EXPERIMENTAL STUDY OF SUGARCANE BAGASSE ASH & QUARRY DUST ON STRENGTH OF CONCRETE

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Abstract - *This research work examines the possibility of using sugarcane bagasse ash and quarry dust as replacement of cement and fine aggregate in concrete. Compressive strength tests for 7days are done for the concrete before using the quarry dust of various percentages such as 20%,30% & 40% as partial replacement with sand. These results shows that the use of quarry dust is limited to 30% which is higher among the other sand replacements. We partially replaced 0%,5%,10%, 15%, 20%, 25% and 30% of cement with SCBA and 30% of sand with quarry dust. We compared compressive strength, tensile strength with those of concrete made with cement and natural fine aggregate. The compressive strength test results indicate that the use of sugarcane bagasse ash in cement replacement is limited to 15%,after that, there is a decrease in strength results and the optimum split tensile strength is obtained at 5% SCBA replacement. We also done non-destructive test of ultra sonic pulse velocity and durability test of water absorption and compared the results with conventional concrete. The durability test results shows that the sugarcane bagasse ash absorbs more water than the cement.*

Key Words: Fly Ash, SBA, Carbon Dioxide, Split Tensile, Sugar Factory.

1. INTRODUCTION

Development of world is mainly based on the infrastructure of various nations in large scale. Increase in infrastructure leads to use of various material during construction which also have disadvantage in some extent.

Ordinary Portland cement (OPC) is recognized as one of main construction material used worldwide. In today's world, global warming is increasing due to rate of carbon-dioxide (CO2) emission through various materials, in which cement is also one component which emits 5-8% CO2. When cement and water are considered individually they do not contain individual strength nor they can act as binder, but when they are mix together for a purpose at that time calcium oxide (CaO) and silica oxide (SiO2) react with water to form Calcium Silica Hydroxide gel (C-S-H) which brings strength to the mixture. As it is exothermic reaction, heat is generated which is known as heat of hydration. When this reaction exists the emission of carbon-dioxide takes place which contributes in GHG phenomenon.

When the studies was carried out it was identified that partial replacement of cement can be done using various pozzolanic materials. Pozzolanic material contains high amount of silica, addition of these materials helps silica (SiO2) to react with free lime released during heat of hydration which reduces carbon-dioxide emission. Industrial waste such as fly ash, blast furnace slag, silica fume contains pozzolanic properties, in addition agricultural wastes also contains high amount of pozzolanic properties in rice husk ash, wheat straw ash and sugarcane bagasse ash.
Sugarcane is a major crop grown in about 115 countries which has production 1600 million tonnes yearly. India produces 300 million tonnes of sugarcane per year. A thousand tonne sugar cane produce 26% of bagasse and 0.62% of bagasse ash. This ash is produced by controlled burning of sugarcane bagasse above 120oC and below 800oC. After burning bagasse it gives amorphous silica which has pozzolanic properties.

Bagasse ash contains around 68.82% of silica which helps to reduce carbon emission after reacting with cement and it also contains sugar in some amount which is responsible for increase in strength. Therefore it is possible to use Sugarcane Bagasse Ash (SBA) as partial cement replacement material to improve quality, strength and reduce cost of construction.

2. MATERIALS & METHODS:

2.1CEMENT: Cementitious material used was OPC 53 grade, Is the main ingredient used in for bonding of concrete. The usage of other cement is possible but depends on local availability. Supplementary cementitious material is replaced with

bagasse ash at about 0%,5%,15% 20% 25% 30% with cement. The test conducted on cement are initial setting time, final setting time, soundness, specific gravity test.

2.2FINE AGGREGATE: Fine aggregates used were available on site and are tested, the results are as per Indian standards BIS: 383: 1970. Specific gravity of fine aggregate is 2.94. These are used in replacement to river sand. Use of fine aggregate improves the compressive strength of concrete. The aggregates to cement ratio usually varies between 4:1 to 5:1. Use of fine aggregates provides better bonding or interlocking of both fine and coarse aggregates.

2.3COARSE AGGREGATE: The aggregates used were 20mm nominal maximum size and are tested as per Indian standards and the results are within permissible limits (BIS: 10262, BIS: 383). The specific gravity of coarse aggregate is 3.09. Aggregates should be kept moist or wet when high temperature is expected, If wet aggregates are used absorption and moisture must be considered. Improper amount of free water can lead to excess drying or improper compaction. Adversely too much of water will make the paste or mortar too thin and improper bond between aggregates and allowing paste/mortar seepage. The paste/mortar will result in lower permeability rates of system.

2.4WATER:

Water required for curing and casting was being available on site and does satisfy as per IS456:2000 pH value of water used was 7.3

2.5Sugarcane Bagasse Ash:

Sugarcane bagasse ash which is obtained after burning of sugarcane it is a waste product which can be useful as partially replacing cement due various chemical property. Bagasse ash was collected from Ajinkyatara Sahakari Sakhar Karkhana Ltd; Satara in Maharashtra state of India. Bagasse ash contains 40-50% moisture at the time of collection from factory. Bagasse is by product which burnt to generate power required for different activities in factory.

Use of sugarcane bagasse ash as a replacement material to cement improves the quality and reduce the cost of construction. Sugarcane Bagasse Ash (SBA) is used as mineral admixture as it has high silica content, thereby helps in increasing the strength of concrete. Reduces the setting time of concrete as it has some properties of admixture due to presence of sugar content in SBA. The chemical properties of Sugarcane bagasse ash are as follows:

Table No.:- 1.1 Chemical properties of sugarcane bagasse ash3

CHEMICAL COMPOUND	ABBREVIATION	% CONTENT
Silica	SiO_2	68.42
Aluminium Oxide	Al_2O_3	5.812
Ferric Oxide	Fe_2O_3	0.218
Calcium Oxide	CaO	2.56
Phosphorous Oxide	P_2O_5	1.28
Magnesium Oxide	MgO	0.572
Sulphide Oxide	SO_3	4.33
Loss on Ignition	LOI	15.90

Source:- As per data supplied by Sugar Factory

3.EXPERIMENTAL DETAILS

In this experiment number of cubes, beams and cylinders were 45, 30 and 30 respectively. The size of the moulds of cubes, beams and cylinder were 150x150x150 mm, 150x150x700 mm and 150x300 mm respectively. The mix design was made using IS 10262-2009 for M30 grade concrete in which mix proportion was 1:1.91:2.42 for $1m_3$ concrete. Water cement ratio used was 0.38. SCBA was partially replaced in concrete by 0%,5%, 10%, 15%,20%,25%30% by the weight of cement. Compaction of concrete specimen was done using hand compaction and vibrator. The specimens were removed after 24 Hrs. from the time of casting and kept in curing tank for 7, 28, 90 days for cubes & 28, 90 days for beams and cylinders.

Compression test for cubes were conducted on Compression Testing Machine (CTM) of capacity 2000kN. Flexural and splint tensile test were conducted on Universal Testing Machine (UTM) of capacity 600KN.

4. TEST RESULTS

4.1. COMPRESSIVE STRENGTH TEST

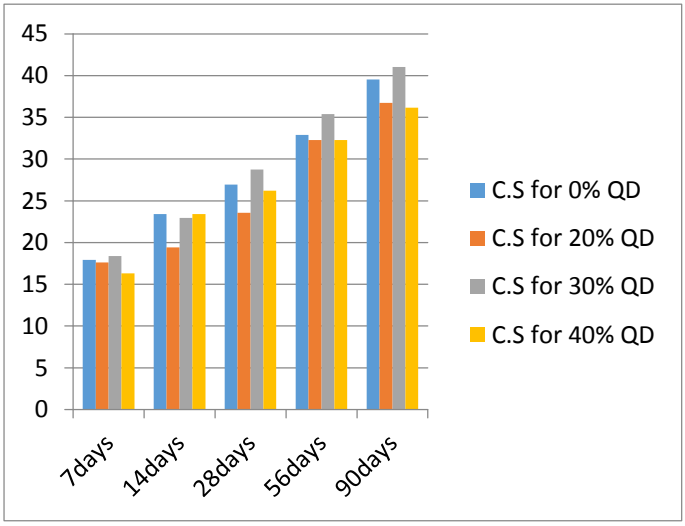
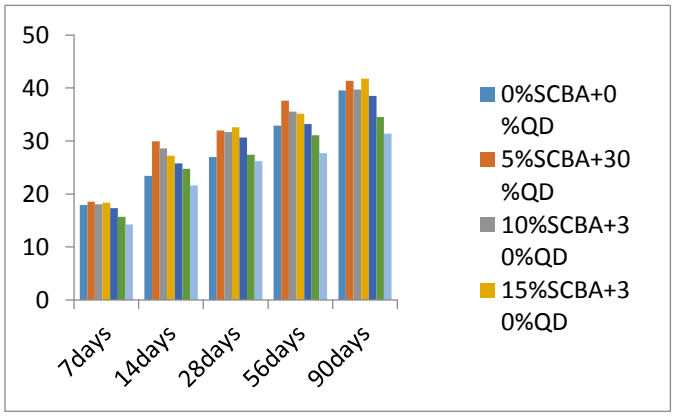


Fig-1 Showing the comparison of compressive strength results for 0%,20% 30% & 40% QD.

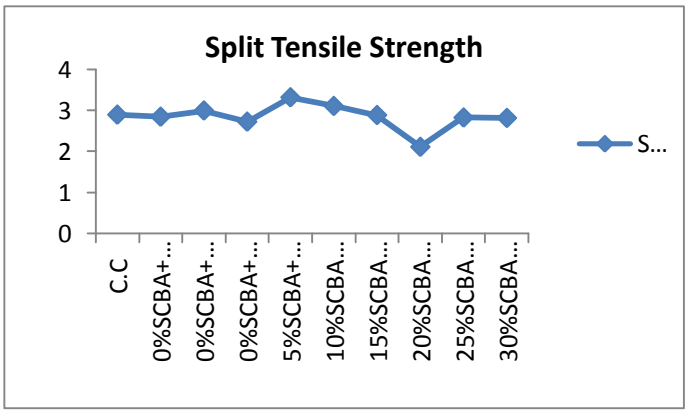
The above graph shows the variation of compressive strength results for the replacement of 0%,20%,30% & 40% quarry dust with sand. It was observed that there is increase in strength for 30% quarry dust replacement with sand while compared to other percentages of quarry dust. Hence, 30% quarry dust has put constant for all sugarcane bagasse ash replacements.



Graph 2: Showing the comparision of compressive strength results for all age cubes.

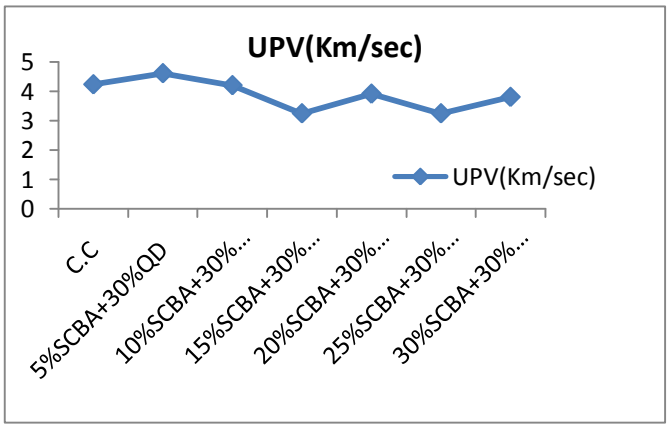
It was observed from the compressive strength results that there is an increase in compressive strength from 5% to 15 % SCBA replacement, after that we observed there is decline in the compressive strength results while the percentage of SCBA increases. Hence, it is observed that we got satisfactory compressive strength results of 20.88% increment at 15% SCBA and 30% QD replacement.

4.2. SPLIT TENSILE STRENGTH TEST



Graph 3: Showing the split tensile strength results for various SCBA & QD replacements

The split tensile strength for 15%,20%,25% and 30% SCBA replacements are 2.89 N/mm2, 2.12 N/mm^2, 2.83 N/mm2 and 2.82 N/mm^2. From these results,it is observed that the maximum split tensile strength is obtained at 5% SCBA & 30% QD is 3.3 N/mm^2. Later on, the strength decreases while the percentage of SCBA replacement increases.



Graph 4 : showing the ultra sonic pulse velocity results

5. CONCLUSIONS

The use of bagasse ash as a cement replacing material in concrete production was studied and after the research work is done, the following conclusions were made:

1. Higher replacements of cement by bagasse ash resulted in higher normal consistency (implying higher water demand for certain workability) and longer setting time.
2. The workability of concrete containing bagasse ash decreases slightly as the bagasse ash content increases which is due to the higher water demand of bagasse ash.
3. Density of concrete decreases with increase in SCBA content.
4. SCBA in concrete increased its strength under compression 5 to 15% of SCBA replacement, after that strength results were decreased.
5. SCBA at 5% gives higher split tensile strength results and further increase in SCBA results in gradual decrease in split tensile strength.
6. The replacement of the sand with quarry dust shows an improved in the compressive strength of the concrete.
7. As the replacement of the sand with quarry dust increases the workability of the concrete is decreasing due to the absorption of the water by the quarry dust.

8. Water absorption test results indicate that if the amount of SCBA is more, the amount of water absorption is also more.
9. The optimum compressive strength results were obtained at 15% SCBA and 30% QD replacement level.

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