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Study On Aspect Ratio and Strength Characteristics of Pet Strap Fibre Reinforced Concrete

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ABSTRACT

The fibre reinforced concrete is a composite material consisting of cement paste, mortar or concrete with fibres like asbestos, glass, plastic, carbon or steel. Such fibre reinforced concrete may be useful when a large amount of energy has to be absorbed (Ex: In explosive loading), where high tensile strength and reduced cracking are desirable, or even when conventional reinforcement cannot be placed because of the shape of the member.

PET Strapping Rolls are made from polyethylene terephithala material, a substitute of steel strap. These PET Strapping Rolls are available with requisite density with excellent tensile and welding strength. PET Strapping Rolls are used for palletizing, reinforcing, packing, bundling and unitizing etc. through manual clip sealing or electric or battery operated strap sealing machines in different industrial sectors.

Thus, in this project an attempt will be made to study characteristic strength properties of PET Strap fibres reinforced concrete. This PET Strap fibres reinforced concrete show many improved qualities and act as environmental friendly building material.

Keywords—PET Strap; FRC; Aspect Ratio; Strength Characteristics;

I. INTRODUCTION

Concrete is a miraculous man made material for civil engineering construction which is preferred to use all over the world, due to its strength, structural stability, high mould ability and low cost. Concrete is the backbone for infrastructural development of whole world.

The concrete has many advantageous properties such as good compressive strength, durability, impermeability, specific gravity and fire resistance. However the concrete has some bitter properties like - weak in tension, brittleness, less resistance to cracking, lower impact resistance, heavy weight, etc. To overcome some of these bitter properties of concrete, the discrete fibers can be added as one of the ingredients of concrete. The fibers inclusion in cement base matrix acts as unwanted micro crack arrester. The prevention of prorogation of cracks under load can result in improvement in static and dynamic properties of cement based matrix. The serviceability of fiber reinforced cement concrete is also enhanced due to restricting entry of water and other contaminants through micro cracks which causes corrosion to steel reinforcement.

Waste is the one of the main challenges to dispose and manage. It has become one of the major environmental, economical and social issues. Recycling is the most promising waste management process for disposal of waste materials. The waste utilization in Civil Engineering construction has become an attractive alternative for disposal and protecting environment Industrial activities are associated with significant amount of non-biodegradable solid waste. The waste plastic is being among the most prominent. The waste polyethylene terephthalate (PET) bottles are recycled and used in industries for different purposes. The recycled waste plastics in different forms are being use in pavements, bridges, floors, dams and many other civil engineering works.

The advantage of using waste plastic in concrete not only solves the problem of their safe disposal but also improves the basic properties of concrete like compressive strength, tensile resistance, impact resistance, permeability, flexural strength, thermal insulation, etc. The main benefit of using plastics in concrete is its durability, resistance to chemicals and light in weight. The main disadvantage of using plastic in concrete is that it has smooth surface, their bond characteristics become a hindrance to use them as concrete ingredient. It has low melting point so that it cannot be used in furnaces. From previous research works it is clear that the post consumed polyethylene teraphthalate (PET) bottles in fiber form can be used to improve the mechanical properties of concrete. The PET fibers inclusion in concrete is an innovative material that can be promote in construction field.

Further research to evaluate the use of plastic waste in concrete production is therefore required. This is the background of our present study. The waste polyethylene teraphthalate (PET) bottles were converted into fibers and added in concrete as an additional ingredient of concrete.

Figure 1: Variants of PET strap fibres

II. OBJECTIVES

- To study the effect of different aspect ratios on PET Strap fibres reinforced concrete.
- To study the Compressive strength characteristics of PET Strap FRC for different aspect ratios.
- To study the Tensile strength characteristics of PET Strap FRC for different aspect ratios.
- To study the Flexure strength characteristics of PET Strap FRC for different aspect ratios.
- To study the Shear strength characteristics of PET Strap FRC for different aspect ratios.

III. METHODOLOGY

The following steps are involved in the implementation of the project and are not limited to,

- Literature survey
- Collection of required raw materials
- Designing of concrete M25 Grade mix as per IS 10262-2009
- Casting and Curing of Concrete Cubes, Beams, Cylinders, Plates (25cm x 25cm) moulds.
- Testing of concrete
- Discussions and Conclusions on the results obtained.

IV. OBSERVATIONS AND DISSCUSSIONS

A. PREDICTION OF COMPRESSIVE STRENGTH PROPERTIES

Cube strength= (Average load) / (c/s area of specimen)

Table 1: Compressive Strength Test Results

SL NO.	SAMPLE TYPE	NO. OF DAYS OF CURING	FAILURE LOAD KN	COMPRESSIVE STRENGTH N/mm^2	COMPRESSIVE STRENGTH (AVG) N/mm^2

1	R-sand	28	710	31.55	33.33
		28	680	30.22	
		28	860	38.22	
2	M-sand	28	720	32.00	34.80
		28	780	34.66	
		28	850	34.77	
3	FRC: 2cm/0.1cm	28	1008	44.80	44.30
		28	1007	44.70	
		28	980	43.50	
4	FRC: 3cm/0.1cm	28	832	37.00	33.07
		28	720	32.00	
		28	680	30.22	
5	FRC: 4cm/0.1cm	28	911.3	40.50	39.03
		28	923.2	41.03	
		28	800.5	35.644	
6	FRC: 5cm/0.1cm	28	1000	44.44	44.00
		28	990	44	
		28	980	43.56	
7	FRC: 6cm/0.1cm	28	1112	49.87	47.4
		28	1080	48	
		28	1001	44.44	
8	FRC: 7cm/0.1cm	28	1036	46	45.90
		28	1029	45.7	
		28	1038	46.1	
9	FRC: 8cm/0.1cm	28	962.8	42.8	45.20
		28	1018	45.24	
		28	1066	47.4	
10	FRC: 9cm/0.1cm	28	980	45.56	43.27
		28	1041	46.27	
		28	900	40	
11	FRC: 10cm/0.1cm	28	1007	44.75	44.40
		28	1060	47.11	
		28	1019	45.3	

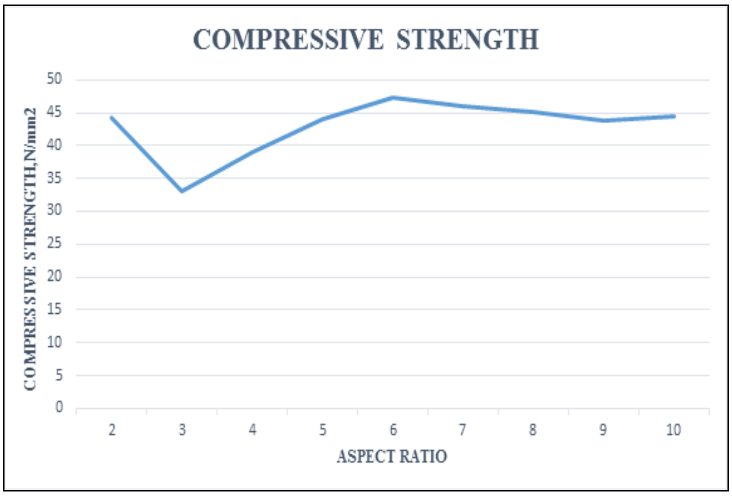

Figure2: Graph of Compressive Strength Vs Aspect Ratio

B. PREDICTION OF TENSILE STRENGTH PROPERTIES

Tensile Strength = $2P / (\pi dl)$

Table 2: Tensile Strength Test Results

SL NO.	SAMPLE TYPE	NO. OF DAYS OF CURING	FAILURE LOAD, KN	TENSILE STRENGTH, N/mm^2	AVG TENSILE STRENGTH, N/mm^2
1	R-sand	28	97.00		2.58
		28	65.00		
		28	80.00		
2	M-sand	28	97.00		2.65
		28	90.00		
		28	70.00		
3	FRC: 2cm/0.1cm	28	100.0	3.18	3.34
		28	105.0	3.34	
		28	110.0	3.5	
4	FRC: 3cm/0.1cm	28	110.9	3.5	3.3
		28	112.3	3.53	
		28	103.0	3.30	
5	FRC: 4cm/0.1cm	28	89.90	2.86	2.88
		28	95.40	3.03	
		28	86.40	2.75	
6	FRC: 5cm/0.1cm	28	129.5	4.10	3.12
		28	70.00	2.23	
		28	95.00	3.02	
7	FRC: 6cm/0.1cm	28	117.6	3.74	3.16
		28	108.7	3.5	
		28	70.00	2.23	
8	FRC: 7cm/0.1cm	28	145.0	4.60	3.62
		28	125.0	3.40	
		28	90.00	2.86	
9	FRC: 8cm/0.1cm	28	103.0	3.30	3.49
		28	104.0	3.31	
		28	121.0	3.85	
10	FRC: 9cm/0.1cm	28	84.40	2.68	3.11
		28	80.50	2.56	
		28	130.0	4.10	
11	FRC: 10cm/0.1cm	28	96.90	3.08	3.28
		28	93.60	2.98	
		28	118.5	3.77	

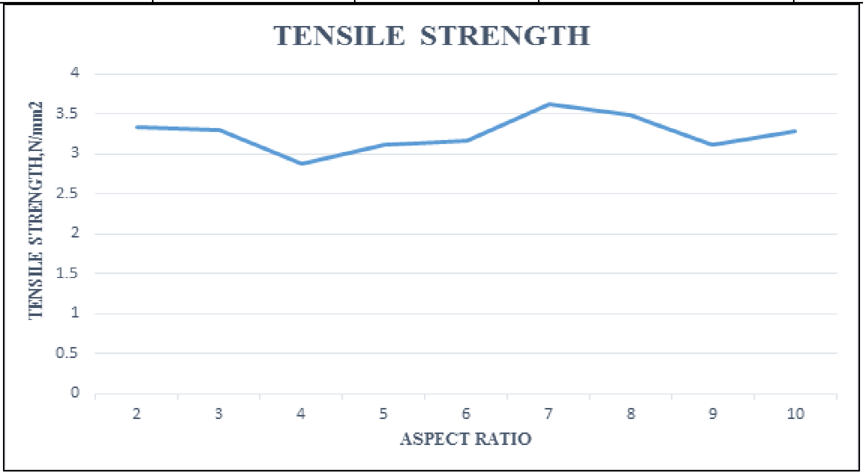

Figure3: Graph of Tensile Strength Vs Aspect Ratio

C. PREDICTION OF FLEXURAL STRENGTH PROPERTIES

FLEXURAL STRENGTH= Pl / (bd$^{3)}$

Table 3: Flexural Strength Test Results

SL NO.	SAMPLE TYPE	NO. OF DAYS OF CURING	FAILURE LOAD, KN	FLEXURAL STRENGTH, N/mm^2	AVG FLEXURAL STRENGTH, N/mm^2
1	R-sand	28	21.1	10.55	11.67
		28	26.6	13.3	
		28	22.35	11.2	
2	M-sand	28	18.5	9.25	13.9
		28	33.05	16.5	
		28	32.09	16.04	
3	FRC: 2cm/0.1cm	28	31.2	15.6	15.1
		28	30.7	15.35	
		28	28.7	14.35	
4	FRC: 3cm/0.1cm	28	31.5	15.75	15.3
		28	31.8	15.9	
		28	28.6	14.317.05	
5	FRC: 4cm/0.1cm	28	33.2	16.6	17.05
		28	34	17	
		28	35	17.5	
6	FRC: 5cm/0.1cm	28	30.2	15.1	16.55
		28	36	18	
		28	33	16.5	
7	FRC: 6cm/0.1cm	28	30.2	15.1	17.15
		28	36.5	18.25	
		28	36.2	18.1	
8	FRC: 7cm/0.1cm	28	33.5	16.75	16.85
		28	34.6	17.3	
		28	33.2	16.6	
9	FRC: 8cm/0.1cm	28	40	20	22.2
		28	44	22	
		28	49	24.5	
10	FRC: 9cm/0.1cm	28	32.39	16.2	17.55
		28	37.3	18.65	
		28	35.6	17.8	
11	FRC: 10cm/0.1cm	28	33.25	16.6	17.45
		28	32.22	16.1	
		28	39.2	19.6	

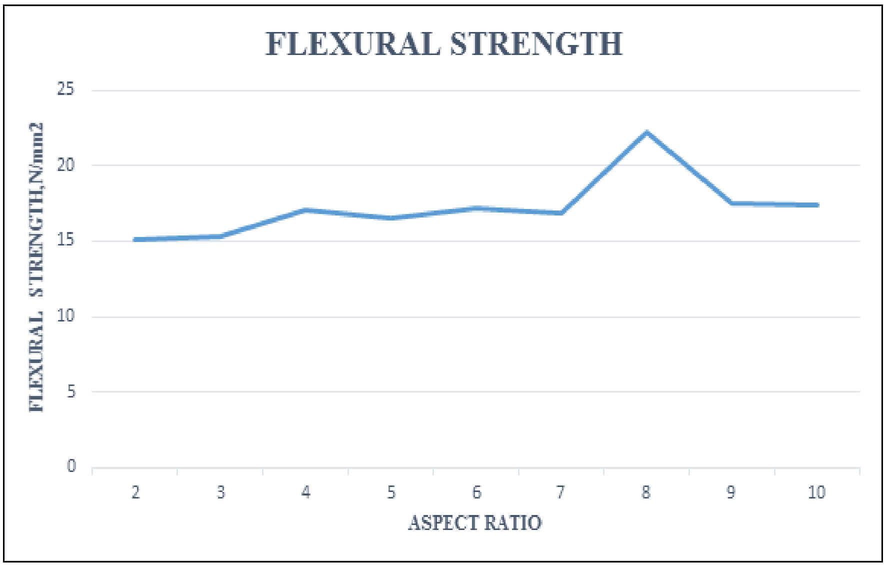

Figure 4: Graph of Flexural Strength Vs Aspect Ratio

D. PREDICTION OF SHEAR STRENGTH PROPERTIES

Failure load = $PL_1 / (L_1+L_2)$
Shear strength = (Failure load / A) X 1000

Table 4: Shear Strength Test Results

SL NO.	SAMPLE TYPE	NO. OF DAYS OF CURING	FAILURE LOAD, KN	SHEAR STRENGTH, N/mm^2	AVG SHEAR STRENGTH, N/mm^2
1	R-sand	28	50	5.5	5.08
		28	40	4.44	
		28	47.5	5.3	
2	M-sand	28	47.9	5.3	4.98
		28	47.3	5.25	
		28	40	4.4	
3	FRC: 2cm/0.1cm	28	60	6.67	5.64
		28	46	5.11	
		28	46.3	5.14	
4	FRC: 3cm/0.1cm	28	50.5	5.61	5.48
		28	52.5	5.83	
		28	45	5	
5	FRC: 4cm/0.1cm	28	68.6	7.6	5.73
		28	54.4	6.04	
		28	32	3.56	
6	FRC: 5cm/0.1cm	28	32.5	3.6	4.06
		28	35	3.88	
		28	42.5	4.7	
7	FRC: 6cm/0.1cm	28	58.8	6.5	6.6
		28	49.3	6.6	
		28	60	6.67	
8	FRC: 7cm/0.1cm	28	39	4.33	4.24
		28	38.5	4.3	
		28	37	4.1	
9	FRC: 8cm/0.1cm	28	30	3.3	4.5
		28	51.35	5.7	
		28	40.35	4.5	

10	FRC: 9cm/0.1cm	28	49.46	5.5	4.9
		28	35	3.9	
		28	48.1	5.34	
11	FRC: 10cm/0.1cm	28	48.8	5.4	5.3
		28	57.2	6.35	
		28	36.75	4.08	

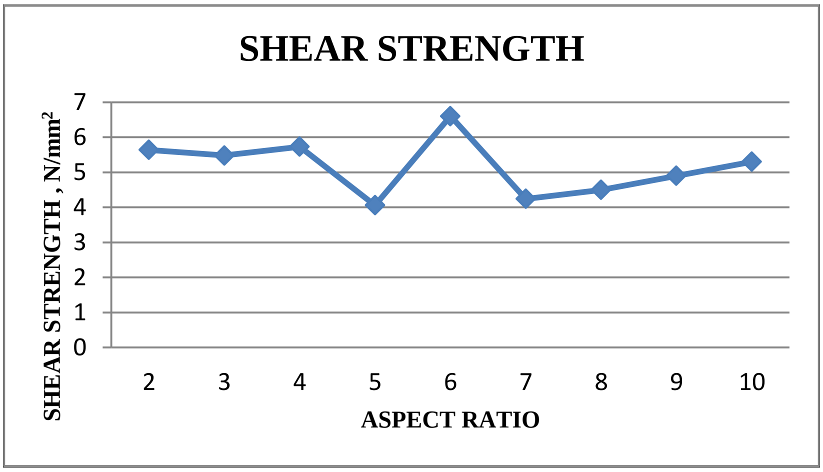

Figure 5: Graph of Shear Strength Vs Aspect Ratio

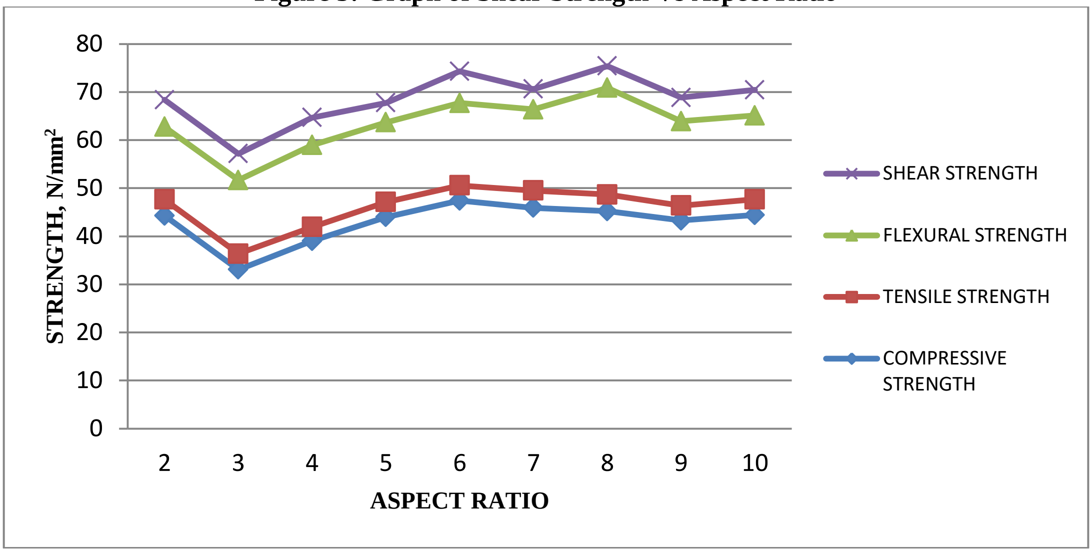

Figure 6: Graph of Comparison of FRC Strength Properties vs Aspect Ratio

V. RESULTS

- The compressive strength and shear strength at aspect ratio 60 was found to be maximum.
- The tensile strength at aspect ratio 70 was found to be maximum.
- The flexural strength at aspect ratio 80 was found to be maximum.
- The workability was found to be limited for 80.

VI. CONCLUSIONS

- PET fibre show good potential and increased strength to be used in fibre cement products compared to the conventional concrete blocks
- It was observed that normal concrete broke suddenly into two pieces but PFRC specimens did not suddenly break and failure was ductile

- It has crack resisting characteristics of fibre concrete, the cover concrete crack spalling and reinforcement debonding failure due to macro-crack propagation are delayed
- Inclusion of fibres improves the mechanical properties of concrete which is an innovative low-cost material which can be promoted in construction field and also prevents environmental pollution as it is eco-friendly.

VII. SCOPE FOR FURTHER STUDIES

- To study the effect of PET Strap fibres on impact strength of concrete.
- To study the effect of mineral admixtures on PET Strap fibres.
- To study the effect of polymers on PET Strap fibres.

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