

Detailed Investigation on Concrete Using Lime Sludge from Sugar Industry

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ABSTRACT

The sand requirement for construction activities increased proportionately but, all the materials required for producing cement and concrete are obtained from the earth's crust only. Hence, the natural resources are exploited in an extremely high manner and resulted in depletion of the same and creating environmental strain. The increase in demand for the ingredients of concrete is met by partial replacement of the materials by the solid waste products obtained by means of human activities on the earth. Lime sludge is one of such waste material obtained from agricultural industry by processing sugarcane. The annual production of sugar in our country comes around 110 million tons. For every 660 tons of sugar cane crushed, about 2 tons of lime sludge is produced. Experimental investigations have been made to study the suitability of the use of lime sludge as a waste material from sugar industry for sand replacement in concrete in order to reduce the environmental problems. This experimental study is aimed to utilize such lime sludge as a partial replacement material for sand in concrete and to study the suitability of this waste material for sand replacement. M20 grade of concrete is taken for investigation. The sand is replaced by lime sludge from 0% to 30% with an increment of 5%. The concrete mix design is done as per IS 10262-2009 for various percentage of replacement of sand. The properties studied include the durability tests such as acid resistance and flexural strength for various percentage of replacement of sand by lime sludge. The investigations show that the lime sludge can be effectively used in concrete up to 10% replacement of sand without affecting much of its strength characteristics

Keyword-- Lime Sludge, Fly ash, replacement in cement mortar, compressive strength

I. INTRODUCTION

India being an agricultural based country, a lot of Agro Industries has come up. The sugar and paper industries are generating a huge quantity of lime sludge as waste, creating ecological problems because of

dumping in open places causing environmental pollution.

The lime sludge obtained from sugar factory normally contains calcium carbonate and small amount of free lime. Hence lime sludge can be utilized in concrete and in construction industry. In this work, it has been planned to use it in concrete with the partial replacement of sand by using lime sludge added as an additional ingredient in different proportions to enhance the binding property of concrete.

The experimental studies are conducted for durability characteristics of concrete and flexural strength of hardened concrete with lime sludge. From the results the optimum replacement of lime sludge is determined.

II. LITERATURE REVIEW

[14] et al said that reinforced concrete is the most extensively used material for construction worldwide. A particle substitution of cement by an industrial waste such as fly ash is not only economical but also improves the properties on fresh and hardened concrete and enhances the durability characteristics. The reactive silica component present in them combines with the free calcium hydroxide, liberated during hydration of cement, to form additional calcium-silicate-hydrate (CSH), which otherwise would have leached out and increasing the porosity of the cement matrix. The additional CSH increases the denseness of the matrix and refines the pore structure. Hence the use of supplementary cementitious materials in concrete can lead to enhanced durability characteristics. It also improves the rheology of the fresh mixes, enhances the strength of concrete and reduces the cost.

[13] in his research study, the movement of ions in a porous medium under a concentration gradient is called diffusion. It is often necessary to ascertain the impermeability of concrete to chloride ions as a quality control measure and also for assessment of improvements effected in properties of new concretes.

Measurement of chloride diffusion co-efficient requires a long time for establishment of steady state conditions. Therefore, a direct current (DC) potential is usually applied to accelerate migration of ions.

III. EXPERIMENTAL INVESTIGATIONS

MATERIAL USED

Lime sludge

The lime sludge is a solid 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.

Sand

Sand is either round or angular grains and is often found mixed in various gradation of fineness. Specific gravity of sand 2.64

Water

Excess of acidity or alkalinity in water is to be avoided. Potable water is used for this work.

Cement

Cement is a binding material in concrete which is used in all building elements. Ordinary Portland Cement 43 grade is used with specific gravity 3.15.

Course Aggregates

These are the inert or chemically inactive materials which form the bulk of Cement concrete. The aggregates are bound together by means of cement. Specific gravity of coarse aggregate was found to be 2.64

IV. METHODOLOGY AND MIX PROPORTION

M20 Grade of concrete with mix ratio 1:1.5:3 was used in this work. Methodology is shown in table 1. Flexural strength and acid curing was done for 28 days for below mentioned ratio

TABLE 1 Ratio of Sand with Lime Sludge

Ratio of Sand with Lime Sludge
95% Sand + 5% Lime sludge
90% Sand + 10% Lime sludge
85% Sand + 15% Lime sludge
80% Sand + 20% Lime sludge
75% Sand + 25% Lime sludge
70% Sand + 30% Lime sludge

V. FLEXURE STRENGTH

Prism of standard size is casted and cured for 28days and Flexural strength test is done as per IS: 516:1959 specifications and the results are shown in table 2

Chloride attack

In order to access the chloride attack in concrete it is exposed to chemical media. For acid test hydrochloric acid was prepared by mixing 5% of HCl with one litre of water as per ASTM G20-8. After curing

period of 28 days, cubes were taken out and tested in compression testing machine. And the results are shown in Fig 1

Sulphate attack

To assess the sulphate attack in concrete it is exposed to chemical media. For sulphate test sodium sulphate and magnesium sulphate was prepared by mixing 5% with one liter of water as per ASTM G20-8. After curing period of 28 days, cubes were taken out and tested in compression testing machine. And the results are shown in Fig 2

TABLE 2 FLEXURAL STRENGTH TEST AFTER 28DAYS CURING

Sl. No	Description	Avg Flexural strength N/mm ²
1	Normal concrete 0%	3.18
2	5 % lime sludge replacement	3.26
3	10%lime sludge replacement	3.28
4	15%lime sludge replacement	3.48
5	20%lime sludge replacement	2.88
6	25%lime sludge replacement	2.97
7	30%lime sludge replacement	2.82

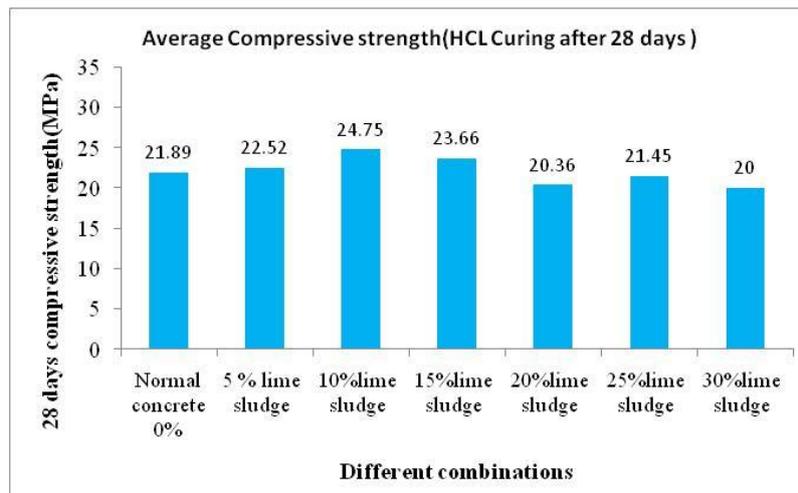
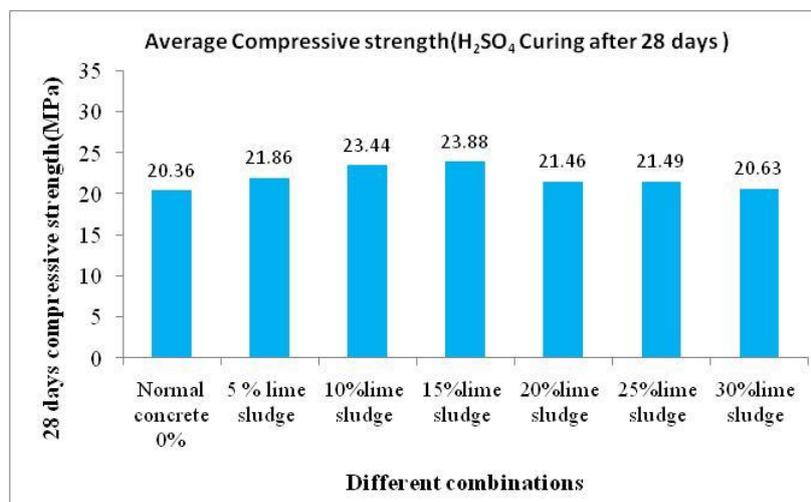


FIG – 1 Compressive strength of concrete after 28 days HCL Curing

FIG – 2 Compressive strength of concrete after 28 days H₂SO₄ Curing

VI. CONCLUSION

From our experimental study the following conclusions were drawn

- Flexural behaviour of 15% replacement was found to be good
- Lime sludge can also be used as a substitute material for weathering course replaced by pure lime there by reducing cost of construction.

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- Durability properties of 5%,10%, 15% replacement was found to have good durability property
- Higher percentage of replacement were found to be poor in acid curing
- Lower percentage was found to be good and has acquired good strength
- Lime sludge can be used as a replacement material for durability purpose
- Using of these type of material is eco friendly

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