STRENGTH CHARACTERISTICS OF CONCRETE INCORPORATED WITH E-FIBER WASTE

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ABSTRACT - In many developing nations, concrete is the man made materials that is most frequently used for all types of civil engineering projects. Additionally, concrete is environmentally friendly material, which is crucial in regions where environmental consciousness is developing. Since decades, experts have conducted several studies in an effort to increase the quality, strength and durability against harmful exposures. Concrete made of Portland cement is thought to be a somewhat fragile substance. The concrete which is not reinforced, will fail and make crack when it is subjected to tensile loads. Steel reinforcement has been utilized to solve those issue, since in middle of 19th century. As a composite system, it is expected that reinforcing steel can support all tensile loads. The addition of e- waste fibers to the concrete mixture can also increase the tensile loading capability of composite system. In fact studies have shown that adding fiber reinforcing can make concrete stronger overall. This project makes an effort to solely employ e-waste fibers. Test samples of volume 5%, 10%, 15%, 20%, and 25% of coarse aggregate were prepared with and without E-fiber waste. At 7, 21, and 28 days after curing, split tensile and compressive strength tests were performed. 10% of E-waste fiber replacement was discovered to be the ideal content for achieving the best mechanical performance from concrete.

Keywords : e-fibre waste, waste management, compressive strength, strength characterization.

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1. INTRODUCTION

Tension is weak in concrete. At about 10 to 15% of the ultimate load, the micro cracks start to form in the matrix of a structural element, and at 25 to 30% of the ultimate stress, they start to spread into micro cracks . Therefore, without the insertion of continuous bar reinforcing elements in the tensile zone of supported components like beam or slabs, plain concrete members cannot be anticipated to withstand considerable transverse loading. However, the micro and macro cracking that are already present cannot be stopped or slow by using only continues reinforcement . A section tensile zone's role is replaced by this reinforcement, which is also assumes the tension equilibrium force within the section. Incorporating discontinuous fiber pieces with random spacing could help to stop the growth or spread of the little cracks that are known to appear early in the loading history. Since the dawn of time, fibers have been employed to strengthen fragile materials like concrete; nevertheless, in the last three decades, newly created fibers have seen widespread use. Commercially, various kinds are offered, including steel, glass, polypropylene, and figureite. They have demonstrated their ability to enhance the mechanical properties of concrete, both as structure and a material, not in place of, but in addition to, continuous-bar reinforcement where it is required.

The overlays for bridge decks, highway and airport pavements, industrial floors, shotcrete applications, seismic and explosion- resistant structures, super flat surface slabs on grade in warehouse, and the elimination of expansion joints are common uses for fiber reinforced concrete. It explains the mechanical characteristics and geometry of several fibers types that can be employed as filaments spread at random in a concrete matrix. Before choosing a fiber type, the designers should be directed by the manufacturer's data on each product and experience with it due to the vast range of attributes for each type of fiber.

2. E-WASTE FIBER REINFORCED CONCRETE: (EWRC)

On the other side, in the sphere of building, efforts have been undertaken to partially replace coarse aggregate with e-components wastes parts. Utilizing crushed e-waste materials in place of conventional concrete and other building materials reduces the price of producing the concrete. The most effective way to decrease the amount of e-waste produced, create environmentally friendly concrete, and save the environment from the effects of pollution is through recycling. The goal of this study is to lower building costs by testing the effectiveness of concrete made with e-waste in place of coarse aggregate.

Applications:

- **i.** slab on grade: every kind of pavement and overlay, commercial floor, public streets, airport hangars, etc.
- **ii.** concrete used for structural purposes includes bridge decks and girders, machine foundations, slabs, column beams and lintels, and shallow and deep foundation
- **iii.** buildings that retain water include RCC retaining walls, water tanks, cross drains, swimming pools, check dams, canal lining, ETPs, jetties, ports, and spillways, among other things
- **iv.** sunken toilets, rooftop water proofing, etc.

3. MATERIALS AND METHODOLOGY

This chapter discusses methods as well as the physical, mechanical, and chemical characteristics of several material like cement, fine aggregate, coarse aggregate, fly ash, quarry dust and industrial trash.

3.1 CEMENT:

The chemical composition of cement determines its many physical and chemical traits. The qualities and types of cement produced by varying the grinding fineness are oxide compositions cement. There are many distinct types of cements available as a result of the addition of additives, changing chemical composition, and usage of various raw materials. The experimental work's cement is ordinary portland cement, which comes in 43 grades and complies with IS: 8112/1989. Table 1 properties the characteristics of cement.

Table 1: properties of cement

S.NO	PROPERTIES	TEST RESULTS	IS: 169-1989
1.	Normal consistency	0.32	
2.	Time of Initial setting	50min	Minimum of 30min
3.	Time of Final setting	320min	Maximum of 600min
4.	Specific gravity	2.7	
5.	Compressive strength	56.6Mpa	Minimum of 53Mpa

3.2 COARSE AGGREGATE:

As coarse aggregate, crushed granite with particle sizes of 10 and 20 mm is employed. According to IS 383-1970 [Methods of physical tests for hydraulic cement], these were put to the test. Table 2 displays the physical characteristics including specific gravity, bulk density, flakiness index, elongation index, and fineness modulus. As coarse aggregate, crushed granite with a 10mm particle size is employed**.**

Table 2 : properties of coarse aggregates

S.NO	DESCRIPTION	TEST RESULTS
1.	Utilized Nominal size	10mm
2.	Specific gravity	2.7
3.	Impact value	10.5
4.	Water absorption	0.15%
5.	Sieve analysis	20mm
6.	Aggregate crushing value	20.19%
7.	Bulk density poured & tapped	1687.31kg/m3 1935.3 kg/m3

3.3 FINE AGGREGATE:

As Fine aggregate (M-sand), which met the criteria for experimental work and complies with zone as defined by IS: 383- 1970. Table 3 deals the Fine Aggregate Characteristics.

Table 3: properties of fine aggregates

S.NO	DESCRIPTION TEST	RESULT
1.	Sand zone	Zone – iii
2.	Specific gravity	2.6
3.	Free moisture	1%
4.	Bulk density poured & tapped	1385.1kg/m3 1606.2kg/m3

3.4 QUARRY DUST:

The rock is crushed into different sizes during quarrying activities; the dust produced during the process is referred to as quarry dust and it is created as trash. As a result, it is rendered unusable and contributes to air pollution. Therefore, quarry dust should be used in construction projects to lower construction costs, save on construction materials, and ensure proper use of natural resources. Quarry dust has been utilized in the construction industry for a variety of purposes, including bricks, tiles, aggregates for roads, and building materials. Table 4 shows the properties of quarry dust. In this project the quarry dust of particle size 0.75 – 5mm is used

Table 4 : properties of quarry dust

S.NO	DESCRIPTION TEST	RESULT
1.	Specific gravity	2.57
2.	Fineness modulus	2.41
3.	Density	1.85gm/cc
4.	Void ratio	0.42

3.5 E-WASTE:

This project makes use of e-waste non-metallic printed circuit board. Waste E-plastic particles are found to have split particle sizes ranging from 16 to 20 mm. Waste E-plastic particles have been used in cement concrete in varying amounts as filler material. Table 3.1 displays the fiber's characteristics

Table 5 : properties of E-waste

S.NO	DESCRIPTION	TEST RESULTS
1.	specific gravity	1.4
2.	color	dark
3.	shape	angular
4.	water absorption	<0.2
5.	fineness modulus%	2.932
6.	bulk density g/cc	0.738

3.6 FLY ASH :

One of the most widely utilized supplementary cementitious materials in the building industry that resembles Portland cement is class F fly ash. It is a finely separated residue that is inorganic, noncombustible, and collected. Less than 20 micrometers is the average particle size for Class F Fly Ash, with particle sizes ranging from less than 1 micrometer to more than 100 micrometers. Although some Class F Fly Ashes can have surface areas as low as 200 m2/kg and as high as 700 m2/kg, their surface area is normally between 300 and 500 m2/kg.The grade I of IS: 3812 - 1981 [Specifications for Fly Ash for Use as Pozzolana and Admixture] confirms this. According to IS: 1727 -1967 [Methods of test for pozzolana materials], it was put through testing. Table 3.5 displays the usual oxide composition of Indian fly ash. Tables 6 provide information on the chemical make-up and physical features of Class F Fly Ash utilized in the current experiment.

Table 6 : characteristics of fly ash

S.NO	CHARACTERISTICS	PERCENTAGE
1.	Silica	49-67
2.	alumina	16-28
3.	Iron oxide	4-10
4.	lime	0.7-3.6
5.	magnesia	0.3-2.6
6.	Sulphur trioxide	0.1-2.1
7.	Loss on ignition	0.4-1.9

8.	Surface area m²/kg	230-600

4. METHODOLOGY:

Using various amounts of e-waste, a preliminary investigation on compressive strength, tensile strength, and flexural yielded a range of fiber dosages of 0%, 5%, 10%, 15%, 20%, and 25% by volume. combined with regular aggregate. Experimental concrete cubes and cylinders measuring 150mm in diameter and 300mm in height, each made of PCC (plain concrete) and E-waste fiber reinforced concrete with experimental fibers, were cast in the current study and tested for compression and tensile strength after 7, 21, and 28 days of curing. A concrete beam with the dimensions 150mm x 150mm x 500mm was cast, and its flexural strength was assessed after 7, 21, and 28 days as well as during the beam flexural test.

Despite some visibly significant variations, e-waste reinforced concrete can often be made using normal concrete techniques. The main challenge is adding enough equally dispersed to the new mix while maintaining enough workability to allow for correct mixing, placement, and finishing while achieving the needed improvements in mechanical behavior . E-waste with a higher aspect ratio has a greater impact on the performance of the hardened concrete because it strengthens the link between the fibers and the matrix. On the other side, a high aspect ratio has a negative impact on how easily the fresh mix can be worked. In general, as fiber length and volume rise, the issues with workability and uniform distribution get worse. Using standard concrete equipment, e-waste reinforced concrete may be laid successfully.

Due to the fibers' propensity to prevent flow, it looks to be highly rigid; but, when vibrated, the material will flow easily into the shapes. It should be emphasized that water should only be cautiously added to E-26 waste fiber reinforced concrete mixes to promote workability because, above a w/c ratio of roughly 0.5, more water may cause the concrete's slump to increase without improving its workability or ability to withstand vibration. Although probably greater attention should be paid to workmanship, the finishing processes for E-waste fiber reinforced concrete are practically the same as for ordinary concrete.

5. RESULT AND DISCUSSIONS:

5.1 COMPARISON OF COMPRESSIVE STRENGTH:

The primary consideration in structural design is compressive strength. At 7, 21, and 28 days, the strength development in E-Waste fiber reinforced concrete was studied. The compressive strength's range with various percentages of E-waste fiber (0%, 5%, 10%, 15%, 20%, and 25%) over regular aggregate concrete. Due to the fact that all concrete specimens increased in compressive strength as the curing age increased. .The table ‘7’ shows the 7, 21 & 28 days compressive strength results. the graphical representations of compressive strength results are shown in figure '1'.

Table 7 : 7, 21 & 28 days compressive strength

Mix	7 days N/mm	21 days N/mm	28 days N/mm
0%	21.093	25.44	31.08
5%	22.702	29.55	36.94
10%	24.062	31.59	39.48
15%	20.56	24.64	30.6
20%	21.81	28.52	35.8
25%	23.6	30.64	37.7

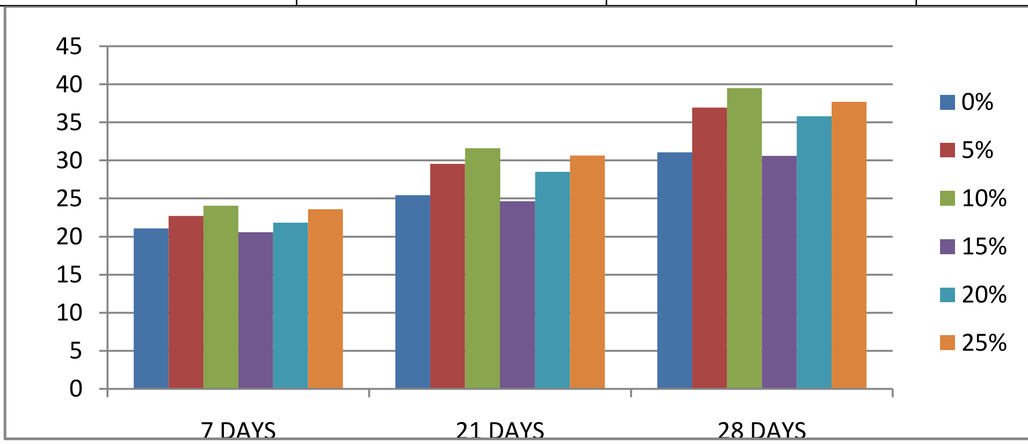

Figure1 : comparison of compressive strength

E-Waste Fibers do improve the concrete's static compressive strength, with gains in strength ranging from virtually none to about 5%. The fibers have no impact on compressive strength even in components that also have conventional reinforcement in addition to the E-waste fibers. The material's post-cracking ductility, or capacity to absorb energy, is significantly improved by the fibers.

5.2 SPLIT TENSILE STRENGTH:

For damp cured concrete specimens, the splitting tensile strength was assessed at ages of 7, 21, and 28 days. According to the test results for splitting tensile strength, all different types of concrete specimens generally showed a steady increase in splitting strength during the course of curing times.

From the figures, it can be shown that E-waste fiber reinforced concrete has more splitting tensile strength than regular concrete at all stages of curing. This rise may be attributed to the cement matrix's large reduction in capillary porosity and the cement grains' effective distribution throughout the mixture, which increased bond strength and, in turn, significantly increased splitting tensile strength. .The table '8' shows the 7, 21 & 28 days split tensile strength results. the graphical representations of split tensile strength results are shown in figure '2'.

Table 8 : 7, 21 & 28 days split tensile strength

Mix	7 days N/mm	21 days N/mm	28 days N/mm
0%	3.177	3.36	4.21
5%	3.414	3.46	4.34
10%	3.814	3.95	4.65
15%	3.03	3.10	3.91
20%	3.2	3.38	4.01
25%	3.5	3.72	4.3

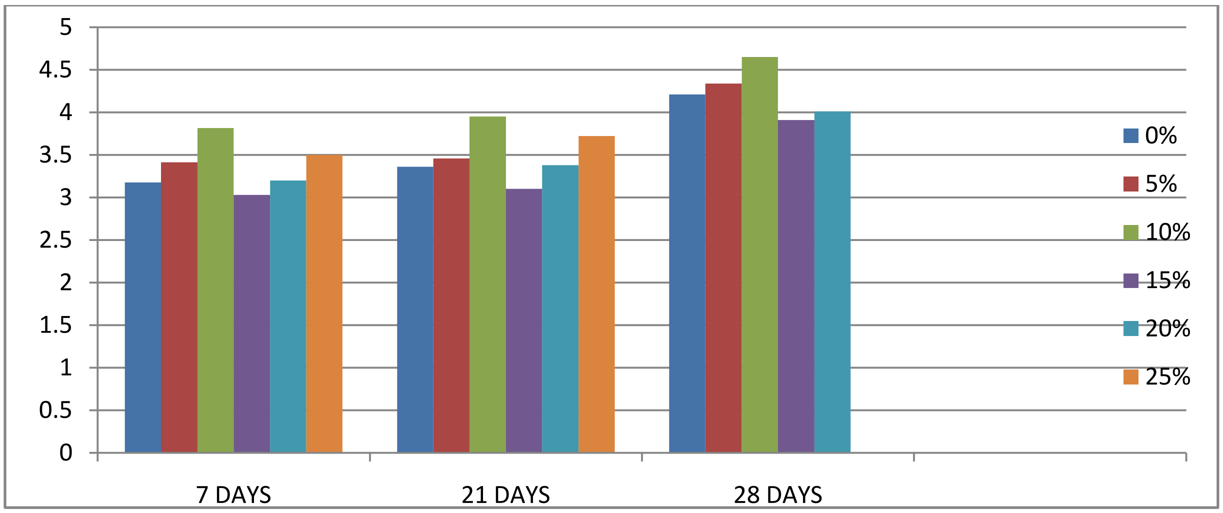

Figure 2 : comparison of split tensile strength

E-waste fibers may see gains in direct tensile strength of up to 8% when fibers are aligned in the direction of the tensile stress. For fibers that are dispersed more or less randomly, the gain in strength is substantially smaller and can sometimes be as low as 0% to as high as 40%, with many studies finding intermediate values. Similar results were found in the EWRC splitting-tension test. However, as in compression, E-waste fibers do contribute to considerable increases in the post-cracking behavior or toughness of the composites.

5.3 FLEXURAL STRENGTH:

Although the relationship is not one of direct proportionality, it is clear that the strength of concrete in compression and tension in both directions (i.e., direct tension and flexural tension) is strongly connected. The relationship between the two strengths depends on the overall strength of the concrete. To put it another way, higher compressive strength of concrete for typical aggregate concrete indicates higher tensile strength, but the rate of rise of tensile strength is rising order . The table '9' shows the 7, 21 & 28 days flexural strength results. the graphical representations of flexural strength results are shown in figure '3'.

Table 9 : 7, 21 & 28 days flexural strength

Mix	7 days N/mm	21 days N/mm	28 days N/mm
0%	5.80	6.0	7.12
5%	6.08	6.66	7.40
10%	6.56	7.02	7.82
15%	4.96	5.96	6.61
20%	5.28	6.32	7.00
25%	5.84	6.6	7.40

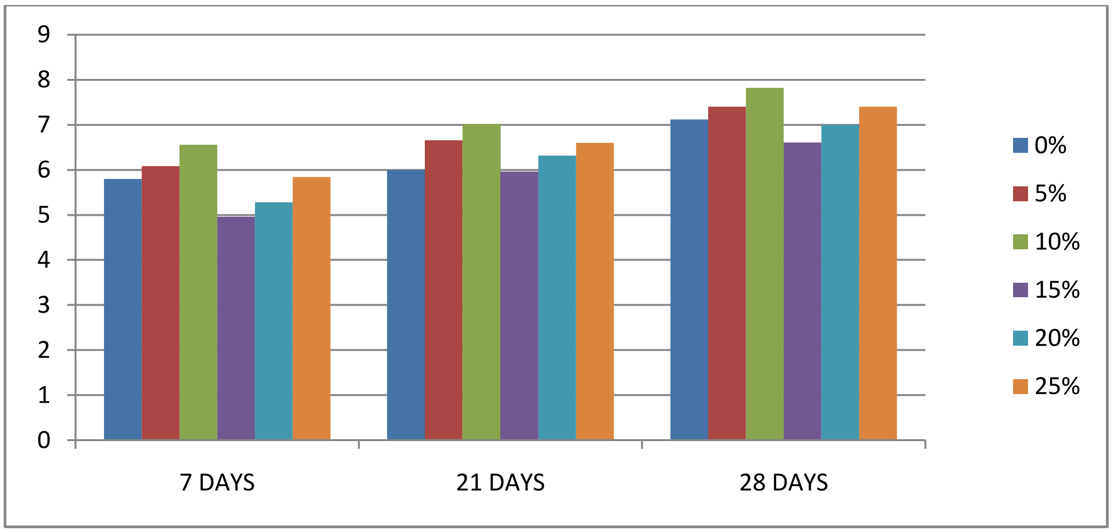

Figure 3 : comparison of flexural strength

With increases of more than 7.5% observed, e-waste fibers are often found to have a normal aggregate far higher effect on the flexural strength of EWRC than on either the compressive or tensile strength. In addition to the fiber volume, the aspect ratio of the fibers also affects the improvements in flexural strength, with a higher aspect ratio resulting in greater strength increases. At the same volume concentrations, fibers having superior bond properties—that is, deformed fibers or fibers with a larger aspect ratio—give higher toughness values than do smooth, straight fibers for all empirical measurements of toughness.

6. CONCLUSION:

The compressive strength is affected by the addition of E-waste fibers in a way that increases by 5% with 10% of fiber, starts increasing, and then declines with more fiber added.

The results of the splitting tensile strength tests indicate that adding more fiber increases strength. In comparison to other mixes, 10% of E-waste fibers had the highest splitting tensile strength, which was discovered to be about 5.39 N/mm2. 8% more weight can be carried than the standard specimen, according to the load bearing capacity.

According to the results of the experimental tests, the 10% mix has improved flexural strength at ages 7, 21, and 28 days, compared to all other mixes.

E-waste fibers are employed because they are affordable and corrosion-resistant. To achieve optimum performance, EWRC involves particular design considerations and construction techniques. The reduction in maintenance and rehabilitation activities offsets the initial cost increase by 15–20%, making EWRC more affordable. Structural stability aids in growth and development in a large, quickly developing nation like India.

Our society is disturbed by resistance to change, no matter how minor, therefore we are never willing to accept even the finest. It's time to push through the obstacles and aim for the summits. EWRC offers fresh hope for improving "True Indian Structures'" quality and globalizing their appearance.

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