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A STUDY ON MECHANICAL AND DURABILTY PROPERTIES OF CONCRETE BY PARTIAL REPLACING CEMENT WITH SUGAR CANE BAGASSE ASH AND FINE AGGREGATE WITH QUARRY SAND

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ABSTRACT

The infrastructure need of our country is increasing day by day and with concrete as a main constituent of construction material and the safety of systems is to be ensured.

Portland cement is the major construction material throughout the world. Today researchers are focusing on utilizing industrial or agricultural waste, as a source of raw materials for industry which results in foreign exchange earnings and environmental pollution. Industrial wastes, such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement materials. The utilization of bagasse ash is more, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. There is a possibility in using sugarcane bagasse ash as cement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, and concrete roof tiles and cement interlocking block. Cement is a prime ingredient for concrete based construction but it's over usage leads to environmental pollution.

The function of the fine aggregate is to assist in producing workability and uniformity in the mixture. The river deposits are the most common source of fine aggregate. Now-a-days the natural river sand has become scarce and very costly. Hence we are forced to think of alternative materials. The Quarry dust may be used in the place of river sand fully or partly.
A comparatively good strength is expected when sand is replaced partially or fully with or without concrete admixtures.

Utilization of sugarcane bagasse ash as replacement in cement and Quarry dust in replacement with fine aggregate with a percentage replacement of 10%, 15% and 25% respectively.

This paper contains preparation of sugarcane bagasse ash and quarry dust based concrete which undergoes certain tests compared to conventional concrete, which results in being better than conventional concrete.

Keywords: *Sugarcane bagasse ash, Quarry dust, strength properties of conventional concrete.*

I. INTRODUCTION

The infrastructure need of our country is increasing day by day and with concrete as a main constituent of construction material and the safety of systems is to be ensured.

Portland cement is the major construction material throughout the world. Today researchers are focusing on utilizing industrial or agricultural waste, as a source of raw materials for industry which results in foreign exchange earnings and environmental pollution. Industrial wastes, such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement materials. The utilization of bagasse ash is more, the residue from an in-line 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. The study of pozzolanic activity and their suitability as binders, have been carried out on the ashes in replacing cement. There is a possibility in using sugarcane bagasse ash as cement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, and concrete roof tiles and cement interlocking block. Cement is a prime ingredient for concrete based construction but it's over usage leads to environmental pollution.

Regular concrete is often produced with four components namely, a) cement and b) water, together acting as binder, c) crushed stone and d) natural sand and sometimes other cementitious and chemical admixtures. The aggregates are relatively inert filler materials, which occupy 70% to 80% of the concrete and can therefore be expected to have influence on its properties. The proportion of these components, the paste and the aggregate is controlled by the strength, durability of the desired concrete, the workability of the fresh concrete and the cost of the concrete. Agricultural wastes like wheat straw ash, rice husk ash, hazel nutshell and Sugar Cane Bagasse Ash (SCBA) contribute for the development of concrete by acting as pozzolanic materials. Presently, the study is to utilize SCBA, the waste from sugar industry. When this waste is burned at around 600-8000C, it produces ash containing large amount of amorphous silica having pozzolanic properties. So, it is conceivable to use SCBA as cement replacement material to improve concrete properties like workability and strength. Utilization of different cementitious materials along with SCBA for the production of SCBA blended cements confers to get sustainable concrete. Tremendous quantities of SCBA are obtained as by-product from combustion in sugar industries; Therefore, SCBA is suitable supplementary cementitious material for use in concrete. Ontogeny of population, growing urbanization, and the mounting standard of living due to technological inventions are the reason for an increase in the quantity and variety of solid wastes generated by mining, domestic industrial and agricultural activities. Annually, Asia alone produces 4.4 billion tonnes of solid waste. The second largest producer of SCBA is India (44,000 tonnes/day).

Sugarcane is one of the major crops grown in over 110 countries and its total production is over 1500 million tons. In India sugarcane production is over 300 million tons/year that cause around 10 million tons of sugarcane bagasse ash as an un-utilized and waste material. After the extraction of all economical sugar from sugarcane, about 40-45 percent fibrous residue is obtained, which is reused in the same industry as fuel in boilers for heat or power generation leaving behind 8 -10 percent ash as waste, known as sugarcane bagasse ash (SCBA).

The SCBA contains high amounts of unburnt matter, silica, alumina and calcium oxides. It is very valuable pozzolanic material if carbon free and amorphous ash could be obtained by further combustion. But these ashes are produced under uncontrolled and non-uniform burning conditions with temperatures rising above 1000°c resulting in a crystallization of the matter. Sugarcane production in India is over 300 million ton/year leaving about 10 million tons of SCBA as un-utilized and hence waste material. Sugarcane bagasse ash is normally used as fertilizer in sugarcane plantation

Concrete is a widely used construction material consisting of cementing material, fine aggregate, coarse aggregate and required quantity of water, where in the fine aggregate is usually natural sand. The use of sand in construction results in excessive sand mining which is objectionable, due to rapid growth in construction activity, the available sources of natural sand are getting exhausted. (Palaniraj, 2003) Also, good quality sand may have to be transported from long distance, which adds to the cost of construction.In some cases, natural sand may not be of good quality. (Dhir&carthy, 2000) quarry dust is one such material which can be used to replace sand as fine aggregate. The present study is aimed at utilizing quarry dust as fine aggregate in cement mortar and cement concrete, replacing natural sand. The study on mortar includes determination of compressive strength of different mortar mixes. (Nadgir&Bhavikatti, 2006) the study on concrete includes determination of compressive strength of concrete.

The function of the fine aggregate is to assist in producing workability and uniformity in the mixture. The river deposits are the most common source of fine aggregate. Now-a-days the natural river sand has become scarce and very costly. Hence we are forced to think of alternative materials. The Quarry dust may be used in the place of river sand fully or partly.

A comparatively good strength is expected when sand is replaced partially or fully with or without concrete admixtures.

It is proposed to study the possibility of replacing sand with locally available crusher waste without sacrificing the strength and workability of concrete.

II. MATERIALS

Sugar Cane Bagasse Ash

Sugarcane bagasse ash is a byproduct of sugar factories found after burning **sugarcane bagasse** which itself is found after the extraction of all economical sugar from **sugarcane**. The disposal of this material is already causing environmental problems around the sugar factories. It is the fibrous residue remaining after sugarcane stalk has been crushed and the juice removed. The annual production of bagasse in the world exceeds 100 million tons, more than half of which is produced in the western hemisphere. Because of its fibrous nature, sugarcane bagasse has been most widely used as a fuel, paper and pulp, structural materials, and agricultural uses. Recently, due to increasing worldwide shortage of food and energy sources, sugarcane bagasse has been considered as a substrate for single cell protein (SCP), animal feed, and renewable energy production.

Fig 2.1 Sugarcane Bagasse Ash

2.1 (a) Physical, Chemical, and Mineralogical Properties of Sugar Cane Bagasse Ash

2.1.1 Physical Properties

Table 2.1

Density (g/cm3)	2.52
Blaine surface area (cm2/g)	5140
Particle size (μm)	28.9
color	Redish grey

2.1.2 Specific Gravity

Specific gravity of Sugarcane bagasse ash is 2.83

2.1 (b) Chemical compositions

Table 2.2

Sio2	62.43
Al2O3	4.38
Fe2O3	6.98
CaO	11.8
MgO	2.51
SO3	1.48
K2O	3.53
LOI	4.73

2.2 Quarry Dust

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing countries are under pressure to replace fine aggregate in concrete by an alternate material also to some extent or totally without compromising the quality of concrete. Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles.

The present research work mainly deals with the influence of different replacement proportion of sand with quarry dust on the properties of concrete. The present study is planned to study the effects of quarry dust addition in normal concrete and to assess the rate of compressive strength development.

Fig 2.2

2.2.1 Properties

Specific gravity: 2.63;
Absorption: 0.60 %;
Maximum size: 4.75 mm;
Fineness modulus: 4.20.

2.3 COARSE AGGREGATE

Coarse aggregate used in the investigations was of two sizes viz. 20mm and 12mm. The crushed coarse aggregate was obtained from the local crushing plants. The physical properties of the coarse aggregate such as gradation, fineness modulus, specific gravity and bulk density are tested in accordance with IS:2386-1963 and IS:383-1970. The results for 20mm aggregate are tabulated below:

Table 2.3 Physical properties of coarse aggregate of size 20mm

S.NO	PROPERTIES	RESULT
1	Fineness modulus	7.228
2	Specific gravity	2.60
3	Bulk density in loose state	1361 kg/m^3

The data obtained from sieve analysis to determine fineness modulus of 20mm aggregate is tabulated.
Weight of sample taken = 5kgs

Table 2.4 Sieve analysis of coarse aggregate (20mm)

S.NO	IS SIEVE SIZE	WEIGHT RETAINED (gms)	% WEIGHT RETAINED	% WEIGHT RETAINED	% PASSING
1	40 mm	0	0	0	100
2	20 mm	1140	22.8	22.8	77.2
3	10 mm	3860	77.2	100	0
4	4.75 mm	0	0	100	0
5	2.36 mm	0	0	100	0
6	1.18 mm	0	0	100	0
7	600 µm	0	0	100	0
8	300 µm	0	0	100	0
9	150 µm	0	0	100	0

III. METHODOLOGY

3.1 Introduction

In this method the conventional concrete of mix M25 which is compared to different trail mixes.

The mix design of M25 is given in chapter 3.2.

The cement is partially replaced by sugarcane bagasse ash and fine aggregate is partially replaced by Quarry Dust with proportions of 10%, 15%, 20% and 10%, 15%, 20% respectively.

3.2 Mix Design

Mix Design For Concrete

For M25 Mix

Target mean strength=25+ (s*1.65)
=25+ (4*1.65)

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Fm = 31.6 KN/mm2

W/C ratio = 0.6

For 20mm aggregate water to cement ratio 186 kg/m3 of water is required and Fine aggregate volume is 35% for 1% of total.

$$V=[W+\frac{C}{Sc}+\frac{1}{P}*\frac{Fagg}{SFagg}]*\frac{1}{10^3}$$

3.3 Preparation of specimens:

The common procedure for preparation of specimens is through cube moulds, beam moulds and cylindrical moulds for various tests.

Cube moulds used are of size 150x150x150mm.

Basically, the force supplied by a concrete compression machine is a definite value. For normal concrete strength application, say below 50MPa, the stress produced by a 150mmx150mmx150mm cube is sufficient for the machine to crush the concrete sample. However, if the designed concrete strength is 100MPa, under the same force (about 2,000kN) supplied by the machine, the stress under a 150mmx150mmx150mm cube is not sufficient to crush the concrete cube. Therefore, 100mmx100mmx100mm concrete cubes are used instead to increase the applied stress to crush the concrete cubes.For normal concrete strength, the cube size of 150mmx150mmx150mm is already sufficient for the crushing strength of the machine.

Figure 3.1 cube moulds

Beam moulds of 100x100x500mm and 100x100x700mm are available.

Figure 3.2 beam moulds

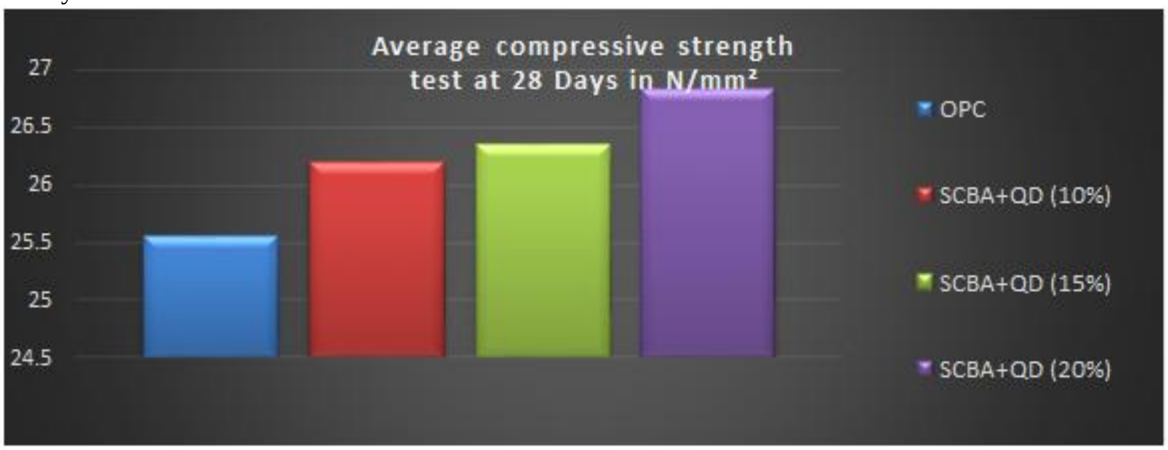
Cube moulds of 150x150x150mm are casted for both OPC and SCBA with Quarry dust each for 3,7and 28 days respectively.

3 cubes are casted for SCBA+QD (10%), 3 beams are casted for SCBA+QD (10%), 3 cylinders are casted for SCBA+QD (10%) , 3 cubes are casted for SCBA+QD (15%) , 3 beams are casted for SCBA+QD (15%) , 3

cylinders are casted for SCBA+QD (15%) , 3 cubes are casted for SCBA+QD (20%) , 3 beams are casted for SCBA+QD (20%) , 3 cylinders are casted for SCBA+QD (20%)

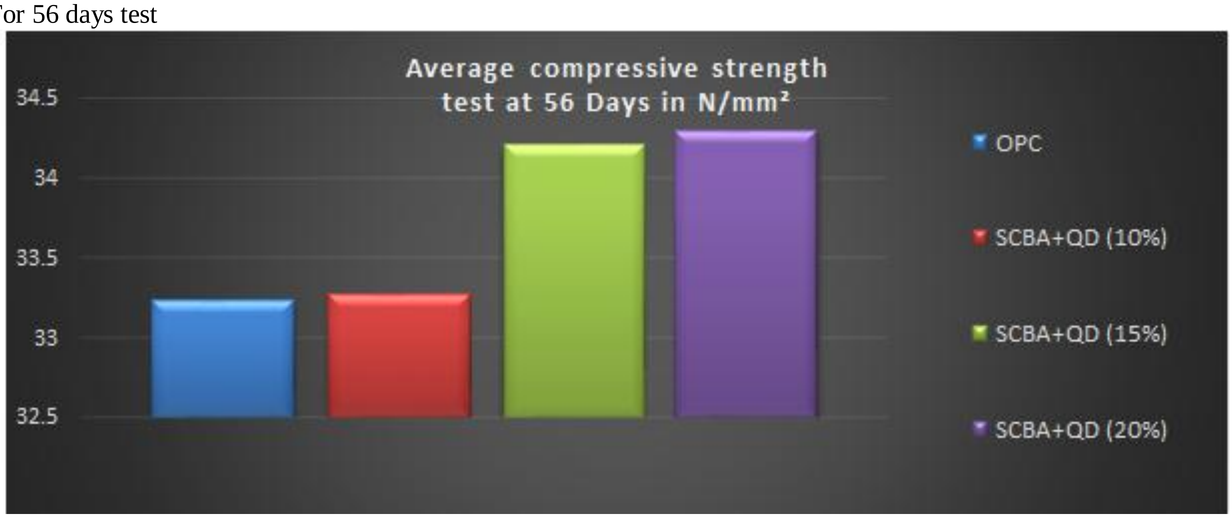
IV. RESULT & DISCUSSION

For 28 days test



Graph 4.1

For 56 days test



Graph 4.2

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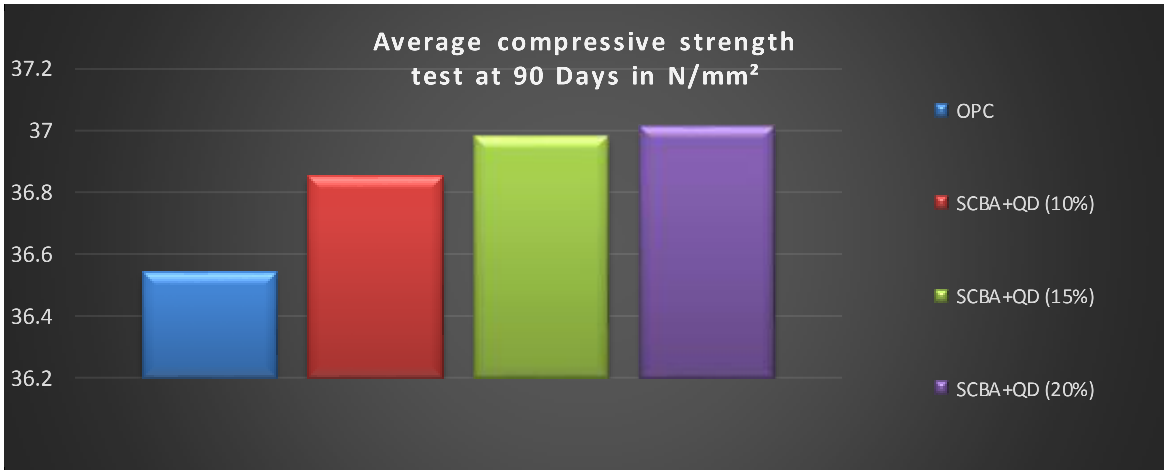
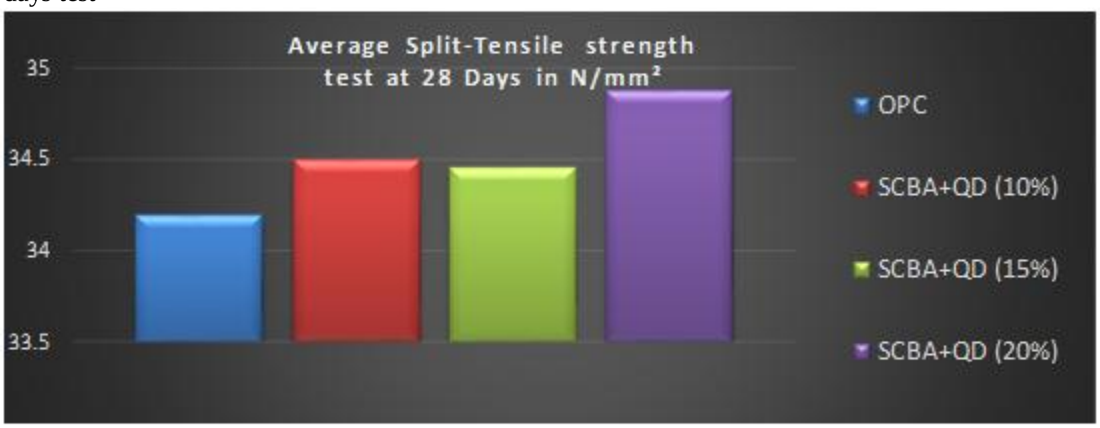
For 90 days test



Graph 4.3

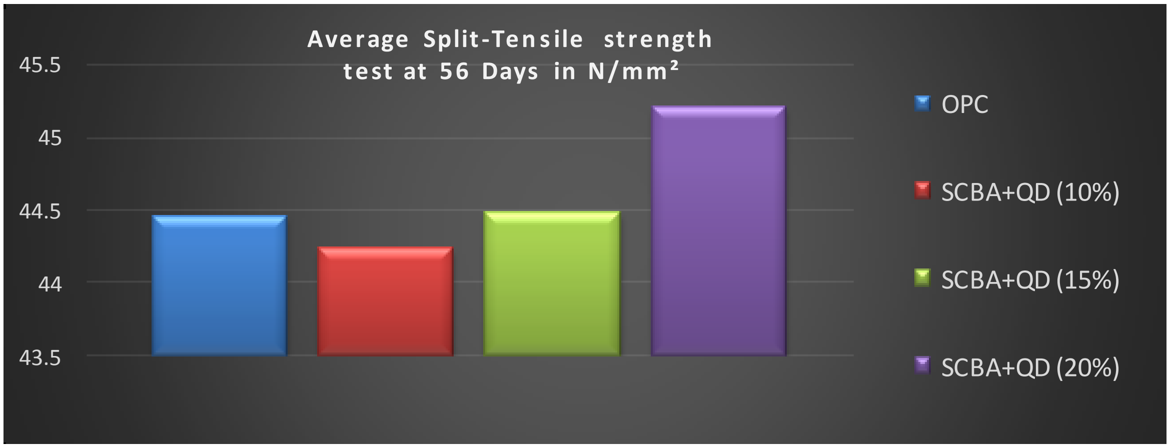
Comparison between **Split-Tensile strength** of Ordinary Portland Cement concrete

For 28 days test



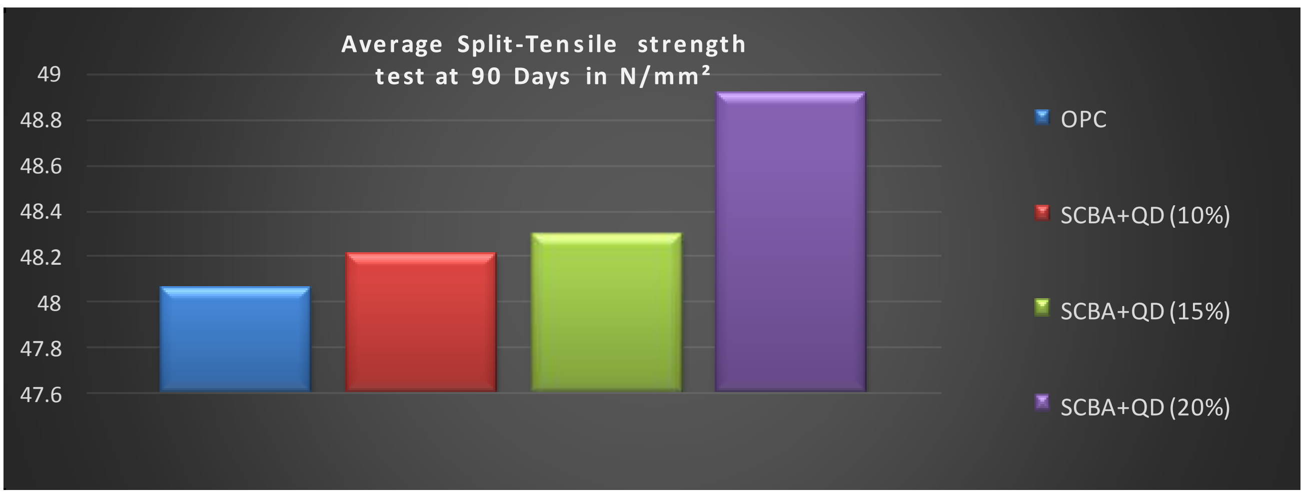
Graph 6.7

For 56 days test



Graph 6.8

For 90 days test



Graph 6.9

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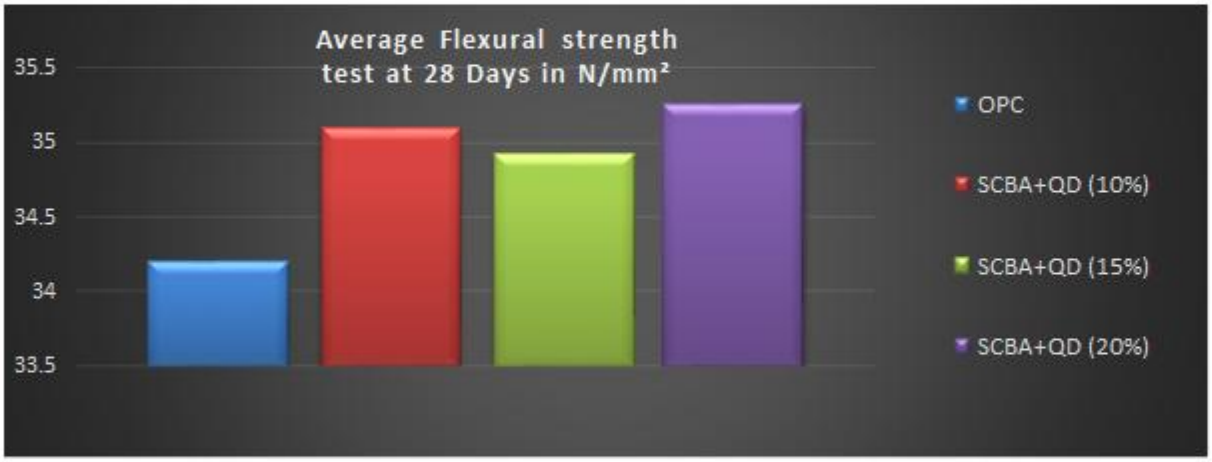
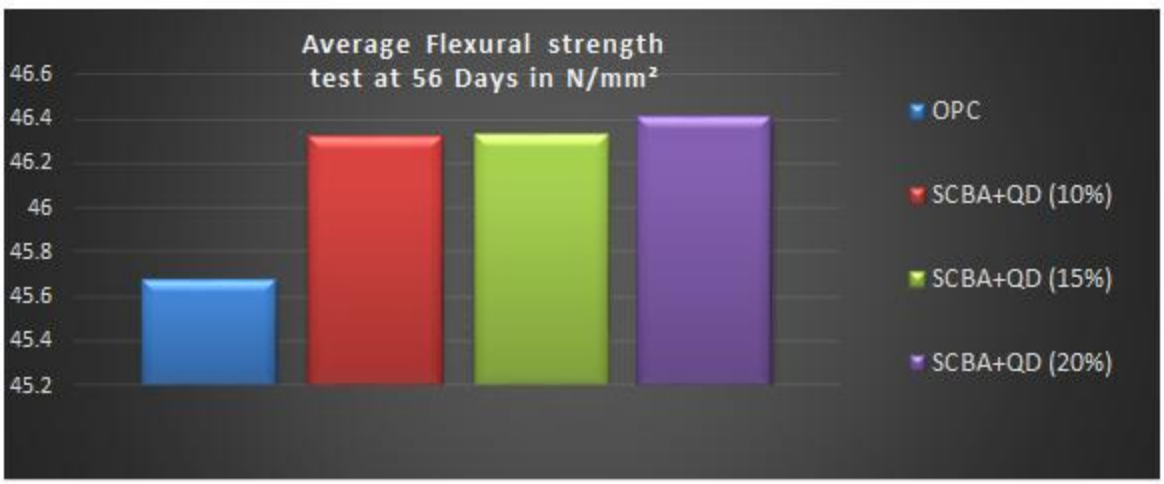
Comparison between **Flexural strength** of Ordinary Portland

For 28 days test



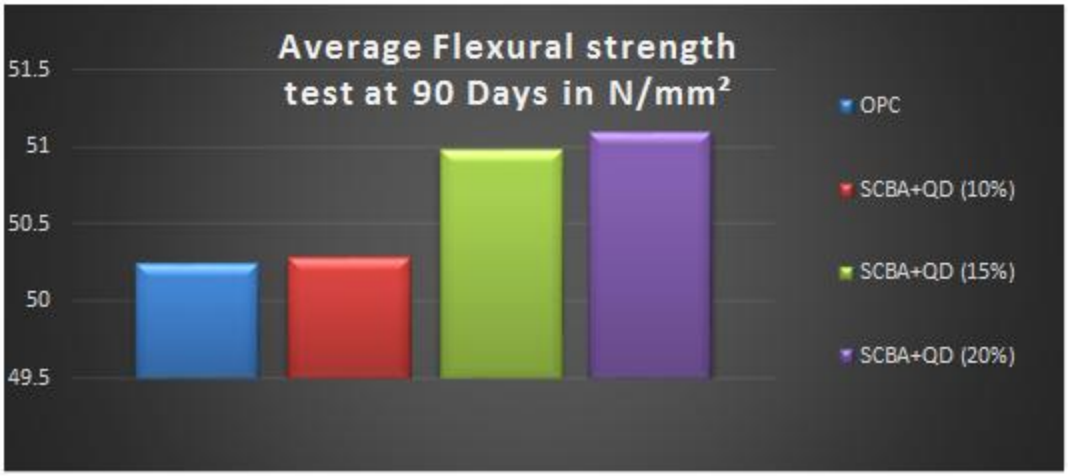
Graph 6.11

For 56 days test



Graph 6.12

For 90 days test



Graph 6.13

V. CONCLUSION

From the above values and graph it can be concluded that

- As the percentage of both Sugarcane Bagasse Ash in cement and Quarry dust in fine aggregate increases the strength of the concrete also increases.
- In compressive strength at *28* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *2.5%*, Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *3.05%*, Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *5%*.
- In compressive strength at *56* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *2.5%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *3.05%* , Sugarcane Bagasse Ash and Quarry Dust at 20% mix is 5% ,
- In compressive strength at *90* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *2.5%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *3.05%* , Sugarcane Bagasse Ash and Quarry Dust at 20% mix is 5% ,
- In split-tensile strength at *28* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *2.63%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *2.13%* , Sugarcane Bagasse Ash and Quarry Dust at 20% mix is 3.09%
- In split-tensile strength at *56* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at 10% mix is 0.009% , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *0.04%* , Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *0.10%*
- In split-tensile strength at *90* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *0.31%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *0.49%* , Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *2.04%*
- In flexure strength at *28* days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *0.80%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *0.76%* , Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *2.01%*
- In flexure strength at 56 days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *1.4%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *1.42%* , Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *1.72%*
- In flexure strength at 90 days the percentage increase of concrete with Sugarcane Bagasse Ash and Quarry Dust at *10%* mix is *0.07%* , Sugarcane Bagasse Ash and Quarry Dust at *15%* mix is *1.47%* , Sugarcane Bagasse Ash and Quarry Dust at *20%* mix is *1.711%*

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- The Percentage increase of test results may be less but these values are the proof that we can use sugarcane bagasse ash and quarry dust replacing cement and fine aggregate respectively in concrete manufacturing. Therefore reducing some amount of cement use in construction industry and helping the environment being ecofriendly.

REFERENCES

1. *De Larrard F, Belloc A (1997). The influence of aggregate on the compressive strength of normal and high-strength concrete. ACI Mater J., 94(5):417–426.*
2. *Partial Replacement of Sand by Quarry Dust in Concrete Sumit L. Chauhan, RajuA.Bondre. IJSE*
3. *Galetakis M, Raka S (2004). Utilization of limestone dust for artificial stone production: an experimental approach. Miner. Eng., 17:355–357.*
4. *IS: 516-1959. Indian Standard Methods of Test for Strength of concrete. Bureau of Indian Standards, New Delhi.*
5. *Aigbodion.V.S, Hassan.S.B, Olajide.S,O, Agunsoye.O.J, AbdulRahaman.A.S. Okafor.G.E, the use of rice husk ash as an aggregate for foundry sand production in Nigeria, Proceedings of the Nigerian Metallurgical Society (NMS), (2008) Annual Conference & Annual General Meeting, pp 16-22.*
6. *IS 10262 -1981 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi*
7. *Al-Zboon, K., Yahal, M., Abu-Hamatteh, Z.S.H., Al-Harashseh, M.S., 2010. Recycling of Stone Cutting Sludge in Formulations of Bricks and Terrazzo Tiles. Waste Management & Research 28, 568-574.*
8. *R. Somna, C. Jaturapitakkul, P. Rattanachu and W. Chalee, "Effect of ground bagasse ash on mechanical and durability properties of recycled aggregate concrete", Materials and Design, Vol. 36, pp. 597–603, 2012*