STRENGTH AND ANALYSIS OF BASALT FIBRE IN CONCRETE

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Abstract — *This thesis attention on — "STRENGTH AND ANALYSIS OF BASALT FIBRE", works had been carried out on experimental investigation of basalt fibre concrete. Properties of concrete were checked by trying out cubes and cylinders. The specimens were solid the usage of M25 Grade concrete with locally available substances. The item of the existing paintings is to observe the impact of different proportions of basalt fibres within the concrete and find out foremost percentage of fibres with most electricity standards. The specimens like cubes and cylinders had been solid to check the compression energy, break up tensile energy and flexural strength. Concrete specimens with special proportions (0.5%, zero.1%, and 1.Five%) of basalt fibres have been solid together with manage specimens. Based at the literature take a look at, it became found that the basalt fibre concrete have better toughness and effect strengths than the manipulate concrete. It become additionally observed that the addition of basalt fibre in concrete modifications the mode of failure from brittle mode of failure to ductile mode of failure while subjected to compression, bending and impact. Because of its excessive tensile property it improves tensile energy of concrete whilst jumbled in premiere fibre ratio and has shown adequate enhancement in flexural behavior including Load-deflection, Moment-curvature and crack pattern.*

Key words **- Basalt fibre concrete (BFC), Compressive strength, Split tensile strength, Chopped basalt fibres**

I. INTRODUCTION

Construction is a primary part of development plan of growing nations along with India. To meet the large call for for infrastructure improvement, maintenance and lifestyles enhancement of structures are very vital. Concrete is the most broadly used man- made creation cloth. Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Conventional concrete doesn't meet many functional requirements including impermeability, resistance to frost accurately. The presence of micro cracks at the mortar–combination interface is responsible for the inherent weakness of simple concrete. Because of the poor tensile power, crack propagates with the utility of load leading to brittle fracture of concrete. Micro cracks are formed in concrete all through hardening level. Natural screw ups like earthquakes, cyclones, tsunami, and so forth wreck the high upward thrust buildings, bridges, enormous systems, global wonders, and many others. During the past few decades Common River sand has become expensive due to excessive cost of transport from natural sources. Large scale depletions of these sources have led to many environmental impacts. In order to overcome these impacts manufactured sand (M-sand) has found to be economical alternative to the river sand. M-sand is obtained as a crushing of granite stones in required grading to be used for construction purposes as a replacement for River sand.

The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of construction industry in many parts of the country. In the present work, it is aimed at developing a new building material from the granite scrap, an industrial waste as a replacement material of fine aggregate in concrete. By doing so, the objective of reduction of cost of construction can be met and it will help to overcome the problem associated with its disposal including the environmental problems of the region. Concrete had a good future and is unlikely to get replaced by any other material on account of its ease to produce, infinite variability, uniformity, durability and economy with using of basalt fibre in high strength of concrete. Basalt fibre offers more characteristics such as light weight, good fire resistance and strength. For many years, basalt has been used in casting processes to make tiles and slabs for architectural applications. Additionally, cast basalt liners for steel tubing exhibit very high abrasion resistance in industrial applications.

II. BASALT FIBRE

Fig:1 Basalt Fibre

Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to fiberglass, having better physio mechanical properties than fiberglass, but being significantly cheaper than carbon fiber. It is used as a fireproof textile in the aerospace and automotive industries and can also be used as a composite to produce products such as camera tripods.

Basalt fibres are manufactured in a single-stage manner by melting naturally occurring natural basalt rock. Basalt is a herbal, difficult, dense, dark brown to black volcanic igneous rock. It is the most commonplace type inside the earth's crust (the outer 10 to 50 km).

Its origins are at a depth of hundreds of kilometers underneath the earth surface and it reaches the surface as molten magma. Basalt density ranges among 2700 to 2800 kg/m3. The simple traits of basalt materials are high-temperature resistance, excessive corrosion resistance, resistance to acids and alkalis, excessive strength and thermal stability.

Basalt can be shaped into non-stop fibres with the same technology utilized for E-Glass and AR-Glass fibres, but the production-procedure requires less power and the uncooked substances are broadly subtle all over the global. This justifies the lower price of basalt fibres in comparison to glass fibres. Moreover, basalt fibres are environmentally secure, non-toxic, non-corrosive, non-magnetic, possess high thermal balance, have desirable heat and sound insulation properties, durability and vibration resistance.

Some studies have already investigated on essential residences of basalt fibres and its utility as strengthening and reinforcing cloth. It is located that the basalt fibre affords a modulus of elasticity atleast 18% higher than that of E-Glass fibres and beams strengthened with basalt fibres confirmed a extra ductile failure than those reinforced with E-Glass fibres.

Properties of Basalt Fibre

PROPERTY	VALUE
Tensile strength	2.8 - 3.1 GPa
Elastic modulus	85 - 87 GPa
Elongation at break	3.15%
Density	2.67 g/cm^3

ADVANTAGES OF BASALT FIBRE

1. Basalt fibre substances does now not go through any poisonous reaction with water and air, additionally do not have any facet consequences on human health.

2. Basalt fibres have important features like acid resistance, alkali resistance. It is thermally, electrically and sound insulated.

3. Basalt can replace almost all the packages of asbestos, which poses fitness hazards by means of unfavorable respiration device, and has three times its warmness insulating property.

4. Basalt is more available than another uncooked fabric. Also the melting temperature is lower throughout the producing technique and the energy consumptions is noticeably low. This makes the fee of basalt fibres appreciably decrease than that of different fibres.

Five. Basalt base composites can replace metallic (1 kg of basalt reinforces equals nine.Eight kg of steel) as mild weight concrete may be get from basalt fibre.

6. Basalt has numerous superb houses like excessive Elasticity modulus and wonderful warmness resistance. These fibres have massive functionality of heat & acoustic damping and are exceptional vibration isolators.

7. The basalt fibre has low density as 2.8 g/cc to 2.9 g/cc, which is an awful lot decrease than different metals and in the direction of carbon and glass fibres, even though inexpensive than carbon fibre and excessive strength than glass fibre. Hence basalt is suitable as low weight cheaper tough composite material.

8. They possess a modulus of Elasticity as a minimum 18% better than that of E-Glass fibres.

III. MANUFACTURED SAND (M-SAND)

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less. Specific gravity, particle size & shape and water absorption of fine aggregates were tested in laboratory.

Fig. M- sand.

ADVANTAGES OF MANUFACTURED SAND (M-SAND)

- It is well graded in the required proportion.
- It does not contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- M-Sand is cubical in shape and is manufactured using technology like High Carbon steel hit rock and then rock on rock process which is synonymous to that of natural process undergoing in river sand information.
- Modern and imported machines are used to produce M-Sand to ensure required grading zone for the sand.

IV. MIX PROPORTION

The mixture proportioning turned into achieved in step with the Indian Standard Recommendation technique IS 10262-2009. The everyday Portland cement (opc) of Grade 53 is used. Cement, nice combination, coarse combination & basalt fibre have been well combined collectively according with IS code in the ratio 1:1.93:1.67 by means of weight before water became brought and become properly blended together to acquire homogenous cloth. Water absorption ability and moisture content have been considered and as it should be subtracted from the water/cement ratio used for blending. Basalt fibres with specific probabilities 0.5%, 1%, 1.5% are being changed for the whole extent of concrete. Cubes, cylinders and prism moulds have been used for casting; compaction of concrete in 3 layers with 25 strokes of 16mm rod turned into done for every layer. The concrete turned into left within the mildew and allowed to set for 24 hours earlier than the moulds had been de-moulded after which they were positioned within the curing tank until the day of checking out (7&28 days). The blend percentage obtained is as shown beneath.

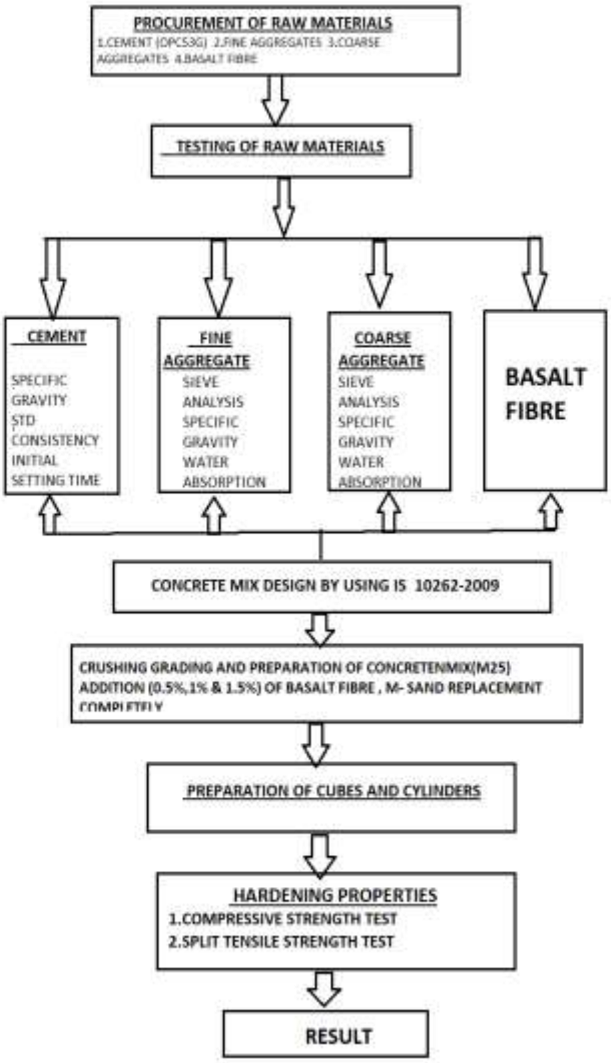
Table: Mix proportion

Concrete Type	Notation Used	Ratio	W/C
Conventional concrete	C1	1:1.93:1.67	0.477
0.5%BF+M-sand	C2	1:2.39:2.08	0.55
1.0%BF+M-sand	C3	1:2.39:2.08	0.55
1.5%BF+M-sand	C4	1:2.39:2.08	0.55

V. PROPERTIES OF USED MATERIALS

- Chopped 12mm Basalt fibre.
- Cement: Ordinary Portland cement of 53 grade having specific gravity of 3.14
- Fine aggregate: M sand conforming to IS-383, Zone-II having specific gravity 2.67
- Coarse aggregate: Crushed granite angular aggregate of size 20mm confirming to IS-383 having specific gravity 2.63.
- Water: Ordinary potable water conforming to IS 456.

VI METHODOLOGY



V. STRENGTH PROPERTIES

GENERAL

The programwas conducted for understanding the effectiveness of adding basalt fibres in concrete, the testing was carried out on 12 concrete cubes (150mm x 150mm x 150mm) for compressive strength, 12 concrete cylinders (150mm x 300mm) for Elasticity modulus. Casting was made in M_{25}Grade and thespecimens were made to cure for 28 days in potable water.

Table: Details of specimens

Specimens	Cubes	Cylinders
Conventional concrete	3	3
Concrete with basalt fibre at 0.50%	3	3
Concrete with basalt fibre at 1.0%	3	3
Concrete with basalt fibre at 1.5%	3	3

VI. COMPRESSION STRENGTH TEST

The Compressive strength is the capacity of a material or structure to withstand compressive load without failure. It can be measured by plotting applied force against deformation noted from the universal testing machine. Some materials fracture at their compressive strength limit, others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is the key value for design of concrete structures.

Compressive strength of the concrete is obtained by testing the cubes of size 150mmx150mmx150mm at 7th & 28th day. The concrete cubes designed for M_{25} grade were cast and cured for 28 days. After 28 days of continuous curing the specimens were taken out and they were exposed to atmosphere for few hours. Surface water and grit shall be wiped off and any projecting fins are removed. In the case of cubes, the specimen is placed in the machine in such a manner that the load is applied to opposite sides of the cubes. The axis of the specimen is carefully aligned with the centre of thrust of the spherically seated plate. No packaging is used between the faces of the test specimen; The movable portion is rotated is rotated gently by hand so that uniform seating may be obtained. The load is applied without shock and increased continuously until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The compressive test on hardened control & Basalt concrete were performed on a 2000kN capacity hydraulic testing machine in accordance to the relevant Indian standards. A typical setup is shown in fig 2. Three concrete cubes were tested for every compressive strength test.

$$\text{Compressive strength} = \frac{\text{Ultimate load}}{\text{Area of specimen}}$$

Fig 2 Comptressive strength test set up

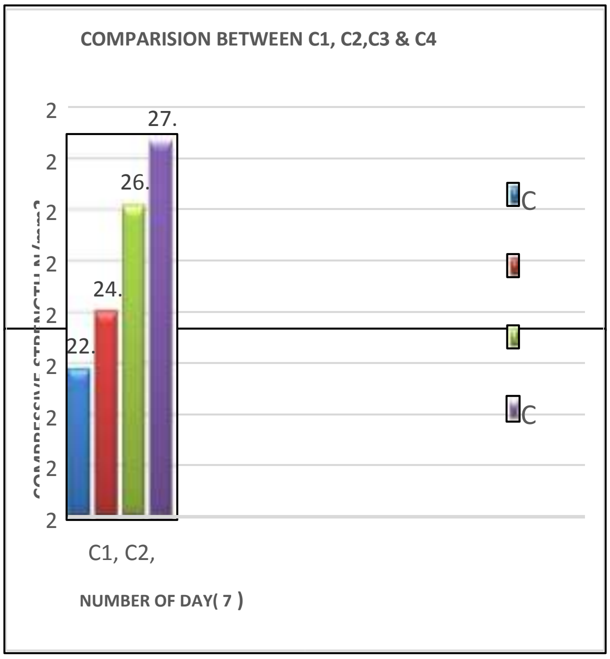
Table2: Compressive strength results

Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Compressive strength at 7 days
1	Conventional C1	342	521.66	22.89
		713		
		510		
2	0.5%BF+M-Sand C2	519	540.66	24.02
		514		
		589		

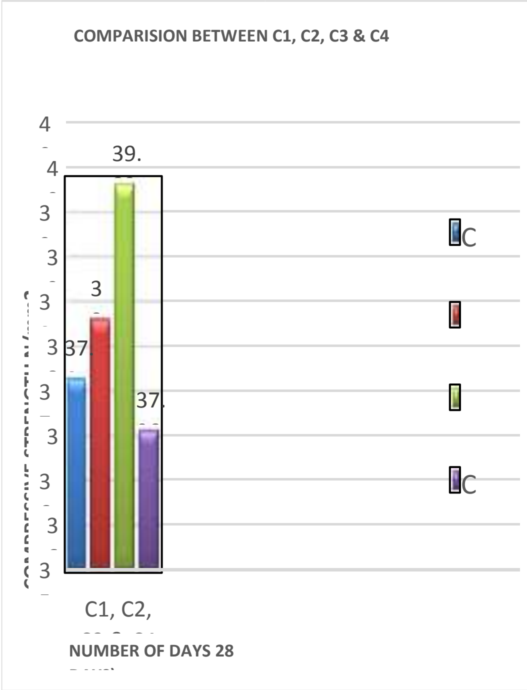
3	1.0% BF+M-Sand C3	626	582.66	26.09
		535		
		587		
4	1.5%BF+M-Sand C4	561	615.33	27.34
		561		
		734		

Sl. no	Type of specimen	Ultimate load in KN	Average Load in KN	Compressive strength at 28 days
1	Conventional C1	803	847	37.64
		925		
		813		
2	0.5%BF+M-Sand C2	861	863	38.3
		831		
		897		
3	1.0% BF+M-Sand C3	945	896	39.82
		875		
		868		
4	1.5%BF+M-Sand C4	864	834	37.06
		822		
		816		

Graph1.Compariosion b/w C1,C2,C3,&C4 @ 7 Days



Graph2. Comparison between C1,C2,C3&C4 @ 28 Days



Percentage increase or decrease of strength w.r.t Conventional Concrete and Admixture Concrete is given below:

Table: 4 Percentage increase or decrease of strength in Cubes @ 7days

Concrete Type	Strength N/mm²	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	22.89	----
0.5%BF+M-sand	24.02	4.936 increase
1.0%BF+M-sand	26.09	13.97 increase
1.5%BF+M-sand	27.34	19.44 increase

Table: 5. Percentage increase or decrease of strength in cubes @28 days

Concrete Type	Strength N/mm²	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	37.64	----
0.5%BF+M-sand	38.3	1.750 increase
1.0%BF+M-sand	39.82	5.791increase
1.5%BF+M-sand	37.06	1.540 decrease

VII. SPLIT TENSILE OF CONCRETE

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

APPARATUS & EQUIPMENT**:** Compression test machine, cylindrical mould of 200mm height and 100mm diameter, Curing Tank, Tamping rods, weighing balance.

Fig.3 Split Tensile Test Setup

PROCEDURE:

1. Take the wet specimen from water after 7 days and 28 days of curing.
2. Wipe out water from the surface of specimen.
3. Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
4. Note the weight and dimension of the specimen.
5. Set the compression testing machine for the required range.
6. Keep are plywood strip on the lower plate and place the specimen.
7. Align the specimen so that the lines marked on the ends are vertical and centred over the bottom plate.
8. Place the other plywood strip above the specimen.
9. Bring down the upper plate to touch the plywood strip.

Apply the load continuously without shock at a rate of approximately 14-21kg/cm2/minute.

10. Note down the breaking load (p).

FORMULA:

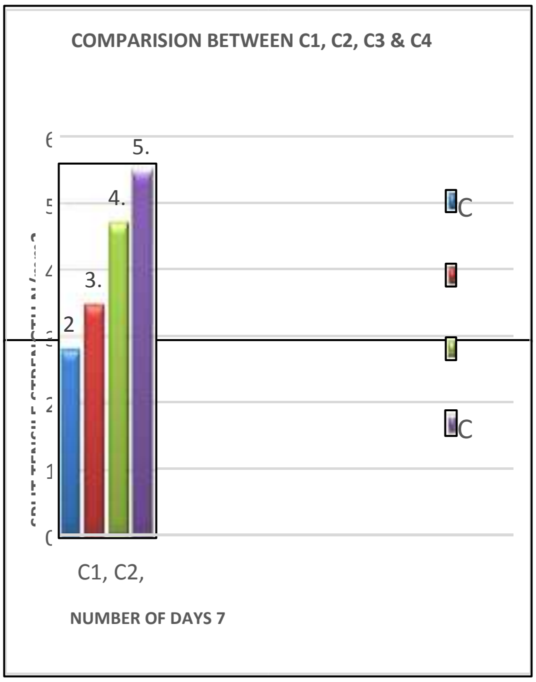
Split tensile Strength = 2P/ (3.142*D*L)s

Table6: Split tensile test of concrete cylinder @ 7 days

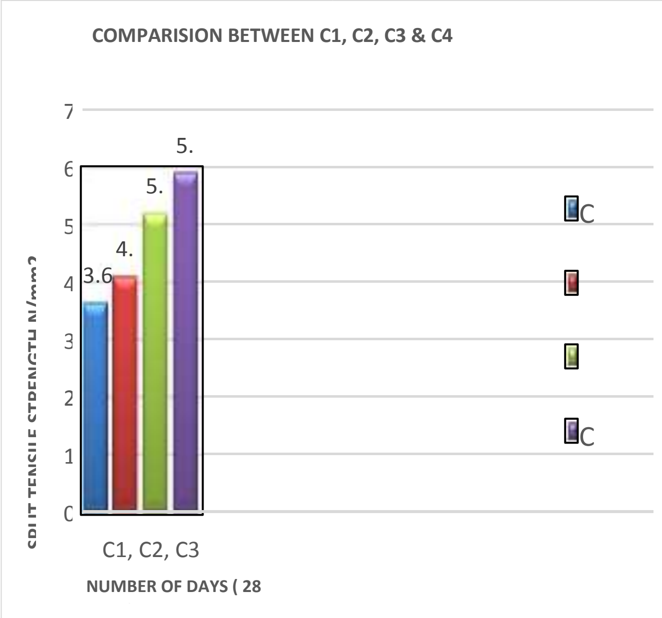
Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Split Tensile strength N/mm² at 7 days
1	Conventional C1	198	198	2.80
		202		
		192		
2	0.5%BF+M-Sand C2	285	245	3.47
		220		
		257		
3	1.0% BF+M-Sand C3	321	333	4.71
		342		
		335		
4	1.5%BF+M-Sand C4	406	388	5.48
		382		
		376		

Table7: Split tensile test of concrete cylinder @ 28 days

Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Split Tensile strength N/mm² at 28 days
1	Conventional C1	236	258	3.64
		276		
		262		
2	0.5%BF+M-Sand C2	286	289	4.1
		311		
		272		
3	1.0% BF+M-Sand C3	382	367	5.2
		298		
		422		
4	1.5%BF+M-Sand C4	428	417	5.9
		462		
		361		



Graph.3 Comparision b/w C1,C2,C3&C4 @ 7 days



Graph.4: Comparision b/wC1,C2,C3&C4 28 days

Percentage increase or decrease of strength w.r.t

Conventional Concrete and Admixture Concrete is given below:

Table8: Percentage increase or decrease of strength in Cylinder @ 7days

Concrete Type	Strength N/mm^2	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	2.80	----
0.5%BF+M-sand	3.47	23.92 increase
1.0%BF+M-sand	4.71	68.21 increase
1.5%BF+M-sand	5.48	95.71 increase

Table9: Percentage increase or decrease of strength in Cylinder @ 28days

Concrete Type	Strength N/mm^2	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	3.64	----
0.5%BF+M-sand	4.1	12.63increase
1.0%BF+M-sand	5.2	42.85increase
1.5%BF+M-sand	5.9	62.08 decrease

VIII. CONCLUSIONS

1. Compressive strength of addition 0.5% of Basalt fibre + M- sand concrete (C2) increases when compared with the conventional concrete (C1) by 4.93% at 7 days & 1.75% at 28 days respectively.
2. When compared to Compressive strength of C1, addition 1.0% of Basalt fibre + M- sand concrete (C3) increases by 13.97% and 5.79% at 7 days and 28 days respectively.
3. When compared to Compressive strength of C1, addition 1.5% of Basalt fibre + M- sand concrete (C4) increases by 19.44% at 7 days and decreases by 1.54% at 28 days respectively.
4. Split tensile strength of addition 0.5% of Basalt fibre + M- sand concrete (C2) increases when compared with the conventional concrete (C1) by 23.92% at 7 days & 12.63% at 28 days respectively.
5. When compared to split tensile strength of C1, addition 1.0% of Basalt fibre + M- sand concrete (C3) increases by 68.21% and 42.85% at 7 days and 28 days respectively.

6. When compared to split tensile strength of C1, addition 1.5% of Basalt fibre + M- sand concrete (C4) increases by 95.71% and 62.08% at 7 days and 28 days respectively.
7. For the Saline test , the split tensile strength of M- sand Conventional concrete (C1) compared with the salt water curing conventional concrete (C5) decreases by 8.24% at 28 days, and also compared with the addition of 1.0% of Basalt

REFERENCES

[1] “Experimental investigation of concrete with Basalt Fibre” **APRIL 2016.** N. Gopi, P .Baskar, B. Dharani and P. Abinaya. ISSN: 0976-1353 Volume 21 Issue 1.

[2] “Experimental Study on Mechanical Properties of M-Sand Concrete by Different Curing Methods- 2016. Sagura, Jagadeesan, e-ISSN: 2278-1684, p-ISSN: 2320- 334X, PP 19-25

[3] Rashid Hameed, Alain Sellier, AnacletTuratsinze, Frederic Duprat(2013) “Flexural Behaviour of Reinforced Fibrous Concrete Beams Experiments andAnalyticalModelling” Engineering and application science – vol 13 pp 19-28

[4] Singaravadivelan, N Sakthieswaren and K.L Muthuramu (2012) “Experimental Investigation on the Behaviour of Flexural Strengthening of Beam Using Basalt Fiber” -Mechanical and Materials Engineeringpp 19-20, 2012.

[5] India Mart office, Mumbai.

[6] Concrete technology theory and practice - M S Shetty.