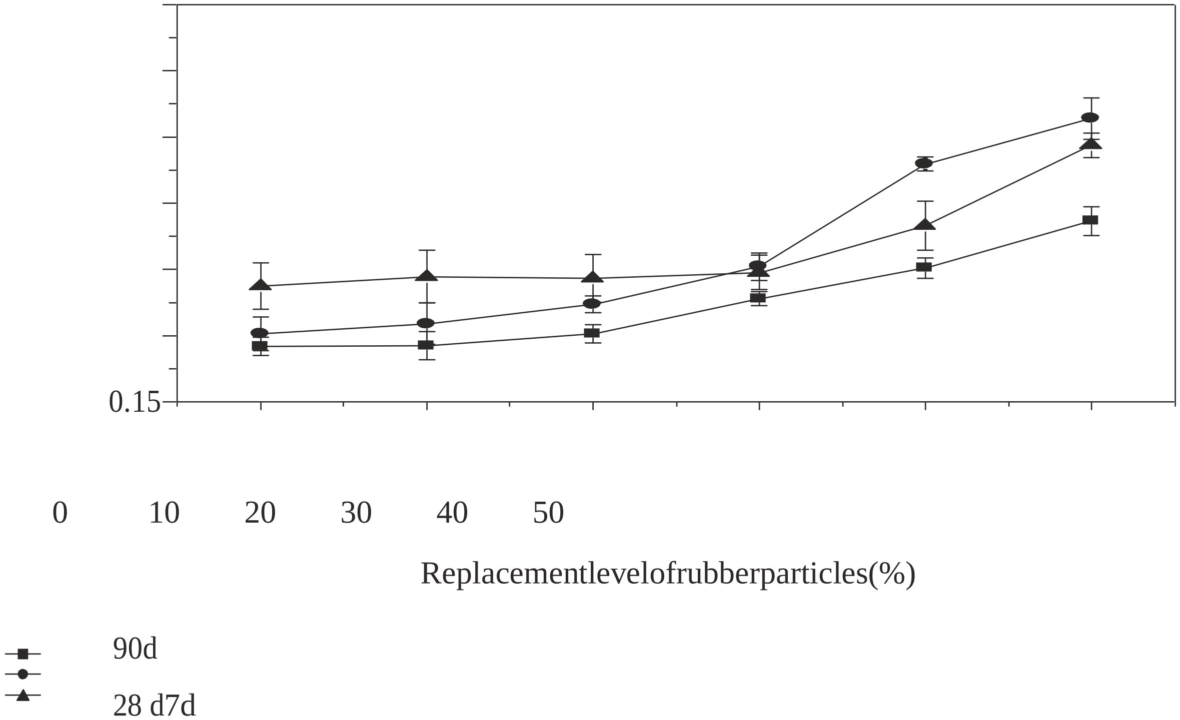

FIgurE 25: Flexural strength of SCRLC versus replacement level ofrubberparticles.

FIgurE26:Ratioofflexuralstrengthtocompressionstrengthversusreplacementlevelofrubberparticles.

References

[1] H.HuynhandD.Raghavan,"Durability ofsimulatedshredded rubber tire in highly alkaline environments," *AdvancedCementBasedMaterials*,vol.6,no.3-4,pp.138–143,1997.

[2] J.Lv,T.Zhou,Q.Du,andH.Wu,"Effectsofrubberparticlesonmechanicalpropertiesoflightweightaggregateconcrete,"*ConstructionandBuildingMaterials*,vol.91,pp.145–149,2015.

[3] A. M. Nayef, A. R. Fahadand, and B. Aluned, "Effect ofmicrosilica addition on compressive strength of rubberizedconcrete at elevated temperatures," *Journal of Material CyclesandWasteManagement*,vol.12,no.1,pp.41–49,2010.

[4] E.Ozbay,M.Lachemi,andU.K.Sevim," Compressivestrength, abrasion resistance and energy absorption capacityofrubberizedconcreteswithandwithoutslag,"*MaterialsandStructures*,vol.44,no.7,pp.1297–1307,2010.

[5] M. A. Aiello and F. Leuzzi, "Waste tyre rubberized concrete:properties at fresh and hardened state," *Waste Management*,vol.30,no.8-9,pp.1699–1704,2010.

[6] H.-Y.Wang,B.-T.Chen,andY.-W.Wu,"Astudyofthefreshproperties of controlled low-strength rubber lightweight aggregateconcrete(CLSRLC),"*ConstructionandBuildingMaterials*,vol.41,pp.526–531,2013.

[7] N. Ganesan, J. Bharati Raj, and A. P. Shashikala, "Flexuralfatiguebehaviorofselfcompactingrubberizedconcrete,"*ConstructionandBuildingMaterials*,vol.44,pp.7–14,2013.

[8] O. Onuaguluchi and D. K. Panesar, "Hardened properties ofconcrete mixtures containing pre-coated crumb rubber andsilica fume," *Journal of Cleaner Production*, vol. 82, pp. 125–131,2014.

[9] H. Zhu, J. Liang, J. Xu, M. Bo, J. Li, and B. Tang, "Research onanti-chlorideionpenetrationpropertyofcrumbrubberconcreteatdifferentambienttemperatures,"*ConstructionandBuildingMaterials*,vol.189,pp.42–53,2018.

[10] J.Xu,Z.Fu,Q.Han,G.Lacidogna,andA. Carpinteri,"Micro-crackingmonitoringandfractureevaluationforcrumbrubberconcrete based on acoustic emission techniques," *StructuralHealthMonitoring*,vol.17,no.4,pp.946–958,2017.

[11] T.-C. Ling, "Prediction of density and compressive strengthfor rubberized concrete blocks," *Construction and BuildingMaterials*,vol.25,no.11,pp.4303–4306,2011.