Experimental Study on Bentonite with Silica Fume as Partial Replacement of Cement in M20 Grade Concrete

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Abstract: An evaluation of the usage of supplemental cementitious materials in concrete is done using bentonite and silica fume as a blend with regular Portland cement. Environmental concerns over the harm done by raw material extraction and CO2 emissions during cement production have increased pressure to limit cement use by incorporating additional ingredients. Portland cement and pozzolan mixes are frequently utilized in the manufacturing of concrete to solve environmental issues and economic benefits. So, the purpose of this study is to explore the range of proportions of bentonite and silica fume which was used as a partial replacement to regular Portland cement that can be identified to be suitable for various applications in the construction sector.

Keywords: bentonite, silica fume, CO_2 emissions

I. INTRODUCTION

Bentonite is a type of calcined clay and the fundamental mineral that gives it its qualities is called montmorillonite. Due to its widespread availability and affordable pricing, calcined clay appears to offer the most overall potential as a pozzolanic option for concrete. The final shape of the hardened concrete has been observed to benefit from the interaction of clay with the CSH gel generated during typical Portland cement. Its use as a partial replacement for some of the regular Portland cement has been discovered to have advantages for longevity as well as improved strength and durability.

Another compound that was mixed with fresh concrete was silica fume, which chemically reacts with the CH to make more high-strength concrete. The benefits of this reaction are that it provides greater tolerance to chemicals. Compressive strengths are produced as a result of a large increase in the binding between the coarse aggregate and the concrete paste in the key interface area. Thereby silica fume was used to improve the compressive strength and resistance to chemical attack.

II. SCOPE OF THE STUDY

- The effectiveness of using bentonite and silica fume for cement to obtain high-strength concrete
- Determine the characteristics of M20 grade concrete in the fresh and hardened states when silica fume and bentonite are used to replace some of the cement.

III. OBJECTIVES

- To find out the material properties
- To study the properties of M20 concrete with 10%, 15%, 20% and 25% of bentonite powder as partial replacement of cement
- To study the properties of M20 concrete with 5%, 10% and 15% of silica fume along with the optimum percentage of bentonite obtained as partial replacement of cement
- To compare the results with conventional concrete mixes

IV. EXPERIMENTAL RESULTS

MIX RATIO:

Grade of concrete – M20
Mix ratio – 1:1.42:2.95
W/C ratio – 0.5

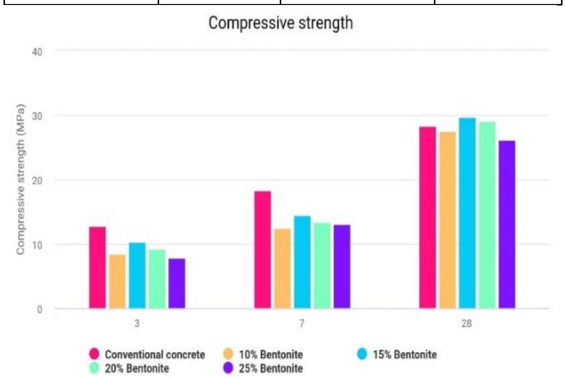
RESULTS:

Table:1 Conventional Concrete

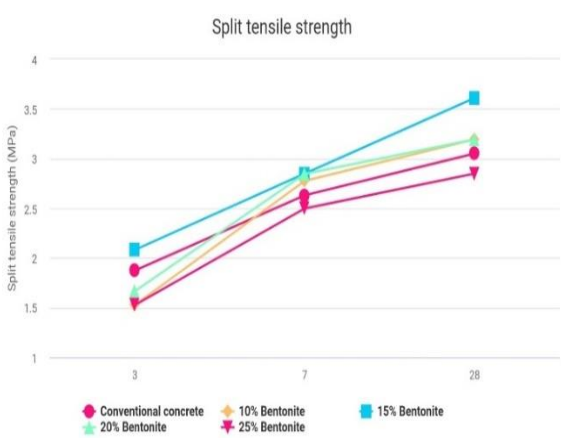
No. of days curing	Compressive Strength (MPa)	Tensile Strength (Mpa)
3	12.762	1.873
7	18.312	2.630
28	28.343	3.050

Table:2 Replacement of Bentonite

% Replacement	No. of days curing	Compressive Strength (MPa)	Tensile Strength (MPa)
10	3	8.429	1.526
	7	12.498	2.775
	28	27.613	3.192
15	3	10.318	2.081
	7	14.533	2.848
	28	29.648	3.608
20	3	9.156	1.665
	7	13.370	2.845
	28	29.060	3.192
25	3	7.848	1.526
	7	13.080	2.497
	28	26.160	2.848



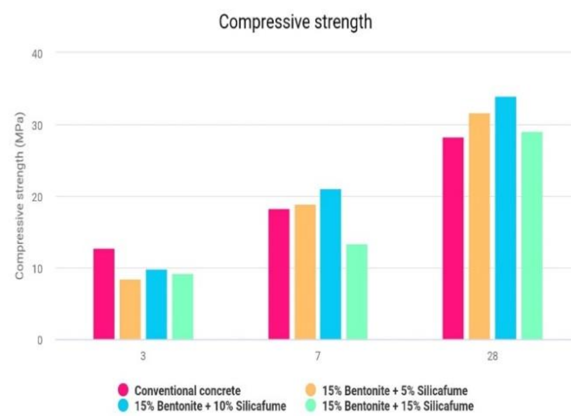
Conventional Concrete vs Bentonite (Compressive Strength)



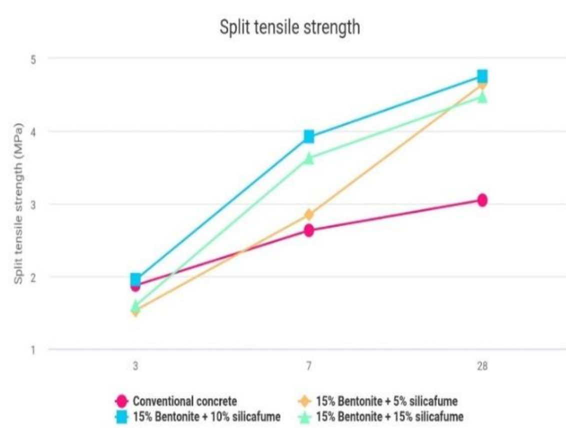
Conventional Concrete vs Bentonite (Split Tensile Strength)

Table:3 Replacement of Silica-Fume (fixing the percentage of Bentonite)

% Replacement		No. of days curing	Compressive Strength (MPa)	Tensile Strength (MPa)
Bentonite	Silica Fume			
15	5	3	8.414	1.530
		7	18.931	2.844
		28	31.661	4.641
	10	3	9.821	1.949
		7	21.096	3.917
		28	34.007	4.756
	15	3	8.092	1.593
		7	18.213	3.628
		28	30.185	4.472



Conventional Concrete vs Bentonite & Silica Fume (Compression Strength)



Conventional Concrete vs Bentonite & Silica Fume (Split Tensile Strength)

V RESULTS

- Bentonite proportion was kept constant at 15% as this was the optimum value that was obtained from the above results and then the proportion of silica fume was varied (5%, 10% and 15%) and casting was done for these percentages.

- The results showed that maximum strength was obtained for the 10% addition of silica fume with 15% bentonite as a partial replacement for cement.
- Optimum value thus found was 15% bentonite + 10% silica fume as partial replacement to cement in M20 grade concrete

VI CONCLUSION

While early strength may be relatively low, a bentonite blend containing no more than 15% substitution can produce the desired results when mixed with regular Portland cement. However, with time, significant levels of compressive strength will be attained. Results were improved when 10% silica fume and 15% bentonite were used. There is a chance that doing so will increase durability and reduce environmental pollution from cement manufacture. Moreover, the water-cement ratio of 0.5 produces the best compressive strength for mixtures including up to 15% bentonite. Bentonite and silica fume are currently more affordable than cement, their combination results in more economically sound concrete.

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