STRENGTH PARAMETERS OF BFRP WRAPPED CONCRETE ELEMENTS

Rajeswaran P[1], Thahira Banu[1], Visali S[2], Mohamed Meera Maidheen M[1], Mohanasundari R[1],

1- Assistant Professor, Department of Civil Engineering, Sethu Institute of Technology, Kariapatti, Virudhunagar

2- PG Scholar, Structural Engineering, Sethu Institute of Technology, Kariapatti, Virudhunagar

ABSTRACT

In this project to investigate the performance of confined concrete cylinder with externally bonded Basalt Fiber Reinforced Polymer (BFRP) under axial compression. The confined cylinders were cast on two different grades of concrete such as M20 and M30. The properties of concrete such as compressive strength, split tensile strength, flexural strength and density were determined as per relevant Indian and ASTM standards. The primary objective of this study is to observe the compressive behavior of BFRP confined cylindrical concrete column specimens under the effect of different number of layers of basalt fiber as a study parameter (single, double and triple layers). For this purpose, concrete specimens with no internal steel reinforcement were tested under compression to failure. The results of BFRP-confined concrete specimens of this study showed a bilinear stress-strain response with two ascending branches. The different parameters that will be considered are types of wrapping and number of layers of BFRP wrapping.

1.0 Introduction

Columns are the main load bearing element of a structure. Therefore, columns have an important function in many structures and can be vulnerable to exceptional loads. As structures age, the columns often have a lack of transverse reinforcement, which is unable to provide sufficient confinement to the concrete core or to prevent buckling of the longitudinal reinforcement which causes premature strength degradation of the column. The primary objectives of this research are to investigate the behavior of axially loaded concrete columns confined with an obscure material in civil engineer for strengthening, basalt fiber reinforced polymer jacket (BFRP).

Basalt Fiber Reinforced Polymer (BFRP) is a new material in civil engineering and has shown to be a promising material for infrastructure strengthening: In comparison to carbon fiber, glass fiber and other composites, it has some advantages such as high-temperature resistance and low cost.

BFRP is made from basalt rocks through melting process and contain no other additives in the producing process which makes advantages in cost. Basalt fiber is an inorganic fiber material. The first attempts to produce basalt fiber were made in the United States in 1923 by Paul Dhe was granted U.S. Patent. Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. Basalt is a dark gray to black, medium grained dense volcanic rock, thus mineral, and 100% inorganic. The typical diameter of the basalt fiber lies between 9 and 13 microns, which guarantees the best possible compromise between stability and durability.

2.0 Experimental Program:

Material Used

The materials such as Cement, Fine aggregate and coarse aggregate are mixed together for making concrete. The fine aggregate used in the study was river sand. Fine aggregates passing through 4.75mm sieve was taken. Construction aggregate, or simply aggregate, is a broad category of coarse- to medium-grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. In concrete Elements With thin section closely spaced reinforcement or small corner consideration should be given to the use of 10mm nominal maximum size.

3.0 Methodology

The following steps involved in the project.

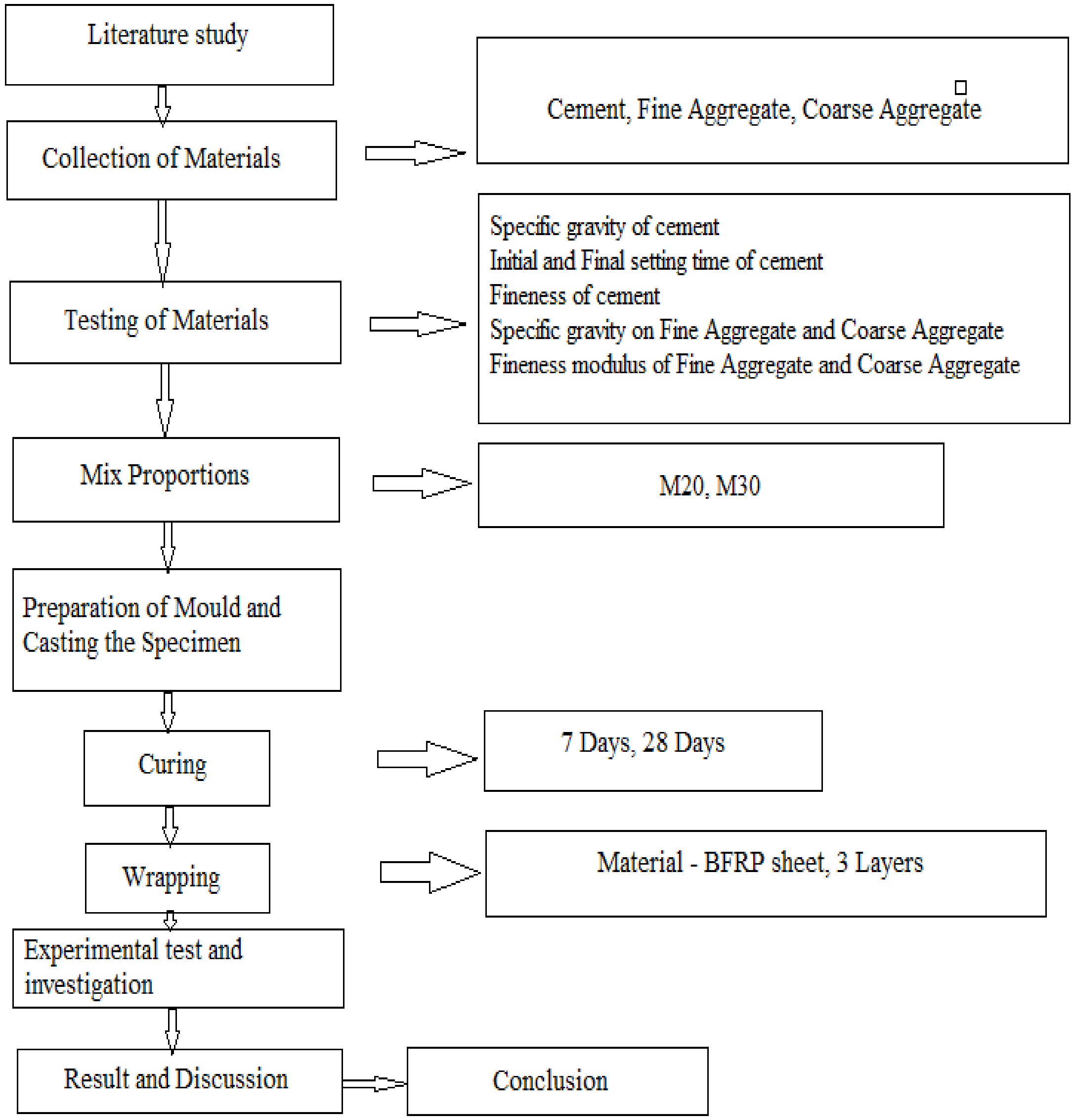

Fig.1. Methodology

4.0 Mix Proportion & Details of Specimens

Table.1. Mix Proportions

Grade of Concrete	Cement	Fine aggregate	Coarse aggregate	Water-cement ratio
M20	1	2.24	2.31	0.5
M30	1	2.03	2.19	0.45

Table.2. Details of Testing Specimens

Name of the Test	Grade of concrete	7 Days	28 Days
Compressive Strength Test	M_{20} (Cubes)	3	3
	M_{30} (Cubes)	3	3
Split Tensile Strength Test	M_{20} (Cylinder)	3	3
	M_{30} (Cylinder)	3	3
Flexural Strength Test	M_{20}(Prism)	-	3
	M_{30}(Prism)	-	3

5.0 Experimental Instigation

A. Density Test

Table.3.Density values

S.No	Specimen	Grade	Density (kg/m^3)			Mean (kg/m^3)
			S1	S2	S3	
1	Cube	M20	2560	2569	2557	2562
		M30	2495	2504	2513	2504
2	Cylinder	M20	2475	2487	2479	2480
		M30	2449	2455	2467	2457
3	Prism	M20	2528	2522	2530	2527
		M30	2448	2454	2456	2453

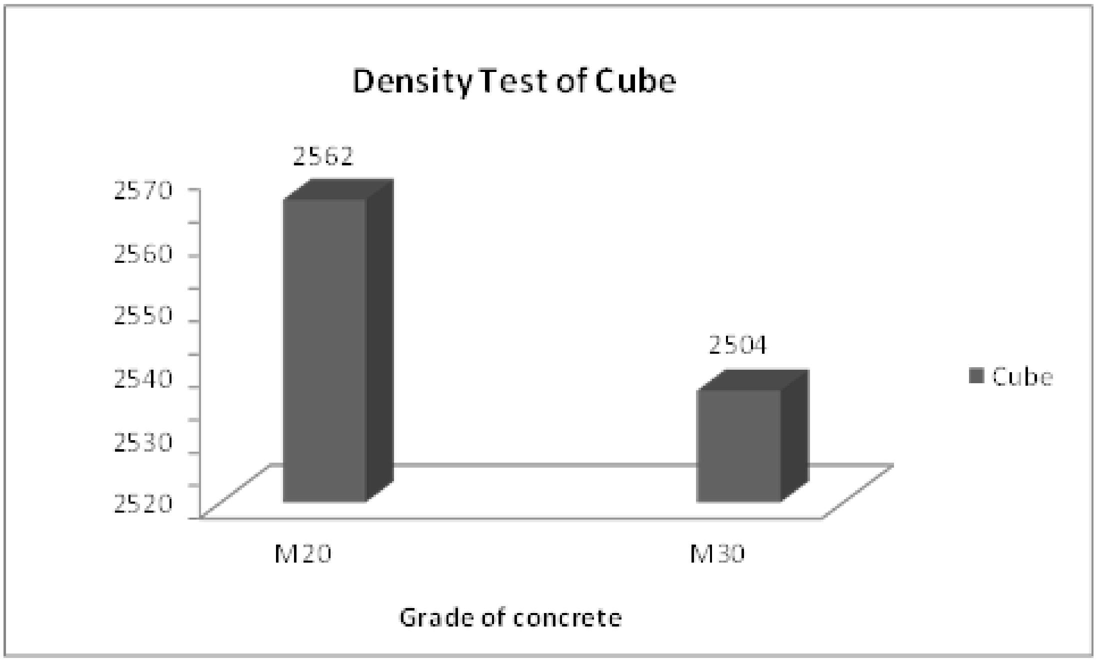

Fig.2. Density of Concrete Cubes

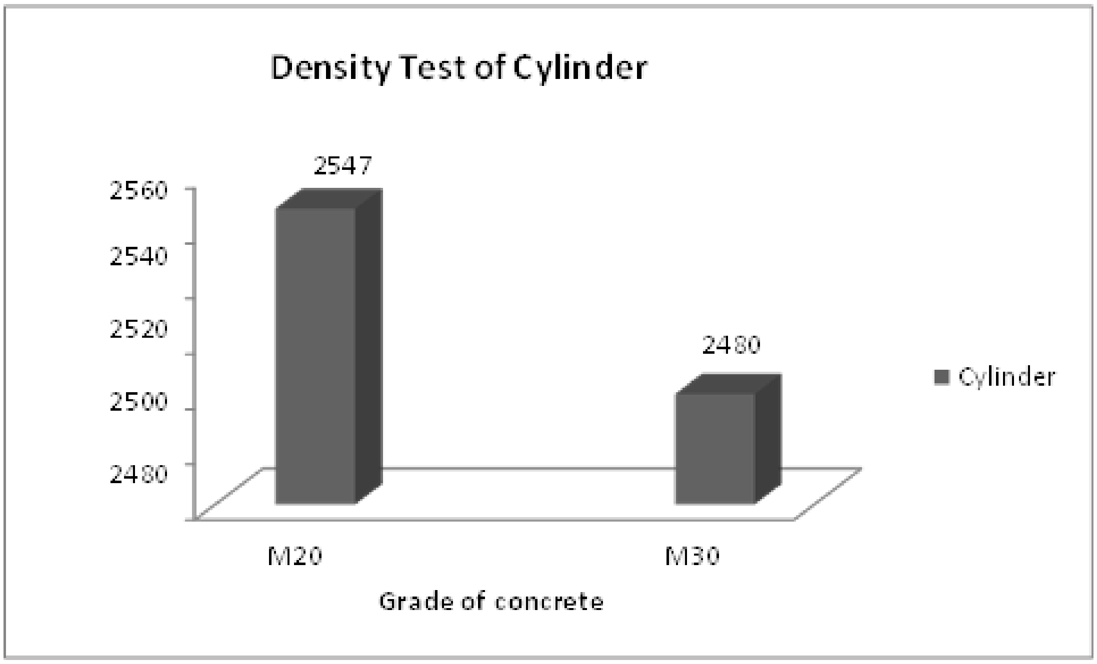

Fig.3. Density of Concrete Cylinder

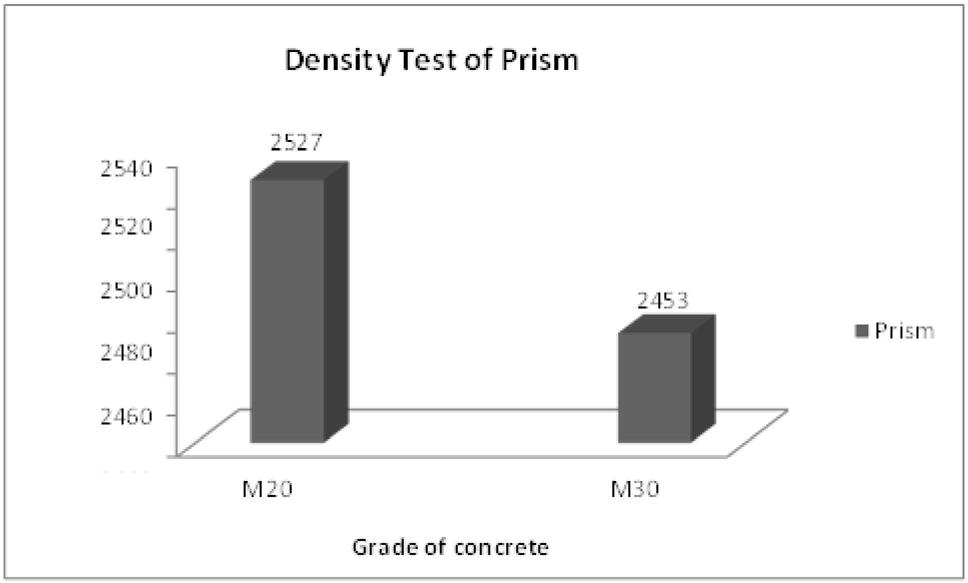

Fig.4. Density of Concrete Prism

B. Compressive Strength Test

Compressive Strength is defined as ultimate load by Area. Tests were performed on 150x150x150 mm specimens with 7 and 28 days curing.
Compressive Strength (N/mm^2) = Ultimate load (kN)/ Area (mm^2)

Table.4. Compressive Strength of Concrete Cube Specimens

Grade	Days	Area	Maximum Ultimate Load kN			Average Ultimate Load kN	Compressive Strength N/mm^2
			S1	S2	S3		
M20	7	22500	419.3	415.2	423.7	419.4	18.64
M30	7	22500	778.4	749.8	611.4	713.2	31.69
M20	28	22500	580.2	560.2	576.4	572.3	25.43
M30	28	22500	978.2	960.1	972.4	970.2	43.12

Fig.5. Mixing, Casting & Testing of Cube Specimens

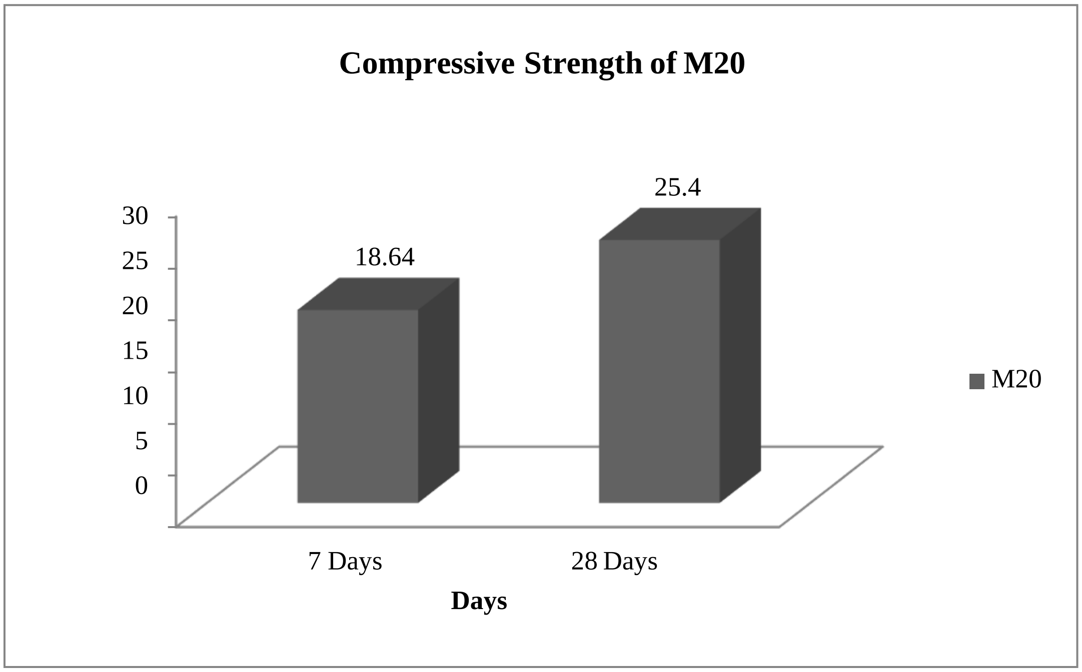

Fig.6. Compressive Strength of M20 Grade of Concrete Cube Specimens

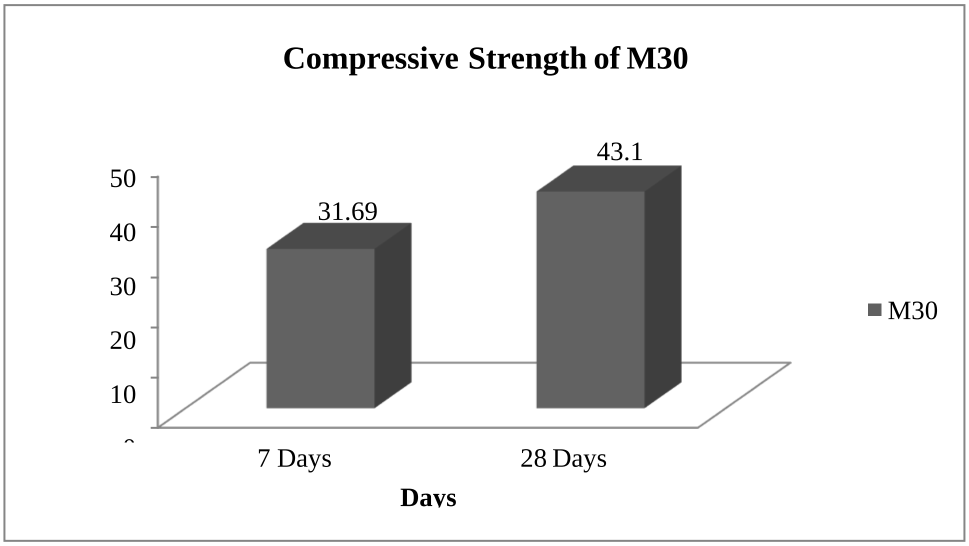

Fig.7. Compressive Strength of M30 Grade of Concrete Cube Specimens

C. Split Tensile Strength Test

As per IS456, split tensile strength of concrete= 0.7Fck.

Tests were performed on 300x150mm specimens with 7 and 28 days curing. The splitting tensile strength is calculated using the formula

$T_{sp} = P/\pi DL$

Where,

Tsp = Split Tensile strength, P = Ultimate load, D = diameter of the specimen & L = length of the specimen

Table.5. Split Tensile Strength of Concrete Cylinder Specimens

Grade	Days	πDL	Ultimate Load (P)			Average ultimate load	Split Tensile Strength T_{sp} (N/mm^2)
			S1	S2	S3		
M20	7	141.37x10^3	124.6	127.5	123.6	125.2	1.77
M30	7	141.37x10^3	146.7	152.8	159.6	153.0	2.17
M20	28	141.37x10^3	280.4	278.9	281.2	280.2	3.96
M30	28	141.37x10^3	294	297	304.2	298.4	4.22

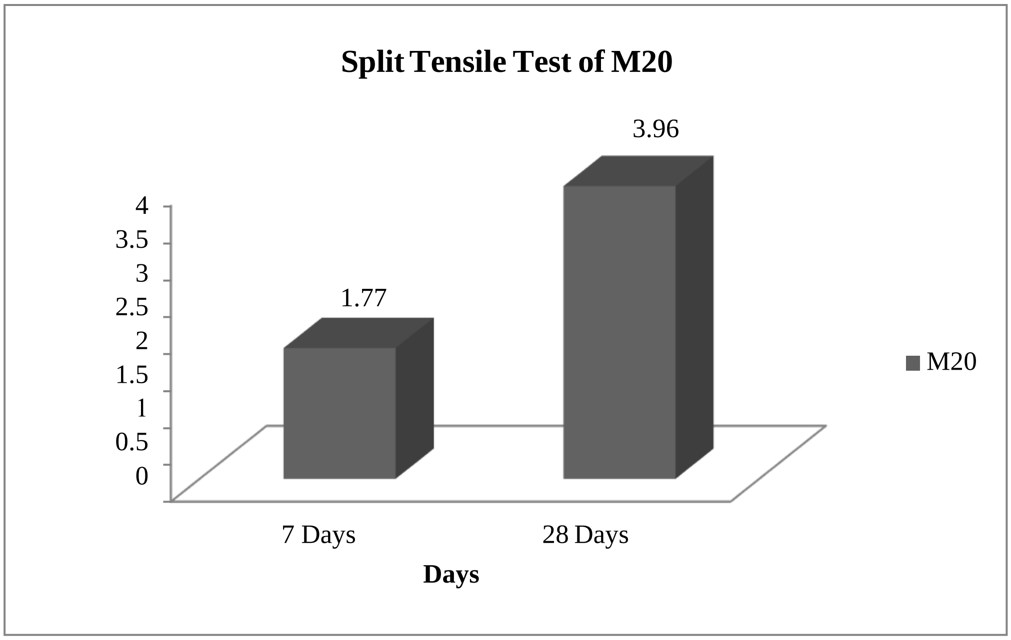

Fig.8.Split Tensile Strength of M20 grade of Concrete

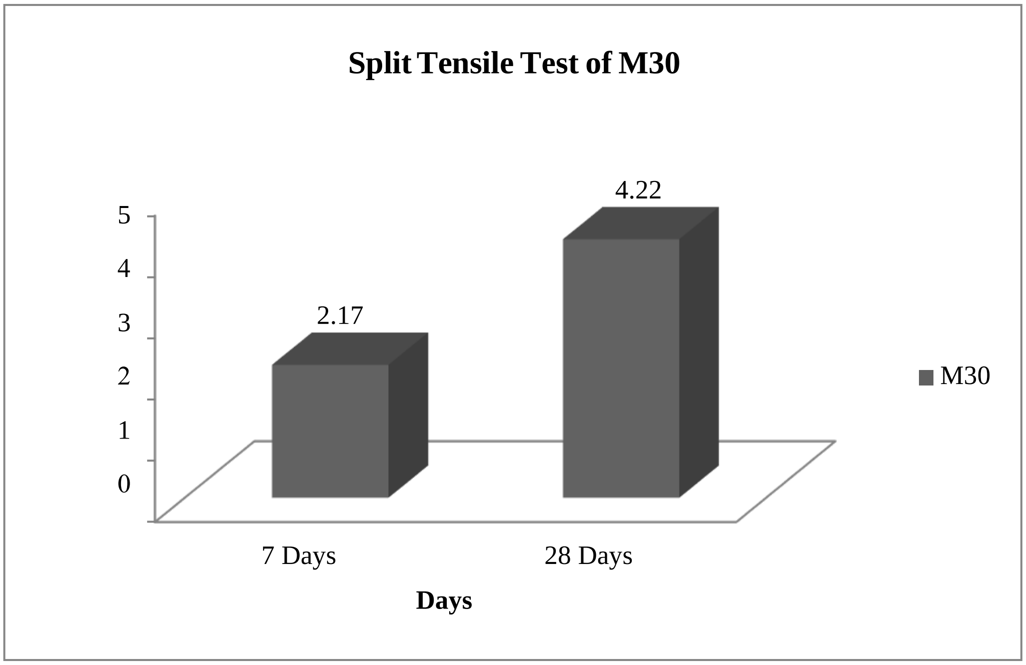

Fig.9.Split Tensile Strength of M30 grade of Concrete

D. Flexural Strength Test

Flexural test of Concrete is an indirect method for Measuring Tensile strength of concrete Tests were performed on 100X100X500mm specimens with 28 days curing.

Tensile strength $F_b = Pl/bd^2$

Table.6. Flexural Strength Test of Concrete Prism Specimens

Grade	Days	Size	Maximum load kN			Average Maximum Load	Modulus of Rupture N/mm²
			S1	S2	S3		
M20	28	100x100x500	10.8	11.4	11.0	11.07	4.98
M30	28	100x100x500	12.0	13.0	12.5	12.5	5.60

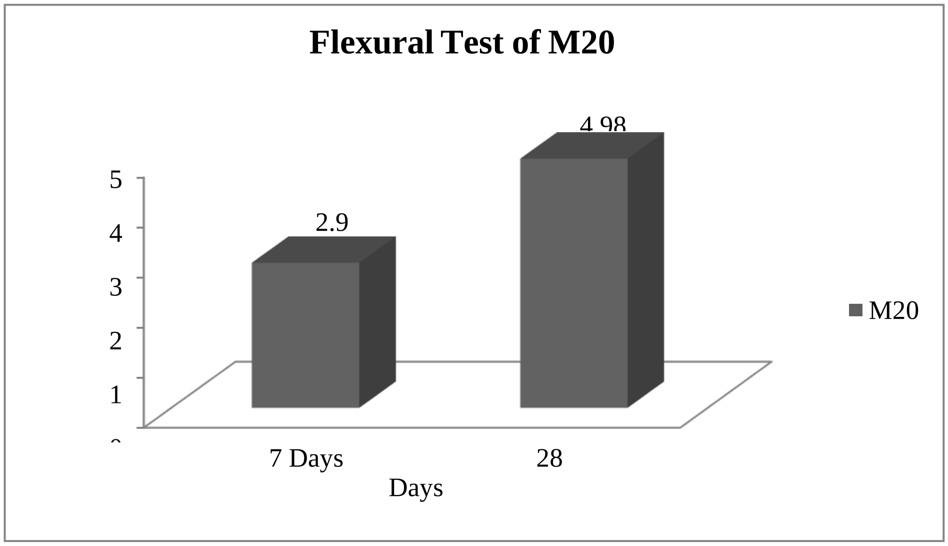

Fig.10.Flexural Strength of M20 grade of Concrete

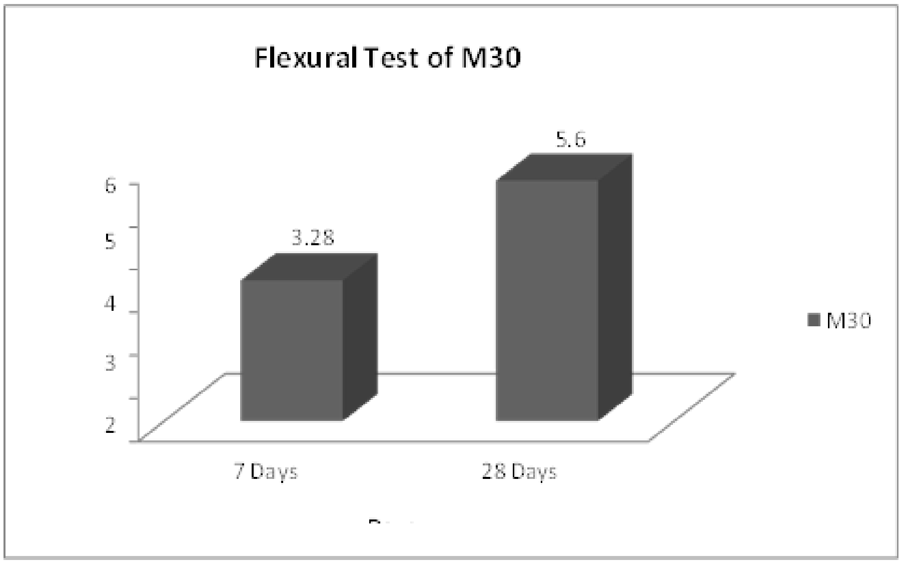

Fig.11.Flexural Strength of M30 grade of Concrete

6.0 Conclusion

An experimental study on the compressive behavior of concrete specimens has been presented in this paper. A total of 40 specimens were tested under monotonic axial compression under the effect of 3 parameters (Different grade, and FRP layers). Based on the results, the conclusion of this study can be summarized as follows:

- Newly developed BFRP composite can be effectively used in improving the overall compressive behavior of confined concrete.
- Density of the cubes tends to decrease with increase in Grade of concrete. Density of the cylindrical column tends to decrease with increase in Grade of concrete and simultaneously increases with increase in Layer of BFRP.
- Compressive strength of both cube and cylindrical column seems to be directly proportional to M20 and M30 and also the increasing the BFRP layer.
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