Effect of varying Cement Content on Compressive Strength of Shotcrete

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Abstract

Shotcrete is a concrete conveyed through a hose and sprayed pneumatically at a high velocity onto a receiving surface. Pneumatic application ensures proper compaction of shotcrete. It helps in achieving high strengths and low permeability. It has immense applications in slope-stabilization, tunneling and domes. In this paper, the use of shotcrete as slope-stabilizing agent in USBRL project(J&K) of Br. No. 87 A1-P1 is practically accomplished.

Keywords: shotcrete, pneumatic, hose, highvelocity, compaction, low permeability, slope-stabilization, tunneling, domes.

Introduction

Shotcrete is a structurally durable and long-lasting construction material which exhibits eminent bondingcharacteristics to an existing concrete, rock, steel, andvarious other materials. It usually has high strength, lowabsorption, good resistance to weathering, and resistance to chemical attack. Many of the physicalproperties of shotcrete are comparable or superiorto those of conventional concrete having thesame composition. Improperly applied shotcrete maylead to conditions much worse than the untreatedcondition.

Shotcrete is used in place of conventional concrete, in most cases, for reasonsof cost and convenience. Shotcrete has merits insituations when formwork is cost prohibitive and where form work can be eliminated, access to the construction area is difficult, thinlayers or variable thicknesses are required, or normalcasting techniques cannot be engaged. Shotcrete with rockbolting can be employed for immediate slope stabilization where the soil mass encountered is loose, seepage is prominent and cutting depth is large.

The excellent bonding ofshotcrete to other materials is an important designparameter. The force of the impact of thispneumatically spurredmaterial on the surface causescompaction of the shotcrete matrix into the finesurface irregularities and results in good adhesion to the surface and cohesion between the particles. Within limits, the material is capable ofsupporting itself in vertical or overhead applications.

The selection of shotcrete for a particular application depends on knowledge, experience, and a vigilant study of required material performance. The performance of the shotcrete for that application is contingent upon proper planning and supervision, and also the skill and cautious attention provided by the shotcrete applicator.

In bridge repairs, shotcrete can be used for bridge deck rehabilitation, but it has generally been

Uneconomical for major full-thickness repairs. It however is advantageous for beam repairs of variable depths, caps, columns, abutments,flywalls and underdecks from the standpoint of technique and cost.

In building repairs, shotcrete is mostly used for repair of fire and earthquake damage

and deterioration, strengthening walls, and encasing structural steel for fireproofing. The repair worksof structural members such as beams, columns, and connections is common for structures that are damaged by an earthquake.

In underground excavations in the rock shotcrete is effectively usedin the advancement of tunnels through altered, cohesionless, and loose soils. Typical underground shotcrete applications range from supplementing or replacing conventional support materials such as lagging and steel sets, sealing rock surfaces, channeling water flows, and installing temporary support and permanent linings.
Shotcrete is mostly used for temporary protection of exposed rock surfaces that will deteriorate when exposed to air. Shotcrete is also used to permanently cover slopes or cuts that may erode in time. Slope protection must be properly drained to prevent damage from excessive uplift pressures.
In this paper slope stabilization using shotcrete-reinforced with steel fiber having low aspect ratio (L/D) is discussed in detail which is being employed in the USBRL project at Bridge 87 A1-P1 site. The steel fiber used is 35kg per cum. The effect on compressive strength with varying cement content is studied for 3day,7 day and 28 days. Analysis of results depict a gradual increase in compressive strength of shotcrete with increase in cement content keeping the water-cement ratio constant. It was seen that compressive strength increases by 7% for every 10kg increase in cement.

Images showing the application of shotcrete at Br. No. 87 A1-P1 site (USBRL Project J&K)

Proportioning of Shotcrete materials.

The various ingredients of shotcrete mix are as follows:

1. Cement: Ambuja cement of 43grade was used with varying contents ranging from 460kg to 480kg per cum as show in table1.

2. Aggregates: Crusher sand (dust) was blended with 10mm aggregates in ratio of 68%: 38% respectively.

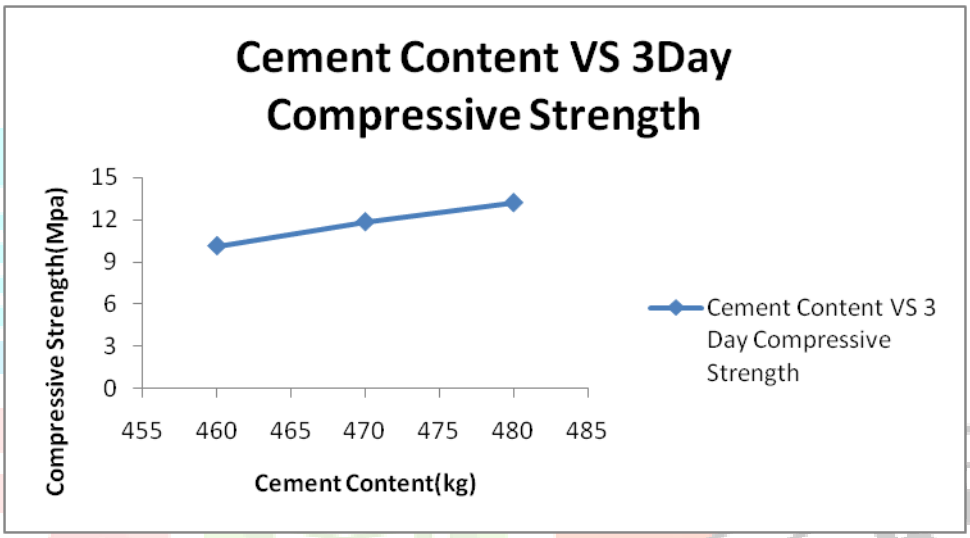
3. water-cement ratio: The water cement ratio of 0.37 was kept constant in all the three mixes.

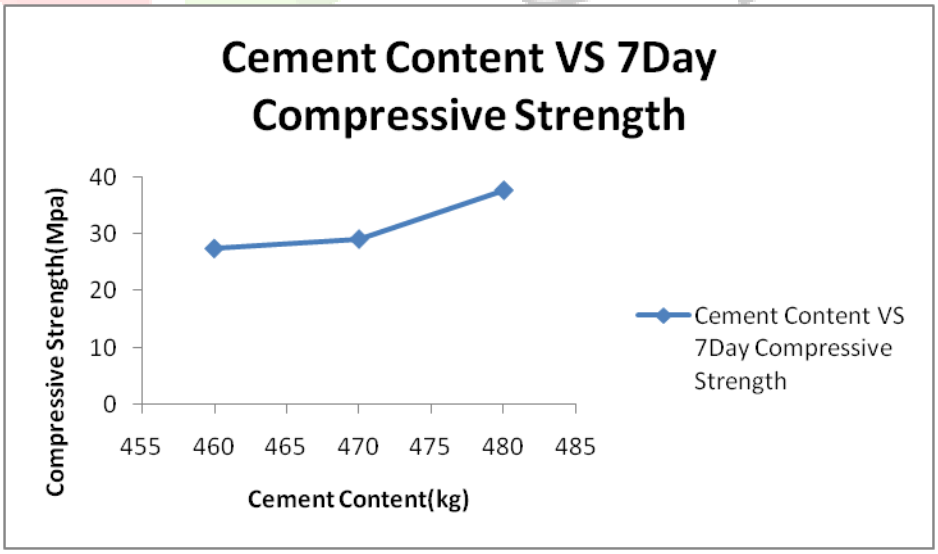
4. Steel fiber: 35kg steel fiber of low aspect ratio was used per cum.

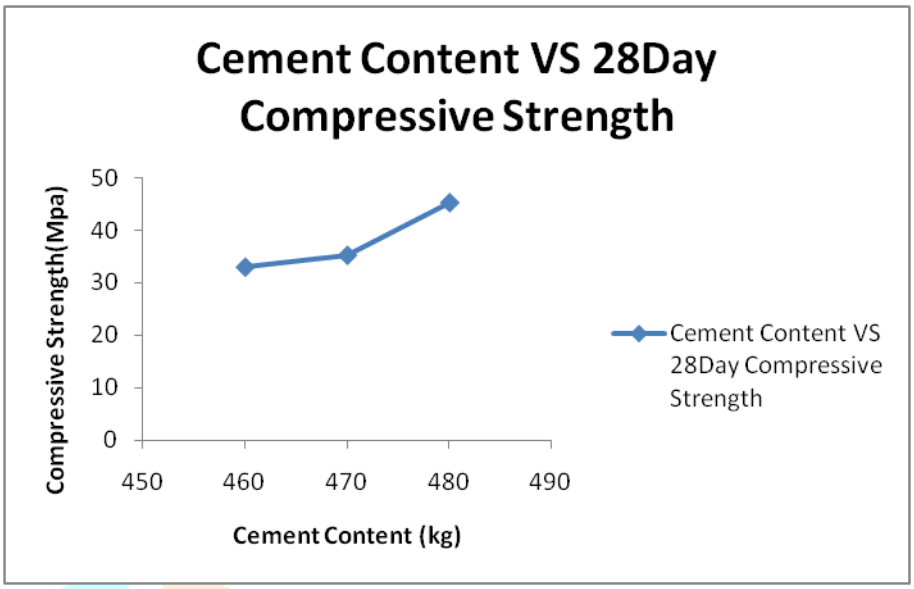
5. Admixture: 0.7 % of AT-PlAST-260 was used as an accelerator.

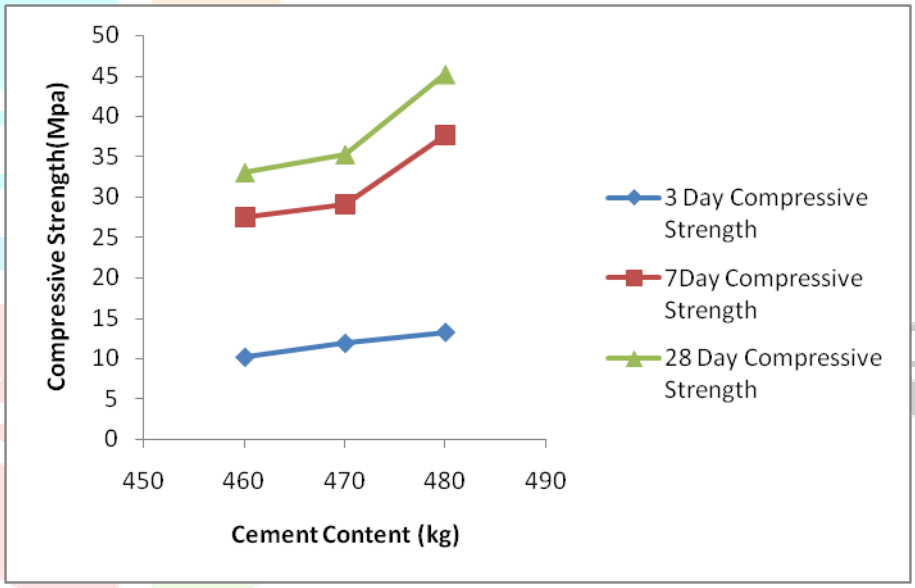
TABLE 1

Grade of Shotcrete	W/C Ratio	Steel Fibre (kg)	Cement Content(kg)	Crusher Sand(dust)	Coarse aggregate (10mm)	Compressive Strength(Mpa)		
						3Days	7Days	28Days
M25	0.37	35	460	68%	32%	10.13	27.46	32.98
M25	0.37	35	470	68%	32%	11.86	29.11	35.23
M25	0.37	35	480	68%	32%	13.24	37.67	45.21









Conclusion

Three trial mixes were conducted at a constant water cement ratio of 0.37 and effect on compressivestrength with varying cement content was evaluated. The cubes at 3days, 7days and 28 days were tested which proved that with increase in cement content the compressive strength increases .The graphs of compressive strength versus cement content were also plotted.

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