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Analysis of Fibre Reinforced Beams

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Abstract

There has been research into the flexural behaviour of composite beams with a variety of fibre layer depths, all of which were designed using the balancing section and the limit state design idea. The fibre depth is estimated to be 112 mm (d = 112 mm), with the first three dimensions being 94.44 mm (d1 = 94.44 mm), 46.12 mm (d2 = 22.35 mm), and 22.35 mm (d3) respectively. The percentage of fibre in the cement might vary from 0.28% to 0.50% to 0.70% to 1% depending on the depth. Compression and tensile tests have been conducted on both the cube and cylinder portions of the beam specimen. For example, brittle failure is seen in beam specimens comprised completely of Steel fibres and no Mild Steel (M.S) bars. Reinforced with steel fibre and demolition debris, concrete can withstand micro-cracks, cavitations, and other flaws with ease (DW). Fibre-rich waste items might be utilised to create a suitable replacement. Its extreme dispersion creates additional challenges for specialised production. Due to cavitations, the interconnectivity of the particles is weakened, and the concrete's stress zone becomes more transparent. Waste materials such as fibre and river bed material (RBM) may assist address this deficiency by filling in the spaces between the coarse aggregates. An experimental study was done on both fresh and cured concrete with a notional mix of 1:1:3 by weight and a water-to-cement ratio of 0.5:1 in order to achieve the necessary mean strength as defined by Indian Standard 456:2000. Researchers have undertaken trials to evaluate the strength and durability of RBM (3 mm–4.80 mm), demolished rubbish (13.5 mm–22 mm), and fibre (FRC) to that of standard concrete. The results show that fibre addition improves concrete binding abilities and micro crack control makes the material more adaptable. These investigations show that the inclusion of 0.5% fibre greatly improves the mechanical features of FRC in comparison to RC in the stress zone.

Keywords: Fibre Reinforced Concrete, Human hair, flexural strength, compressive strength, Fly ash, Stone dust

INTRODUCTION

Extent RAC beams' flexural behaviour under short-term stress is similar to, or different from, that of NAC beams, and hence whether or not RAC may be used in structural concrete components. Our analysis of load deflection, fracture pattern, and service deflection was informed by the work of other researchers. [1], failure mechanism, and ultimate flexural capacity testing, we compared NAC and RAC beams. Analyses revealed that, for both service and ultimate stress, the flexural behaviour of RAC beams is preferable to that of NAC beams. Within the scope of this study, it is determined that the use of RAC in RC beams is technically viable. Beams made using demolition debris aggregate [2] have been evaluated for their flexural behaviour. Both conventional concrete and concrete made from 100% recycled concrete aggregate (RCA) were tested for their flexural strength in the context of constructing a full-scale reinforced concrete beam (CC). The beams were put through their paces with a straightforward four-point load [3]. ACI 318-11, Euro code 2-05, and the modified

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compression field theory (MCFT) approach were used to evaluate the cracking, yielding, and ultimate moment of the beams. Ultimate flexural strength is similar between CC and RCA [4] beams, however RCA beams have around 13% more deflection at the same ultimate flexural strength. Recycled aggregate concrete (RAC) beams made with various percentages of RCA have been put through low velocity impact testing [5]. In addition to the physical and mechanical properties of RCA and RAC, the behaviour of the RAC beams under impact load is investigated in terms of acceleration, stresses, and support reaction histories [6]. Adding 25% RCA does not seem to have any effect on the strength of concrete. Results further show that the reactions and stresses of RAC with 50% and 100% RCA are much lower and greater than those of regular concrete and RAC with 25% RCA for a given impact energy (the energy delivered by the hammer per blow) [7]. With the vast potential for demolished concrete to serve as a source of quality aggregate feed stock in a wide range of structural and non-structural applications, understanding the flexural fatigue behaviour of Steel Fiber Reinforced Recycled Aggregate Concrete (SFRRAC) is becoming increasingly important [8]. This study is a follow-up to others that have been undertaken to determine how to best put recycled aggregate to use [13-19].

Stiff pavements made of concrete. Recycled aggregate content, natural aggregate content, steel fibre presence, and stress levels were all variables in the study. The results of the research demonstrated that recycled aggregates may be utilised in stiff pavements as well, and that the addition of fibres can improve the fatigue performance of recycled aggregate concrete [9].

FABRICATION OF MATERIAL:

- The total load of a river system is made up of the dissolved load, the wash load, and the bed material load. Specifically, the fraction of sediment carried by a stream that is composed of bed material is called the bed material load. All of the bed load and the fraction of the suspended load that is reflected in the bed sediments make up the bed material load [10-12]. RBM (2 mm–4.75 mm) is a fine aggregate that may be obtained in the area; its physical features include a specific gravity of 2.68 g/cc, an absorption of 0.46 percent of water, a silt content of 2.22 percent, and a fineness Modulus of 3.02.
- Normal consistency 27%, Initial setting time 31 min, and Final setting time 370 min were measured using the ordinary Portland cement of grade 43 according to I.S.8112:1989

PREPARATION OF SPECIMEN

Mechanical characteristics have been determined by casting 150 mm cubes, 100 mm cylinders, 200 mm beams, and 1000 mm squares as shown in Figure 1. The concrete's W/c ratio needs to be close to 0.5 in order to achieve the desired mean strength. Table 1 displays the percentages of each component used in each test series. Fiber has been dispersed softly and the dry weighted material has been blended with a trowel. Fibre aggregation was avoided, and uniform dispersion was ensured, to the best of our abilities. A lot of attention was paid to making sure the Concrete was compacted and laid correctly.

PROPERTIES OF HARDENED CONCRETE

Compressive Strength

As the percentage of aged fibres in concrete grows, the material's compressive strength rises practically linearly. The stress zone (d3 = 22.35 mm) compressive strength of fibre reinforced concrete with a fibre content of 0.5% is higher than that of RC by 17.03%. (Table 2). Figure 2 shows compressive strength of reinforced concrete

Tensile Strength

Research shows that using recycled building materials (RBM), demolition waste aggregate (DW), and fibre content (0.5%) as a partial replacement improves bond connectivity in particle packing, leading to an 18.84% improvement in tensile strength in the stress zone layer (d3 = 22.35 mm)

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compared to RC (Table 2) Figure 3 shows tensile strength of reinforced concrete

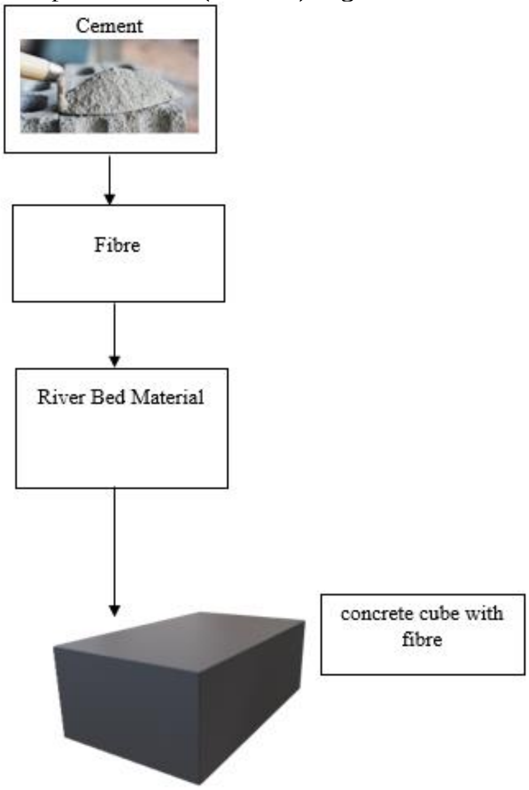

Figure 1. Fibre concrete cube with using RBM.

Table 1. Design Mix Property of Concrete

Designation	Constituent							Proportion
	Fibre content %	***Cement (Kg/m^3)***	***RBM (Kg/m^3)***	***C-A (Kg/m^3)***		***DW***	***DW***	
				12.5 mm	*20 mm*	*12.5 mm*	*20 mm*	
d – 0.28 FC	0.25	389.025	660	235	425	235	425	(0.9975+0.0025) :1.8:3.1
d – 0.50 FC	0.50	388.050						(0.9950+0.0050) :1.8:3.1
d – 0.75 FC	0.75	387.075						(0.9925+0.0075) :1.8:3.1
d – 1.00 FC	1.00	386.100						(0.9900+0.0100) :1.8:3.1
d – RC	-	390.000		470	850	-	-	1:1.8:3.1
d – 0.28 FRC	0.25	389.025		235	425	235	425	(0.9975+0.0025) :1.8:3.1
d – 0.50 FRC	0.50	388.050						(0.9950+0.0050) :1.8:3.1
d – 0.75 FRC	0.75	387.075						(0.9925+0.0075) :1.8:3.1
d – 1.00 FRC	1.00	386.100						(0.9900+0.0100) :1.8:3.1
d1 – 0.28 FRC	0.25	389.025						(0.9975+0.0025) :1.8:3.1
d1 – 0.50 FRC	0.50	388.050	600	235	425	235	425	(0.9950+0.0050) :1.8:3.1
d1 – 0.75 FRC	0.75	387.075		235	425	235	425	(0.9925+0.0075) :1.8:3.1
d1 – 1.00 FRC	1.00	386.100		235	425	235	425	(0.9900+0.0100) :1.8:3.1
d2 – 0.28 FRC	0.25	389.025		235	425	235	425	(0.9975+0.0025) :1.8:3.1
d2 – 0.50 FRC	0.50	388.050		235	425	235	425	(0.9950+0.0050) :1.8:3.1
d2 – 0.75 FRC	0.75	387.075		235	425	235	425	(0.9925+0.0075) :1.8:3.1
d2 – 1.00 FRC	1.00	386.100		235	425	235	425	(0.9900+0.0100) :1.8:3.1
d3 – 0.28 FRC	0.25	389.025		235	425	235	425	(0.9975+0.0025) :1.8:3.1
d3 – 0.50 FRC	0.50	388.050		235	425	235	425	(0.9950+0.0050) :1.8:3.1
d3 – 0.75 FRC	0.75	387.075		235	425	235	425	(0.9925+0.0075) :1.8:3.1
d3 – 1.00 FRC	1.00	386.100		235	425	235	425	(0.9900+0.0100) :1.8:3.1

*(d-depth of fibre) d=112 mm d1 = 94.44 mm d2 = 46.12 mm and d3 = 22.35 mm R.C-Reinforced Concrete, F.R.C-Fibre Reinforced Concrete

Table 2. Hardened concrete of mix FRC

Mix	Compressive Strength MPa	Tensile Strength MPa	Flexure Strength MPa	Modulus of Elasticity x10^5 MPa
RC	22.50	2.80	4.25	2.08
d 0.50 FRC	24.25	2.90	4.30	1.98
d1 0.50 FRC	25.25	3.05	4.28	2.01
d2 0.50 FRC	25.12	3.15	4.32	2.06
d3 0.50 FRC	27.12	3.45	4.35	2.15

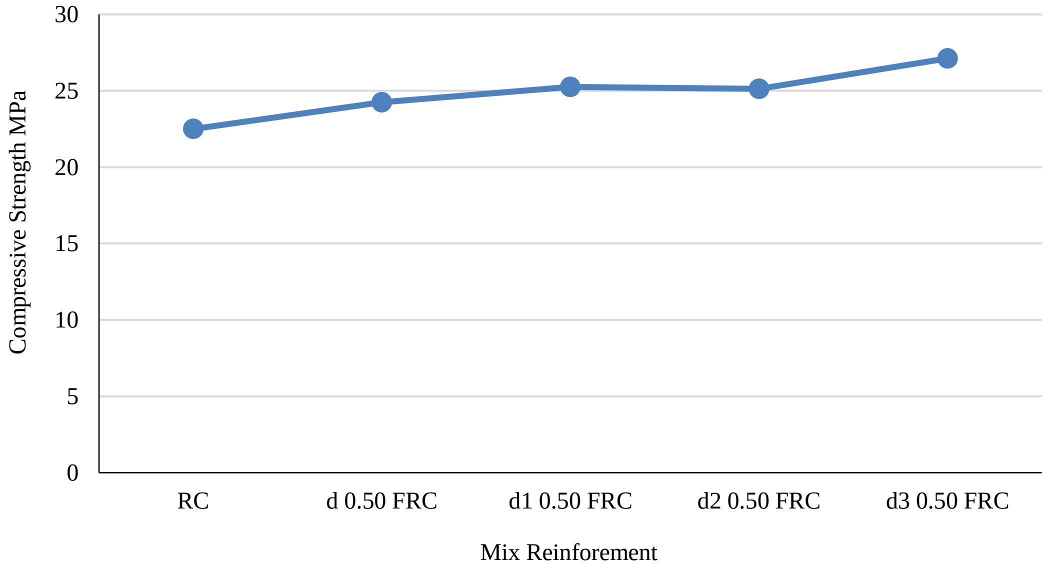

Figure 2. Compressive strength.

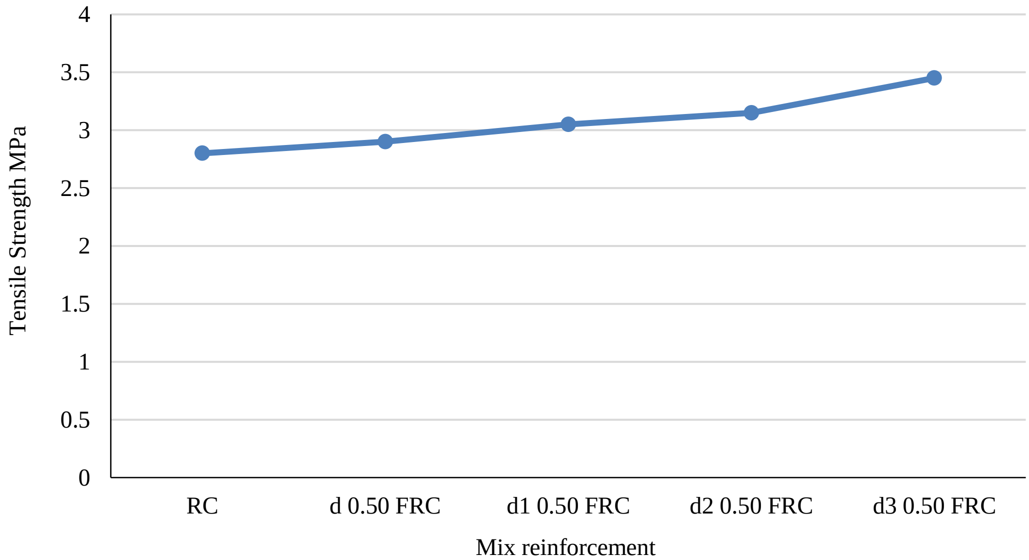

Figure 3. Tensile strength.

Flexural Strength

To put it simply, the flexural behaviour of the horizontal/flat component under static/axial and evenly distributed stress is its most dependable and significant attribute. Figure 4 shows Flexural

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Strength of reinforced concrete. The 0.5% fibre concentration in the bottom quarter zone was shown to boost flexural strength by 3% compared to RC (Table 2).

Modulus of Elasticity

In comparison to RC in the tension zone with 0.5% fibre, the value increases by 3.25 percent when it is proved that concrete is flexible (Table 2). Figure 5 shows Modulus of Elasticity of reinforced concrete.

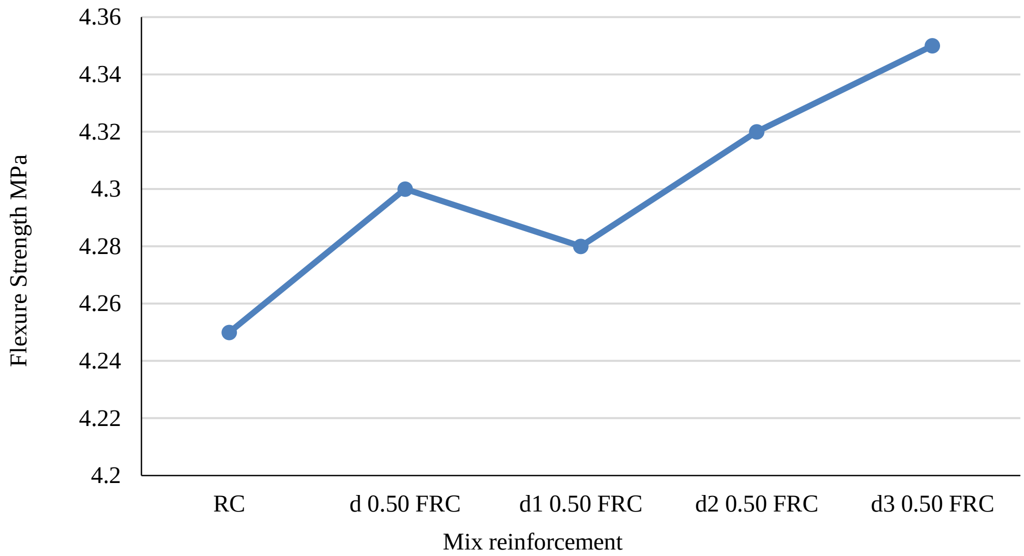

Figure 4. Flexural Strength.

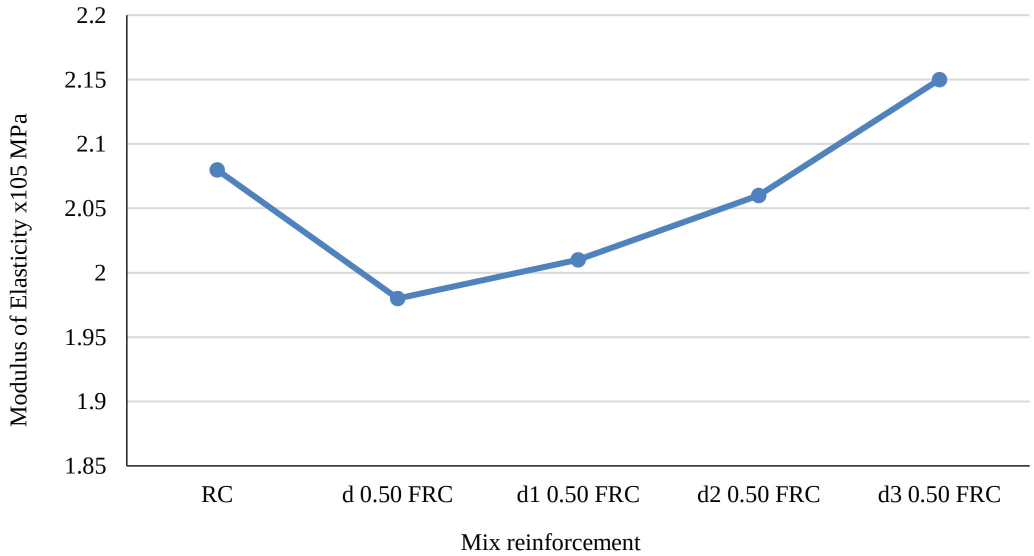

Figure 5. Modulus of Elasticity.

RESULTS

- Compressive strength of mortar made using RBM showed values of 19.5 MPa and 24.8 MPa after 3 days and 7 days, respectively; these values increased to 22.5 MPa and 33.7 MPa with the inclusion of steel fibre. When fibre is added, the tensile strength of the mortar increases to 2.16 MPa after 3 days and 2.96 MPa after 7 days.
- Steel fibres are often used when preventing fractures from spreading is the primary concern of the design. But longer highly deformed fibres, with their better matrix anchoring at large fracture widths and severe deformations, give stronger post-crack strength. Fibres of steel with

dimensions between 0.48 and 0.6 millimetres in diameter and 50 to 60 millimetres in length are required. It has been shown that the aspect ratio (l/d) is (83-104) to (100–125).
- Specific gravity of 2.66 g/cc, water absorption of 0.43 percent, and Fineness Modulus of 2.98 are typical of the crushed stone aggregate and Demolished waste aggregate (DWA) of 12.5 mm and 20 mm used in accordance with I.S.383.1971(2). Debris from demolition sites was cleaned up to meet the standards of Indian Standard 2386:1998(3) and substituted for some of the coarse aggregate in the mix.

Flexural Behaviour of R.C & F.C Beam Specimen

Beams made of fibre concrete (F.C) that lacked a steel reinforcement bar of the kind known as MS bar suddenly collapsed. In the absence of a reliable method for recording concrete's brittle failure, the first fracture load and deflection have not been recorded:
- With 0.5% fibre, the first fracture load and ultimate load in a beam specimen with a fibre layer depth of (d = 112 mm) are found to be identical, (d 0.25 FRC to d 1.00 FRC) (Figure 1) whereas the deflection at the first crack load and the ultimate load is found to be 26% and 37% higher, respectively.
- The RC and 0.5% fibre content beams both had identical first crack loads, (d1 0.25 FRC to d1 1.00 FRC) (Figure 2) however the 0.5% fibre content beam had a 1.85% reduction in ultimate load and a 36% increase in deflection at first crack load and a 51% increase in deflection at ultimate load.
- At 0.5% fibre content, it has been observed that the initial crack load remains unchanged but the ultimate load is reduced by 8.88% in a beam with a fibre layer depth of 46.12 mm. (d2 0.25 FRC to d2 1.00 FRC) (Figure 3) When compared to RC, the deflection rises by 58% at the first fracture load and by 48.83% at the ultimate load.
- At 0.5% fibre content, the first fracture load and ultimate load increase by 25% and 8.47%, respectively, d3 (0.25 FRC to d3 1.00 FRC) Figure 4 and the deflection rises by 59% and 35%, compared to RC, for a beam specimen with a fibre layer depth of 22.35 mm.

CONCLUSION

There was no initial fracture load or matching deflection seen in a Fibre Concrete (FC) beam specimen that had been reinforced with Mild Steel (MS) bars, suggesting that the failure mode was brittle. When compared to RC beams, the ultimate load applied to the whole F.C beams specimen was around ten times less.
- The first crack load remains unchanged but the ultimate load reduces by 1.85% when the fibre depth layer is reduced from (d = 112 mm) to (d1 = 94.44 mm), but the deflection at both the first crack load (13.69%) and the ultimate crack load (22.22%) rises.
- It has been determined that when the depth of the layer is reduced from (d1 = 94.44 mm) to (d2 = 46.12 mm), the first crack load remains the same and the ultimate load falls by 7.16%, while the deflection rises by 34.58% for the first crack load and lowers by 5.43% for the ultimate load.
- The initial fracture load increases by 25% and the ultimate load by 16.61% when the beam depth layer is reduced from (d2 = 46.12 mm) to (d3 = 22.35 mm). However, while the ultimate load is reduced by 20.54 percent, the deflection of the initial fracture load is almost zero in both layers.

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