

Enhancing Concrete Barrier Reflectivity With A Recycled Glass Aggregate Replacement

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Abstract – On the roadways of the United States, increased accident rates during the evening and rainy weather conditions entail the need of improving the visibility of highway concrete barriers. The reflectance of these delineators is directly correlated to their degree of visibility. The use of white cement as opposed to grey cement and the installation of raised pavement markings to the side of the barriers are two of the suggested approaches that might potentially boost the reflectivity of these concrete barriers. There are several other potential methods. One of the suggested approaches that was put through more laboratory testing was the use of recycled glass in the production of concrete. The purpose of the laboratory experiment was to determine the appropriate mixing proportions that would reduce the likelihood of the alkali-silica reaction (ASR) occurring in recycled glass aggregate concretes without having any detrimental impacts on the compressive strength of the concrete. This paper includes the results of an evaluation done on the retro reflectivity of different concrete mixes.

Keywords- detrimental impacts, recycled glass, etc.

I. INTRODUCTION

In Figure 2, they demonstrate a rise in compressive strength of concrete by ratios of 3.6, 7.1, and 9.3%, and in Figure 2.3, they show an increase in splitting tensile strength of about 1, 4.3, and 12.5%, respectively. Fig. 2.2 It was also determined that the use of glass fibers in concrete increased the young's modulus by 9.7, 56.6, and 84%, respectively. Slump is lessened with an increment in fiber content, although Yogesh Murthy et al. observed a 30% in flexural strength while testing Glass fiber reinforced concrete beams with 1.5% glass fibers in the same year. Later, in 2013, G. Jyothi Kumari et al. replaced fine glass fiber with glass fiber reinforced polymer flats that were silica coated to demonstrate shear and display reasonably higher ductility.

Tassew et al. (2014) found that adding glass fiber to ceramic concrete at volumes of 0% to 2% by volume had little effect on compressive strength and modulus of elasticity, but led to significant increases in flexural strength and direct shear strength, regardless of the matrix type or fiber length, but at the cost of workability. Researchers Ahmet B. Kizilkanat et al. (2015) examined the mechanical characteristics and fracture behavior of glass-reinforced concrete at dosages of 0.25, 0.5, 0.75, and 1.0 and discovered that fracture energy rose dramatically after the 0.25% dose. Mechanical performance of the concrete

series was through experiments testing Compressive strength, splitting tensile strength, flexural tensile strength, and static and dynamic modulus of elasticity; in 2015 by Kutalmis Recep Akça et al., who used polypropylene fiber at concentrations of 0%, 1%, and 1.5% by volume to replace normal aggregate. In this study, there is a remarkable increase in split tensile and flexural strength on increment of fiber content. Research conducted by Arslan M. E. in 2016 found that there is no significant increase in compressive strength and Young's modulus of concrete, but flexural strength and split tensile strength were found higher on usage of 1 Kg/m³ of glass fiber reinforced concrete. Figures 4 and 5 display the effects of increasing the amount of glass fiber in concrete, demonstrating that doing so is not a good idea.

Concrete with a lower cement content was studied by Rath B. et al. in 2017 by combining glass fibers with the supplemental cementitious ingredient coal ash. Glass fiber addition is helpful for concrete, but it's pricey, therefore using fly ash can help cut costs and aid in finding the optimal mix, as determined by Scanned Electron Microscope (SEM) and Ultrasonic Pulse Velocity Test (UPVT). After that, in 2017, Faisal Sheikh Khalid et al. investigated the mechanical properties of concrete made with 25%, 35%, and 45% RCA and ceramic waste as coarse aggregate replacement and reported that 35% RCA and 35% ceramic waste showed the best properties compared with the normal concrete. Using scrap Tyres and recycled aggregates in concrete, Mohsen Ahmadi et al. came at the same conclusion.

Incorporating recycled fibers into concrete made with recycled aggregates resulted in the manufacture of structural concrete with a 50% replacement of aggregates, as the primary findings indicated. Recycled fiber additions of 0.5% and 1% of concrete by volume result in an 8% and 16% reduction in concrete pavement thickness, respectively. Properties of Recycled Aggregate Concrete (RAC) Utilizing Sodium Silicate and Silica Fume was the topic of Ngoc Kien Bui's 2017 dissertation. Compressive strength was increased by up to 50%, splitting tensile strength by up to 33%, and elastic modulus by up to 42% when the suggested approach was applied to 100% of coarse recycled concrete aggregate in comparison to untreated RAC. The experimental data in Figure 2.6 demonstrates that "the compressive strength of the treated RAC can be estimated at any age". An investigation into "the improvement of the mechanical properties of recycled concrete aggregate (RCA) produced by adding chopped basalt fibers (BF) with contents of 0.1%, 0.3%, 0.5%, 1%, and 1.5% by total volume of the mix to treated and untreated recycled aggregates" was published in 2017 by Hasan Katkhuda.

To better the connection between the recycled aggregate and the cement, the aggregate was pre-soaked in a 0.1 M hydrochloric acid (HCl) solution for 24 hours to remove the adhering mortars. Additionally, chopped BF was used in both the experimental and control normal aggregate (NA) concrete mixtures. The use of chopped BF increased the concrete's flexural and splitting tensile strengths while only slightly increasing the material's compressive strength. In addition, for untreated RCA, a BF concentration of 0.5% provided the same splitting tensile and compressive strength as NA, while a BF level of 0.3% produced the same flexural strength as NA (0.1%). Utilizing 20% recycled aggregates and 5% recycled hydrated cement (RHC) was shown to be the optimal mix in a study conducted by Viviana Letelier et al. in 2017. Then, in 2018, Christiana

Alexandridou et al. conducted an experimental study in which natural aggregates were partially replaced by recycled aggregates at percentages ranging from 0% to 75%; the results showed that "compressive strength of recycled concrete ranges from significantly lower (37% reduction) to equal, compared to conventional concrete, depending on the composition of recycled aggregate";

Experimental "behavior of compressive strength and flexural strength on usage of recycled aggregate in concrete" was investigated by G. Wardeh et al. in 2018; they discovered that the introduction of recycled aggregates decreases compressive strength and causes the elastic modulus to drop, leading to more cracks in the concrete than in conventionally made concrete. Printed

reports indicate in Kaiyun Wu et al. gave a talk at the IOP conference series about an experiment they did on the "fracture behavior of recycled aggregate concrete using 50%, 70%, and 100% of normal aggregates to partially replace normal aggregates and test initial cracking load and fracture energy."

The testing approach and predicted results indicated that regular aggregate concrete had a high initial cracking load, while recycled aggregate concrete had a lower one. In addition, the same trend is reflected in fracture energy behavior, and it was discovered that employing recycled aggregate concrete significantly reduces fracture energy. The compressive strength of recycled aggregate concrete (RAC) is lower than that of natural aggregate concrete (NAC) under the condition that water cement ratios (w/c) are the same. This was discovered in a study conducted by Jianzhuang Xiao in 2018. He compared the behavior of RAC to that of NAC when 0, 30, 50, 70, and 100 percent replacement of normal aggregates was performed. "Collecting data from 40 countries, it was found that till 2012, the construction and demolition waste generated per year was more than \$3 billion and was constantly increasing."

write Ali Akhtar et al. in their review article. To meet the strength criteria, his study report suggests using recycled aggregate at a rate of 30–50%, "not sufficient for developing countries like India and China". Yijie Huang et al. examined the mechanical qualities of concrete made with 50% and 100% recycled aggregate, natural coarse aggregate, and coral coarse aggregate.

Assessing "the performance of structural concretes containing 20%, 25%, 50%, 75%, or 100% mixed recycled coarse aggregate," B. Cantero analyzed the workability, density, and air content of new concrete as well as the compressive, flexural, and splitting tensile strengths of hardened concrete. Longer cure times reduced the strength loss compared to standard concrete. Even at advanced ages, performance dropped by 10% or more in most characteristics in concretes containing up to 50% recycled material. Based on these results, it is plausible that mixed recycled aggregates like those utilized in this study might be suitable for use in structural concrete with a characteristic strength of up to 30 MPa. Fracture energy and tensile strength rely on the increased amount and strength of coarse particles, as was discovered by Z. Jun in 2003 through his study of concrete beams notches and the use of the three-point bending test. Parameters of the two-parameter model of fracture were investigated and analyzed by R. Ince in 2008.

Experiments were done to look at the silicone rubber repetition of charged crack tips in SENB samples of different YR steels. Crack opening profiles and CTOD were used to do this. CTOD was standardized to the true CTOD in YR = 0.9 material for BS 7448. Still, a

noticeable overestimation was seen in the $YR = 0.6$ material. The varied strain hardening properties determined the position of the plastic strain, and from there, these paths emerged. With a focus on plastic restraint variation in fracture toughness specimens and structural elements with pop in repair metal, Shinde et al. discussed the effects of precisely tiny weld beams and high resistance overmatching on the fracture strength of laser beam-repaired parts. To account for restricted failure in structural parts, the CTOD toughness was analyzed numerically to get the corresponding CTOD ratio.

II. LITERATURE REVIEW

A comprehensive review of the prior studies conducted by several researchers from all over the world is performed. Using recycled aggregates has been shown to increase water absorption and carbonation while diminishing their strength properties. Instead, "glass fibers" have been proven to improve the performance of concrete in ways like strength and believability. More "recycled aggregates in concrete" may be used if "glass fibers" are included in the material.

Mechanical Properties of Glass Fiber Reinforced Concrete and Recycled Aggregate Concrete: A Review of Literature. Multiple studies have confirmed that recycled aggregates may be reused in concrete, and glass fiber has been discovered to be a substance that helps increase the flexural strength of concrete. Using recycled aggregates in concrete can lessen the environmental toll of demolished concrete, which is significant in the present day. Studies on "glass fiber reinforced concrete and recycled aggregate concrete" conducted by various scientists are listed in increasing order, such as:

In 1974, researchers Junji Takagi et al. did excellent work studying the impact of randomly oriented glass fibers on the "flexural strength, compressive strength, splitting tensile strength, and Young's modulus of concrete," drawing the conclusion that increasing the fiber content is beneficial to concrete because it gives it more strength. After that, in 1996, C. Vipulanandan et al. examined the flexural behavior of polyester polymer concrete with a fiber content of 6% by weight, varying the polymer quantity up to 18%. Usually, it is discovered that "flexural strength, failure strain (strain at peak stress), and fracture properties" all improve when fibers are added, but C.

Vipulanandan's research shows that the flexural modulus of Polymer Concrete barely changes at all. The "flexural strength" of Polymer Concrete was found to improve to 41.6 MPa with 6% by weight fiber content and saline treatment of aggregates and fibers, nearly doubling the strength of unreinforced 18% Polymer Concrete. In 2000, Limbachiya M. C. tested the effects of recycled aggregates on concrete by partially substituting

natural coarse aggregates, and they found that, up to a 30% recycled aggregate content, there was no change in concrete strength. At the "Federal University of Rio Grande do Sul, Brazil, by Leite" in 2001, "recycled aggregates" were utilized to make concrete as part of a campaign. Researchers found that a high percentage of fine RA decreases "compressive strength, splitting and flexural tensile strength, and modulus of elasticity". When testing with coarse, fine ceramic, and recycled concrete at water-cement ratios of 0.4, 0.45, 0.60, 0.75, and 0.80.

The use of "glass fiber reinforced plastic bars" (GFRP bars) as a reinforcing substance for concrete structures was further investigated by S.H. Alsayed et al. in 2001, who discovered that these bars have a low modulus of elasticity and could be used to regulate deflection in long beams. According to research conducted by Chini A. R. et al. in 2002 employing 100% recycled aggregates in pavement results in adequate compressive strength but lower flexural and split tensile strengths. Then, in 2002, F. Buyle-Bodin et al. examined the effects of "coarse and fine recycled aggregates" on the water absorption, air permeability, and carbonation of recycled aggregate concrete.

Recycled aggregate concrete also has a higher carbonation rate, which decreases its durability and makes it more susceptible to environmental hazards. Furthermore, in 2002, L. Azzouz et al. compared the mechanical qualities of concrete made with 100% natural aggregates to those of concrete made with 0, 25, 50, 75, and 100% recycled concrete aggregates. The study's findings indicated that "it is possible to manufacture concrete with a maximum of 50% recycled aggregates, and the strength thereafter is reduced." In 2003, researchers at the "Israel Institute of Technology by Katz" explored the potential of "recycled aggregate" by crushing 1, 3, and 28-day-old concrete samples in the lab. The recycled aggregates' characteristics varied widely depending on particle size group while the crushing age had little to no influence. When compared to concrete formed with fresh aggregates, the RA-manufactured concrete exhibited significantly worse quality.

The characteristics of concrete formed with aggregates crushed at 3 days were superior to those of concrete made with aggregates crushed at older ages. Strength and strain in confined fiber-reinforced concrete (CFRC) were shown to increase when evaluated using a strain control rate of loading by K. Ramesh et al., 2003. The researchers used nine prisms measuring 150 x 150 x 300 mm. In 2004, J.M.L. Reis et al. conducted an experiment showing that "glass fiber polymer concrete (GFPC)" has a 13% higher fracture toughness compared to non-reinforced polymer concrete with epoxy.

This finding prompted additional investigation into the glass fiber. Strength was reduced by roughly 15% to 30% when fine recycled aggregates of particle size less than 5 mm were employed in place of river sand, as demonstrated in Figure 2.1 by a study conducted by Khatib J. M. in 2004. In a 2004 study by Kou Shi C et al., they found that "decrease in strength of concrete on increase in content of recycled aggregate in concrete" occurred when "steam curing method was used for curing recycled aggregate concrete with fly ash using 0%, 20%, 50%, and 100% of recycled aggregates with 0.45 water-cement ratio and fly ash of 0%, 25%, and 35% by weight replacements of cement." The use of fly ash between 25 and 35% with steam curing allows for larger amounts of recycled aggregate to be included in concrete. Additional studies conducted by Poon C. S. in 2004 show a similar situation, demonstrating that recycled aggregates perform best up to 50% utilization, after which their workability decreases in concrete.

Additionally, Yeol Choi et al. (2005) discovered that "glass fiber reinforced concrete (GFRC)" and "polypropylene fiber reinforced concrete (PFRC)" may boost "split tensile strength" by 20% to 50% and "compressive strength" by 9% to 13%, respectively. Using recycled aggregates in concrete and pavement was the subject of an extensive study by Saeed A. and his colleagues in 2006. Using recycled aggregates in concrete, albeit in small quantities, was also considered in the study as a way to mitigate the impact on the environment. In continuation, G. Barluenga et al. (2007) concluded that "the maximum crack control ability, but in larger amounts, this did not increase the efficiency further," is achieved when "Alkali Resistant (AR) glass fibers" are added to both regular and self-compacting concrete at a rate of about 600 g/m³.

The RCA families were categorized according to whether or not synthetic fibers were used in the concrete mix during a campaign led by Cervantes et al. (2007) at the "University of Illinois, USA. Natural aggregates were mixed with either zero, fifty, or one hundred percent recycled concrete, plus either two and a half percent (0.2%) synthetic fibers or neither. The w/c ratio has stayed the same at 0.51 effective. Compressive strength, splitting tensile strength, modulus of elasticity, and shrinkage were among the tests conducted on the cured concrete. "Use of 50% RCA with 0.2% synthetic fibers produced a pavement-quality concrete with similar fracture and shrinkage properties to that of the virgin coarse aggregate concrete" was stated as the outcome of the tests.

In 2007, M. Etxeberria conducted experiments to determine the shear behavior and strength of beams using four concrete mixes with varying percentages of recycled aggregates with partial replacement (0 percent, 25 percent,

50 percent, and 100 percent) with different transverse reinforcements taking the same "compressive strength." He found that "a substitution of less than 25% of coarse scarcely affects the shear capacity of RC beams." According to research conducted by Srinivasa Rao et al. in 2009, "there is an increase in durability of concrete by conducting "quick chloride penetration tests" on alkali-resistant glass fiber-reinforced concrete of M30, M40, and M50 grades and also compared with conventional concrete. Increased acid resistance and less bleeding were also observed";

In 2009, A. Bordelon et al. studied "fracture behavior of paving concrete made with recycled concrete as a coarse aggregate, virgin coarse aggregate, and a blend of recycled concrete and virgin coarse aggregate with Discrete structural fibers and observed that a 50-50 blend of virgin and recycled concrete coarse aggregate produced similar fracture properties to VAC and both were 53% higher than the total fracture energy of the 100% RCA concrete." In 2010, Jorge de Brito et al. used experimental results to establish a relationship between the "compressive strength, splitting and flexural tensile strength, modulus of elasticity, abrasion resistance, shrinkage, water absorption, carbonation penetration, and chloride penetration" of hardened concrete and the "density and water absorption" of the aggregates. Knowing the replacement rate and the qualities of the aggregates allows one to predict the decline in performance of concrete made with recycled aggregates compared to normal concrete.

III.SYNOPSIS OF LITERATURE

According to the results of a literature review, "flexural strength and split tensile strength of concrete" decrease when recycled aggregates account for more than half of the total, so there is a need for a material that can compensate for this loss of strength while still delivering optimal durability and cost effectiveness. Examining the several methods available for boosting the "flexural strength and split tensile strength" of "glass fibers" revealed promising improvements in both flexure and tension. S2 glass fiber was found to have the highest tensile strength compared to the other types of glass fibers tested. Since the introduction of glass fibers in concrete enhances not only its strength but also its workability, Chlorine resistance, and cost effectiveness, researchers have zeroed in on optimizing mixes that maximize these qualities. It is also summed up that the ANSYS workbench may be used for modeling and analysis to verify the acquired optimal mixtures.

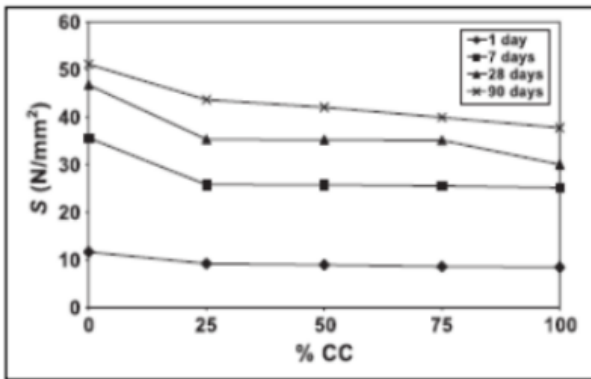


Fig. 1 Effect of fine recycled aggregate on compressive strength.

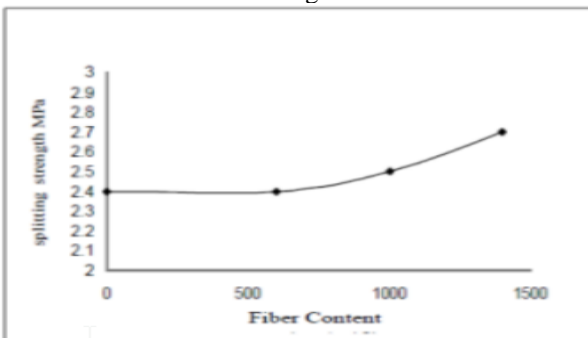


Fig. 2 Splitting tensile strength for concrete at different fiber content.

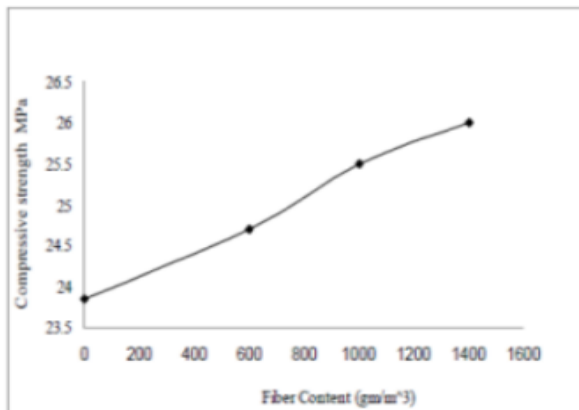


Fig. 3 Compressive strength for concrete at different fiber content.

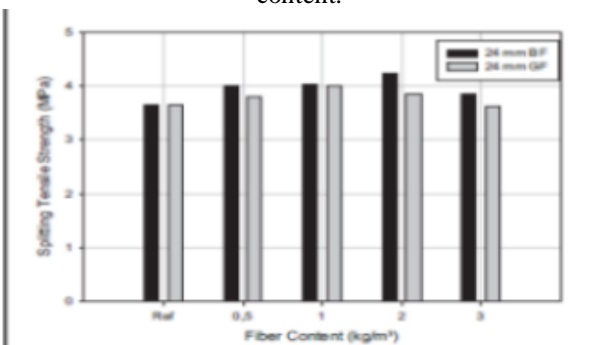


Fig. 4 Splitting tensile strength of the mixtures.

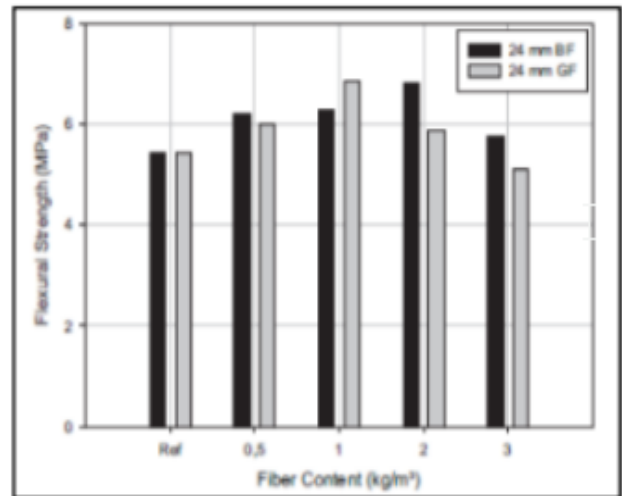


Fig. 5 Flexural strength of the mixtures

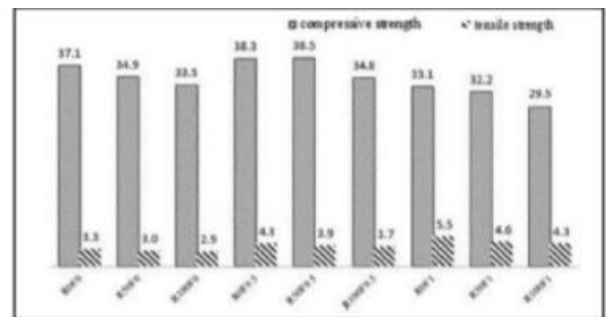


Fig. 2.6 Variation of Compressive strength and Tensile strength on the addition of recycled aggregates and steel fibers to concrete.

IV. EXPERIMENTAL PROGRAM

The M25 design mix is employed in this investigation. Physical attributes essential to mix design are being evaluated in the testing being done on the materials. S2 class glass fibers are utilized in the following percentages by weight of concrete: 0.25%, 0.5%, 0.75%, and 1.00%. Forty percent, sixty percent, seventy percent, eighty percent, and one hundred percent of natural coarse aggregates are being replaced with recycled aggregates. According to the reviewed literature, increasing the quantity of recycled aggregates to more than 50% can help maintain the concrete's strength, but utilizing recycled aggregates at all reduces the material's durability. Concrete, sand, gravel, S2 glass fibers, and recycled aggregates will all be put through their paces.

Concrete of the M25 quality has its mix designed in accordance with IS:10262-2009 Crack length and crack tip opening are measured for different mixes of concrete to determine their workability, compressive strength, flexural strength, split tensile strength, and fracture behavior. In the mix design of M25 grade concrete, the ingredients

“cement, fine aggregates, coarse aggregates, water” are employed. The following is a list of their characteristics and technical details: As the cement utilized in this study, we will refer to it as “ordinary Portland cement” of grade 43. The is devoid of coarse lumps and is a consistent grayish green in color. TABLE 3.1 provides a summary of the results of two separate experiments performed on cement. Both the IS:4031-1999 [84] and the IS:8112-2013 [85] protocols are followed in conducting these analyses.

Sub-micron particles: The grading zone III conforming fine aggregates used in the experiments were sourced locally. The fine aggregate is sieved according to IS:383-1970 in the laboratory. After being cleaned to get rid of the dust, the sand is sieved using a 4.75 mm sieve to get rid of any particles larger than that size. TABLE 3 and TABLE .3 illustrate the physical characteristics and sieve analysis of fine aggregates, respectively. Third, the coarse aggregates employed in the study are trampled rock aggregates (which be found in the area) with a nominal size of 20 millimeters.

The aggregates are washed to eliminate any remaining dust and grime, and then they are desiccated to an extremely dry state. The aggregates “are tested in accordance with IS:383-1970” [86].TABLE 3.4 displays the results of the different tests necessary for mix design, and TABLE 3.5 displays the results of the sieving of aggregates. Figure 3.1 shows a large boulder obtained from demolished concrete being broken down into smaller pieces using iron brushes to remove attached cement mortar before being cleaned from soil and labeled as recycled aggregates in Figure 3.2. Recycled aggregates are sourced from construction and demolition debris in Jalandhar, Ludhiana, and Amritsar.

Mix design necessitates testing the physical qualities listed in TABLE 3.6. The tensile strength of S2 glass fibers is far higher than that of any other type of glass filament. Made with a higher silica content than regular glass fibers. As can be seen in Figure 3.4, the CaO-free glass fibers employed in scientific studies are between 12 and 15 mm in length. TABLE 3.7 details the glass fiber specifications. Detailed information on the supplier of the S2 glass fiber ordered by the client is included in APPENDIX 4: Glass Fiber Vendor Information. It is recommended that gloves be always worn when handling S2 Glass Fiber.

Table 3.1 Physical Properties of Cement

S. No.	Characteristics	Values obtained	Standard Values
1	Normal consistency	33.3%	—
2	Initial setting time	48.5 min	>30 min
3	Final setting time	240.5 min	<600 min
4	Fineness	4.81 %	—
5	Specific gravity	3.12	—
6	Compressive strength		
S. No.	Days	Compressive strength	
1	3	24.81 MPa	
2	7	37.52 MPa	
3	28	47.64 MPa	

Table 2 Physical Properties of Fine aggregate

S. No	Characteristics	Value
1	Specific gravity	2.585
2	Bulk density	1.333 g/cc
3	Fineness modulus	2.628
4	Water absorption	0.889
5	Grading zone	Zone III

Table .3 Sieve analysis of Fine aggregate

Sr.No.	IS- Sieve (mm)	Weight Retained (gm)	Percentage Retained	Percentage Passing	Cumulative % retained
1	4.75	14.6	1.46	98.54	1.46
2	2.36	37.2	3.72	94.82	5.18
3	1.18	246.52	24.652	70.168	29.832
4	600 μ	205.51	20.551	49.617	50.383
5	300 μ	287.53	28.753	20.864	79.136
6	150 μ	176.92	17.692	3.172	96.828
7	Pan	31.72	3.172		
	Total	1000.000		SUM	262.819
				FM =	2.628

Table 4 Physical Properties of Coarse aggregates

S. No.	Characteristics	Value
1	Typé	Crushed
2	Specific gravity	2.692
3	Water absorption	0.557 %
4	Fineness Modulus	6.912

Table.5 Sieve analysis of Coarse aggregates

S. No.	Sieve size	Weight retained(gm)	Percentage retained (%)	Percent Passing (%)	Cumulative percentage retained
1	80	0.00	0.00	100.00	0.00
2	40	0.00	0.00	100.00	0.00
3	20	68.51	2.283	97.717	2.283
4	10	2776.48	92.549	5.168	94.832
5	4.75	113.51	3.783	1.385	98.615
6	Pan	0.00	0.00	0.00	
	Total	3000.00		SUM	195.73 + 500 =
				FM =	6.95



Fig.1 Concrete boulders obtained from demolished structures.



Fig. 2 Demolished concrete broken, and recycled aggregates obtained is processed for cleaning.

Table 6 Physical Properties of Recycled aggregates

SN	Characteristics	Value
1	Water Absorption	7.92%
2	Specific Gravity	2.34



Fig. 3 Recycled aggregates.



Fig.4 S2 Glass fiber to be not handled with bare hands.

Table 7 Properties of S2 glass fiber

Property	Results
Type of material	Magnesium alumino silicate glass without CaO
Fiber length (mm)	12-15 (mixed)
SiO ₂ Content	64-66%
Elastic Modulus(E)	79-89 MPa
Aspect Ratio	300-350

Mix Design of Concrete

The Mix design of M25 grade concrete is carried out as per according to IS:10262-2009 as this is the most used grade in structural purposes where there is no specific requirement. The material test values obtained are used to perform mix design and target mean strength is used by calculating using standard deviation. The water cement ratio used is 0.44 taken from IS code. Characteristics strength = M25 Target mean strength = $25 + 1.65 \times 4 = 31.6$ N/mm² Maximum water cement ratio = 0.44 Minimum cement content according to IS:456-2000 = 400 kg/m³ Nominal maximum size of aggregate = 20mm According to IS:10262-2009 maximum water cement ratio=186 Lit For 50 75mm slump = $186 + 3\%$ of 186 = 191.58 kg/m Water cement ratio is 0.44 so, cement comes to be 435.409 kg/m 435.409 kg/m > 400 kg/m According to zone of site for fine aggregate Volume of Coarse aggregate 0.64 As the concrete is to be used in pumps also therefore reduce 10% in volume of coarse aggregates "Volume of Coarse aggregate= $0.64 \times 0.9 = 0.576$ Volume of Fine aggregate = $1 - 0.576 = 0.424$

Mixing calculation per unit the volume of concrete

a. Volume of water- 1m³

$$= 191.58 \times (1/1000)$$

$$= 0.191 \text{ m}^3$$

b. Volume of cement- $435.409/3.12 (1/1000) = 0.1396$

c. Volume of all in aggregate = (b + c)

$$= 1 - (0.1396 + 0.191) = 0.6694 \text{ m}^3$$

$$= 0.6694 \text{ m}^3$$

"Mass of coarse aggregate (e) vol of coarse aggregate specific gravity of coarse aggregate 1000

$$= 0.6694 \times 0.576 \times 2.69 \times 1000$$

$$= 1037.19 \text{ kg}$$

"Mass of fine aggregate (e) volume of fine aggregate specific gravity of fine aggregate 1000

$$= 0.6694 \times 0.424 \times 2.59 \times 1000$$

$$= 735.108 \text{ kg}$$

$$= 735.108 \text{ kg}$$

Table.8 Compressive strength after 7 days

S. No.	Weight of Cube (Kg)	Peak Load (KN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
1	7.787	454.8	20.21	23.19
2	8.172	571.4	25.39	
3	8.167	539.2	23.96	

Table 9 Compressive strength after 28 days

S. No.	Weight of Cube (Kg)	Peak Load (KN)	Compressive Strength (N/mm ²)	Average Compressive Strength (N/mm ²)
1	7.93	798.6	35.49	33.39
2	7.91	723.4	32.15	
3	7.89	732.2	32.54	

Material compositions intended for use in academic study After reviewing the available literature, it was determined that up to 50% of the aggregates in concrete may be made from recycled materials. By including a greater proportion of recycled aggregates, this study aims to develop a novel type of environmentally friendly concrete. Environmental

depletion is causing major problems like global warming in many 11 countries. As can be seen in Figure 3.6, carbonation emissions rise if construction debris is deposited without first being handled. Strength and workability issues are the primary concerns when increasing the proportion of recycled aggregates in concrete.

Flexural strength decreases most when recycled aggregates are used in large quantities. Glass fiber was shown to be more promising than other materials that may be used to boost the flexural and split tensile strength of concrete. Therefore, in this study, we investigate the effects of varying the proportion of recycled aggregates to natural coarse aggregates from 40% to 100%. S2 glass fibers, which have the highest tensile strength of all the glass fibers employed, are the ones that are put to use here. After reviewing the available research, the following glass fiber additions were made to the concrete mix: 0.25 percent, 0.5 percent, 0.75 percent, and 1 percent, respectively. Figure 3.7 depicts the finished material mixture. TABLE 3.10 details the ingredients needed to cast 1 cubic meter of concrete using a variety of different mix proportions. Concrete samples have been given the identifier CR__G__, the meaning of which is depicted in Figure 5.

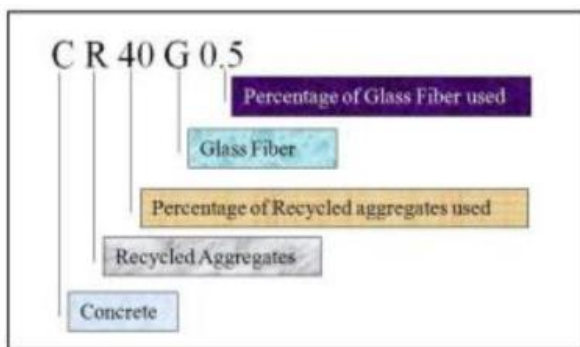


Fig. 5 Mix designation explanation in detail.



Fig. 6 Demolished concrete dumped creating pollution

Table 10 Material composition of different mix designations for experimental study

Material	CR0G0	CR40G0.25	CR40G0.5	CR40G0.75	CR40G1.0
Cement	435.41	435.41	435.41	435.41	435.41
Coarse Aggregate	1037.19	622.31	622.31	622.31	622.31
Fine Aggregate	735.11	735.11	735.11	735.11	735.11
Recycled aggregate	0.00	414.88	414.88	414.88	414.88
Glass Fiber	0.00	5.52	11.04	16.56	22.08
Water	191.58	191.58	191.58	191.58	191.58
Material	CR60G0.25	CR60G0.5	CR60G0.75	CR60G1.0	CR60G1.0
Cement	435.41	435.41	435.41	435.41	435.41
Coarse Aggregate	414.88	414.88	414.88	414.88	414.88
Fine Aggregate	735.11	735.11	735.11	735.11	735.11
Recycled aggregate	622.31	622.31	622.31	622.31	622.31
Glass Fiber	5.52	11.04	16.56	22.08	22.08
Water	191.58	191.58	191.58	191.58	191.58
Material	CR70G0.25	CR70G0.5	CR70G0.75	CR70G1.0	CR70G1.0
Cement	435.41	435.41	435.41	435.41	435.41
Coarse Aggregate	311.16	311.16	311.16	311.16	311.16
Fine Aggregate	735.11	735.11	735.11	735.11	735.11
Recycled aggregate	726.03	726.03	726.03	726.03	726.03
Glass Fiber	5.52	11.04	16.56	22.08	22.08
Water	191.58	191.58	191.58	191.58	191.58
Material	CR80G0.25	CR80G0.5	CR80G0.75	CR80G1.0	CR80G1.0
Cement	435.41	435.41	435.41	435.41	435.41
Coarse Aggregate	207.44	207.44	207.44	207.44	207.44
Fine Aggregate	735.11	735.11	735.11	735.11	735.11
Recycled aggregate	829.75	829.75	829.75	829.75	829.75
Glass Fiber	5.52	11.04	16.56	22.08	22.08
Water	191.58	191.58	191.58	191.58	191.58
Material	CR100G0.25	CR100G0.5	CR100G0.75	CR100G1.0	CR100G1.0
Cement	435.41	435.41	435.41	435.41	435.41
Coarse Aggregate	0.00	0.00	0.00	0.00	0.00

Compressive Strength Test: Compression testing, using a compression testing equipment of Make HEICO of 1000 KN, is conducted on specimen cubes of size 150 mm x 150 mm x 150 mm, cast in accordance with Indian specifications IS:516-1959 [81]. Three samples were evaluated after 7 days and three after 28 days of curing for each designation, and the average value of the findings was used. TABLE 3.11 and TABLE 3.12 detail the outcomes. Bars representing the average strengths of the different mix designations are shown in Graph 3. Table 12 Compressive strength of Cubes after 28 days in N/mm²

Mix Designations	CR40G0.25	CR40G0.5	CR40G0.75	CR40G1.0
Sample 1	23.51	20.00	19.11	18.49
Sample 2	28.71	19.42	23.82	19.25
Sample 3	25.64	22.62	25.29	17.70
Average	25.96	20.68	22.74	18.48
Mix Designations	CR60G0.25	CR60G0.5	CR60G0.75	CR60G1.0
Sample 1	21.11	30.77	22.07	20.04
Sample 2	21.58	31.36	20.22	22.46
Sample 3	22.80	32.57	21.98	19.24
Average	21.83	31.57	21.42	20.58
Mix Designations	CR70G0.25	CR70G0.5	CR70G0.75	CR70G1.0
Sample 1	27.87	21.88	21.07	21.33
Sample 2	27.93	19.30	19.47	20.31
Sample 3	25.47	19.24	19.64	23.29
Average	27.09	20.14	20.06	21.64
Mix Designations	CR80G0.25	CR80G0.5	CR80G0.75	CR80G1.0
Sample 1	29.94	25.20	32.98	24.09
Sample 2	31.97	23.64	34.80	21.91
Sample 3	30.04	25.56	32.53	22.86
Average	30.65	24.80	33.44	22.95

Flexural Strength Test: The beam sample is 100 mm x 100 mm x 500 mm, and there are three of each designation cast. Compression testing equipment is used to examine beams; flexural strength at four points. Figure 3.10 shows the flexural Strength test rig used to determine the strength of a 1000 kN HEICO specimen in accordance with Indian standards IS:516-1959.

Table 14 Flexural strength of various Mix designations

Specimen	Flexural strength (N/mm ²)	Specimen	Flexural strength (N/mm ²)
CR0G0	4.06	CR70G0.75	4.03
CR40G0.25	3.82	CR70G1.0	3.23
CR40G0.5	3.89	CR80G0.25	3.76
CR40G0.75	3.95	CR80G0.5	3.82
CR40G1.0	3.41	CR80G0.75	3.89
CR60G0.25	3.85	CR80G1.0	3.12
CR60G0.5	3.87	CR100G0.25	3.19
CR60G0.75	3.97	CR100G0.5	3.08
CR60G1.0	3.32	CR100G0.75	3.25
CR70G0.25	3.94	CR100G1.0	2.85
CR70G0.5	3.99		

V.CONCLUSION

The ultimate load of concrete beams made using 60% recycled aggregates and 0.75 percent fiber material was increased by 32.2%, and the fracture strength was increased by 31.45%, compared to conventional concrete beams. In comparison to regular concrete, the ultimate load in bending and shear was increased, and fracture strength was increased, when 60% RA and 0.5% fiber material were used. Because of the similarity in price to regular concrete, the researchers concluded that CR60G0.5 might be utilized for beams and slabs subject to flexure in concrete structures.

The critical load and fracture characteristics of GFRC beams were much higher than those of ordinary concrete beams. When compared to concrete of the same grade, RAC displays the same behavior upon fracture. When the RCA replacement ratio is over 60%, the fracture strength drops by 20%. Adding S2 glass fibers transformed the brittle flexural failure mode into a ductile one. Adding S2 glass fiber in place of 60% RA increases the CTOD the concrete. Based on experimental data, we know that CR60G0.75 has a fracture brittleness number of 271 mm, which places it between the ranges of 150 and 300 mm. Crack tip opening displacement (CTOD) and stress intensity (K_{ic}) have been correlated using Karl Pearson's and Spearman's correlation coefficient methods, respectively, and the results show a positive, strong correlation between the two for mixtures containing 60% and 80% recycled aggregates.

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