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Effect on CO_2 Cured Concrete Exposed to Sodium Sulphate

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ABSTRACT

This research presents the use of sugarcane bagasse ash (SCBA) material for producing high strength concrete. Cement is replaced with 5% and 15% and 25% with SCBA and 10% silica fume. This research focuses on CO_2 being used in construction practice. This study summarizes the potential of CO_2 cured concrete when exposed to 2% sodium sulphate. To verify the durability of concrete cured in CO_2 an environment is created for curing cubes, cylinders and prisms using dry ice and CO_2 gas. In this research the effect of CO_2 was checked by dry ice curing and CO_2 gas curing. The specimens are cured in water and tested for 28 days, 90days and 120days. The specimens are cured in CO_2 and Dry ice for 8hours and they are immersed in 2% Na_2so_4 for 28 days, 90days and 120days and are tested for compression, flexural and split tensile strength. The performance of dry ice and CO_2 cured specimens are compared with specimens cured in water

Key words : Compressive Strength, CO_2 Gas Curing, Dry Ice, Flexural Strength, Na_2SO_4,Sugarcane Bagasse Ash, Split Tensile Strength

1.INTRODUCTION

CO_2 emissions are one of the most serious concerns among all greenhouse gas emissions. Due to human activities CO_2 is increasing in the atmosphere. As CO_2 is the most dominant greenhouse it should be reduced. It can be captured and used as a curing agent. Strength of concrete increases when cured with CO_2 when compared to specimens cured in CO_2 free environment.

The replacement of 20%, 30%, 40% and 50% by mass in a cement paste samples and cured after initial curing of 24 hr studied in [1]. The results showed the increase in compression strength in carbonated cured specimens compared to non-carbonated cured specimens. (samples were immersed in acetone at 7 & 28 days).

The influence of curing duration before accelerated carbonation of concrete studied in [2]. Various samples with few design mixes and water binder ratio are casted and cured for 7, 14 & 28 days and kept in CO_2 chamber for 180 days. Testes on specimens are conducted for every 1 month. There is increase in compressive strength and split tensile strength irrespective of the water cement ratio.

The products of tricalcium silicate paste and carbonation reaction heat exposed to CO_2 for rapid curing described in [3]. Retrofitted micro-calorimeter is used to measure reaction heat. The compression strength of a CO_2 cured C_3S paste for 2 hours and 24 hours was 27.5 MPa and 62.9 MPa. There is increase in 24hr strength compared to 28 days hydration strength.

The curing have done in two methods, pressurized CO_2 curing and flow through curing method the strength and curing degree properties were investigated[4]. The results showed that for the first 2hrs of pressurized curing there is increase in curing degree and strength. When PCC-cured concrete blocks are compared to FCC-cured concrete blocks, PCC cured concrete blocks show low curing degrees and slow strength development initially. After 24 hours of CO_2 curing. The fast strength development has attained. This curing method can be used for concrete blocks production.

The durability of concrete made with recycled mortar aggregates and cured with carbon dioxide given in [5]. The durability properties such as compressive and split tensile strength ETC were studied. These mortar mixes were casted & cured for 90 days. The specimens are cured in carbon dioxide chamber for 6,12,24,48 &72hrs with a pressure of 0.1 bar. Then the specimens were tested. The results shown that the compressive strength concrete made with carbonated RMA2 concrete is similar to control mix at 90days curing period & at 90 days the splitting tensile strength was slightly higher than the control concrete.

The impact of silica fume in concrete for properties like flexural strength, compressive strength, tensile strength found out in [6]. In this study 28thday strength of concrete with silica fume gives high compressive strength. Early high compressive strength can be achieved with addition of silica fume, with proper concrete mix design method very high strength can be achieved after 28 days.

The partial replacement for cement with SCBA in conventional concrete presented in [7]. The Compressive strengths for 7, 14 and 28 days were determined. The results showed increase in strength by adding SCBA in all cases. With 15% SCBA and 0.35 w/c ratio the rapid strength increase has noted.

Studies are done to evaluate the effects of sulphates on cement and fly ash mortar made with treated domestic wastewater[8].The specimens were casted in water and 90 days age specimens are cured with wastewater and immersed in Na_2SO_4 and magnesium sulphate solutions. Compression strength has decreased for both the sulphates.

The compressive strength of concrete, the cement is replaced with (PSA) Periwinkle shell ash at 0%,10%,20%,30%,40% and are exposed to sulphates of magnesium, sodium, calcium at 0%,1%,3% and 5% after the samples are cured in water for 28days[9][10].The results show increase in compressive strength with increase in age but decrease as the PSA contents increased.

Mechanical properties of GGBS concrete under immersed curing and membrane curing methods (M30 Grade concrete)[11]. Airtight polyethene covers are used for membrane curing. The strength of concrete is increased up to 30% when replaced cement with GGBS under immersed curing condition and membrane curing condition.

2. MATERIALS

2.1 Cement

Ordinary portland cement of grade 53 was used for this work shown in Table 1 and Table 2.

Table 1: Properties of Cement

Property	Value
Specific gravity of cement	3.15
Fineness of cement	8
Standard consistency of cement	31%
Final setting time of cement	320 minutes
Initial setting time of cement	85 minutes

Table 2: Chemical properties of cement, SCBA, SF

Chemical Compound	Cement	SCBA	Silica Fume
SiO_2	20.12	63.00	85
Al_2O_3	5.77	31.50	1.12
Fe_2O_3	3.45	1.79	1.46
Na_2O	0.34	-	0.5
CaO	63.68	0.48	0.8
MgO	0.3	0.4	0.8
LOI	1.47	0.71	0.6

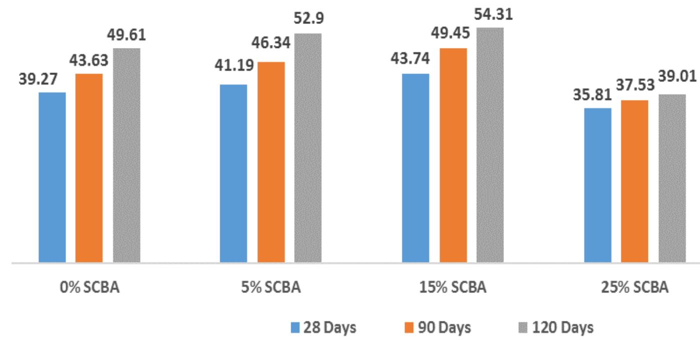

Figure 1: Compressive strength of Water cured specimens

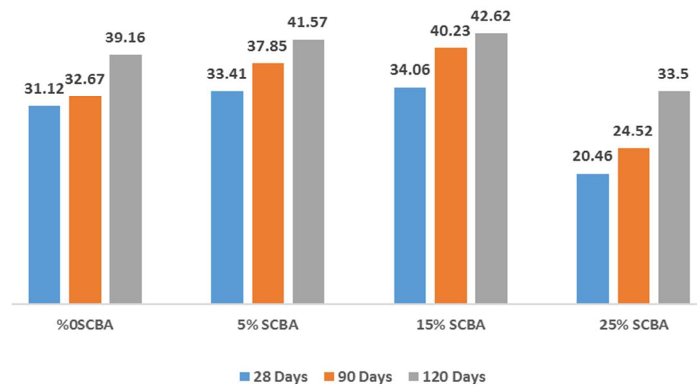

Figure 2: Compressive strength of Gas cured specimens

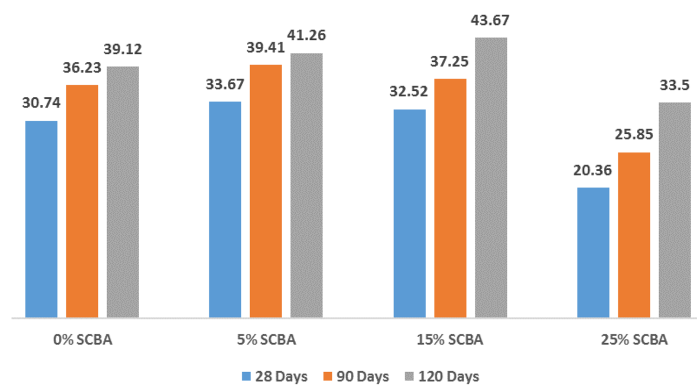

Figure 3: Compressive strength of Dry Ice cured specimens

2.2 Fine Aggregate

Zone 2 fine aggregate is used in this work which has satisfied the conditions of IS 383-1970.

2.3 Coarse Aggregate

Coarse Aggregate occupies 70-80% of the volume of concrete. Aggregate which satisfies the conditions of IS 383-1970 is used in this project.

2.4 Sugarcane Bagasse Ash

In this research we have used 5% 15% and 25% of SCBA is used.

2.5 Water

Water which is free from impurities and free from oil is used in this work for 28,90 and 120 days.

2.6 Sulphate

Sodium Sulphate (Na_2SO_4) 2% concentration are maintained for 28, 90 and 120 days.

3. RESULTS AND DISCUSSIONS

After de-moulding, CO_2 curing and chemical curing the cubes are tested for compressive strength, split tensile strength, flexural strength. These results are discussed in following sub sections.

3.1 Compressive strength

A. Compressive strength results of water cured specimens

The water cured results are tabulated and shown Figure 1. The compression strength increased by 5.14%, 6.21%, 6.63%, 11.38% 13.33% 9.47% when replaced with 15% SCBA and 10% silica fume for 28, 90 and 120 days of curing. And decreased with replacement of 8.81% 13.98% 21.3% for 25% of SCBA and 10% silica fume for 28, 90 and 120 days of curing.

B. Compressivestrength results for gas cured specimens

The gas cured results are tabulated and shown in Figure 2. The compression strength increased by 7.35% 15.85% 6.15%, 4.25% 23.14% 8.83% when replaced with15% SCBA and 10% silica fume for 28, 90 and 120 days of gas curing. And decreased by 24.55% 24.94% 14.4% with replacement of 25% of SCBA and 10% silica fume.

C. Compressive strength results for Dry Ice cured specimens

The dry ice cured results are shown in Figure 3. the compression strength increased by 9.53% 8.77% 5.47%, 5.7% 8.77% 11.63%, when replaced with15% SCBA and 10% silica fume for 28, 90 and 120 days of dry ice curing. And decreased by 33.76% 28.65% 14.3% with replacement of 25% of SCBA and 10% silica fume.

3.2Split tensile strength

A. Split tensile strength results of water cured specimens

The water cured results shown in Figure 4. The split tensile strength increased by 4.6% 6.87% 5.6%, 14.5% 15.12% 12.9% when replaced with of 15% SCBA and 10% silica fume for 28, 90 and 120 days of curing and decreased by 42.55% 5.8% 6.2% with replacement of 25% of SCBA and 10% silica fume.

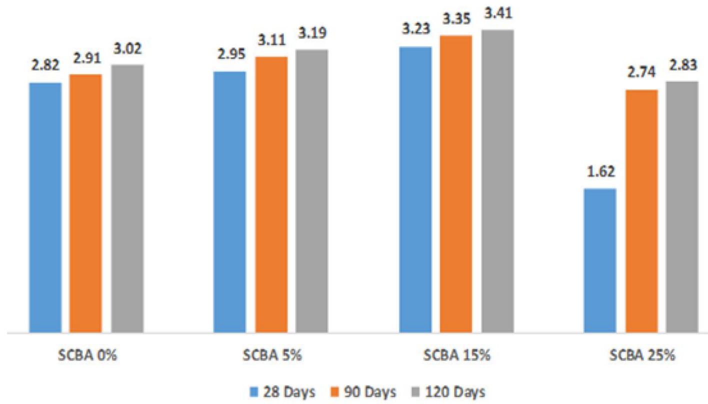

Figure 4: Split tensile strength of Water cured specimens

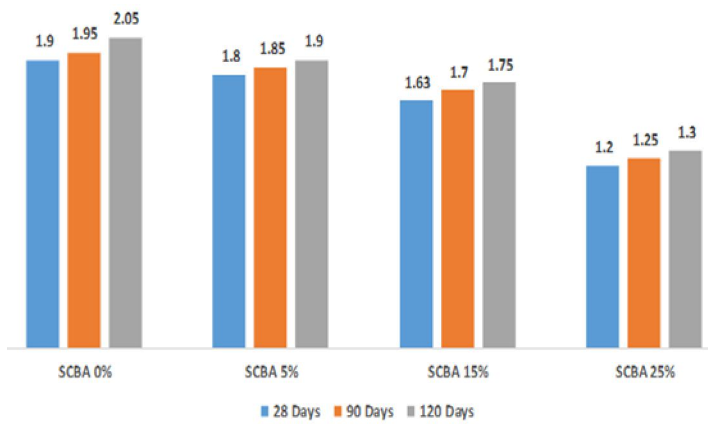

Figure 5: Split tensile strength of Gas cured specimens

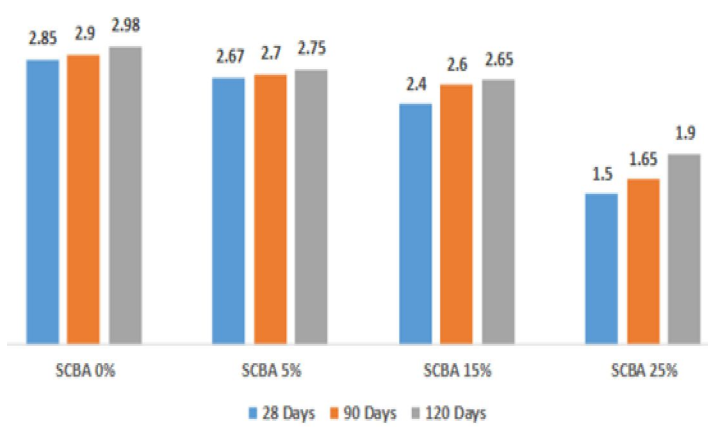

Figure 6: Split tensile strength of Dry Ice cured specimens

B. Split tensile strength results of gas cured specimens

The gas cured results shown in Figure 5. The split tensile strength decreased by 5.2% 5.12% 7.3%, 14.2% 12.8%

14.6%,36.8% 35.8% 36.58% when replaced with 5% SCBA and 10% silica fume for 28, 90 and 120 days of gas curing.

C. Split tensile strength results of Dry Ice cured specimens

The dry ice cured results are shown in Figure 6. split tensile decreased by 6.31% 6.89% 7.7%, 15.7% 10.3% 11.0%, 47.36% 13.1% 36.24 when replaced with 5% SCBA and 10% silica fume for 28, 90 and 120 days of dry ice curing.

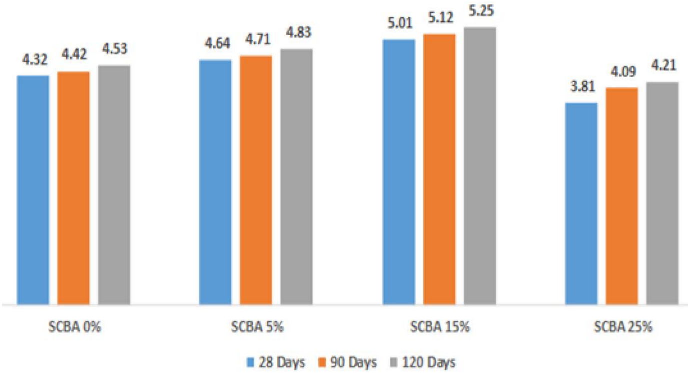

Figure 7: Flexural Strength of Water cured specimens

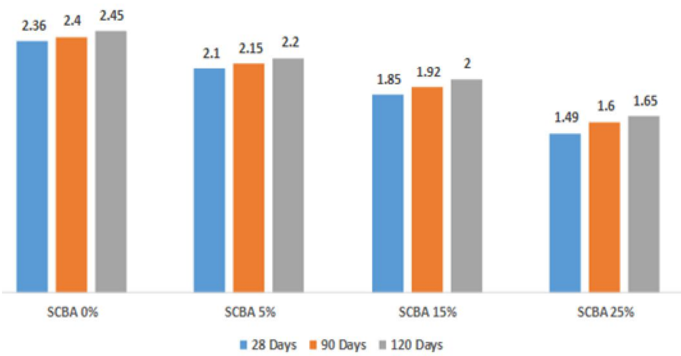

Figure 8: Flexural Strength of Gas cured specimens

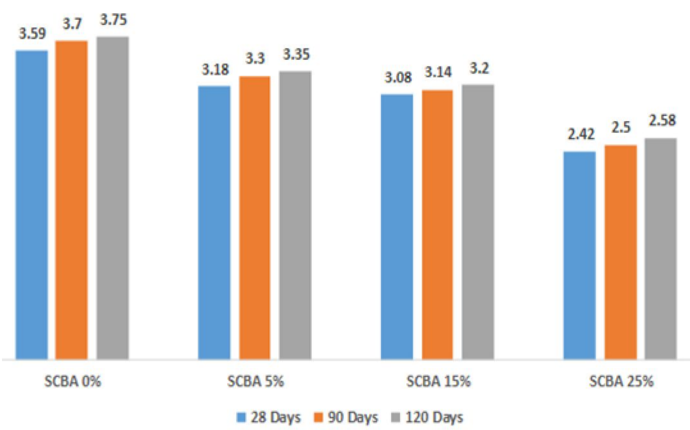

Figure 9: Flexural Strength of Dry Ice cured specimens

3.3 Flexural Strength

A. Flexural strength results of water cured specimens

The water cured results are shown in Figure 7. Split tensile strength increased by 7.40% 6.65% 6.62%,15.97% 15.8% 15.8% when replaced with 15% SCBA and 10% silica fume for 28, 90 and 120 days of curing and decreased by 11.8% 7.46%, 7.06% with replacement of 25% of SCBA and 10% silica fume.

B. Flexural strength results of gas cured specimens

The gas cured results are shown in Figure 8. Flexural strength decreased by 11.01% 10.4% 10.2%,21.6% 20% 18.3%, 36.8% 33.3% 32.65% when replaced with 5% SCBA and 10% silica fume for 28, 90 and 120 days of curing.

C. Flexural strength results of Dry Ice cured specimens

The dry ice cured results are shown in Figure 9. Flexural strength decreased by 11.42% 10.8% 10.6%, 14.2% 15.13% 14.66%, 32.5% 32.43% 31.2 when replaced with 5% SCBA and 10% silica fume for 28, 90 and 120 days of dry ice curing.

4. SUMMARY AND CONCLUSIONS

The results from the experimental study carried out for evaluating the properties of specimens replaced with different percentages of SCBA and silica fume that are cured in water,CO_2, and Dry ice and immersed in 2% Na_2S0_4 solution. The following Conclusions can be summarized by analysing tests performed on concrete specimens:

1. TBASF15 concrete mix showed significantly higher strength when compared with TBASF0 after curing with water
2. Compressive strength of TBASF15 when water cured with water is high compared to dry ice and CO_2 curing
3. TBASF15 concrete mix split tensile strength is higher when compared with TBASF0 after curing with water.
4. Split tensile strength decreased from TBASF0, they could not sustain sulphate attack after curing with dry ice and CO_2.
5. TBASF15 concrete mix flexural strength is higher when compared with TBASF0 after curing with water.
6. Flexural strength decreased from TBASF0, they could not sustain sulphate attack after curing with dry ice and CO_2.

REFERENCES

1. Seo, J. H., Amr, I. T., Park, S. M., Bamagain, R. A., Fadhel, B. A., Kim, G. M., ... & Lee, H. K. (2018). **CO_2 uptake of carbonation-cured cement blended with ground volcanic ash.** Materials, 11(11), 2187. https://doi.org/10.3390/ma11112187
2. Babu, G. & Kumar, P.G.. (2018). **Effect of sulfates on cement and fly ash mortar made with treated domestic wastewater.** International Journal of Recent Technology and Engineering. 7. 139-141.
3. Umoh, A. A., & Olusola, K. O. (2012). **Effect of different sulphate types and concentrations on compressive**

strength of periwinkle shell ash blended cement concrete. International Journal of Engineering & Technology IJET-IJENS, 12(5), 10-17.

4. Valencia Saavedra, W. G., Angulo, D. E., & Mejía de Gutiérrez, R. (2016). **Fly ash slag geopolymer concrete: Resistance to sodium and magnesium sulfate attack.** Journal of Materials in Civil Engineering, 28(12), 04016148.
5. Vedalakshmi, R., Saraswathy, V., & Yong, A. K. (2011). **Performance evaluation of blended cement concretes under $MgSO_4$ attack.** Magazine of concrete research, 63(9), 669-681. https://doi.org/10.1680/macr.2011.63.9.669
6. King, D. (2012, August). **The effect of silica fume on the properties of concrete as defined in concrete society report 74, cementitious materials.** In 37th Conference on our world in concrete and structures, Singapore (pp. 29-31).
7. Lavanya, M., Sugumaran, B., & Pradeep, T. (2012). **An Experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash.** International Journal of Engineering Inventions, 1(11), 2319-6491.
8. Babu, G. & Kumar, P.G.. (2018). **Effect of sulfates on cement and fly ash mortar made with treated domestic wastewater.** International Journal of Recent Technology and Engineering. 7. 139-141..
9. Umoh, A. A., & Olusola, K. O. (2012). **Effect of different sulphate types and concentrations on compressive strength of periwinkle shell ash blended cement concrete.** International Journal of Engineering & Technology IJET-IJENS, 12(5), 10-17.
10. Feras Al Adday, **Investigational Assessment of Modified Performance of Used Tire Concrete Mixtures.** International Journal of Emerging Trends in Engineering Research, Volume 8, No. 5, May 2020. https://doi.org/10.30534/ijeter/2020/52852020
11. B. Rama Krishna, K. Harish Kumar, T. Mani Kumar, I. Likitha, **Properties of GGBS Concrete Under Various Curing Conditions**, International Journal of Emerging Trends in Engineering Research, Volume 8, No.4, April 2020. https://doi.org/10.30534/ijeter/2020/72842020