

## International Journal of Innovative Research in Science, Engineering and Technology

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# Usage & Impact of Surkhi (Brick Dust) & Fibre Glass in Concrete

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**ABSTRACT:-** Concrete is a globally used material. It is a site-made material unlike other materials of construction and as such can vary to a very great extent in its quality, properties and performance owing to the use of natural materials except cement and sand. The production of natural sand and cement is diminishing and also their use has led to severe environmental problems. Thus, there is a need to replace these materials by some cheap, environmental friendly by-products such as Surkhi (brick dust). Surkhi is obtained from brick kilns. In the process of partial replacement it is sieved to the fineness of sand. The project incorporates the physical properties and chemical composition of Surkhi as well as workability, and compressive strength properties of concrete produced by replacing 10%, 15%, 20% and 25% Surkhi, by weight of sand. The concrete cubes were tested at the ages of 14 days and 28 days. The compressive strength of concrete with Surkhi was lower at early stages but improves significantly after 28 days. It was concluded 20% Surkhi substitution is adequate to enjoy maximum benefit of strength gain. Plain concrete possess very low tensile strength, limited ductility and little resistance to cracking. Plain concrete possess very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks. Fibres when added in certain percentage in the concrete improve the strain properties as well as crack resistance, ductility, flexure strength and toughness. The present project outlines the experimental investigation conducted on the use of glass fibres with structural concrete.

**KEY WORDS:** Concrete, Surkhi, Fibre Glass, Compression test, Slump test, Flexural Test, Split Tensile Test.

### I. INTRODUCTION

Since ancient times, fibres have been used to reinforce brittle materials. Straw was used to reinforce sun baked bricks, and horsehair was used to reinforce masonry mortar and plaster. In modern times, a wide range of engineering materials (including ceramics, plastics, cement, and gypsum products) incorporate fibres to enhance composite properties. The enhanced properties include tensile strength, compressive strength, elastic modulus, crack resistance, crack control, durability, fatigue life, resistance to impact and abrasion, shrinkage, expansion, thermal characteristics, and fire resistance. The production of natural sand and cement is also diminishing and also their use has led to severe environmental problems. Thus, there is a need to replace these materials by some cheap, environmental friendly by-products such as Surkhi (brickdust). Surkhi is obtained from brick kilns. In the process of partial replacement it is sieved to the fineness of sand. Surkhi in concrete is an interesting possibility for economy on waste disposal sites and conservation of natural resources. The project incorporates the physical properties and chemical composition of Surkhi as well as workability, and compressive strength properties of concrete produced by replacing 10%, 15%, 20% and

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25% Surkhi, by weight of sand. The compressive strength of concrete with Surkhi was lower at early stages but improves significantly after 28 days. It was concluded 20% Surkhi substitution is adequate to enjoy maximum benefit of strength gain. In recent times, fibre glass have also become available, which are free from corrosion problem associated with steel fibres. The present project outlines the experimental investigation conducted on the use of fibre glass and Surkhi with structural concrete.

## II. RELATED WORKS

Jan Wakeel Ahmad Wani, Ravi Kumar, [1] Studied on the Influence of Surkhi on various properties of Concrete Bricks, in their work they reached at the conclusion that surkhi being a waste material could be used for constructional purposes by utilizing it as a structural element in the form of a brick and by its pozzolanic property surkhi produces high strength.[2] Pravin Jadav, Ashish PujariaNitin Ghotane, Abhijit Potdar, Prof. Swanand Kadam, studied on experimental behavior of glass fiber reinforced concrete and in their work they pointed that 1% addition of glass fibre into the concrete shows better result in mechanical properties and durability, workability also decreases due to addition of fibres into the concrete.[3]Zamir Irfan, Syed Zeeshan Shafi, Altaf Ahmad Bhat studied on the Utilization of Surkhi as a Partial Replacement of Sand in Concrete and in their research it got concluded that with replacement of sand with surkhi workability of concrete increases and also leads to increase of compressive strength which gives more strength to the concrete as by the normal mixing of ingredients to plain concrete.[4]Komal Chawla, Bharti Tekwani also strength to the concrete. [5] Dr.Srinivase Rao, B. Chandra Mouli, Dr. T.Seshadri Sekhar, studied the various properties of glass with the concrete, the various properties that they investigated in their research are as workability, resistance to concrete due to acids, sulphates and rapid chloride permeability tests of M30, M40 and M50 grade of glass fiber reinforced concrete and ordinary concrete at 28 and 90 days with varying % age of glass fibers.

## III. UTILISATION OF WASTE MATERIALS

Although we have been observing the waste materials like Surkhi and Quarry dust as a waste materials in the past few decades but these materials are considered to be very useful from the civil engineering point of view. Surkhi is used as a partial replacement of sand in concrete provided to be very useful not only in the strength of concrete but also provided economical support which is considered very useful in engineering. The utilization not only protects the environment from pollution but also maintain an ecological balance in the environment which is caused by the extraction of sand.

### NEED AND NECESSITY OF REPLACEMENT

For a variety of reasons, the concrete industry is not sustainable.

- First, huge quantities of virgin materials such as sand, gravel, crushed rock, and fresh water are consumed
- Second, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change.
- Third, many concrete structures suffer from lack of strength and durability which has an adverse effect on the resource productivity of the industry. On the other hand, the industrial and agriculture wastes suffering the problem of disposal and are environmentally hazardous. So these industrial and agricultural wastes need to be utilized in efficient manner. Surkhi cause problems of disposal and lead to environmental pollution. Its adoption will enable concrete construction industry to become more sustainable.

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## IV. PRILIMINARY WORK

**A. Raw Material Collection:** It is a physical collection of materials, ranging from innovative new materials to those found every day in the constructed environment. The collection allows users to rethink conventional applications and promote experimentation in practice. The various materials which were used in the project are;

- Surkhi
- Cement
- Fine Aggregates
- Coarse Aggregates
- Fibre Glass
- Water.

**SURKHI:** Surkhi known as trass, or brick-dust. Surkhi is used as a substitute for sand for concrete and mortar, and has almost the same function as of sand but it also imparts some strength and hydraulicity. Surkhi is made by grinding to powder burnt bricks, brick-bats or burnt clay; under-burnt or over-burnt bricks should not be used nor was bricks containing high proportion of sand. The Surkhi collected from brick kiln at Summer bugh in Budgam district.

**CEMENT:** Ordinary Portland cement of 43 grade were used, conforming to recommendations stated in IS 4031(1999). The normal consistency and initial setting time of cement was 30% and 30 minutes respectively.

**FINE AGGREGATES:** Sand occurs naturally in granular material made of finely alienated rock and in organic particles. The most common component of sand is Silica (silicon dioxide  $\text{SiO}_2$ ), usually in the form of quartz. The sand was collected from Nallah Shillwath, Sumbal, Gandarbal district.

**COARSE AGGREGATES:** Boulder Crushed aggregates available locally taken from Nallah Kunzar, district Baramullah were used in respective portion for different mixes.

**FIBRE Glass:** 12mm in length fibre glass were used throughout the experimental work. These fibres control the cracking processes that can take place during the life-span of concrete.

**WATER:** The water to be used for mixing and curing of concrete should be free from deleterious materials. Therefore potable water was used in the present study in all operations demanding control over water quality.

**B. Sieve Analysis:** Particle size is one of the most important properties of solids, which are used in many fields of human activity, such as construction waste management, metallurgy, fuel fabrication etc. Surkhi is a waste product resulting from brick kiln. Surkhi obtained from kiln and sand are sieved through IS sieve of 600 micron and retained material on 300 micron was used for experimentation purposes. Sand having fineness modulus greater than 3.2 will be unsuitable for making satisfactory concrete.

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**Table 01 (Observation Table for Sieve Analysis Of Sand)**

The below table shows Sieve Analysis of the sand ranging from 150 microns to 4.75mm and the maximum pass percentage is on 4.75mm sieve and minimum with 150 microns, ranging from 99.55 to 0.5% respectively.

S.No	IS Sieve Size	Weight Retained	% age of Weight Retained	Cumulative % age Retained	% age Passing
01	4.75 mm	05	0.5	0.5	99.5
02	2.36 mm	30	03	3.5	96.5
03	1.18 mm	40	04	7.5	92.5
04	600 microns	460	46	53.5	46.5
05	300 microns	390	39	92.5	7.5
06	150 microns	70	07	99.5	0.5

**Total Cumulative % age Retained = 257**

**Fineness Modulus of Sand (FM) = 2.57**

**Table 02 (Observation Table for Fineness Modulus of Surkhi)**

The table below shows fineness modules of Surkhi ranging from 150 microns to 4.75mm and the maximum pass percentage is on 4.75mm sieve and minimum with 150 microns, ranging from 87.55% to 7.3% respectively.

S.No	IS Sieve Size	Weight Retained	% age of Weight Retained	Cumulative % age Retained	% age Passing
01	4.75 mm	12.45	12.45	12.45	87.55
02	2.36 mm	81.5	8.15	20.6	79.4
03	1.18 mm	64	8.2	27	73
04	600 microns	82	36.45	35.2	64.8
05	300 microns	364.5	21.05	71.6	28.35
06	150 microns	210.5	21.5	92.7	7.3

**Total Cumulative % age Retained = 259 Fineness Modulus of Sand (FM) = 2.60**

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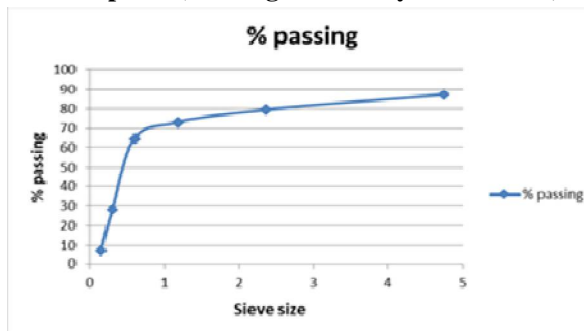
**Table 03 (Observation Table for Sieve Analysis of Coarse Aggregates)**

The table below shows Sieve Analysis of Coarse aggregates ranging from 4.75mm to 20mm and the maximum pass percentage is on 20mm sieve and minimum with 4.75mm, ranging from 86.85 to 0.35% respectively.

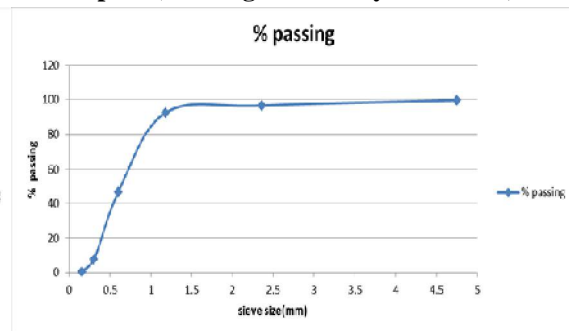
S.No	IS Sieve Size	Weight Retained	% age of Weight Retained	Cumulative % age Retained	% age Passing
01	20 mm	132	13.2	13.2	86.8
02	16 mm	362.5	36.25	49.45	50.55
03	12.5 mm	221	22.1	71.55	28.45
04	10 mm	141	14.1	85.65	14.35
05	6.3 mm	125	12.5	98.15	1.85
06	4.75 mm	15	1.5	99.65	0.35

From the above data coarse aggregates passing through 20mm sieve and retained on 10 mm sieve has been used for the whole study work.

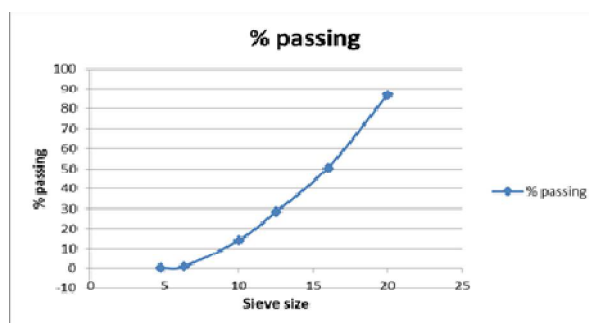
**Graph 01 (showing sieve analysis of Surkhi)**



**Graph02 (showing sieve analysis of Sand)**



**Graph03 (showing sieve analysis of Coarse Aggregate)**



The graph 01, 02 and 03 shows Sieve Analysis of Surkhi, Sand ranging from 150 micron to 4.75mm with surkhi having the maximum passing %age of 87.55 at 4.75mm and for sand with maximum passing % age of 99.50 at

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4.75mm sieve and, for Coarse aggregates ranging from 4.75mm to 20mm with the maximum pass percentage at 20mm of value 86.80%.

## IV. EXPERIMENTATION

It was carried out in four experimental stages

- 1). Concrete mix design.(M25 design mix were used in the trials following the method as per IS 10262-1982).
- 2). Replacement of Sand by different proportions of Surkhi.
- 3). Using different proportions of glass fibre in the design mix.
- 4). Final stage or combination stage.

### STAGE A

#### (a). Slump Test:- Table – 04 ( Slump Test )

Test Sample	Slump ( MM )
18 DT	50

The above table shows the workability of plain concrete (M25) without any usage of Surkhi or fiber glass and the slump recorded in the slump test for the workability of concrete is 50mm

#### Test on Hardened Concrete

#### (b). Compressive Strength test:-

Table – 05 (Compression Test)

The below table shows the Compressive strength of plain concrete (M25) without any usage of Surkhi or fiber glass and the compressive strength after 14 days and 28 days was obtained 14.00 MPa and 33.78 MPa.

Test Sample	Load ( KN )		Compressive Strength	
	14 Days	28 Days	14 Days	28 Days
18 DT	680	760	30.2	33.78

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**(c). Flexural Strength test:-**

**Table – 06 (Flexural Strength Test)**

The below table shows the Flexural strength of plain concrete (M25) without any usage of Surkhi or fiber glass and the Flexural strength after 14days and 28 days was obtained 30.20 MPa and 17.50 MPa.

Test Sample	Load ( KN )		Compressive Strength	
	14 Days	28 Days	14 Days	28 Days
18 DT	28	35	14	17.5

**(d). Split Tensile test:-**

**Table – 07 (Split Tensile Test)**

The below table shows the split Tensile strength of plain concrete (M25) without any usage of Surkhi or fiber glass and the test values after 14days and 28 days was obtained 1.20 MPa and 1.48 MPa.

Test Sample	Load ( KN )		Compressive Strength	
	14 Days	28 Days	14 Days	28 Days
18 DT	85	105	1.20	1.48

**STAGE B**

**REPLACEMENT OF SAND BY DIFFERENT PROPORTIONS OF SURKHI**

**Casting:** The cubes were casted by varying percentage replacement of sand Surkhi .The different percentage replacements used were 5%, 10%, 15%, 20% &25%.

**(a). Slump test:**

Slump test was conducted and slump values have been obtained Shown in observation table.

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**Table – 07 (Slump Test with Surkhi)**

The below table shows the workability of concrete ( M25) with the usage of Surkhi ranging from 05% to 25% ,and the slump values during the test for the workability of concrete in each increase of 05% is 100mm,80mm,75mm,50mm, 40mm respectively.

Percentage of Surkhi Replacement	Slump ( MM )
05	100
10	80
15	75
20	50
25	40

**(b). Test on Harden Concrete:-**

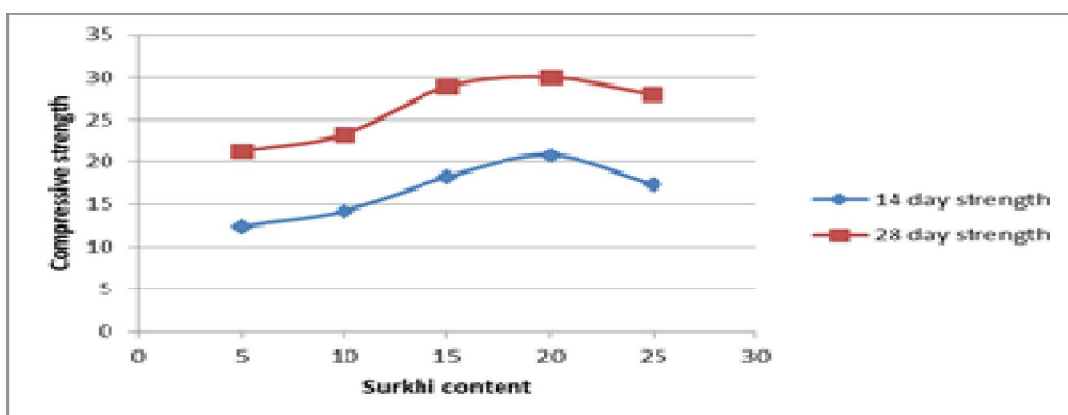
**Compression Test When Surkhi Added**

**Table – 08 (Compression Test of Concrete when Surkhi Added)**

The below table shows the compressive strength of concrete ( M25) with the usage of Surkhi ranging from 05% to 25% ,and the strength values during the test of concrete in each increase of 05% for 14 days and 28days are ranging from 12.4MPa to 17.3MPa and 21.33MPa to 28.00MPa respectively.

Test Sample	Surkhi % age	Load ( KN )		Compressive Strength MPa	
		14 Days	28 Days	14 Days	28 Days
18 A1	05	280	480	12.4	21.33
18 A2	10	320	525	14.2	22.33
18 A3	15	410	650	18.2	28.89
18 A4	20	470	675	20.8	30
18 A5	25	390	630	17.3	28

**Graph 04 (Graphical representation of Compressive strength of Surkhi)**





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The above graph shows the increase in the compressive strength with increase in the % age of Surkhi for both values of 14 days and 28 days strength upto 20% and then it tends to decrease for both the values.

### STAGE C

**USING DIFFERENT PROPORTIONS OF GLASS FIBRE IN DESIGN MIX:** The basic mix proportion for M 25 grade of concrete is cement, fine aggregate, coarse aggregate and water: 1:1.43:2.65 Mix 18D1, 18D2 & 18D3 contains 0.02%, 0.04% & 0.06% glass fibre by weight

#### (a). Slump Test:-

**Table– 10 (Slump Test with FibreGlass)**

The below table shows the workability of concrete ( M25) with the usage of Fiber Glass ranging from 0.02% to 06% ,and the slump values during the test for the workability of concrete in each increase of 0.02% is 50mm, 40mm and 35mm respectively.

Test Sample	% age of Fiber Glass	Slump ( MM )
18 D1	0.02	50
18 D2	0.04	40
18 D3	0.06	35

#### (b). Test on Harden Concrete:-

##### **Compression Test When Fibre Glass Added**

**Table – 11 (Compression Test Of Concrete when Fiber Glass Added)**

The below table shows the compressive strength of concrete ( M25) with the usage of Fiber Glass ranging from 0.02% to 0.06% ,and the strength values during the test of concrete in each increase of 0.02% for 07 days and 28 days are ranging from 19.50MPa to 23.11MPa and 35.56MPa to 39.54MPa respectively.

Test Sample	% age of Fiber Glass	Load ( KN )		Compressive Strength MPa	
		07 Days	28 Days	07 Days	28 Days
18 D1	0.02	440	800	19.5	35.56
18 D2	0.04	490	850	21.78	37.78
18 D3	0.06	520	890	23.11	39.54

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### (c). Flexure Strength Test:-

**Table – 12 (Flexural Test Of Concrete when Fiber Glass Added)**

The below table shows the Flexural strength of concrete ( M25) with the usage of Fiber Glass ranging from 0.02% to 0.06% ,and the strength values during the test of concrete in each increase of 0.02% for 07 days and 28 days are ranging from 16.00MPa to 19.2MPa and 20.00MPa to 24.00MPa respectively.

Test Sample	% age of Fiber Glass	Load ( KN )		CompressiveStrength MPa	
		07Days	28 Days	07 Days	28 Days
18 D1	0.02	32	40	16	20
18 D2	0.04	35	44	17.6	22
18 D3	0.06	38	48	19.2	24

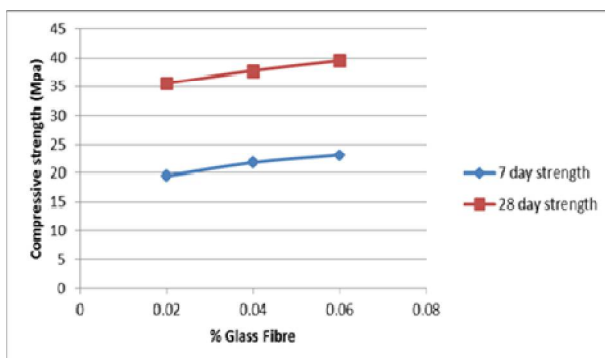
### (d). Split Tensile Strength:-

**Table – 13 (Split Tensile Test Of Concrete when FiberGlass Added)**

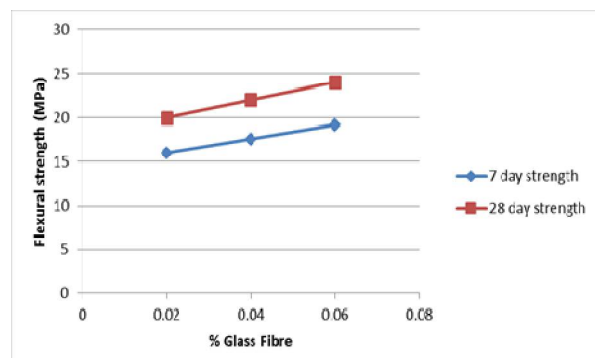
The below table shows the split tensile strength of concrete ( M25) with the usage of Fiber Glass ranging from 0.02% to 0.06% ,and the strength values during the test of concrete in each increase of 0.02% for 07 days and 28 days are ranging from 1.34MPa to 1.80MPa and 1.70MPa to 2.06MPa respectively.

Test Sample	% age of Fiber Glass	Load ( KN )		CompressiveStrength MPa	
		07 Days	28 Days	07Days	28 Days
18 D1	0.02	95	120	1.34	1.70
18 D2	0.04	115	145	1.60	2.05
18 D3	0.06	130	160	1.80	2.06

**Graph 05(Graphical representation of  
Compressive Strength of FRC**



**Graph 06 (Graphical representation of  
Flexural Strength of FRC)**



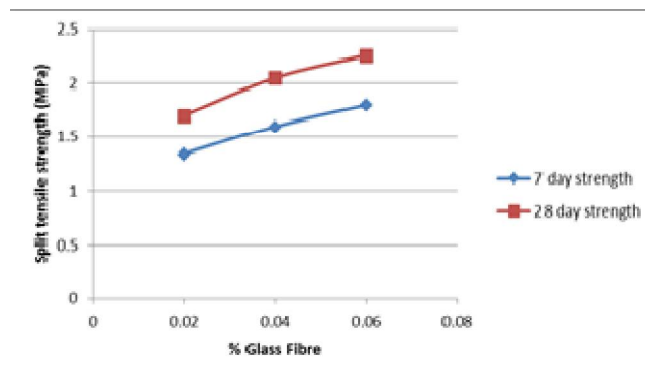
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**Graph – 07 (Graphical representation of Split tensile Strength of FRC)**



The graph 05, 06 and 07 shows the increase in the compressive strength, flexural strength split tensile strength of concrete when mixed with fiber glass and the value for compressive strength is much higher as compared to flexural strength and split tensile strength.

**FINAL STAGE OR COMBINATION STAGE:**

The two sample with maximum strength in stage (B) and stage (C) were combined for final project that is in the final project 20% sand was replaced by Surkhi and 0.06 % Fibre Glass was added to it .The ultimate results of the final project are given below:

**Casting:**A mix was prepared with 20% sand replaced by Surkhi and 0.06 % FiberGlass added to it.

**(a). Slump Test:-**

**Table – 14 (Slump Test with both Combination of Surkhi and Fiber Glass)**

The below table shows the workability of concrete ( M25) with the usage of Surkhi and Fiber Glass having the %age of 20% and 0.06 % respectively and the slump values during the test for the workability of concrete is determined as 50mm.

Test sample	% age of Surkhi	% age of Fiber Glass	Slump ( MM )
18 DF	20	0.06	50

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**(b).Test of Hardened Concrete:-**

**Compressive Strength:-** The Compressive Strength For final stage is shown in the table below

**Table 15 (Compressive Test with both Combination of Surkhi and Fiber Glass)**

The below table shows the compressive strength of concrete ( M25) with the usage of Surkhi and Fiber Glass having the %age of 20% and 0.06 % respectively ,and the strength values during the test of concrete is determined as 23.50MPa and 39.80MPa and for 07 days and 28 days respectively.

Test Sample	% age of Surkhi	% age of Fiber Glass	Load ( KN )		CompressiveStrength MPa	
			7 Days	28 days	7 Days	28 Days
18 DF	20	0.06	530	895	23.5	39.8

The compressive strength of concrete mixes was observed to be increasing as the inclusion of fibres and Surkhi increases. The addition of 0.02% fiber glass by weight of concrete mix and replacing 5% of sand by Surkhi increases the strength of M 25 grade of concrete. On addition of 0.04% of fibres and 10 % of Surkhi there is further increase in strength. This shows that as we go for higher %age of Surkhi and increase the percentage of fibres increases the strength rapidly. Therefore, the maximum strength was obtained at 20 % replacement of sand and .06% addition of fibre glass.

**(c). FLEXURAL STRENGTH:** The flexural test results are shown below.

**Flexural Strength:-** The Flexural Strength is shown in the table below

**Table – 16 (Flexural Strength Test with both Combination of Surkhi &Fiber Glass)**

The below table shows the flexural strength of concrete ( M25) with the usage of Surkhi and Fiber Glass having the %age of 20% and 0.06 % respectively ,and the strength values during the test of concrete is determined as 20.00MPa and 25.00MPa and for 07 days and 28 days respectively.

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Test Sample	% age of Surkhi	% age of Fiber Glass	Load ( KN )		CompressiveStrength MPa	
			7 Days	28 days	7 Days	28 Days
18 DF	20	0.06	40	50	20	25

The flexural strength was also observed to increase with the increase of Surkhi & Fiber Glass percentage.

### (d). Split Tensile Strength:-

**Table – 17 (Split Tensile Strength Test with both Combination of Surkhi &Fiber Glass)**

The below table shows the split tensile strength of concrete ( M25) with the usage of Surkhi and Fiber Glass having the %age of 20% and 0.06 % respectively ,and the strength values during the test of concrete is determined as 1.86MPa and 2.33MPa and for 07 days and 28 days respectively.

Test Sample	% age of Surkhi	% age of Fiber Glass	Load ( KN )		CompressiveStrength MPa	
			7 Days	28 days	7 Days	28 Days
18 DF	20	0.06	135	165	1.86	2.33

The table and result shows that there is a significant improvement in the tensile strength of concrete with the addition of fibre glass. Addition of 0.06% fiber glass increases the tensile strength by considerable amounts.

## V. CONCLUSION

**From the results of the various tests performed, the following conclusions can be drawn:**

- i). SURKHI being a pozzolanic material could be utilized for various structural elements by making it as in the form of bricks and even can be used as an admixture in the concrete to gain the strength.
- ii). By the analyses and experimentations it got pointed out that by addition of Surkhi workability decreases.
- iii). By the addition of Surkhi the main structural properties of the concrete like compressive strength, flexural strength etc gets considerable increases up to certain extent and it tends to decrease with the high % age usage of the same.
- iv). It has also been observed that the compressive strength increases with increase in time.
- v).The percentage increase of compressive strength of various grades of Fibre Glassconcrete mixes compared with 28 days compressive strength is observed 5.2 %, 11.8% and 17.05% with addition of 0.02%, 0.04% and 0.06% of Fibre Glass respectively.

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- vi). The percentage increase of split tensile of various grades of FibreGlass concrete mixes compared with 28 days split tensile is observed 14.8%, 38.5% and 52.7% for 0.02%, 0.04% and 0.06% of FiberGlass respectively
- vii). The percentage increase of flexural strength of various grades of Fibre Glass concrete mixes compared with 28 days flexural strength is observed 14.2%, 25.7% and 37.10% for 0.02%, 0.04% and 0.06% of Fiber Glass respectively.
- viii). By 20% partial replacement of sand by Surkhi and incorporation of 0.06% of fibre Glass simultaneously the compressive strength increases by 17.8%, flexural strength increases by 42.85% and split tensile strength increases by 57.

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