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Flexural and Abrasion Behaviour of Flooring Tile with Roselle Fiber

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Abstract*: *In the world-wide research is being conducted concerning the use of fibers. This research aims to analyze the strength and behavior of natural fiber tiles relative to the conventional tiles. The researchers are exploring new materials that expand choices of flooring tiles. In this researcher produces tiles using Roselle fibers. India is the country having largest producer of roselle fiber. In this study Roselle fiber is used in two techniques, one in the form of mesh and another is mixing it with mortar. For both techniques the percentage of natural fiber was different. Because of increasing environmental problems, scientists and researchers are using natural fiber instead of synthetic fiber as the main component in composites. Cement mortar has very low tensile strength, limited ductility and little resistance to cracking. This study aims to compare flexural strength and abrasion of tiles by using natural fiber tile and conventional tile.

Keywords* : *Flooring tiles, Natural fiber, Roselle fiber, Flexural strength, Abrasion.

I. INTRODUCTION

Cost optimization in construction industry is very significant factor for exploitation of potential profit. This is achievable by exploring advance techniques which gives better or equivalent result with less investment. The approximate cost in any residential construction project for flooring is around 4 % to 5 % of total construction project. Flooring tile is the building element which is made-up of materials like ceramic, stone, metals, or even glass, which are hard wearing materials, generally used for covering roofs, floors, walls, showers or other objects such as tabletops. Floors are subjected to load, wear and tear. There are various types of flooring used for covering such as Carpet flooring, Wood flooring, Laminate flooring, Ceramic flooring, Resilient flooring, Seamless polymer flooring, Cork flooring, Rubber flooring, etc. Fiber is a material which helps in enhancing the tensile property of the material.

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The research studies the behaviour of Floor tiles to be more durable also to withstand wear and tear of foot traffic every day. This research uses Roselle fiber as reinforcing material in mortar of tiles to improve flexural strength and abrasion resistance. The application of such tile will be to satisfy the tile constraints of limited thickness with high flexural strength. Roselle fiber is used in the form of mesh and mix with mortar for casting of tiles.

Material properties:

Cement: Pozzolana Portland Cement (fly ash based JK cement) is used for casting the tiles reinforced with Roselle fiber.

Fine aggregate: River sand passing through 4.75mm IS sieve is used for making mortar. According to IS 2386:1963 (Part III) various tests such as void ratio, bulk density are conducted on fine aggregates. The average properties of fine aggregates are Bulk Density: 1880.52 kg/m^3, Porosity: 25.9% and void ratio: 35 %.

Roselle Fiber:

Roselle fiber consists of cellulose, Hemi-cellulose, Lignin. The water absorption of this fiber is 40-50%. So as to reduce it, fibers are soaked in 0.02% w/v K2Cr2O7concentrated aqueous solution for 2 min. This fiber is used in two techniques, in first technique Roselle fiber mesh is prepared by weaving fiber to exact dimensions of tile as shown in fig 1 (a). In second technique fibers are cut to length 25mm and diameter is 10 to 14µm shown in fig 1 (b) and mixed it with mortar.

II. METHODOLOGY

A. *Design:* For weaving technique, selection of Cement Sand proportion in mortar, the tiles were casted at proportions of 1:2, 1: 2.5 and 1:3. The results were better, for proportions of 1:2 & 1:2.5. Hence proportion of mortar was finalized as 1:2.25. From the literature review for the enhanced analysis of tile behavior, the percentage of Roselle fiber is taken as 0.5 %, 0.75% and 1% by weight of cement. Roselle fiber mesh is reinforced at height of 5mm from the bottom of tile. For second technique, mixing of fiber with mortar proportion is selected as 0.1%, 0.25% and 0.5% by dry weight of mortar. Water cement ratio is 0.45 for both the techniques. From IS: 1237(2012) Standard dimension of tile selected is 300mmX300mmX20mm.

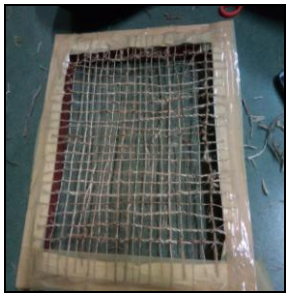
B. Casting of tile specimen

Teak wood is used for preparing mould. Internal dimension of mould is 300mmx300mmx20mm.

From the above techniques and the proportions, the mortar was prepared and tiles were casted. For each technique and each proportion three tiles were casted as shown in figure 2.

C. Curing of tile specimens

The moulds were removed after 24 hours of casting and wrapped in gunny bags for 1 day as shown in fig 3 (a). Further the tiles were kept for curing in tank shown in fig 3 (b). As per IS standard curing of tiles were done for 28 days.



(a) Weaving Technique

(b) Second technique

Figure 1: Roselle Fiber Techniques used in Tile

(a)Mesh-Reinforcement

(b) Casted tile

Figure 2: Casting of Tile

III. EXPERIMENTATION

The specimens were tested against standard specification given by IS: 1237(2012) for flexural strength as shown in fig 3. Flexural strength determined for three specimen and average of three is taken as flexural strength. The strength of Roselle fiber mesh tile and Roselle fiber mixing tile is compared with conventional tile. Tests results are shown in table no 1.

Figure 4: Flexural test of tile

Tiles normally used for floors are subjected to constant movement of men and materials. Abrasion test is carried out to measure the resistance to wear in term of reduction in thickness by subjecting the specimen to abrasion in standard abrasion testing machine as shown in figure 5. The best result of flexural strength was achieved in Technique B for 0.25% fiber proportion, hence same proportion is used for abrasion testing.

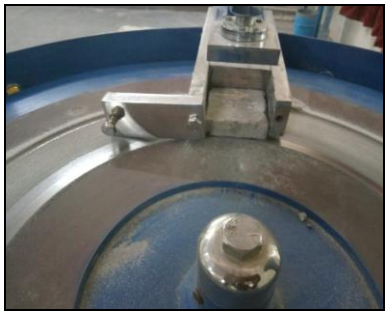


Figure 5: Abrasion test of tile

IV. RESULT AND DISCUSSION

A] Flexural Test:

Average flexural strength of conventional tile is 4.67 N/mm2 and fiber mesh tile (Technique A) for fiber proportions 0.5%, 0.75% and 1% are 6.54 N/mm2, 5.13 N/mm2, and 4.94 N/mm2 respectively as shown in fig 5. As per IS code (IS 1237:2012), flexural strength for tile should be greater than 3 N/mm2. Maximum strength is observed for 0.5% fiber proportioned tile. The strength is increased by approximately 40% compared to conventional tile.

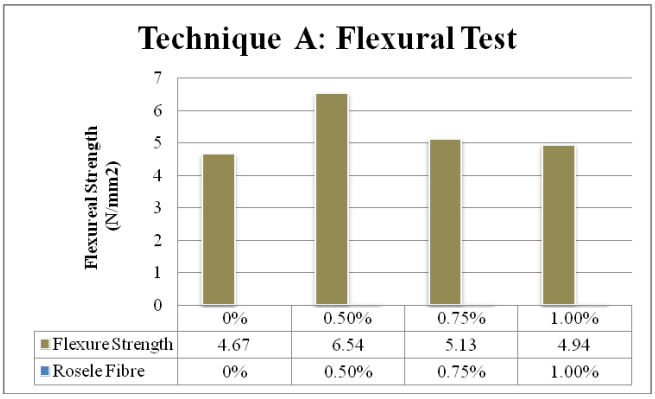


Figure: 5 Flexural Strength (Technique A)

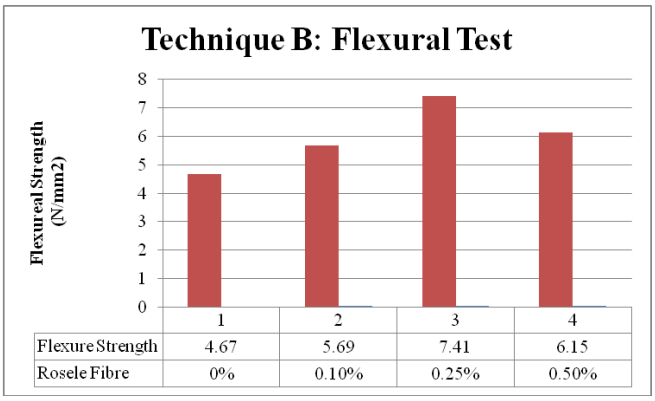


Figure: 5 Flexural Strength (Technique B)

Strength for fiber mix tile (Technique B) for fiber proportions 0.1%, 0.25% and 0.5% are 5.96, N/mm^2 7.41 N/mm^2, and 6.15 N/mm^2 respectively as shown in fig 6.

In this technique maximum strength was observed for 0.25% fiber proportion. This technique gives improves the strength by approximately 58.67% as compared to conventional tile. Also in contrast to Technique A, Technique B improves the flexural strength by 13.3%.

Table- 1: Flexural Test Results

Type of tile	Sample ID	Fiber Proportion	Failure load in (N)	Flexural Strength (28 days) (N/mm2)	Avg. Flexural Strength (N/mm2)
Conventional	C1	0 %	1724.99	5.15	4.67
	C2		1602.56	4.79	
	C3		1502.49	4.08	
Roselle Fiber mesh	R1	0.5 %	2024.78	6.83	6.54
	R2		1819.06	5.58	
	R3		2148.39	7.21	
	R1	0.75 %	1507.99	5.00	5.13
	R2		1655.14	5.04	
	R3		1739.90	5.36	
	R1	1 %	1609.52	5.07	4.94
	R2		1706.94	5.31	
	R3		1445.02	4.43	
Roselle Fiber mixed With mortar	RM1	0.1 %	2265.38	6.78	5.69
	RM2		1758.02	5.37	
	RM3		1538.04	4.94	
	RM1	0.25 %	2214.63	6.76	7.41
	RM2		2538.14	8.29	
	RM3		2323.17	7.19	
	RM1	0.5 %	2356.98	6.76	6.15
	RM2		2000.20	5.60	
	RM3		1946.59	6.10	

A] Abrasion Test:

The average loss of thickness of conventional tile is 0.902mm and for fiber mix tile is 0.469mm which is less than conventional tiles. According to IS the individual wear of any specimen should not be greater than 4.0 mm and average wear of flooring tiles should not be greater than 3.5 mm. The average abrasion for conventional tile is 0.94 mm, whereas for technique B is 0.61mm. Hence it's improved by 35% as compared to conventional tile. The detailed results of abrasion test are shown below table 2.

Table- 2: Abrasion Test Results

Sample	Fiber Proportion	Area of Tile (mm^2)	Thickness (mm)			Average
			Initial	Final	Diff	
C1	0%	4900	20.46	19.23	1.23	0.94
C2		4900	20.13	19.15	0.97	
C3		4900	21.77	21.13	0.64	
R1	0.25% (Technique B)	4900	19.58	19.48	0.1	0.61
R2		4900	20.87	20.1	0.86	
R3		4900	19.47	18.61	0.86	

V. CONCLUSION

The result of both technique have showed promising potential for flooring tiles. The presence of roselle fiber significantly improved the properties of flooring tile.

More specifically, considering all proportions of Roselle fiber, the flexural strength for Technique A of 0.5% fiber proportion is improved by 40.04% and for Technique B of 0.25% is improved by 58.67 % than conventional tiles. The abrasion of Technique B tile of 0.25% is improved by 35.00% than conventional tiles. This research gives better results for least thickness of tiles stated by standard specification limits for flexural strength and Abrasion.

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