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Hardened Properties of Concrete Made with Different Fibers Available in Bangladesh

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Abstract: **Concrete is widely known to have high compressive strength and low tensile strength. To compensate the lack of tensile ability, concrete samples were made with the addition of different types of fibers such as steel, bamboo and jute using locally available brick chips as coarse aggregate and Sylhet sand as fine aggregate. Cement type was CEM Type I as per BDS: EN-197-2001. Concrete specimens were made with the addition of different fibers which were added in % weight of cement used. % of fiber added was also varied for different concrete specimens. Specimens were tested for hardened properties of concrete such as compressive strength and split tensile strength. Investigation showed that use of steel fiber improves the hardened properties of concrete.**

Keywords: **Steel fiber, Bamboo fiber, Jute fiber, Hardened properties.**

I. INTRODUCTION

Demand of concrete in construction industry have significantly increased during last few decades. Traditional concrete is a composite mixture of cement, coarse aggregate, fine aggregate and water. Concrete prepared using these materials provide high compressive strength but very low tensile strength. Some studies concluded that fine internal cracks decrease the overall tensile strength of concrete [1]. Although, traditionally steel bars are used in concrete structure to withstand tensile stress, but it is the demand of time to redefine concrete with some additional material which will strengthen concrete with both compressive strength and tensile strength. Use of discrete fibers may able to enhance the tensile strength of concrete by reducing internal micro cracks.

Several studies were carried out to investigate the mechanical properties of steel fiber-reinforced concrete [2–7]. This study was planned to use some fibers locally available in Bangladesh. So, steel fiber and fiber extracted from the naturally grown dried bamboo and jute was used to prepare concrete specimens using brick chips as coarse aggregate, Sylhet sand as fine aggregate and CEM Type I as binding material. The concrete specimens were tested at 28 days to investigate the effect of these fiber on hardened properties of concrete.

II. EXPERIMENTAL METHODS

A. *Materials*

Brick aggregate collected from the local market was used as coarse aggregate and graded to satisfy the grading requirements of ASTM C33 [8]. Natural river sand locally known as Sylhet sand was used as fine aggregate. The specific gravity, absorption capacity, abrasion, unit weight and fineness modulus of both coarse aggregates and fine aggregates used are summarized in Table 1.

Table 1: Properties of Coarse and Fine Aggregates

Type of Aggregate		Specific gravity	Absorption (%)	Unit weight (SSD) Kg/m^3	Abrasion	FM
Fine Aggregate	Sand	2.47	3.1%	1576	-	2.58
Coarse Aggregate	Brick Chips	1.99	11.3%	1210	38%	Controlled as per ASTM C33

Table 2: Mineral Compositions of Different Cements

Cement Type		Composition (% by mass)		
		Clinker	(Slag, Fly ash, Limestone)	Gypsum
OPC	CEM Type I	95~100	0	0~5

B. Mix Proportion, Specimen Preparation and Test Setup

Cylindrical concrete specimens of 100 mm diameter and 200 mm height were made with a fixed sand to total aggregate volume ratio (0.44); W/C ratios (0.45), cement content (340 kg/m^3) and different fibers (0% fiber, 10% steel fiber, 20% steel fiber, 10% bamboo fiber, 20% bamboo fiber, 5% jute fiber, 10% jute fiber, 20% jute fiber). A total of 8 different cases were investigated. The investigated cases & mixture proportions are summarized in Table 3.

Table 3: Mixture proportion of concrete

Case No.	% of Fiber	Fiber Type	W/C	s/a	Unit content (kg/m^3)			
					Cement	Water	Coarse Aggregate	Fine Aggregate
1	0%	-	0.45	0.44	340	153	1044.42	820.617
2	10%	Steel						
3	20%							
4	10%	Bamboo						
5	20%							
6	5%	Jute						
7	10%							
8	20%							
Total no of cases = 8.								
Cylinder per case = 5; (Total no of cylinders 8×5=40).								
Specimen Plan= 3 Compressive Strength Test and 2 Split Tensile Strength Test.								

After casting of the specimens, they were initially cured for 24 hours by covering the molds with wet cloths. After 24 hours of initial curing, the specimens were demolded and cured under water till the age of testing. The compressive strength of concrete was measured at 28 days as per ASTM C 39 [10] using Universal Testing Machine. The split tensile strength of concrete was also measured at 28 days using Universal Testing Machine

III. RESULTS AND DISCUSSION

A. Effect of Fiber on Compressive Strength of Concrete

The variation of compressive strength of concrete made with different % of fiber at the age of 28 days are shown in Figure 1. The lowest compressive strength is found for concrete made with jute fiber and the highest compressive strength is found for concrete made with steel fiber. Comparatively the highest % of steel fiber (20%) showed more compressive strength than the lower % of steel fiber (10%).

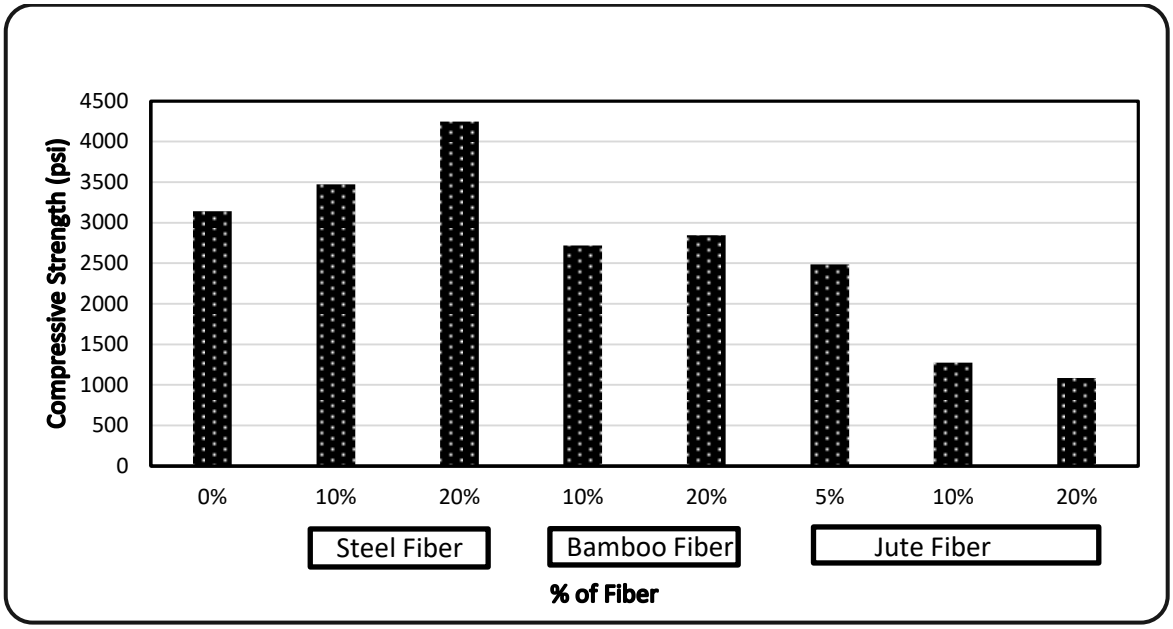

Figure 1: Effect of fiber on compressive strength of concrete

B. ***Effect of Fiber on Split Tensile Strength of Concrete***

The variation of split tensile strength of concrete made with different % of fiber at the age of 28 days are shown in Figure 2. The lowest split tensile strength is found for concrete made with jute fiber and the highest split tensile strength is found for concrete made with steel fiber. Results show that use of steel fiber and bamboo fiber increases split tensile strength of concrete. In case of steel fiber and bamboo fiber the highest % of fiber (20%) shows more split tensile strength than the lower % of fiber (10%).

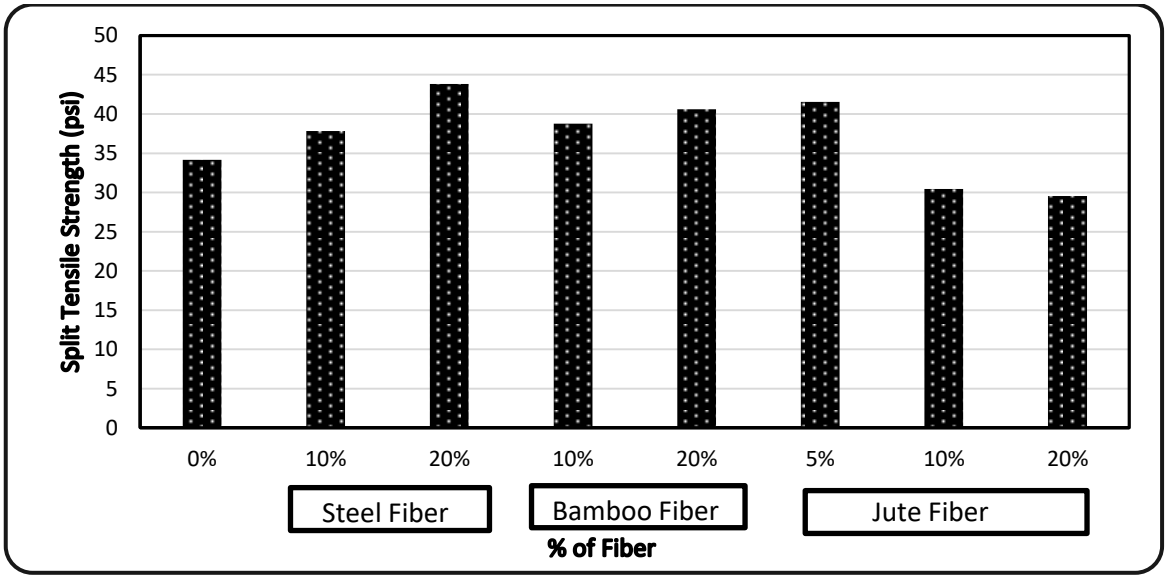

Figure 2: Effect of fiber on splitting tensile strength of concrete

IV. CONCLUSION

The following conclusions are drawn based on the experimental results of this study:

I. Additional use of fibers have a significant effect on hardened properties of concrete.

II. Use of steel fiber increases both compressive strength and split tensile strength of concrete significantly.

III. Use of bamboo fiber decreases compressive strength but increases split tensile strength of concrete.

IV. The compressive strength and split tensile strength of concrete with jute fiber has significantly decreased.

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