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# EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT BY SUGARCANE ASH AND QUARRY DUST AS FINE AGGREGATE.

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**Abstract-**In India, natural river sand fine aggregate is traditionally used in concrete. However growing, environmental restriction to the exploitation of sand from riverbed leads to research for utilization of an alternative material industrial waste for fine aggregates in the construction industry. This study deals with the utilization of waste material like sugarcane ash and quarry dust. In the morden emerging world, it needs to develop their infrastructure by cement based materials. So the dement for cement has been predominantly increased but the cement production creates pollution to the environment. Therefore replacement should be done. The Cement can be partially replaced by sugarcane ash in the percentage of 10%, 20% and 30%.And the Sand can be replaced by quarry dust in the range of 20%, 30% and 40%.Here the behavior of the Sugarcane ash and quarry dust should be investigable. The study will be concluded with the strength of attainment of the casting cubes and cylinders. Casting and curing of the cubes and cylinders should be done. The test carried out in the period of 7days, 14days, and 28days.

**Keywords-** Cement-Sugarcane ash, Quarry dust-Fine aggregate, coarse aggregate, Compressive strength.

## I. INTRODUCTION

The concrete is the most commonly used construction material. It is usage by the communities across the global second only to water. Customarily concrete is produced by using the OPC as the binder. The usage of OPC is on the increase to meet infrastructure developments the main component of concrete structure is cement. It is change the climate due to global warming. One of the greatest environmental issues has become a major concern during the decade. The global warming is caused by the emission of greenhouse gases such as carbon dioxide, methane, chloral fluoric carbon, hydrofluoric carbon, and water vapour etc. he global cement industry contributes around 1.3 billion tons of the greenhouse gas emission annually 7% of the total manmade greenhouse gas emission to the earth atmosphere in years of 1987. Every one ton of concrete loads to $CO_2$ emissions which vary between 0.05 to 0.13 tons about 95% of all $CO_2$ emissions from a cubic yards of concrete are from cement liberates about one ton of $CO_2$ as the results of de-carbonation of limestone during manufacturing of cement and combustion of fossil fuels.

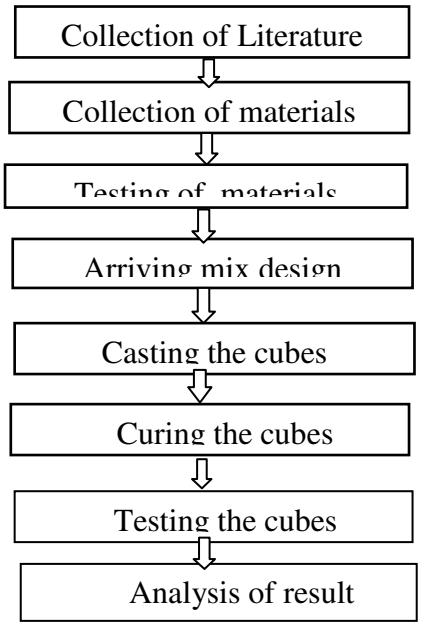
Therefore any direct or attempts to reduce greenhouse gas emission would be encouraged. In order to produce environmental friendly green concrete reduce use of natural resources, technology consuming less amount of energy and producing lower $CO_2$ emission is suggested. Mc affray suggested that the amount of $CO_2$ emission by the cement industries can be reduced by decreasing the amount of calcimined material in cement by decreasing the amount of concrete and by decreasing the number of building elements using cement.

## II. LITERATURE REVIEW:

**IJCSE-International Journal of Civil & Structural Engineering Research Piyush Kumar ,Anil pratapsingh(2015);**they studied on " Effect of use of Bagasse Ash on Strength of Concrete", with increasing demand and consumption of cement ,researchers and scientist are in search of developing alternate binders that are eco-friendly and contributes towards waste management .In these paper SCBA has been chemically and physically characterized and partially replaced in the ratio of 0%,5%,10%,15%&20% by weight of cement in concrete. The properties for fresh concrete are tested like slump cone test and for hardened concrete compressive strength at the age of 7&28 days by using grade M30.The test result indicate that the strength of concrete increase up to 10% SCBA replaced with cement.

**IJSLE-International for Service Learning In. Engineering R S**rinivasan and **K Sathiya (2010);** they studied on "Experimental Study on Bagasse Ash in Concrete". The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economic, environmental, and technical reasons. 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 mainly contains aluminum ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement.

## III METHODOLOGY:



## IV. MATERIAL PROPERTIES:

a) Cement

b) Fine aggregate

c) Coarse aggregate

d) Quarry dust

e) Sugarcane ash

### 4.1 CEMENT:

Ordinary Portland cement of 53 grades, conforming to IS 12269-1987 was used. Tests were carried out on various physical properties of cement.

i) Specific gravity

ii) Fineness modules (by Sieve Analysis)

iii) Consistency

iv) Initial Setting time

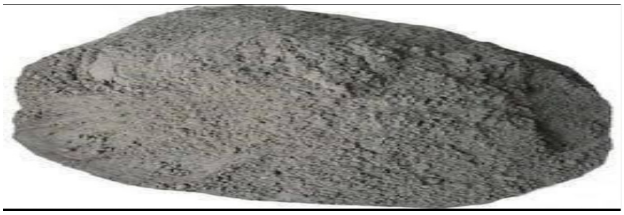


**Fig 4.1 Cement**

### 4.1.1 FINE AGGREGATE:

Fine aggregate should consist of natural sand or crushed stone sand. It should be hard, durable and clean and be free from organic matter. Fine aggregate should not contain any appreciable amount of clay balls and harmful impurities such as alkalis, salts, coal, delayed vegetation. The silt content should not exceed 4%.Fine aggregates are the aggregate whose size is less than 4.75mm.Sand is generally considered to have lower size limit of about 0.07mm, also free from clay mineral sand salt.

**Fig. 4.1.1 Fine aggregate.**

**Physical properties of fine aggregate**

| S.No | Characteristics | Value |
|---|---|---|
| 1 | Type | River sand |
| 2 | Specific gravity | 2.60 |
| 3 | Moisture content | 0.16% |
| 4 | Net water absorption | 0.86% |
| 5 | Fineness modulus | 4.35 |

**Fig 4.1.1 physical properties of fine aggregate**

### 4.1.2 COARSE AGGREGATE:

Coarse aggregate are a broad category particulate inert materials used in construction. Hard stones are crushed to the required size and are used as coarse aggregate

i) Surface moisture

ii) Fineness modulus

iii) Specific gravity

The materials that is retained on as IS Sieve of size 4.75 mm is called coarse aggregate. The coarse aggregates are tested before the concrete mixing. The test such as specific gravity and fineness modulus. The size of coarse aggregates are 7 mm, 14 mm, 20 mm. The aggregates are taken as 77% of mass of concrete in the preparation of 65:35.The aggregate most of which are retained on the 4.75mm IS sieve are termed as coarse aggregates. 20mm and 12.5mm size of coarse aggregate.

**Fig4.1.2 Coarse aggregate**

**Properties of coarse aggregate:**

| S.No | Characteristics | Value |
|---|---|---|
| 1 | Type | Crushed |
| 2 | Maximum size | 20mm |
| 3 | Specific gravity | 2.76 |
| 4 | Fineness modulus | 7.23 |

**Fig 4.12 physical properties of coarse aggregate**

### 4.1.3 QUARRY DUST:

Quarry dust is a waste product produced during the crushing process which is used to extract stone. It is rock particles. When huge rocks break in to small parts for the construction in quarries. It is like sand but mostly grey in colour. It is mineral particles. The density of Quarry dust is 1650 kg/m³.Quarry dust is a waste obtained during quarrying process. It has recently gained good attention to be used as an effective filler material instead of fine aggregate Crushed Sand less than 4.75mm is produced from hard granite rock using state of crushing plants. Production of quarry dust fines is a consequence of extraction and processing in a quarry and collected from the near-by quarry the amount produced depends on the rock type, amount of fragmentation by blasting and type of crushing used. The product is washed to remove excess fines to get sand of excellent shape and unwanted contamination.

**Fig 4.13 Quarry dust**

**Characteristics of Quarry dust**

The physical and chemical properties of quarry dust obtained by testing the sample as per the Indian standards are listed in the below table.

**4.13 physical properties of quarry dust**

| S.no | Properties | Result |
|---|---|---|
| 1 | Specific gravity | 2.34 |
| 2 | Water absorption | 0.6% |
| 3 | Fineness modulus | 14 |
| 4 | Moisture content | NIL |
| 5 | Sieve analysis | Zone II |

**4.1.4 SUGARCANE ASH:**

Sugarcane ash is one of the most abundant material on the Earth. It is also a crucial ingredient in the creation of concrete due to its role in the polymerization process. The main objective of this research was to determine the effectiveness of sugarcane as a cement replacement material in concrete. The sugarcane ash consists of approximately50% of the callous, 25% of hemicellous and 25% of lignin. Earth ton of sugarcane generates approximately 26% of sugarcane ash (at a moisture content of 50%) and 0.62% residual ash The residue after combustion present a chemical composition dominates by the silicon dioxide (sio2).In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane ash


**Fig 4.1.4 sugarcane ash**

**Characteristics of sugarcane ash**

The following tabulation explain about the physical and chemical characteristics of sugar cane ash.

**Physical properties of sugarcane ash**

The various physical properties of sugarcane ash is given below in table

| S.no | Properties | Result |
|---|---|---|
| 1 | Colour | Block to gray |
| 2 | Bulk density(g/cm$^3$ | 2450kg/m$^3$ |
| 3 | Specific gravity | 2.68 |
| 4 | Moisture (%) | 3.92 |

**Fig 4.1.4 physical properties of sugarcane ash**

**Chemical composition of sugarcane ash**

The various chemical composition of sugarcane ash is given below table

| S.no | Chemical composition | % |
|---|---|---|
| 1 | Silicon dioxide($Sio_2$) | 59 |
| 2 | Aluminum oxide($Al_2O_3$) | 21.0 |
| 3 | Iron oxide($Fe_2$ | 3.7 |
| 4 | Calcium oxide(Cao) | 6.91 |

## V. MIX DESIGN

**5.1 Mix Design for M20 grade (1: 1.4:3):**

Cement = 348.28 kg/m$^3$

Water= 191.8 lit/m$^3$

Fine aggregate= 584.4 kg/m$^3$

Coarse aggregate= 1223.8kg/m$^3$

### 5.1.1 Sugarcane ash 10%& Quarry dust 20%:

| Material | Quantity |
|---|---|
| Coarse aggregate | 13.86kg |
| Cement | 3.78kg |
| 10% sugarcane ash | 420g |
| Fine aggregate | 5.82kg |
| Quarry dust | 1440kg |

### 5.1.2 Sugarcane ash 20% & Quarry dust 30%:

| Material | Quantity |
|---|---|
| Coarse aggregate | 13.86kg |
| Cement | 3.360kg |
| Sugarcane ash (20%) | 840g |
| Fine aggregate | 5.094kg |
| Quarry dust (30%) | 2160kg |

### 5.1.3 Sugarcane ash 30% & Quarry dust 40%:

| Material | Quantity |
|---|---|
| Coarse aggregate | 113.86kg |
| Cement | 2940kg |
| Sugarcane ash | 1260kg |
| Fine aggregate | 4371kg |
| Quarry dust | 2880kg |

## VI. MATERIAL TEST

### 6.1Material testing:

a) Specific gravity test
b) Water absorption test
c) Finesse modules test
d) Compressive strength test
f) Flexural strength test
e) Split tensile test

### 6.1.1Casting and testing of cubes:

The quantities as per mix design are mixed with care and concrete cubes of size (150mmx150mmx150mm).The concrete specimens are cured for 7, 14 and 28 days in laboratory. Then concrete cubes are tested in laboratory to get their compressive strength values for various proportions.

**Fig 61.1 casting of cube.**

**Testing of cube specimen:**

After curing harden concrete is tested in compression testing machine. The testing of cube is done for 7, 14, and 28 days.

### 6.1.2 Compression strength test

Compression strength test is the most test conducted on hardened concrete, because it is easy to test and desirable characteristic properties of concrete are measured.

The cube specimen is of the size (150mmx150mmx150mm) isused for testing. The compressive strength test of concrete is done by using compressive testing machine. The specimen is placed in compression testing machine in such a way that load applied gradually in cast surface. The load at failure has been noted.

Compressive strength = (Failure load/Cross sectional area ($N/mm^2$)

**Compressive testing machine:**


**Fig 6.1.2Compressive testing machine**

## VII RESULT AND DISCUSSION:

### 7.1 TEST RESULTS OF COMPRESSIVE STRENGTH:

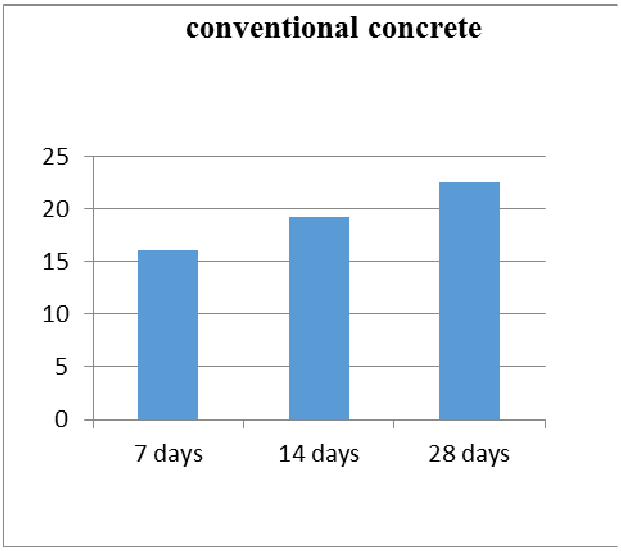
Compressive strength of concrete with various mix combination is determined at 7, 14 and 28 days for M20 grade of concrete. The result of compressive strength are given below in table:

**7.1.1 Compressive strength test for conventional mix** (M20)

For 7, 14 and 28 days, three cubes is tested for conventional mix and compressive strength of conventional mix.

| S.NO | MIX | Average compressive strength(N/mm$^{2)}$ | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | Water curing | 16.02 | 19.20 | 22.53 |

### 7.1.2 Conventional concrete flow chart:



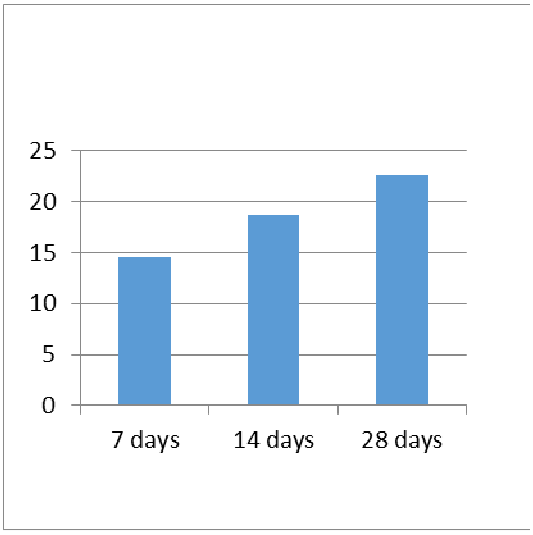

### 7.1.3 Compressive strength for sugarcane ash (10%) and Quarry dust (20%):

For 7 days, 14 days, and 28 days, three cubes is tested for sugarcane ash (10%) and quarry dust is (20%) replacement of concrete in compressive strength of M20 mix are given below in the table.

| S.NO | MIX (sugar cane ash (10%quarry dust (20%) | Average compressive strength(N/mm$^{2)}$ | | |
|---|---|---|---|---|
| | | 7 days | 14days | 28days |
| 1 | Specimen1(water curing) | 14.34 | 17.57 | 20.28 |
| 2 | Specimen2(water curing) | 14.60 | 19.14 | 20.60 |
| 3 | Specimen3(water curing) | 14.0 | 19.0 | 22.0 |
| Average compressive strength | | 14.58 | 18.73 | 20.97 |

**Chart: 2 Sugarcane ash (10%) &Quarry dust (20%):**

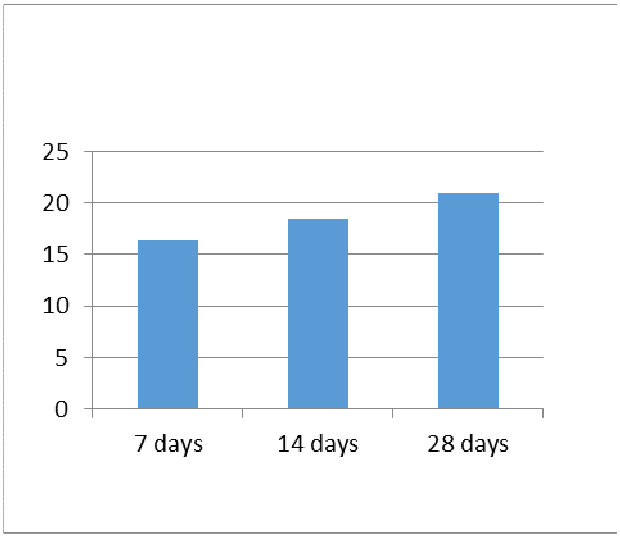



**7.1.4 Compressive strength test for partial replacement of sugarcane ash (20%) and Quarry dust (30%)**

For 7 days 14 days, and 28 days, three cubes is tested for Sugarcane ash (20%) and quarry dust (30%)replacement of concretion compressive strength of M20 mix given below the table.

| S. NO | MIX (sugar cane ash (20%) quarry dust (30%) | Average compressive strength(N/mm$^{2)}$ | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | Specimen1(water curing) | 16.25 | 18.25 | 21.52 |
| 2 | Specimen2(water curing) | 16.30 | 18.0 | 23.25 |
| 3 | Specimen3(water curing) | 16.50 | 18.5 | 25.35 |
| **Average compressive strength** | | 16.35 | 18.50 | 23.37 |

**Chart:3 Sugarcane ash (20%) & Quarry dust (30%):**



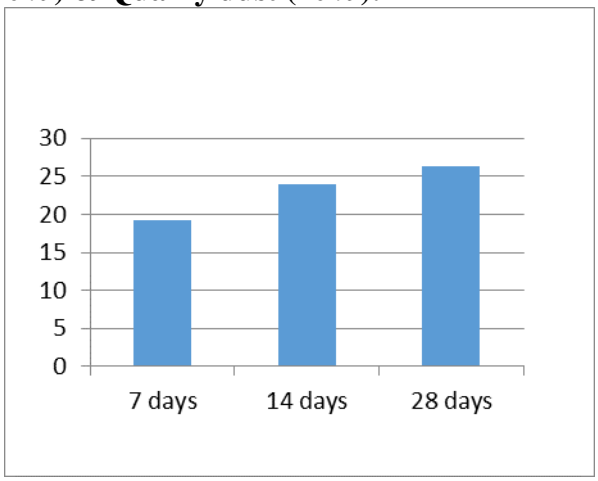

**7.1.5 Compressive strength test for partial replacement of sugarcane ash (30%) and Quarry dust (40%)**

For 7 days, 14 days, and 28 days, three cubes is tested for Sugarcane ash (30%) and quarry dust (40%) replacement of concrete in compressive strength of M20 mix given below the table.

| S.NO | MIX (sugar cane ash (30%) quarry dust (40%) | Average compressive strength(N/mm$^{2)}$ | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | Specimen1(water curing) | 18.33 | 23.08 | 25.52 |
| 2 | Specimen2(water curing) | 18.5 | 24.2 | 26.2 |
| 3 | Specimen3(water curing) | 19.0 | 25.3 | 27.2 |
| **Average compressive strength** | | 19.30 | 24.04 | 26.38 |

**Chart: 4 Sugarcane ash (30%) & Quarry dust (40%):**




## VIII. CONCLUSION

The conclusion is arrived for phase- I project, by finding optimum percentage of addition of sugarcane ash and quarry dust in concrete.

1) The sugarcane ash and quarry dust is the waste material which is cheap and easily available is made on effective material to use in concrete.
2) The compressive strength is increases with slightly increasing sugarcane ash and quarry dust.
3) The optimum strength was observed replacement of sugarCane ash (30%) and quarry dust (40%) as fine aggregate.
4) The slightly increase in compressive strength for mix G3Compared to conventional concrete mix.

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