Experimental Investigations of Normal M25 Grade Concrete Containing Sugar Cane Fibres

Nalla Rameshkumar[1], Ch. Nikhitha[2], K, Abhiram[3], T. Nagamani[4]
[1, 2, 3, 4] Holy Mary Inistitute of Technology And Science

Abstract- *Concrete is an Artificial Stone resulting from hardening of rationally chosen mixture of cement, fine aggregate, coarse aggregate and water. This concrete is the most widely used construction material in the world, with about two Billion tons of utilization worldwide during each year. Concrete is widely used in all types of infrastructural applications because it offers considerable strength at a relatively low cost. Concrete is strong in compression weak in tension zone and it is brittle material. To o these problems add fibers to the concrete.*

Sugarcane bagasse (by product material produced during process of manufacturing sugar) is one of the waste materials which could have promising future in construction industry as a reinforcing material in concrete mixes. An experiment was conducted to investigate the strength properties of the concrete having sugarcane bagasse fibers as a reinforcing material and results have been presented in this thesis. Concrete grade (M_{25}) was used with different proportions of sugarcane bagasse fibers (0%, 1%, 2%, 3%, 4% and 5%) with the weight of the cement in the concrete. Test result that the strength properties of concrete have been improved having the sugarcane fibers with 1% and 2%.

I. INTRODUCTION

1.1 General

Advanced cement-based composites and the fundamental understanding of their behavior is an area of civil engineering that is expanding rapidly. Cement-based components (also referred to her generically as ―concrete) can be engineered to have outstanding combination of strength and energy absorption capacity (ductility) that is fundamentally different from plain concrete made with Portland cement. Conventional concrete is brittle nature, which is strong in compression but weak in tension, thus reinforcement is necessary to improve its tensile strength.

The science of incorporating one or more materials in concrete to improve strength and satisfy design requirements is not new. Since the 17th Century, man has been known to make composite materials to achieve the desired design strengths

Mostly concrete is reinforced with steel bars .Over the years scientists have been doing research on reinforcing concrete with fibers. The approach of replacing steel by incorporating the natural fibers in concrete is termed as Natural Fiber Reinforced Concrete (NFRC).The use of fiber reinforced

Examples of natural fibers are

- Sugarcane Bagasse,
- Coconut (coir fibers),
- Bamboo fibers,
- Sisal
- Elephant grass,
- Jute
- Human hair,
- Animal hair,
- Fur
- Avian fibers,
- Silk fibers etc.

1.2. Advantages and Disadvantages of natural fiber reinforced concrete Advantages

1. Are more resistant to cracking and reduce internal forces by blocking microscopic cracks from forming within the concrete.
2. Lighter than traditional concrete and as a result substantial weight saving can be realized using relatively thin NFRC sections having the equivalent strength of thicker plain concrete sections.
3. Has a unique crack behavior in that it maintains a crack width below 100µm when loaded beyond the elastic range.
4. Has an advantage over steel since corrosion does not take place at its interface with concrete.
5. Suitable for structures where corrosion is to be avoided at maximum.

Disadvantages

The disadvantage of NFRC is in the placement of the fibers in concrete mix as sometimes balling effect occurs.

However, the advantages of NFRC override the disadvantages.

1.3. Fiber Reinforcing Mechanism

The main role of the fibers in cement paste and mortar is secondary reinforcement by modifying the mechanical behavior of the cementitious matrix. Specifically, the fibers account for improvement of ductility of the composite and modification of cracking mechanism,

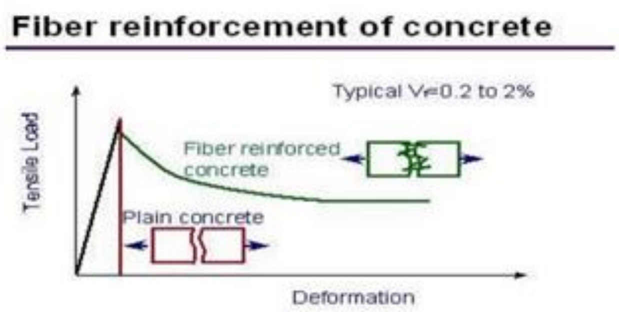

Figure1.1: Tensile Load versus Deformation for Plain and Fiber Reinforced Concrete

1.4. Growing Conditions and Production in India

Sugarcane is a tropical plant that is sensitive to the climate, soil type irrigation, fertilizers, insects, disease control, varieties and harvest period. It thrives best in tropical hot sunny areas. It requires a long warm growing season with high incidence of solar radiation and adequate moisture .And a fairly, sunny and cool but frost free ripening and harvesting period. A temperature of 30oC-34oC is required during the vegetative state, but lowers to 15oC-19oC during ripening

Figure1.2 Cut cane stalks

Figure:1.3. Oven dried & sun dried

1.5. Comparison between oven dried bagasse and sun dried (raw) bagasse

The bagasse fiber has a lot of sucrose left on it and hence it is washed in clean cold water before use so as to remove the sucrose. Drying is necessary to remove the excess water before incorporating it in the concrete mix so as not to upset the water-cement ratio. During this study it was noted that there is a very big difference between oven dried bagasse and sun dried bagasse, not just physically but also chemically.

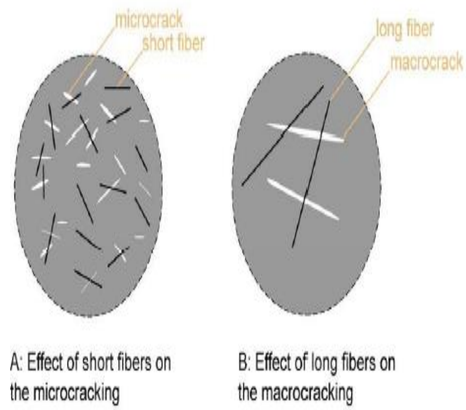

Figure:1.4 Mechanism Of Bagasse Fibers

II. LITERATURE REVIEW

General

Concrete became one of the major construction material in all branches of modern constructions viz., High rise buildings, Rigid pavements, Bridges, Dams, Canals, Airports, Harbors, Metro- Rails, Power Plants etc., Concrete is basically a mixture of Cement, Fine aggregates, Coarse aggregates and water. This Cement Concrete is an Artificial Stone resulting from hardening of rationally chosen mixture of binding material (cement), aggregates and water. Particles of sand and stone aggregate are Car- Cass in concrete. Cement paste resulting from the interaction of cement with water performs the functions of coating on the grains of fine and coarse aggregate and fills the voids between them, lubricates the aggregates and imparts mobility to the concrete mix. When the cement paste hardens, it binds the aggregates in to an artificial stone called as concrete.

2.1 Sustainable concrete using natural fibers a review (october2015)

Jaspal singh, Manmeet kaur, Manpreet kaur,Deptment of civil engineering, punjab, india.

This paper presents that the results of study on the use of sugarcane bagasse fibers as a reinforcing material in concrete . conducted a study on natural fiber reinforced concrete blocks using bagasse fiber. The results show that the compressive strength of air cured reinforced cubes with 1% fiber content was marginally higher that is 1.37N/mm2 than the unreinforced concrete . The tensile test results indicate that the highest tensile strengths were obtained in the mixes with 1% fiber content in both water and air cured conditions. carried out the study on behaviour of sugarcane fibrous concrete

2.2 Application of sugarcane bagasse fibers as concrete composites for rigid pavement: Dipan Patel ME (Transportation), and Prof. V M Patel (2015 April) GEC modasa, india.

Dipan Patel and Prof. V M Patel were investigated on sugarcane fibers as a reinforced in concrete. they introduced the bagasse fibers in a concrete. First the sugarcane was dried directly in sun light till it becomes dry, then it's were chopped off to size of Aspect ratio30, 60 and 90. Place the chopped Bagasse in oven at a constant temperature of 50 to 60ºC for an hour (this makes the Bagasse brittle).

2.3 Investigation of the performance of natural fibres as a micro reinforcement in concrete:

waweru nancy mugure(April 2014) university of nibori, nibori, kenya.

waweru nancy mugure was investigated on sugarcane fibre(1%,2%,3%) in concrete. He compared oven dried bagasse with sun light dried bagasse that is sun light bagasse is more stronger than oven dried bagasse. Studied the fresh concrete properties like workability tests(slump cone test, compaction factor test) and harden concrete

III. MATERIALS

The basic materials for mixing concrete are required such as

- Cement
- Fine aggregate
- Coarse aggregate
- Sugarcane bagasse fibers
- water

3.1 cement

The cement used for the present investigation was ordinary Portland cement 53 grade cement is a Deccan brand cement with a remarkably high C3S (Tri Calcium Silicate) providing long-lasting durability to concrete structures.

This grade was introduced in the country by BIS in the year 1987 and commercial production started from 1991.Advent of this grade in the country owes it to the improved technology adopted by modern cement plants.OPC 53 Grade cement is required to conform to BIS specification IS:12269-1987 with a designed strength for 28 days being a minimum of 53 MPa or 530 kg/sqcm.

3.2 Fine Aggregate

The locally available river sand from Karimnagar, Telangana, India, is used as fine aggregate in the concrete mix design. The specific gravity, water absorption and fineness modulus are 2.62, 0.3% and 2.78 respectively. Sand is of Zone-II as per IS: 383-1970.

The physical properties of aggregate were considered according to IS: 2386(1963).

Sand is naturally occuring granular material composed of finely divided rock and mineral particles. The most common constituent of sand is silicon dioxide, usually in the form of Quartz. Normally fine aggregate is used as fine aggregate in the concrete. An individual particle in this range is termed as sand grain. These sand grains are between coarse aggregate (2 mm to 64 mm) and silt (0.004 mm to 0.0625 mm). Aggregate most of which passes 4.75mm IS sieve is used.

3.3 Coarse Aggregate

Aggregates are the most mined material in the world. Aggregate are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Coarse aggregate of size 20mm is sieved and used.

3.4 Baggase fibers

As per Indians Standards IS 1196-1978, concrete is unaffected by dry sugar or solutions of low concentrations at normal temperatures.

Sugarcane Bagasse is a by-product of the sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced i.e., for each 10tonnes of sugarcane crushed in a sugar factory produces nearly3 tonnes of wet Bagasse.

In this study, it is proposed to investigate the influence of sugarcane fibres as stabilizing additive on engineering properties on Concrete mix.

Figuer3.1. Bagasse fibers

3.4.1 Extraction of Sugarcane Fibers

The samples were subjected to conventional miniature juice extractor where in juice was separated from the sugarcane. The residue left after the extraction of juice called bagasse was collected for extraction of fibers. The soft-core part pith was removed from the bagasse manually to get outer hard rind. The rind was then cut across the length so that the cut portions are free from the nodes.

The samples were then subjected to hot water treatments. In this process, the samples were kept in hot water at around 90°C for 1h for removal of coloring matters and sugar traces.

Figure: 3.2 Boiling of bagasse fibers The samples were then dried under the sunlight. Finally, samples were subjected to chemical extraction.

Figure:3.3 fibers dried under the sunlight

After that we extracted the fibers and also cutting the fibers in aspect ratio.

Figure:3.4 extraction of fibers

In this process, samples were treated with 0.1N NaOH solution, at boiling water temperature for 4hr under atmospheric pressure. During the tenure of this treatment, samples were subjected to vigorous stirring for effective separation of fibers. The well-separated fibers were then dried.

Figure:3.5 Distilled water & NaOH pellets

3.4.2physical properties of fiber

Table:3.3 physical properties of fiber

Properties of fiber	Sugarcane
Diameter	2 mm
Aspect ratio	30
Specific gravity	0.52
Water absorption	286.6
Density(kg/m^2)	260

3.5 Aspect ratio

The aspect ratio of the fiber is the ratio of its length to its diameter typical aspect ratio ranges from 30-150.

Figure:3.8 Aspect ratio

3.6 Water

Water used in concrete is free from sewage, oil, acid, strong alkalies or vegetable matter, clay and loam and is satisfactory to use in concrete.

IV. EXPERIMENTAL INVESTIGATION

4.1General

In the present study we are reinforced concrete by sugarcane fibers for M 25 Grade concrete in different percentages 0%, 1%, 2%, 3%, 4% and casted 18 no of cubes of 150mm x 150mm x150mm.

To achieve the objectives of the investigation the experimental program was planned to cast around 18 No of cubes. And the cubes were tested under 200 ton compression testing machine to study the compressive strength of the cubes, the details of the experimental program for cubes are mentioned in the table below.

4.2 Design mix

Concrete is an extremely versatile building material because, it can be designed for strength ranging from M10 (10Mpa) to M100 (100 Mpa) and workability ranging from 0 mm slump to 150mm slump. In all these cases the basic ingredients of concrete are the same, but it is their relative proportioning that makes the difference.

4.2.1 Basic Ingredients of Concrete

1. Cement – It is the basic binding material in concrete.
2. Water – It hydrates cement and also makes concrete workable.
3. Coarse Aggregate – It is the basic building component of concrete.

4. Fine Aggregate – Along with cement paste it forms mortar grout and fills the voids in the Coarse aggregates.
5. Admixtures – They enhance certain properties of concrete e.g. gain of strength, workability, setting properties, imperviousness etc
6. Concrete needs to be designed for certain properties in the plastic stage as well as in the hardened stage.

4.2.2 Advantages of mix design

Mix design aims to achieve good quality concrete at site economically.

Quality concrete means:

- Better strength
- Better imperviousness and durability
- Dense and homogeneous concrete

a) Economy in cement consumption

It is possible to save up to 15% of cement for M15 grade of concrete with the help of Concrete mix design. In fact higher the grade of concrete more are the savings. Lower Cement content also results in lower heat of hydration and hence reduces shrinkage.

b) Best use of available materials

Site conditions often restrict the quality and quantity of ingredient materials. Concrete Mix design offers a lot of flexibility on type of aggregates to be used in mix design. Mix design can give an economical solution based on the available materials if they meet the Basic IS requirements. This can lead to saving in transportation costs from longer distances.

c) Other properties

Mix design can help us to achieve form finishes, high early strengths for early De shuttering, concrete with better flexural strengths, concrete.

4.3 Mixing

Initially all the materials were weigh batched. Cement , coarse aggregate and fine aggregate were added and thoroughly mixed. Water was measured exactly and added to the dry mix and it was thoroughly mixed to get a cohesive concrete, which is demarcated by obtaining a uniform color all through the concrete.

4.4. Mix Proportion

The concrete mixture proportions for M25 Grade concrete are 1:1:2 and water cement ratio 0.55,the cubes were casted using . we are added the fibers by the weight of the cement.

Table 4.9: Mixing Proportion

Bagasse fibres in percentage by the cement	Weight of the fibers for 3 cubes cast(150×150mm)
1	62.75gm
2	124.5gm
3	186.75gm
4	249gm
5	311.25gm

The percentage range of 0% to 5% was used since it was observed that additional of more fibre past 3% caused balling to occur during mixing and hence difficulties in fabrication. And the resulting concrete was of lower strength.

Figure:4.3 Showing a ball of sugarcane fiber in the concrete mix

- Apply the load gradually without shock
- Record the maximum load and note any unusual features in the type of failure.

V. TESTS AND RESULT

5.1 Workability Test

5.1.1 Slump test

The slump cone continues to be the most commonly used method to assess the workability& consistency of fresh concrete, due to its simplicity. In the present context, the aim was to ensure a minimum slump to facilitate proper placement.

Figure:5.2 slump

5.1.2. compaction factor

Workability of the concrete is the ability with which concrete can easily mixed, transported and placed. This is a major factor which contributes to the other properties of concrete also. If concrete is workable enough then it can be compacted with less compacting effort. So there is relation between the amount of work required to compact a given fresh concrete of low water cement ratio. Slump cone test is also used to find out the workability of the concrete but only recommended for the concrete of higher workability. For less workable concrete, compaction is standardized by various standards.

Table 5.1: workability, slump and compacting factor of concrete with 19 or 38 mm maximum size of aggregates.

Degree of workability	Slump		Compacting factor	Use for which concrete is useful
	Mm	In		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines.
low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement.
Medium	50-100	2-4	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates.
High	100-175	4-7	0.95	High workability concrete; for sections with conjested reinforcement. Not normally suited for vibrations.

The type of concrete, age concrete, density of concrete slump, compaction factor and compressive strength of experiment are tabulated in the table given below.

Table 5.2: Tabulation of compressive strength results

Sl.No	Type of concrete	Age of concrete in days (DAYS)	Weight of block	Density in kg/m3	Failure load in N	Slump (mm)	C.F	Avg. compressive Strength (N/mm2)
		7	8.104	2401.185	330000	120	0.93	14.66
1	0%	14	8.418	2494.222	454000	120	0.93	20.17
	SBF	28	8.376	2481.777	554000	120	0.93	24.62
		7	8.216	2434	378000	70	0.93	16.8
2	1%	14	8.23	2438.51	505000	70	0.93	22.4
	SBF	28	8.24	2444.48	615000	70	0.93	27.33
		7	7.81	2314.07	360000	60	0.91	16
3	2%	14	7.992	2368	485000	60	0.91	21.55
	SBF	28	7.946	2354.37	580000	60	0.91	25.77
		7	7.75	2296.29	172000	65	0.89	7.64
4	3%	14	7.82	2317.03	245000	65	0.89	10.88
	SBF	28	7.816	2315.85	280000	65	0.89	12.44
		7	7.6	2251.85	125000	50	0.84	5.55
5	4%	14	7.736	2292.14	160000	50	0.84	7.11
	SBF	28	7.656	2268.44	195000	50	0.84	8.66
		7	7.22	2139.25	100000	50	0.842	4.44
6	5%	14	7.312	2166.51	140000	50	0.842	6.22
	SBF	28	7.34	2174.81	170000	50	0.842	7.55

5.3 Graphs

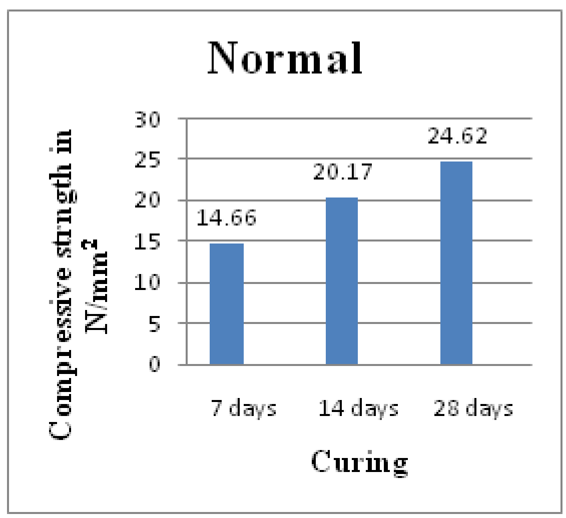

Figure:5.8 SCF 0%

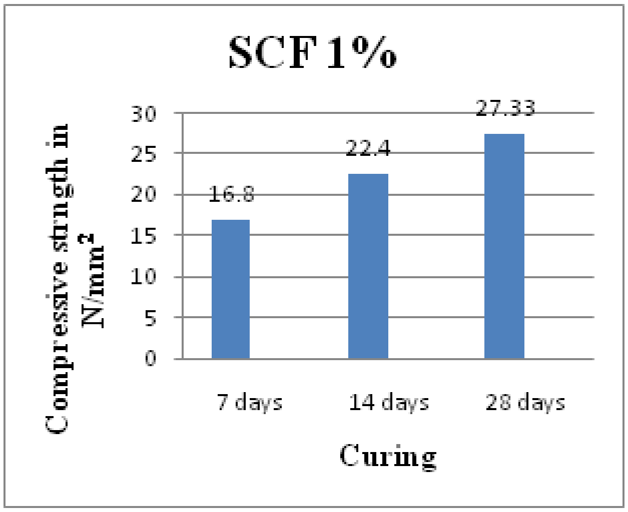

Figure:5.9 SCF 1%

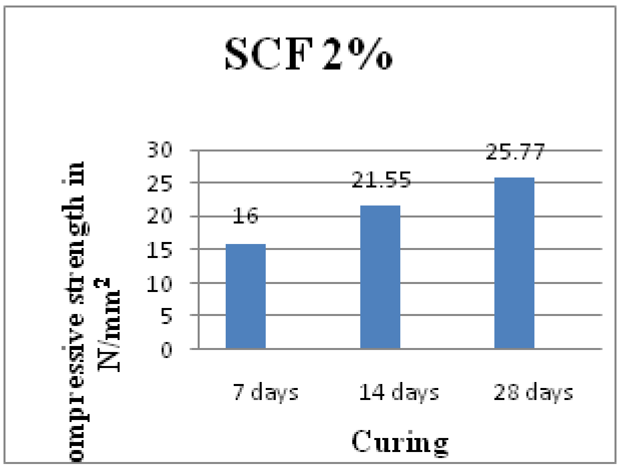

Figure:5.10 SCF 2%

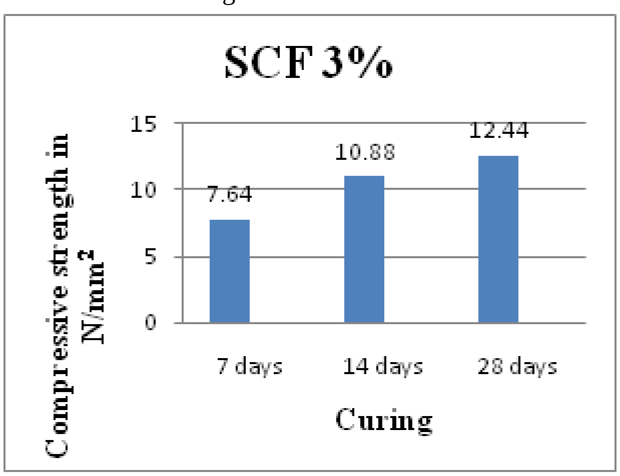

Figure:5.11 SCF 3%

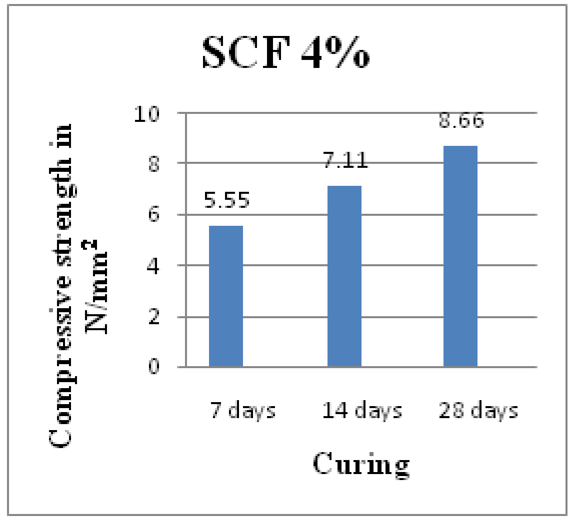

Figure:5.12 SCF 4%

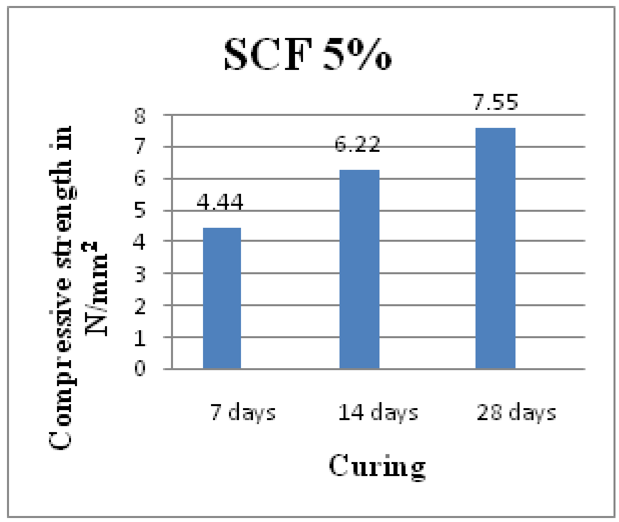

Figure:5.13 SCF 5%

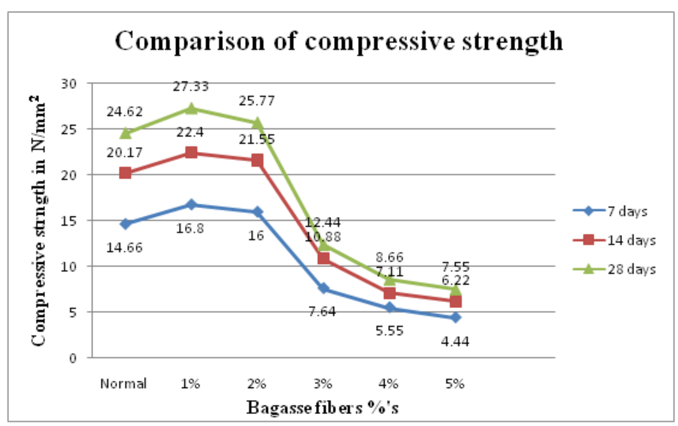

Figure:5.14 Comparison of compressive strength

VI. CONCLUSION

Based on the experimental investigation carried out, the following conclusion was drawn:

- Workability of the concrete is reduced when compare with the normal concrete.
- For 1% and 2% of the bagasse fibres compressive strength increased 2.33MPa and 1.5 MPa respectively.
- From the 3% of fibre reinforced concrete the fibres are not uniformly distributed in the mix and balling forms.
- The bond between the matrixes is very higher than the normal concrete.
- Density of the bagasse fibre concrete is less (i.e light weight concrete).
- Compressive strength for 3% of the fibre reinforced is decreased than the normal concrete.
- Evaporation losses are less, cracks are less after application of the compressive load(i.e micro cracks are reduced).
- Ductility and durability of concrete of the concrete are increased.
- Addition of the 1% of bagasse fibres is more suitable for the concrete.

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