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# Partially replacement of Cement and Sand by using Paper Mill Sludge & SCBA in Concrete

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**ABSTRACT:** Paper mill sludge is a major economic and environmental problem for the paper and board industry. The material is a by-product of the deinking and re-pulping of paper. The million tonnes quantity of paper mill sludge produced in the world. The main recycling and disposal routes for paper sludge are land-spreading as agricultural fertilizer, producing paper sludge ash, or disposal to landfill, Hypo sludge is investigated for its use as a partial replacement for cement in cement mortar. The utilization of Sludge as cement replacement material in mortar or as additive in cement introduces many benefits from economical, technical and environmental points of view. Today researches all over the world are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. Sugar-cane bagasse is one such fibrous waste-product of the sugar refining industry. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength.

**KEYWORDS:** Cement, Paper mill sludge, M20 grade concrete, compressive strength, split tensile strength, Flexural Strength, Sugarcane bagasse.

## I. INTRODUCTION

Present days because low accessibility of natural resources, the ordinary Portland cement and natural sand is being used rapidly in the world, because of construction of industries, residential buildings and other concrete based structures. So, the production and utilization of concrete and sand has been rapidly increased, So due to that lot of heat is emitted into the atmosphere due to hydration action of cement. So to reduce the amount of cement in concrete as well as reduction the impact of using natural sand in concrete we are using by-product of paper industry for cement and Sugarcane bagasse ash (SCBA) for sand. While producing paper the various waste come out from various processes used in paper industry. Paper making Industries generally produce large amount of solid waste. The only way of disposal of this paper mill sludge is dumping which is dangerous for environment. Paper fibres can only be recycled to limited number of times. From paper manufacturing processes three types of sludge are obtained namely lime sludge, ETP sludge, De-linking sludge. In our project we used lime sludge as a partial replacement of cement. Each Indian paper mills produces an average of over 40 tons of sludge per day. The specific gravity of hypo sludge content is low. This value can be compared with specific gravity of cement which is 3.15. The Sand has been replaced by waste Sugarcane bagasse ash and cement by paper millsludge accordingly in the range of 0% (without Hyposludge), 10%, 20% & 30%, by weight for M-20 mix. These tests were carried out to evaluate the mechanical properties like compressive strength, split strength & Flexural strength up to 14 & 28 days are taken. As a result, the Strength in hypo sludge and Sugarcane bagasse ash reduces the strengths gradually. This research work is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement.

## II. SCOPE OF THE PROJECT WORK

To find the possibilities of reducing the amount of cement and sand in concrete as it will create an eco-friendly environment in construction. The need of reduction in the cost of overall construction will be done. It has a large scope

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in high rise projects and this technique is so flexible that it can be used by small projects as well. The project is related to just a study basis but the implementation is infinite. Different methods are applied to reduce the quantity of cement but both the materials i.e. cement and sand is not replaced at once. This will gain a superior increase in the reduction of use of cement and sand.

- **Sugarcane bagasse ash (SCBA)**

The bagasse is fibrous waste-product in nature and has a similar particle size range of sand which indicates that it could be tried as replacement with sand in concrete mixture.



**Fig No. 2.1 Sugarcane bagasse ash**

- **Properties of sugarcane bagasse ash and natural sand**

The following physical and chemical properties of SCBA and natural sand in the laboratory and the results are as shown below in Table III and Table IV.

**Table I - Chemical Properties of Sugarcane Bagasse Ash**

Compound	Percent by weight
Calcium Oxide (CaO)	4.68
Silicon di Oxide (SiO <sub>2</sub> )	77.86
Magnesium Oxide (MgO)	3.61
Phosphorus (P <sub>2</sub> O <sub>5</sub> )	0.23
Ferric Oxide (Fe <sub>2</sub> O <sub>3</sub> )	4.76
Potassium Oxide (K <sub>2</sub> O)	3.19

**Table II - Physical Properties of Sugarcane Bagasse Ash and Natural Sand**

Property	Natural sand	SCBA	Test method
Specific gravity	2.64	1.63	IS 2386 (Part III) - 1963
Fineness modulus	2.79	1.42	IS 2386 (Part I) - 1963

- **Paper mill sludge**

This Paper mill sludge contains, low calcium and maximum calcium chloride and minimum amount of silica. Paper mill sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete

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Fig No. 2.2 Paper mill sludge

Table III Comparison Of Cement And Hypo Sludge

Sr.No	Constituents	Cement (In %)	Paper mill Sludge (In %)
1	Lime(CaO)	66	37.97
2	Silica(SiO <sub>2</sub> )	22	11.92
3	Alumina (Al <sub>2</sub> O <sub>3</sub> )	5	0.671
4	Magnesium (MgO)	1	1.899
5	Calcium sulphate	4	0.565

## • MATERIAL REQUIREMENTS

- Bagasse Ash
- Paper sludge
- cement
- sand
- aggregate

## • TEST TO BE CONDUCTED OF CONCRETE

- Slump test
- Compressive strength test
- Flexural strength test
- Split tensile test

## III. PROCEDURE

The test is carried out using a metal mould in the shape of a conical frustum known as a slump cone, that is open at both ends and has attached handles. The tool typically has an internal diameter of 100 millimetres (3.9 in) at the top and of 200 millimetres (7.9 in) at the bottom with a height of 305 millimetres (12.0 in). The cone is placed on a hard non-absorbent surface. This cone is filled with fresh concrete in three stages. Each time, each layer is tamped 25 times with a 2 ft (600 mm)-long bullet-nosed metal rod measuring 5/8 in (16 mm) in diameter. At the end of the third stage, the

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concrete is struck off flush with the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone. The concrete then slumps (subsides). The slump of the concrete is measured by measuring the distance from the top of the slumped concrete to the level of the top of the slump cone.

### IV. OBSERVATIONS AND RESULTS

- **READINGS FROM COMPRESSIVE TEST FOR 14 DAYS**

**Table IV Readings for Cube**

Percentage C.S	Load (KN)	Mean (KN)	Stress =(Load/Area)
0 %	360.4		
	354.2	359.73	15.98
	364.6		
10%	360.6		
	368.1	360.96	16.04
	354.2		
15%	332.4		
	339.8	333.9	14.84
	329.7		
20%	248.6		
	239.3	244.46	10.86
	245.5		

**Table V Readings for Cylinder**

Percentage C.S	Load	Mean	Stress =(Load/Area) 2P/3.14DL
0 %	249.8		
	232.6	246.57	1.74
	257.3		
10%	238.4		
	229.4	236.3	1.67
	241.1		
15%	223.2		
	229.5	223.7	1.58
	218.4		
20%	190.4		
	193.7	195.13	1.38
	201.3		

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**Table VI Readings for Beam**

Percentage C.S	Load	Mean	Stress =(Load/Area) =PL/BD <sup>2</sup>
0 %	11.40		
	13.02	16.04	3.32
10%	23.70		
	14.40	14.01	2.90
15%	14.45		
	13.20		
20%	14.80	14.2	2.94
	15.50		
	12.30		
	11.45	13.06	2.71
	13.45		
	14.30		

➤ **READINGS FROM COMPRESSIVE TEST FOR 28 DAYS**

○ **Cube**

The result in the table i.e the stress should be equal to the value of  $F_{ck}$

$$\begin{aligned} \text{Value of } F_{ck} &= F_{ck} + 1.65S \\ &= 20 + (1.65 \times 4) \end{aligned}$$

= 26.6

**Table VII Readings for Cube**

Percentage C.S	Load	Mean	Stress =(Load/Area)
0 %	633.10		
	573	598.7	26.60
10%	590		
	617.8	603.71	26.83
15%	590.85		
	602.5		
20%	491.3	486.16	21.60
	479.7		
	487.5		
	353.9	343.46	15.26
	341.7		
	334.8		

○ **Cylinder**

The result in the table i.e the stress should be equal to the value of characteristic strength i.e 28

Value of  $F_{ck}$  can be calculated by following equation =  $(2P/\pi DL)$

For 0%  $F_{ck} = (2 \times 371.8 \times 10^3) / (\pi \times 150 \times 600)$

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= 2.62

**Table VIII Readings for Cylinder**

Percentage C.S	Load	Mean	Stress =(Load/Area)
0 %	374.2		
	360.14	371.8	2.62
	380.1		
10%	363.4		
	342.8	353.46	2.49
	354.2		
15%	320.2		
	301.7	306.56	2.16
	297.8		
20%	289.3		
	304.2	287.73	2.03
	269.7		

○ **Beam**

The result in the table i.e the stress should be equal to the value of  $F_{ck}$

$$\begin{aligned} \text{Value of } F_{ck} &= 0.7\sqrt{F_{ck}} \\ &= 0.7 \times \sqrt{20} \\ &= 3.13 \end{aligned}$$

**Table IX Readings for Beam**

Percentage C.S	Load	Mean	Stress =(Load/Area)
0 %	12.65		
	13.30	16.55	3.43
	23.70		
10%	17.90		
	14.05	15.83	3.1
	15.50		
15%	17.40		
	18.70	15.65	3.1
	18.45		
20%	14.15		
	16.30	15.03	3.0
	14.65		

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