An Experimental Study on Bagasse Ash and Lime as Partial Replacement of Cement in Concrete

Chaitali Solanki[1], Jay Hirpara[2], Pinesh Akbari[3], Vimal Godhani[4], Mohit Vasoya[5], Krunal Koladiya[6]

[1]*Asst. Prof. , Civil Engineering Department, Bhagwan Mahavir College Of Engineering & Technology, Surat, Gujarat, India-395007*

[2,3,4,5,6] *Student of Civil Engineering Department, Bhagwan Mahavir College Of Engineering & Technology, Surat, Gujarat, India-395007*

***Abstract*- Sugarcane bagasse ash is a waste product of the sugar refining industry which is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Due to the use of sugarcane bagasse ash instead of cement, it is necessary to compare the chemical properties of cement and sugarcane bagasse ash. The proportion of lime in the ash of sugarcane is much lower than that of lime in cement. Therefore, it I necessary to add lime for comparison. Porous and open textured materials such as lime plasters, help to stabilize the internal of a building by absorbing and releasing moisture.The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical, environmental and technical reasons. There are lots of environmental impacts of cement on our ecology. Cement industry creating environmental problem by emission of CO2 during manufacturing of cement. Sugar-cane bagasse is a fibrous waste-product of the sugar refining industry, along with ethanol vapour. This waste product (Sugar-cane Bagasse ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash has been chemically and physically characterized, and partially replaced in the various percentages by weight of cement in concrete. Fresh concrete tests as well as hardened concrete tests were undertaken. Lime concrete, produced by this mix, makes a good base for load bearing walls, columns, or laying under floors because it has a degree of flexibility that regular concrete does not. It also has a certain waterproof property to it that prevents subsoil dampness in floors and walls. Additionally, lime concrete can be made easily and cheaply while still providing a durable**

1. INTRODUCTION

Ordinary Portland cement is recognized as major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw material. This waste, utilization would not only be economical, but also result in foreign exchange earnings and environmental pollution control. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. Many additives such as cement, lime, asphalt emulsions, bituminous materials, and natural and industrial byproducts have been tested to improve the mechanical properties and to enhance the durability of the compacted blocks. In view of the above mentioned, several research activities have been directed towards partial or total substitution of Portland cement by pozzolanic binders, e.g. lime, fly ash, and natural pozzolans among others.

The purpose of this paper is to investigate the replacement of cement with lime in the production of normal weight concrete with the express objective of reducing the waste material. In environmental terms, lime does not generate as much CO2 in its production as does the production of Portland cement. Lime has been used as the basis for the pozzalonic material in concrete for thousands of years. Portland cement's development in the late eighteenth century and its adoption as the primary pozzalonic material in concrete resulted in the displacement of lime as the primary cementitious material. Lime has a number of properties that are of interest in the development of long term durability of materials, particularly the slow carbonation rate and resulting self-healing properties. This paper deals with the physical strength properties of concrete when the Portland cement is replaced with hydrated lime of varying proportions.

2. MATERIALS

Cement

OPC 53 grade was used conforming to IS 269-2015

Fine aggregate

Sand conforming to Zone-II (White Sand) was used as the fine aggregate, as per I.S 383-1970. The sand was air dried and free from any foreign material, earlier than mixing. The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming to Grading zone-II of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens. Fine aggregate is defined as material that will pass from No.4 sieve and will, for the most part, be retained on a No. 200 sieve, for increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Coarse Aggregate

Aggregates generally occupy 70 to 80 percent of the volume of concrete and can therefore be expected to have an important influence on its properties. We have used coarse aggregate maximum size of 20 mm. They are granular materials, derived for the most part from natural rock (crushed stone or natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent, mostly in lightweight concretes. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Aggregate classifications are made principally for the purpose of easier identification of particular aggregate lots, or to become familiar with the different types of aggregates. There are numerous ways of classifying aggregates.

Water

Water to be used in the concrete work should have following properties: It should be free from injurious amount of oil, acids, alkalis or other organic or inorganic impurities. It should be free from iron, vegetable matter or other any type of substances, which are likely to have adverse effect on concrete or reinforcement. It should be quite satisfactory for drinking purpose which is used in mixing of concrete.

Quality of Water

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6. A popular yard sticks to the suitability of water for mixing concrete is that, if water is fit for drinking it is fit for making concrete. This does not appear to be a true statement for all conditions. Mixing and curing with sea water shall not be permitted.

To neutralize 200 ml sample of water. Using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NAOH.

To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCL.

Lime

Lime concrete, produced by this mix, makes a good base for load bearing walls, columns, or laying under floors because it has a degree of flexibility that regular concrete does not. It also has a certain waterproof property to it that prevents subsoil dampness in floors and walls. Additionally, lime concrete can be made easily and cheaply while still providing a durable. material that resists weathering and wear and tear. Utilization of industrial and agricultural waste products in the construction industry has been the focus of research for economical and environmental reasons. In this paper, Lime sludge, a paper and pulp industry waste product, has been chemically, physically and thermally characterized, in order to evaluate the possibility of its use as construction materials. X- ray Fluorescence and X-ray diffractometry studies for the determination of composition and presence of crystalline material and Thermo Gravimetric Analysis to identify the phase transition of lime sludge, as well as physical and mechanical properties and its pozzolanic activity have been conducted. It is concluded that the acceptance of this waste product by the construction industry could be decided depending on the application, keeping in view of the limitations on the mechanical strength.

Sugarcane Bagasse Ash

Sugarcane bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of sugarcane bagasse leaves sugarcane bagasse ash as a waste, which has a confrontation property that would potentially be used as a cement replacement material. It has been known that the worldwide total production of sugarcane is over 1500 million tons. sugarcane bagasse while the sugar recovered is about 10%, and the sugarcane bagasse leaves approximately eight% sugarcane bagasse ash (this figure rely on the great and kind of the boiler, contemporary boiler release decrease amount of sugarcane bagasse ash) as a waste, this disposal of sugarcane bagasse ash can be of significant situation.

Sugarcane sugarcane bagasse ash has recently been tested in world for its use as a cement replacement material. The sugarcane bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness.

The higher silica content in the sugarcane bagasse ash was suggested to be the main cause for these improvements. Although the silicate content may vary from ash to ash depending on the burning conditions and other properties of the raw materials including the soil on which the sugarcane is grown, it has been reported that the silicate undergoes a confrontation reaction with the hydration products of the cement and results in a reduction of the free lime in the concrete.

Table 1 : Chemical propertie of SCBA

Chemical Component	Abbreviation	%
Silica	SiO_2	68.43
Aluminium oxide	Al_2O_3	5.813
Ferric oxide	Fe_2O_3	0.219
Calcium oxide	CaO	2.57
Phosphorous oxide	P_2O_5	1.29
Magnesium oxide	Mgo	0.573
Sulphide oxide	SO_3	4.34

Figure 1: Making ash of SCBA

3. MIX DESIGN OF M25 GRADE CONCRETE

Step 1:- Design stipulation for proportioning Grade of concrete

(N/mm2) : M25

Type of cement : Ultratech OPC (53) Max

Nominal size of agg. : 20mm

Min. cement content: 44.5 kg Max

W/C ratio: 0.55 for rest

Workability: 40-150 mm for other

Exposure condition: Severe

Method of concrete Placing: By hand Degree of supervision: Good

Type of aggregate: Crushed angular

Coarse Aggregate 20mm	1.78 %
Fine Aggregate	1.83%

Step: 3 Target Mean Strength of Concrete

ftarget = f ck + 1.65 * s where,

ftarget = Target average compressive strength at 28 days fck = compressive strength at 28 days

s = Standard deviation ftarget = fck + 1.65 * s

=25 + (1.65 * 4.0) = 31.6 N/ mm2

Step: 4 Selection of W/C ratio

Take,

W/C ratio of 0.50 for 4 % and 8 % replacement of cement with Sugarcane bagasse ash

Step: 5 Selection of cement content (For 1 cube)

For M25 (1:1:2),

Density of cement = 1440 kg/m3 Volume of cube = 15cm X 15cm X 15cm Wet volume = 15cm X 15cm X 15cm
= 3375 cm3
=3.375 * 10-3 m3

Dry volume is 54% more than wet volume. herefor,
Dry volume = 1.54 * 3.375 * 10-3 m3
= 5.19 * 10-3 m3
Volume of Cement = 1 * 5.19 * 10-3/(1+1+2)
= 1.3 * 10-3m3
Weight cement = 1440 * 1.3 * 10-3
= 1.87 Kg

Step: 6 Selection of water content (For 1 cube)
W/C = 0.50
Therefore,
W = 0.50 * 1.87
= 0.93 kg
~ 1 kg or 1 litre

Step: 7 Selection of Fine aggregate and coarse aggregate (For 1 cube)
Density of Fine aggregate = 1600 kg/m3
Volume of Fine aggregate = 1 * 5.19 * 10-3/(1+1+2)
= 1.3 * 10-3 m3
Weight Fine aggregate = 1600 * 1.3 * 10-3
= 2.06 Kg
Density of coarse aggregate = 1520 kg/m3
Volume of coarse aggregate = 2 * 5.19 * 10-3/(1+1+2)
= 2.6 * 10-3 m3
Weight coarse aggregate = 1520 * 2.6 * 10-3
= 3.92 Kg

Step: 8 Mix design of M25 for 1 m3 (C:FA:CA)
Table 2 : Quantity for 1 m3

Volume of concrete	1 m3
Mass of cement	554.4 kg
Mass of water	277.2 kg
Mass of coarse aggregate 20 mm	1170.4 kg
Mass of Fine aggregate	739.2 kg

Step: 9 Mix design of M25 with 2%, 4 %, 6% and 8% cement replace by "Sugarcane Bagasse Ash & Lime"
Table 3: Mix design of M25 with 2%, 4 %, 6% and 8%

[Sugarcane Bagasse Ash + Lime](gm)	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (Liter)
0 % (-)	5.610	5.85	11.7	1
2% (112.2)	5.496	5.85	11.7	1
4% (224.4)	5.391	5.85	11.7	1
6% (336.6)	5.273	5.85	11.7	1
8% (448.8)	5.161	5.85	11.7	1

Cement replace by "Sugarcane Bagasse Ash & Lime"

4. MAKING OF CONCRETE BLOCK

Figure 2: Concrete Cube

Slump test for Workability of Concrete
Workability of concrete generally implies the ease with which mix can be handled from the mixer to its finally compacted shape. the measurements of the workability Of fresh concrete is of importance in assisting the practicability of compacting the mix and also in maintaining consistency throughout the job. In addition, workability testes are often used as an indirect check on the water content and therefore on the water/cement ratio of concrete. Workability should be distinguished from consistency which term

as used in concrete practice, relates to the degree of wetness of concrete. On the other hand, consistency has to do with the force flow relationship alone. A job starts with the mix just right cement aggregate are measured, the right amount of water is add, and mixing is then carried out for the given time. 2 ATOOMUS A batch of concrete wetter than the rest will mean the batch of concrete that is weaker and less durable in the finished job . a job batch that is too dry will lead to difficulties in placing, compacting and finishing .that why to find out workability of concrete is 9 cm shear from actual height slump. show in fig

Figure 3: Slump Test

5. RESULT & ANALYSIS

Figure 4: Compression Test

In this experimental program, the compressive strength of concrete containing sugar cane bagasse ash (SCBA) and Lime were investigated.

When M20 concrete with Sugarcane bagasse ash & Lime by replacing cement by 2%, 4%, 6%, 8% is compared with rain forced cement concrete, it is found that the compressive strength decreases to 18%at the end of 7 days.

Table 4: Result obtained after adding Sugarcane Bagasse Ash & Lime

% of {Sugarcane Bagasse Ash + Lime Powder}	Modified Concrete Strenght M25 (N/ mm2)	Normal Concrete Strengh M25 (N/ mm2)	Curing Days
0 %	17.96	17	7
2 %	14.08	17	7
4 %	14.13	17	7
6 %	14.77	17	7
8 %	15.49	17	7

REFERENCES

[1] Amrita Kumari, Prof. Sheo Kumar, "Experimental Study on Partial Replacement of Cement by Sugaracne Bagasse Ash" Vol. 4, Issue: 07, July 2015, IJERT ISSN(Online): 2319-8753, ISSN(Print) : 2347-6710

[2] Beulah M. Asst Professor, Prahallada M. C. Professor, "Effect of replacement of cement by metakalion on the properties of high performance concrete subjected to hydrochloric acid attack", IJERA ISSN: 2248-9622 vol.2, Issue 6, NOV-DEC 2012, pp.033-038.

[3] BIS – IS 10262: 2009, "Indian Standard, recommended guidelines for concrete mix designs", Bureau of Indian Standard, New Delhi.

[4] Kanchana lata Sing and S.M Ali Jawaid,(August 2013) , "Utilization of sugarcane bagasse ash (SCBA) as pozzolanic material in concrete"

[5] M.Vijaya Sekhar Reddy, I.V.Ramana Reddy, "Studies on durability characteristics of high performance concrete" International journal of advanced scientific and technical research, issue 2 volume 6, December 2012 ISS 2249-9954.

[6] Pratheba, Deepeka, Kanimozhi, Malathi, Nandhini, "An experimental study on bagasse ash as partial replacement for cement in concrete"Volume:05, Issue:03 | March 2018, IJRET e- ISSN: 2395-0056 p- ISSN: 2395-0072

[7] U.R.Kawade et al., "Effect of use of cane trash ash on strength of concrete", International journal of innovative research in science, Engineering and technology.(July 2013)