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Experimental Investigation on Properties of Concrete Using Lime Sludge from Sugar Industry

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Abstract

The sugar and paper industries are generating a huge quantity of lime sludge as waste, this waste may create ecological problems because of its dumping in open places causing environmental pollution. A proper utilization of lime sludge from sugar industry is to be used in concrete. We have collected lime sludge. Various tests were conducted for cement, fine aggregate, lime sludge, water and coarse aggregate to find the standard consistency, fineness value, grading zone, alkalinity, PH value and fineness of cement. In this project experimental studies were conducted to study the properties of concrete with the partial replacement of sand by using lime sludge added as an additional ingredient in different proportions. Cubes and cylinders were casted with addition of lime sludge in 0%, 10%, 20%, 30% replacement of sand and tested for its compression test and split test.

Keywords: Lime Sludge, Compressive Strength, Split Tensile Strength, Casting of Cube.

I. INTRODUCTION

Over 300 million tonnes of industrial wastes are produced per annum from agricultural and chemical plants in India [3]. India, being an agricultural based country; a lot of agro industries have come up. Due to growing environment safety awareness and there are various problems managing industrial wastes so the world is looking for research in industrial wastes. So that we are trying to have the lime sludge which is the waste of sugar industry as the secondary raw material for concrete [5]. Analysing the properties of lime sludge, we have decided to use it along with sand and coarse aggregate. In this paper we have decided to make concrete cost effective by using the waste material from the industry as the raw material.

II.LIME SLUDGE

2.1Collection of lime sludge:

Lime is the oldest and cheapest chemical used in sugar manufacturing process as a juice clarifier. The lime sludge is a residue obtained from sugar factory. Free lime is being added in sugar processing for cleaning the juice. The residue obtained along with some soil and cane pith is called lime sludge. It contains a small percentage of free lime which has binding property. This can be utilized with some aggregate for making concrete or building blocks.

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The calcium present in the milk of lime reacts with soluble phosphate from juice to form insoluble precipitate of Tricalcium phosphate. Lime neutralizes the free organic acids present in cane juice forming calcium organic salts. Lime unites with phosphoric acid present in juice and forms calcium phosphate. Lime combines with nitrogenous impurities which are partly precipitated. Due to action of heat and lime, most of the colloidal non sugars are coagulated which tends to settle down.

Lime sludge is collected from sugar factory. The capacity of the sugar industry is of having sugar crushing is of about 7000tons/day and the sugar produced is about 660 tons/day. Lime consumed is 17.5 tons/day which is 0.25% on cane. Lime sludge produced is about 2tons/day. We have collected the lime sludge from Sugar factory and have tested in Laboratory.

	LIME SLUDGE (%)	ORDINARY CEMENT (%)
Sio_2	21.1	20
Al_2O_3	10.6	6
Fe_2O_3	1.5	3
CaO	43	63
MgO	1	1.5
Loss of Ignition	20.8	Less than 5

Table 1
Comparison of lime sludge and ordinary cement

2.2Lime sludge Analysis

The lime sludge is very fine precipitated $Caco_3$.Lime sludge has impurities in form of silica and magnesium. Silica enters mainly via raw materials. During caustic zing operation Sio_2 forms $CaSio_3$, which is gelatinous in nature. This gelatinous property hinders the setting property of lime mud. High percentage of silica in lime mud entraps high moisture content [2].

III. PROPERTIES OF MATERIAL

3.1 Cement

The cement used for the manufacture of concrete cubes is of 43 grade ordinary cement. The properties of cement like Consistency, Initial setting time, final setting time and fitness modulus are tested for the samples and the results are given below

3.1.1Consistency

The consistency of cement paste is its property by virtue of which it flows without segregation. It is identified by the degree of wetness. The standard consistency of cement is identified as the percentage of water required by weight to produce a paste which permits the Vicat plunger to penetrate to the point 5mm to 7mm from the bottom of the Vicat mould. To determine the consistency approximately 300gm of cement is weighted. To the above sample, 30% of water to weight of cement is added and mixed thoroughly and cement paste is filled carefully in the vicat mould and the surface is smoothened. The experiment is repeated for various trial paste until the plunger comes to rest between 5mm to 7mm. The percentage of water which permits the plunger to penetrate to a depth of 5mm to 7mm measured from bottom as percentage for standard consistency is 48%.

S.No	Weight of cement (gm)	% of water by weight of cement	Volume of water	Index reading (mm)
1	400	40	160	14
2	400	45	180	12
3	400	48	192	7

Table 2

Consistency test of cement

3.2 Determination of particle size Distribution

The sample is brought to dry condition before weighing and sieving either by drying it at room temperature or by heating at a temperature of 100°C to 110°C.The dried sample is weighted. The weighted sample is placed on the sieves starting with the largest. Each sieve is shaken separately over a clean tray until not more than a trace passes, but in any case for a period not less than 2minutes.The shaking is done with the varied motion, backward and anticlockwise. Lumps of fine material if present may be broken by gentle pressure with fingers against the side of the sieve. At the end of the sieving 150micron and 75 micron sieves are cleaned from the bottom by light brushing with fine camel hair brush. On completion of sieving, material retained on each sieve together with any material cleaned from the mesh is weighted. It is found that the fineness modulus of fine aggregate is 1.97 and the grade zone of the given fine aggregate if found to be grading zone 3 and it is found that fineness modulus of coarse aggregate is 6.99

3.3 Water

The water is one of the most important constituent of concrete. Water is responsible for setting of cement by the process of hydration. the water used should be portable water the alkalinity due OH^- ,CO_3,HCO_3 are 95mg/lit,190mg/lit, 480mg/lit. The chlorine is also determined to be 144.95mg/lit. The hardness of water is 615mg/lit and its pH-value is found to be 7.1PPM

IV. METHODS EMPLOYED

4.1 Preparation of design mix concrete

To select the water and sand content the required water content is 191.6 lt/m^3 and the cement content is to be 383kg/m^3this cement content is for mild exposure condition.

The aggregate used is 10 to 20mm sieve size. The sand used is 1.19mm and the water used is 0.5W/C ratio.

The mixture proportions of cement, fine aggregate, coarse aggregate are 1:1.43:3.010.

To adopt M_{20} concrete the mixture proportion taken and the cement used is OPC43grade and aggregate used is of 10to 20mm sieve size and the sand used is 1.19mm and water used is 0.5W/C ratio

4.2 Casting of cubes

Take lime sludge as partial replacement of sand by 0%,5%,10%,15%,20%,25%,30% and the period of Curing is about 28 days and 7days.The size of cubical mould is 150mm x150mm x150mm. The size of cylindrical mould is 150mm dia and 300mm height. The casting was made and tests were conducted on concrete are

(i) Slump test and compaction factor test.

(ii) Compressive strength test.

(iii)Split tensile test.

Mix designation	A 0%	B 5%	C 10 %	D 15 %	E 20 %	F 25 %	G 30 %
SLUMP (in mm)	20	19	18	16	14	11	11
COMPACTION FACTOR	0.90	0.86	0.85	0.83	0.78	0.75	0.70

Table 3

Slump test and compaction factor test

Identification	Ratio of sand with lime sludge	Specific Gravity
A	95%Sand+5%Lime sludge	2.652
B	90%Sand+10%Lime sludge	2.625
C	85%Sand+15%Lime sludge	2.604
D	80%Sand+20%Lime sludge	2.594
E	75%Sand+25%Lime sludge	2.545
F	70%Sand+30%Lime sludge	2.521

Table 4

Specific gravity of Lime sludge with sand

SL.NO	DESCRIPTION	AREA OF MOULDS	COMPRESSIVE STENGTH N/mm^2
1	Nominal mix 1:2:4	150mm x 150mm	13.78
2	Design mix 5%	150mm x 150mm	12.66
3	10%	150mm x 150mm	15.55
4	15%	150mm x 150mm	16.60
5	20%	150mm x 150mm	17.55
6	25%	150mm x 150mm	17.02
7	30%	150mm x 150mm	16.15

Table 5

Compression Test Report (7 Days Curing)

SL.NO	DESCRIPTION	AREA OF MOULDS	COMPRESSIVE STRENGTH
1	Nominal mix 1:2:4	150mm x150mm	21.33
2	Design mix 5%	150mm x150mm	21.33
3	10%	150mm x150mm	25.33
4	15%	150mm x150mm	23.55
5	20%	150mm x150mm	16.44
6	25%	150mm x150mm	15.11
7	30%	150mm x150mm	14.22

Table 6

Compression Test Report (28 Days Curing)

The result is obtained from the 7 days curing. From the above results it is obtained that 20% partial replacement gives more strength than the other mixtures. Adding more percentage subsequently reduces the strength. Result is obtained for 28 days curing from the above result it is obtained that 15% present partial replacement gives more strength than other mixtures. It is due to the presence of calcium carbonate and better go for adding mineral admixture. The reason may be due to the slow pozzolanic reaction of lime sludge the strength gain at 28days is not much affected. Based on the test results it can be concluded that lime sludge can be used up to 20% replacement without much affecting the strength of concrete. The durability of concrete will improve due to the addition of lime sludge; the concrete becomes more impermeable due to filler action.

Sl.no	Description	Spilt tensile Load KN(P)	Tensile Strength N/mm^2 =2P/3.14XDXL
1	Nominal mix 1:2:4	260	3.68
2	Design mix 5%	240	3.36
3	10%	220	3.08
4	15%	220	3.08
5	20%	210	2.94
6	25%	200	2.80
7	30%	180	2.52

Table 7

Split tensile test report (28 Days Curing)

V.CONCLUSION

As we aware that a lot of waste material are being generated from industries and dumped in thousands of hectares of land causing environmental pollution, those material could only be utilized in construction industry. In this project work we have concluded that lime sludge from sugar and paper industry could be utilized to make use in concrete works for all construction works. From our experimental study the following conclusions are drawn the compressive strength of concrete cubes increases with decreases in lime sludge content. The cubes made with 15% lime sludge gives optimum compression strength. The strength of cubes decreases beyond 20% lime sludge. The cubes made with 20% of lime sludge may be utilized for lightly loaded masonry walls and nonload bearing wall construction. The cost of production of lime sludge concrete is cheap when compared with normal concrete. hence cost of construction will be reduced.15% partial replacement gives more strength than normal. Adding more percentage subsequently reduces its strength due to higher amount of calcium oxide present in lime sludge.

REFERENCES

1. Archaneswar Kumar, K. Dr. K. Rajasekhar, Dr. C. Sashidhar "Experimental Investigation on Fly Ash and Lime Sludge in Cement Mortar"IJLTEMAS, Vol. V, Issue II, 2016, pp. 47-50
2. Dhananjaya, H.R. & Basavaraj "cost effective composite concrete using lime sludge, fly ash and quarry sand" international journal of advance technology in engineering and science vol. no.4, issue no. 12, 2016, pp.195-202.
3. Shetty, M.S. (2003) "concrete technology theory and practice"-s.chand and company Ltd.
4. Srinivasan, R. Sathiya, K. & M. Palanisamy "experimental investigation in developing low cost concrete from paper industry waste**"** IS 10262-1982-Mix Design Procedures
5. Sudha, S. "durability and strength character of concrete using lime sludge and fly ash as partial replacement of fine aggregate"vol. no.3, issue no.7,2016,pp.1724-1729.
6. Xuanliua,jinshia, yuan zhaob, zifulia, jianzhangb "Experimental research on lime drying process of mechanical dewatered sludge from a wastewater treatment plant in Beijing" Procedia Environmental Sciences vol.16 , 2012 ,pp. 335 – 339.