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Destructive and Non-Destructive Properties of Glass Fiber Reinforced High Performance Concrete with Micro Silica

UPPALAPATI UMA MAHESWAR REDDY[1], PARSINENI BALAKRISHNA[2]

[1]PG Scholar, Department of civil Engineering, Newton's Institute of Science and Technology,

Macherla, Guntur, AP, India.

[2]Assistant Professor, Department of Civil Engineering, Newton's Institute of Science and Technology,

Macherla, Guntur, AP, India.

Abstract: As we well known that, the world is developing rapidly and the construction of buildings takes vital role in this development. If we go through in detail the usage of concrete get raised up so it leads to the shortage of the natural resources. In order to save our natural resources we thought that replace some of the proportions in the concrete with the following measures.The study focuses on the compressive strength, split tensile strength and flexural strength performance of concrete containing glass fiber and different percentage of micro silica as a partial replacement of cement. The cement in concrete is replaced accordingly with the percentage of 7.5%, 10%, 12.5%, 15% and 17.5% by weight of micro silica and 0.5%,1%,1.5%,2% and 2.5% of glass fiber is added by weight of cement. Concrete cubes, cylinders and beams are tested at the age of 7, 14 and 28 days of curing. Finally the strength performance of slag blended fiber reinforced concrete is compared with the performance of conventional concrete.

Keywords: glass fiber, micro silica, compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

Concrete is most normally utilized and exceptionally solid constructional material. Concrete is a blend of concrete, coarse total and fine total and water. Concrete is the coupling material which holds the coarse and fine total together. The concrete and water frames a glue or gel which covers the sand and rock. Coarse total is utilized as quality material. Fine total is utilized as filler. Concrete is excellent in pressure and powerless in strain. To evade these issues now-a-days we are utilizing various sorts of admixtures in the solid. In this examination the expansion of glass strands in the solid and fractional supplanting of cement with micro silica and total volume of concrete with glass fibers. The interest for concrete is next just to water. With the progression of innovation and expanded field of utilization of cement and mortars, different properties of the standard cement required adjustment to make it progressively appropriate for different circumstances, conservative and eco well disposed. This has prompted the utilization of cementitious materials, for example, fly debris, micro silica, silica smolder, metakaolin and so forth which have contributed towards better, vitality protection and economy. The utilization of micro silica in part supplanting the fine total concrete in solid outcomes in decrease of concrete utilized, decrease in the emanation of carbon dioxide (Co2), protection of existing assets alongside the improvement in the quality and strength properties of cement.

1.1 MICRO SILICA

An experimental investigation is carried out to study the behavior of concrete by replacing the cement with micro silica. It involves a certain tests to find the quality improvement of concrete when micro silica is added to it. Micro silica, also referred as micro silica or condensed silica flume, is another material that is used as artificial mineral admixtures. Micro silica as an admixture has opened a new advancement in concrete technology. The usage of super plasticizer with micro silica has been the backbone of modern high performance concrete. It should be noted that micro silica by itself, doesn't contribute to strength. However it produces the property of strength being fine pozzolanic material. Micro silica helps in reduction of water becomes possible in presence of high dosage of super plasticizer and dense packing of cement paste.

1.2 FIBER REINFORCED CONCRETE

Concrete is weak in tension and has a brittle character. The concept of using fibers to improve the characteristics of construction materials is very old. Early applications include addition of straw to mud bricks, horse hair to reinforce

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plaster and asbestos to reinforce pottery. Use of continuous reinforcement in concrete (reinforced concrete) increases strength and ductility, but requires careful placement and labor skill. Alternatively, introduction of fibers in discrete form in plain or reinforced concrete may provide a better solution. The modern development of fiber reinforced concrete (FRC) started in the early sixties (1J. Addition of fibers to concrete makes it a homogeneous and isotropic material. When concrete cracks, the randomly oriented fibers start functioning, arrest crack formation and propagation, and thus improve strength and ductility. The failure modes of FRC are either bond failure between fiber and matrix or material failure. In this paper, the state-of-the-art of fiber reinforced concrete is discussed and results of intensive tests made by the author on the properties of fiber reinforced concrete using local materials are reported.

2. LITERATURE REVIEW

Kumar & Dhaka (2016) write a Review paper on partial replacement of cement with micro silica and its effects on concrete properties. The main parameter investigated in this study M-35 concrete mix with partial replacement by micro silica with varying 0, 5, 9, 12 and 15% by weight of cement The paper presents a detailed experimental study on compressive strength, flexural strength and split tensile strength for 7 days and 28 days respectively. The results of experimental investigation indicate that the use of micro silica in concrete has increased the strength and durability at all ages when compared to normal concrete has increased the strength and durability at all ages when compared to normal concrete

Md.AbidAlam et al. (2015) experimented on glass fiber reinforced concrete to study the properties of the concrete, For experiment Cem-Fil Anti-Crack, HD 12mm, Alkali Resistant glass fiber were used for the work. The specific gravity of the fiber is 2.68 mm and the length 12 mm. For the experimentation, M20 and M30 Grade concrete is used under the proportioning procedure mentioned under IS 10262-2009. For M20 grade of concrete 0.50 W/C Ratio is used and for M30 Grade of Concrete 0.42, W/C Ratio is used. Fibre is added in an increment of 0.02% from 0% to 0.06%. (0%, 0.02%, 0.04%, 0.06%). And according to the test result concrete attain higher strength that the target strength. An M20 grade of concrete attains 41.28 Mpa of Compressive Strength and 5.76Mpa of Tensile Strength when 0.06% of fiber is added in concrete. And M30 grade of concrete attain 62.29Mpa of Compressive strength and 7.17Mpa of Tensile Strength. Almost concrete attain 1 times of the target strength of the concrete.

Yogesh Iyer Murthy et al (2012)., have studied the performance of the concrete when glass fiber is added with an M30 grade of concrete. In this process,the author has undergone compression and flexural strength of the concrete. Thus after curing the concrete for 28 days concrete attains a compressive strength of 40.44Mpa strength when the fiber is added with 1.5 percentages and attains 5.3Mpa of flexural strength of concrete. Thus the experiment shows that the concrete attains almost 30% increase in strength when the fiber is added with conc.

3. MATERIALS PROPERTIES AND EXPERIMENTAL INVESTIGATION

3.1MATERIALS

Raw materials required for the concreting operations of the present work are micro silica , glass fibers, cement, fine aggregate, coarse aggregate, Polycarboxylate and water.

3.2CEMENT

Ordinary Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and most non- specialty grout. Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the Cement content. The Cement used in this project is Ordinary Portland Cement of 53 grade confirming to IS 12269 – 2013.

S No	Properties	Values observed
1	Specific Gravity	3.15
2	Normal consistency	32%
3	Initial setting time	38 min
4	Final setting time	550 min
5	Soundness	7.0 mm

3.1 Physical properties of Ordinary Portland cement -53 Grade

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3.3FINE AGGREGATE

Gradation refers to the particle size distribution of aggregates. Grading is a very important property of aggregate used for making concrete, in view of its packing of particles, resulting in the reduction of voids. This in turn influences the water demand and cement content of concrete.

Grading is described in terms of the cumulative percentages of weights passing a particular IS sieve. IS 383-1970 specifies four ranges or zones for fine aggregate grading. Table gives the range of percentage passing for each zone.

S.No	Property	Result
1	Fineness Modulus	2.7
2	Specific Gravity	2.65

3.2 Physical properties of fine aggregates

3.4 COARSE AGGREGATE

The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate.The normal maximum size is gradually 10-20 mm; however particle sizes up to 40 mm or more have been used in Self Compacting Concrete.

S.No	Property	Result
1	Fineness Modulus	8.01
2	Specific Gravity	2.72

3.3 Physical properties of coarse aggregates

3.4 MICRO SILICA

Micro silica, also referred as micro silica or condensed silica flume, is another material that is used as artificial mineral admixtures

Micro silica as an admixture has opened a new advancement in concrete technology. The usage of super plasticizer with silicafume has been the backbone of modern high performance concrete. It should be noted that micro silica by itself, doesn't contribute to strength. However it produces the property of strength being fine pozzolanic material. Micro silica helps in reduction of water becomes possible in presence of high dosage of super plasticizer and dense packing of cement paste

3.5 GLASS FIBER

Glass fiber-reinforced concrete consists of high-strength, alkali-resistant glass fiber embedded in a concrete matrix. In this form, both fibers and matrix retain their physical and chemical identities, while offering a synergistic combination of properties that cannot be achieved with either of the components acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired locations and orientation, acting as a load transfer medium between the fibers and protecting them from environmental damage.

Type	**Properties**
Density (gm/cc)	7.85
Youngs modulus(m N/m^2)	0.5
Specific gravity	30

Table 3.5 physical properties of glass fibers

3.6 POLYCARBOXYLATE (PC-F)

PC-F is a ready-to-use liquid superplasticizer that extremely improves the superb water-reducing performance when comparing with superplasticizers based on existing polycarboxylic systems. PC-F Polycarboxylate Superplasticizer for high water reducing has been primarily developed for applications in the ready mixed and precast concrete industries where the highest durability and performance is required.

Items	**Specification**
Visual Appearance	Light Yellow Liquid
Solid Content (%)	50.0±2.0

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Density (23℃) (kg/m3)	1.13±0.02
Chloride Content (%)	≤0.20
Na2SO4 Content (%)	≤4.0
Na2O+0.658K2O (%)	≤5.0
Solubility	Completely soluble

Table no 3.6 typical properties of polycarboxylate

4. MIX DESIGN

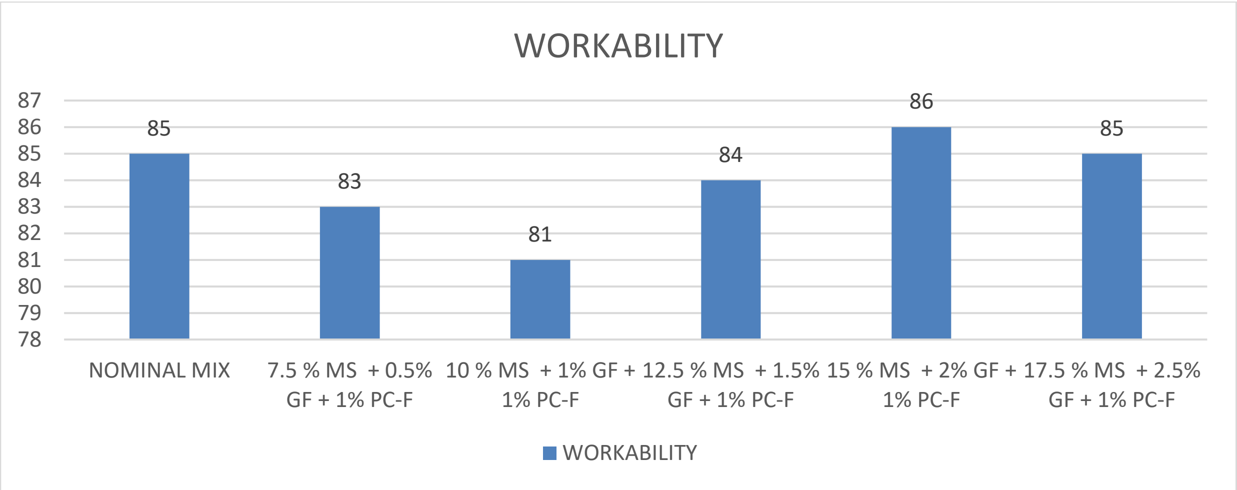
Cement	Fine aggregate	Coarse aggregate	Water
650.6	673.03	938.46	195.18
1	1.03	1.44	0.3

Table no 4.1 mix proportion for m40 grade

5. RESULTS

5.1 SLUMP CONE TEST

The strength of concrete of a given mix proportion is seriously affected by the degree of its compaction. It is therefore important that the consistency of the mix is such that the concrete can be transported, placed and finished sufficiently easily and without segregation. A concrete satisfying these conditions is said to be workable. Workability is a physical property of the concrete depending on the external and internal friction of the concrete matrix; internal friction being provided by the aggregate size and shape and external friction being provided by the surface



Graph no 5.1 workability results

5.2 COMPACTION FACTOR TEST

Scope and Significance Compaction factor test is adopted to determine the workability of concrete, where nominal size of aggregate does not exceed 40mm, and is primarily used in laboratory. It is based upon the definition, that workability is that property of the concrete which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction. To find the workability of freshly prepared concrete, the test is carried out as per specification of IS: 1199-1959.

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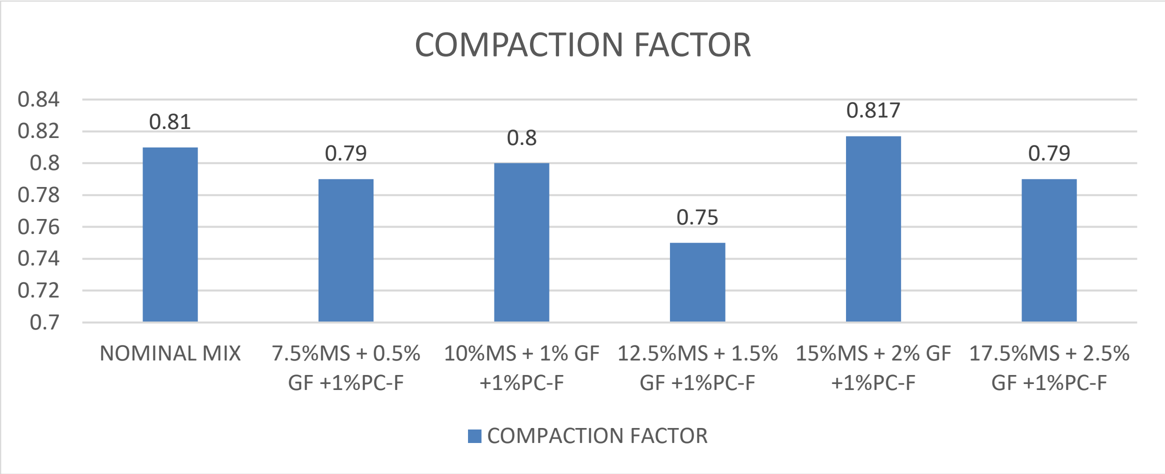
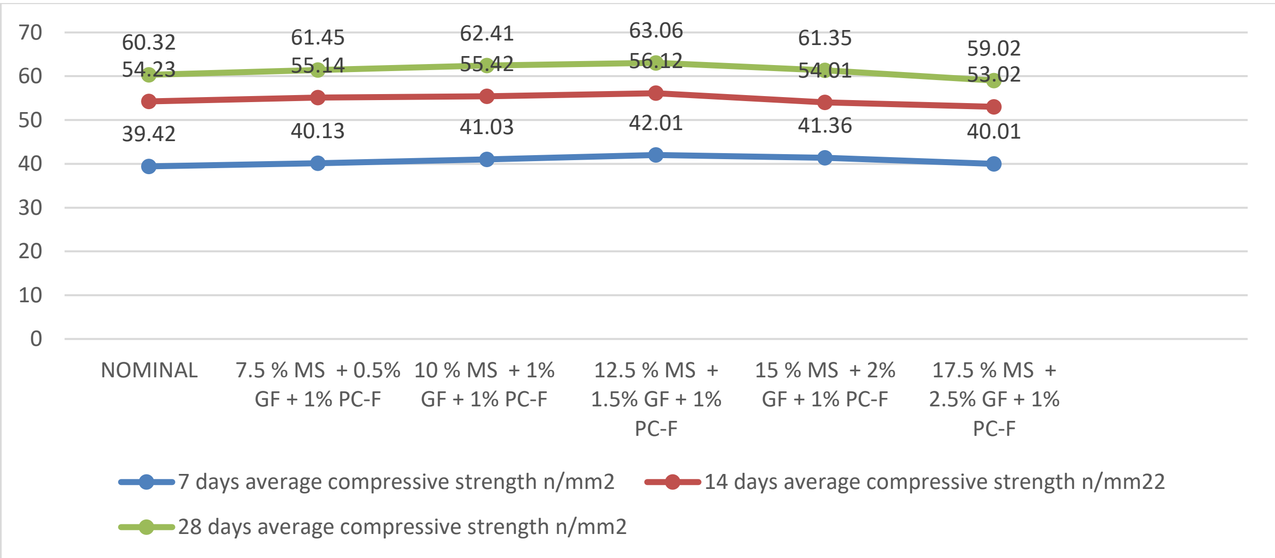


Graph no 5.2 compaction factor results

5.3 COMPRESSION TEST ON CONCRETE CUBES

The determination of the compressive strength of concrete is very important because the compressive strength is the criterion of its quality. Other strength is generally prescribed in terms of compressive strength. The strength is expressed in N/mm2. This method is applicable to the making of preliminary compression tests to ascertain the suitability of the available materials or to determine suitable mix proportions. The concrete to be tested should not have the nominal maximum size of aggregate more than 20mm test specimens are either 15cm cubes or 15cm diameter used. At least three specimens should be made available for testing. Where every cylinder is used for compressive strength results the cube strength can be calculated as under. Minimum cylinder compressive strength = 0.8 x compressive strength cube (10 cm x 10 cm) The concrete specimens are generally tested at ages 3 days 7 days and 28 days. The cubes are generally tested at 3 days 7 days and 28 days..



Graph no 5.3 compressive strength results for 7, 14 and 28 days

3.4 SPLIT-CYLINDER TEST

It is the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS : 5816-1970.A standard test cylinder of concrete specimen (300 mm X 150mm diameter) is placed horizontally between the loading surfaces of Compression Testing Machine. The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the points of application of this load, strips of plywood are placed between the specimen and loading platens of the testing

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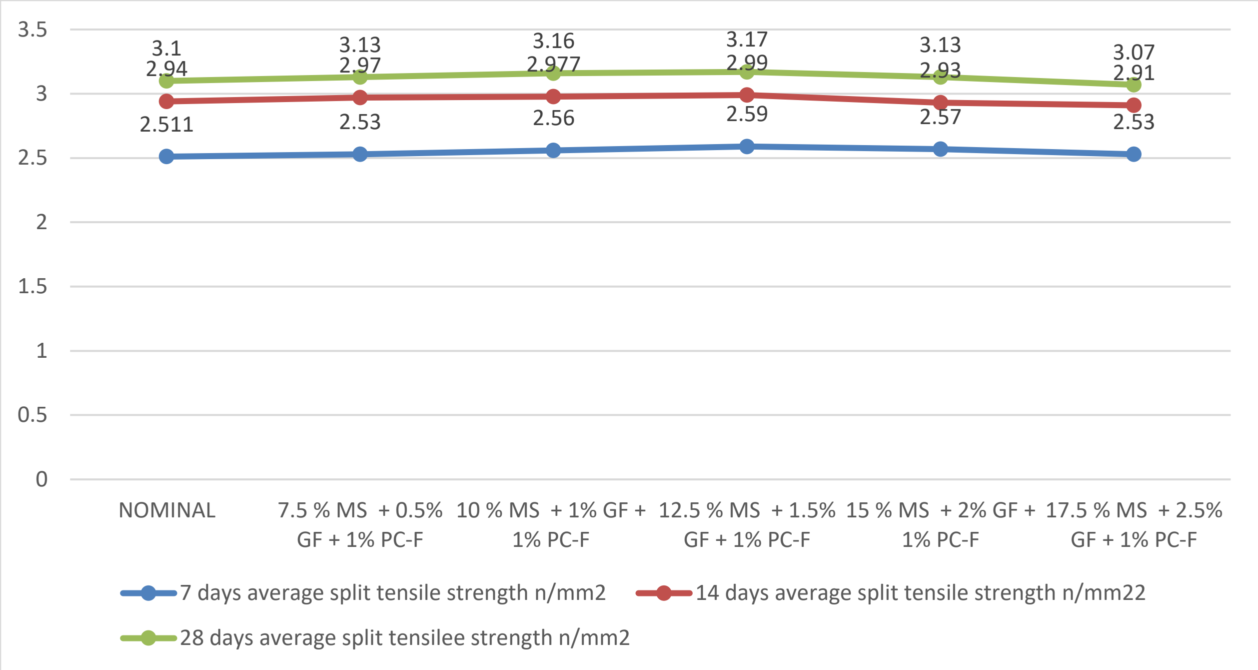
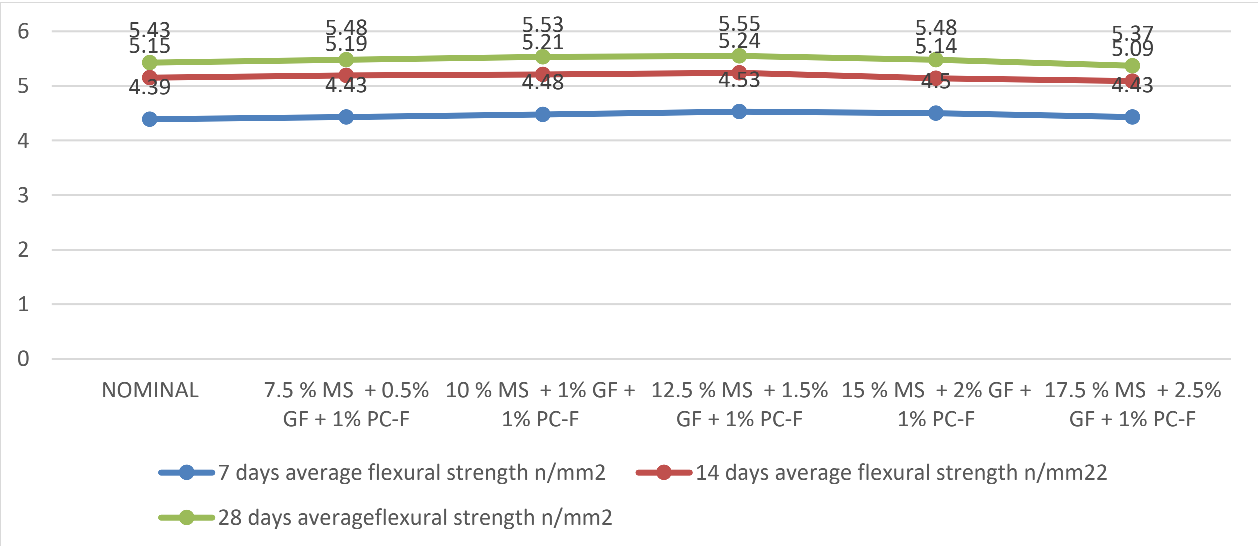
machine. Concrete cylinders split into two halves along this vertical plane due to indirect tensile stress generated by poison's effect.



Graph no 5.4 split tensile strength results for 7, 14 and 28 days

5.5 FLEXURAL STRENGTH OF CONCRETE

The flexural strength would be the same as the tensile strength if the material were homogeneous. In fact, most materials have small or large defects in them which act to concentrate the stresses locally, effectively causing a localized weakness. When a material is bent only the extreme fibers are at the largest stress so, if those fibers are free from defects, the flexural strength will be controlled by the strength of those intact 'fibers'. However, if the same material was subjected to only tensile forces then all the fibers in the material are at the same stress and failure will initiate when the weakest fiber reaches its limiting tensile stress. Therefore, it is common for flexural strengths to be higher than tensile strengths for the same material. Conversely, a homogeneous material with defects only on its surfaces (e.g., due to scratches) might have a higher tensile strength than flexural strength.



Graph no 5.5flexural strength results for 3, 7 and 28 Days

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5.6 ULTRASONIC PULSEVELOCITY (UPV) TEST RESULTS

Mix Identity	**Pulse wave velocity (m/sec)**	**Quality of concrete**
NOMINAL MIX	4450	Excellent
7.5 % MS + 0.5% GF + 1% PC-F	4583	Excellent
10 % % MS + 1% GF + 1% PC-F	4761	Excellent
12.5 % % MS + 1.5% GF + 1% PC-F	4850	Excellent
15 % % MS + 2% GF + 1% PC-F	4628	Excellent
17.5 % % MS + 2.5% GF + 1% PC-F	4539	Excellent

Table no 5.15 upv test results at 28 days(m/sec)

5.7 REBOUND HAMMER TEST

Mix Identity	**Mean rebound value**
NOMINAL MIX	31.5
7.5 % MS + 0.5% GF + 1% PC-F	43.52
10 % % MS + 1% GF + 1% PC-F	44.02
12.5 % % MS + 1.5% GF + 1% PC-F	45.31
15 % % MS + 2% GF + 1% PC-F	30.35
17.5 % % MS + 2.5% GF + 1% PC-F	29.12

Table no 5.16 rebound test results at 28 days

6. CONCLUSION

- We gain the highest compressive strength at the percentage of different admixtures added in M-60 grade concrete (12.5 % % MS + 1.5% GF + 1% PC-F) – 63.06 N/mm2
- We gain the highest split tensile strength at the percentage of different admixtures added in M-60 grade concrete (12.5 % % MS + 1.5% GF + 1% PC-F)– 3.17 N/mm2
- We gain the highest flexural strength at the percentage of different admixtures added in M-60 grade concrete (12.5 % % MS + 1.5% GF + 1% PC-F) – 5.55 N/mm2

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AUTHOR'S PROFILE

UPPALAPATI UMA MAHESWAR REDDY pursuing M.Tech in department of CIVIL (STRUCTURAL ENGINEERING) Newton's Institute of Science and technology.

P. BALAKRISHNA Working as Assistant Professor in Newton's Institute of Science and technology.