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Research Paper



A Study on Porous Sealing Efficacy of hydrophilic Admixture on Blended Cement Concrete

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Abstract

The life of the concrete is strongly influenced by durability parameters. The permeability is one of the main characteristics influencing the durability of concrete. The concrete is more permeable due to the ingress of water, oxygen, chloride, sulphate, and other potential deleterious substances. The durability of concrete is mainly affected by pore structure system of concrete and addingthe supplementary cementitious materials (SCM), such as fly ash, slag cement, and silica fume can be decrease permeability. Crystalline technology enhances the strength of concrete by filling the poresand micro-cracks with non-dissolvable substances. To study the efficiency of crystalline formation in concrete in terms of more permeable should be guaranteed through a specific technique.The effectiveness of crystalline waterproofing system with partial replacement cement by GGBS is studiedin terms of strength and durability. The performance of the two different types of crystalline waterproofing integral admixtures has been studied for compressive strength, Split tensile strength, workability, water permeability, Rapid chloride permeability test and porosity in this paper.The early strength increased in GGBS with crystalline admixture concretes compare to the control concrete. No significant strength reduction is observed in GGBS concretes with crystalline admixture when replaced with 20% and 40% of cement than control concrete.

Keywords: *Crystalline, permeability, admixture, GGBS, capillary, porous, waterproof.*

1. Introduction

Concrete durability may be considered as the ability to maintain serviceability over its design life without significant deterioration. Potential durability may be considered as an immediate capacity of the blend porousness since it reins the time of infiltration of forceful chemical and the development of water amid warming or concreting [1]. Subsequently, decreasing permeability will enhance the potential toughness of a given blend and thus, enhance the serviceability and long existence of the structure. Pressure driven and water holding structures are made with a huge quantity of concrete as they are for the most part tossed by mass concreting. Design life of such weight driven structure is enormous stood out from conventional strong structure. In these structures, concrete is particularly introduced to water or sticky condition [2-3].

The permeability of concrete is chiefly influenced by methods for pore structure arrangement of cement using conventional and modern waterproofing techniques by SaurabhBorle and Ghadge A.N [4]. The Efficacy of Crystalline Waterproofing System in concrete concluded that crystalline water proofing admixture gives good performance in water permeability test about 3mm water penetration when compared to 130mm water penetration in control specimen for a period of 96 hours by NavritBhandari et.al [5]. Therefore, porousness of cement winds up noticeably significant worry for the strength of such structures which can be minimized with different methods by addinga variety of Supplementary Cementitious Materials (SCM) such as fly ash, silica fume and slagcement can also reduce permeability [6]. Fractional Substitution of Cement by GGBS in concrete verifies that the nearness of GGBS in concrete prompts bring down early quality pick up however higher later quality. It exhibits that, as GGBS content increases to 30% and a large portion of, the elastic part quality increases by 12% and 17% appeared differently in relation to the 100% OPC blend by ReshmaRughooputh and JaylinaRana [7].

The point of our examination is to become more acquainted with these SCM's nearby crystalline essential admixture and to look at a few highlights. The most appealing quality is to reduce the permeability of concrete. We will concentrate our examinations on GGBS and crystalline fundamental admixture. In our scientific trails we examine the influence of SCM's and crystalline integral admixture taking placeon strength and durability properties. In this study we depict the consequences of examinations and conclusions with GGBS and crystalline necessary admixture.

2. Material and Methods

2.1. Materials Used

Cement is the important binding material in concrete. Ordinary Portland cement is the normal form of cement. It is essential element of mortar, plaster and concrete. It comprises of blend of oxides of calcium, silicon and aluminum. The cement used in preparing the test specimens was a "OPC 53 grade" conforming to IS 269: 2015 [8]. Ground Granulated Blast Furnace Slag which is a side-effect of steel fabricating industry is an acknowledged mineral admixture for use in concrete. This granulated material when further ground to less than 45micron is called Ground Gran-

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ulated Blast Furnace Slag (GGBFS). The GGBS used in preparing the test specimens was collected from the JSW steel plants confirming to IS 12089:1987 (Reaffirmed 1999) [9]. The gathered GGBS was utilized as part substitution of ordinary Portland cement by guaranteeing uniform mixing with cement.

Aggregates smaller than 4.75 mm and up to 0.075 mm are considered as fine aggregate. The fine aggregates used was locally available natural River sand confirming to Zone II. The material which is hung on IS sifter no 4.75 is named as coarse total as per IS 383 [10]. Chiefly total include 70% in concrete and the coarse aggregate will satisfies the need demonstrated in the code. The coarse aggregate used for experiment was a 20mm and 12.5mm downgraded aggregate which are weighed and mixed separately in the concrete. The coarse aggregate of suitable gradation was obtained by blending 55% of 20mm size with 45% of 12.5mm. The methods of test for fine and coarse aggregates for concrete are conducted confirming to IS 2386-3 [11].

Water is an imperative element of concrete as it effectively takes an interest in substance response with bond. Consumable water adjusting to the prerequisites of IS456:2000 is utilized for making cement and curing the example also [12]. Crystalline integral admixtures from two different brands at the dosage of 1% and 2% of cementitious content were used in preparing the test specimens. The two different admixtures are having the equivalent properties and are in powder form. The admixtures used shall be given the code as AD1 and AD 2 in this investigation.

2.2. Mix proportion details

Many trial batches were performed in the laboratory and several adjustments were carried out to identify the optimum proportions [13]. The concrete ingredients selected for use in this study are representative of materials typically used in Chennai. IS10262:2009 method is used for designing the concrete mix. The final Mix proportion obtained for M40 grade control concrete is 1:1.84: 2.58 (W/C is 0.40) with fixed cement content, aggregate system, and water cement ratio was for consistency. GGBS replacement ranged 20% and 40%, and Crystalline Integral admixture ranged 1% and 2% on the total cementitious material.

2.3. Casting and Testing of Specimens

At first the constituent materials were weighed and dry mixing was improved the situation solid, sand and coarse aggregate and admixtures. This was inside and out mixed physically to get uniform shade of blend. The mixing range was 2-5 minutes and after that the water was incorporated by the blend degree. The mixing was finished for 3-5 minutes term. Oil is associated inside the mould. By then the blend was poured fit as a fiddle molds of size 150 x 150 x 150 mm and after that compacted physically using pressing bars. For each mix, 21 no's of cube, and 9 no's of 100 mm x 300 mm cylindrical shaped test examples be thrown. Following 24 hours, the specimen were demoulded and cured in water at room temperature until the point when they were tried.

Compaction factor and slump cone test were performed on fresh concrete to know the impact including crystalline fundamental admixture and pozzolanic materials on workability of concrete [14-15].Compression test was driven on a 100 ton pressure testing machine accessible in the research center as indicated by IS 516-1959 [16]. The samples were tried for 7 days, 14 days and 28 days. The split tensile test was directed according to IS 5816-1999 [17]. The case was determined to a level plane between the stacking surfaces of the weight testing machine and the store was associated without daze and extended reliably at an apparent time inside the range 1.2 N/(mm2/min) to 2.4 N/(mm2/min) until the failure of the illustration. The cases were striven for 7 days, 14 days and 28 days.

Water Permeability test is finished by GermanStandardDIN1048 on solid examples of size 150x150x150 mm, at an age of 28 days [18]. The Rapid Chloride Penetration Test (RCPT) determines chloride permeability by estimating the quantity of coulombs ready to go through a sample. This is tested based on ASTM C1202 [19].The RCPT test carried after 28 days curing period is over. Water Absorption test was done according to ASTM C 642-97 by stove freshening strategy [20]. The casting and testing specimens are shown in Figure 1.

3. Result and Discussion

3.1. Basic properties

Physical properties of cement are recorded in the below Table 1 describing various parameters like specific gravity, consistency, initial and final setting time, fineness and soundness are tested as per IS 4031 and confirms the requirement of IS 8112:1989.The



Fig.1 Casting and testing of specimens

Tests were conducted to know the physical properties of fine and coarse aggregate as reported by. The test details are given in Table 2. The below Table 2 represents the river sand and the coarse aggregate used for this research satisfies the IS requirements.

Table 1 Physical properties of Cement

Test Conducted	Value
Specific gravity	3.15
Consistency	27.5%
Initial Setting Time	125 mins
Final Setting Time	240 mins
Fineness	292 m^2/kg
Soundness	1.0 mm

Table 2 Physical properties of fine &coarse aggregate

Test Conducted	Sand	Coarse Aggregate	
		20mm	12.5 mm
Specific gravity	2.63	2.70	2.71
Bulk density– Loose	1.54 kg/ltr	1.572 kg/ltr	1.581 kg/ltr
Bulk density–Rodded	1.67 kg/ltr	1.712 kg/ltr	1.734 kg/ltr
Water absorption	1.25 %	0.45 %	0.40 %
Flakiness Index	-----	14.0 %	24.2 %
Elongation Index	-----	14.2 %	21.0 %
IMPact Value	-----	-----	15.15 %
Crushing Value	-----	-----	22.60 %

3.2 Mechanical properties

Performance of concrete is evaluated from mechanical properties which include shrinkage and creep, compressive strength, tensile strength, flexural strength, and modulus of elasticity. It also includes slump &compaction factor tests.The test results of slump value at initial and compaction factor on fresh concrete is shown in Figure 2 and 3.

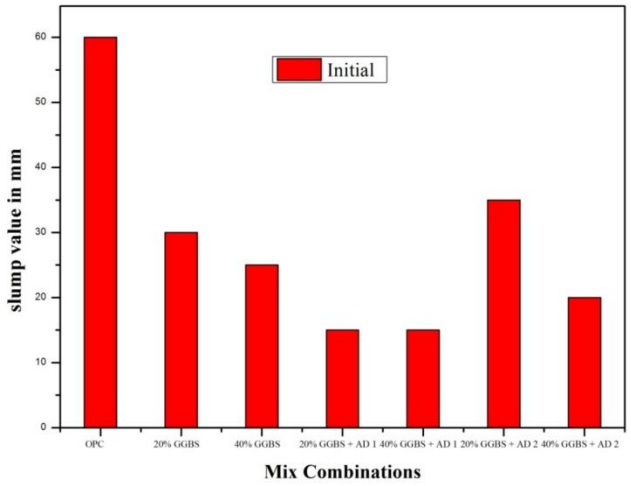


Fig. 2 Initial Slump value

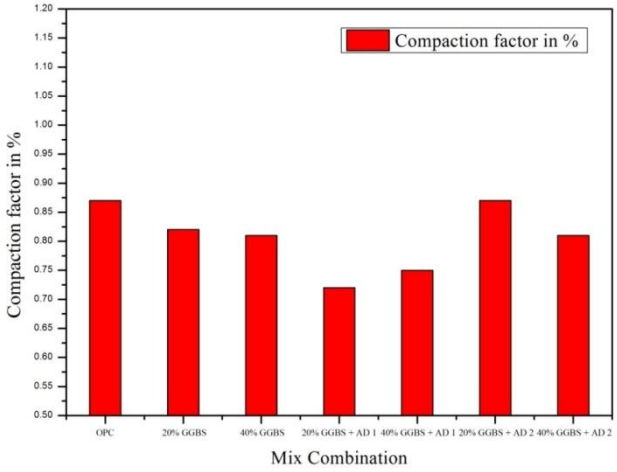


Fig.3 Compaction Factor Value

From the Fig 2, it is observed that GGBS added mix reduces the workability than control mix. Slump reduction is observed 50% and 58% than the control mix for 20% and 40 % GGBS replacement respectively. GGBS is finer than cement and hence it fills the pores in the cement paste and in turn increased the water demand [21]. The crystalline integral admixture added at dosage of 2% with 20% and 40% mix deeply reduces the slump at 75% than the control mix respectively. Also, 2% admixture added mix reduces the slump by 50% and 60% compared to 20% and 40% GGBS added mix respectively. Moreover, 1% admixture added mix with 20% and 40% GGBS reduces the slump by 42% and 67% respectively than control mix increases by 57% and 25% than 2% admixture added mix respectively.

From the Fig 3, Compaction factor test results shows that concrete with 20% and 40% GGBS and 2% and 1% crystalline admixtures added concrete reduces theworkability of new concrete. Pozzolanic materials diminish the workability of new concrete. Workability of plain cement is higher contrasted with concrete with pozzolanic materials and crystalline admixture [22]. No significant changes were observed on the 1% admixture added with the 20% and 40% GGBS.

3.3 Compressive Strength of blended concrete

The compressive strength development of all mix proportions at the ages of 7, 14 and 28 days is shown in Fig4.

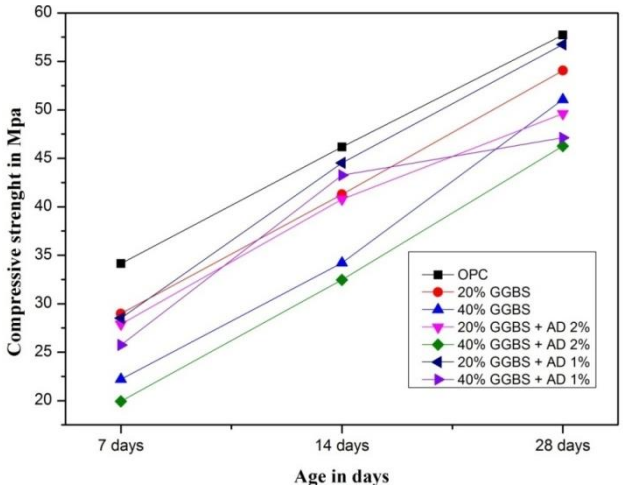


Fig. 4 Compressive Strength development of all mix

The test results shows that themaximum compressive strength achieved is 56.74MPa at 20% of GGBS replacement addition with 1% crystalline admixture and those achieved for 40% with 1% admixture, 20% and 40% GGBS, 20% and 40% GGBS with 2% admixture of concrete is 47.12 MPa, 54.06MPa, 51.07 MPa, 49.62

MPa and 46.26 MPa respectively as compare to 57.73MPa of-strength of plain cement concrete for 28 days.The strength gain is linear in control mix from 7 days to 28 days. The rate of strength gain is increased at the later ages for GGBS concrete and GGBS concrete added with 1% crystalline admixture [23]. The compressive strength development between 7 days to 14 days is 35% for control concrete whereas 42%, 54%, 46%, 63%, 56%, 68% for GGBS 20%, GGBS 40%, GGBS 20% with 2% admixture, GGBS 40% with 2%, GGBS 20% with 1% admixture and GGBS 40% with 1% respectively. The compressive strength development between 14 days to 28 days is 25% for control concrete whereas 31%, 49%, 22%, 42%, 27%, 9% for GGBS 20%, GGBS 40%, GGBS 20% with 2% admixture, GGBS 40% with 2%, GGBS 20% with 1% admixture and GGBS 40% with 1% respectively.

3.4 Split tensile strength of blended concrete

The split tensile strength development of all mix proportions at the ages of 7, 14 and 28 days is shown in Fig 5.

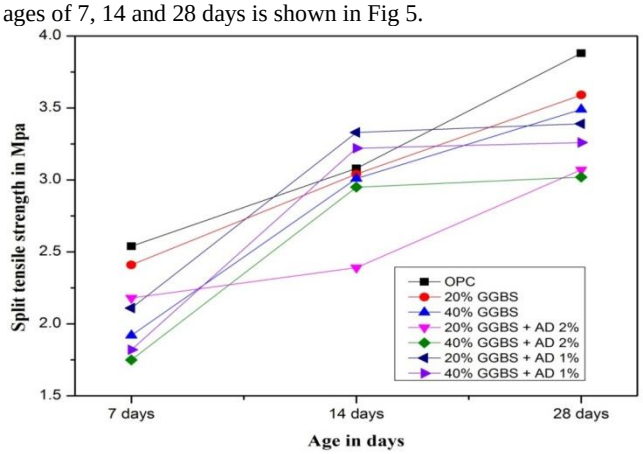


Fig. 5 Split Tensile Strength development of all mix

The test result shows that the maximum tensile strength achieved is3.59MPa at 20% of GGBS replacement addition with 1% crystalline admixture and those achieved for 40% with 1% admixture, 20% and 40% GGBS, 20% and 40% GGBS with 2% admixture of concrete is 3.26MPa, 3.39 MPa and 3.49 MPa, 3.07 MPa and 3.02 MPa respectively as compare to 3.88MPa of strength of plain cement concrete for 28 days. The tensile strength is increased about 8% and 5% than control concrete at the age 14 days and decreased 13% and 16% at the age 28 days for GGBS 20% and 40% added with 1% admixture respectively. The tensile strength is reduced about 22% and 4% at the age 14 days and reduced about 21% and 22% at the age 28 days when 2% admixture is added with 20% and 40% GGBS concrete respectively compared to control mix. The tensile strength gain is linear in control mix from 7 days to 28 days as observed in compressive strength. The rate of strength gain is increased at the later ages for GGBS concrete and GGBS concrete added with 1% crystalline admixture [24].

3.5 Water permeability test

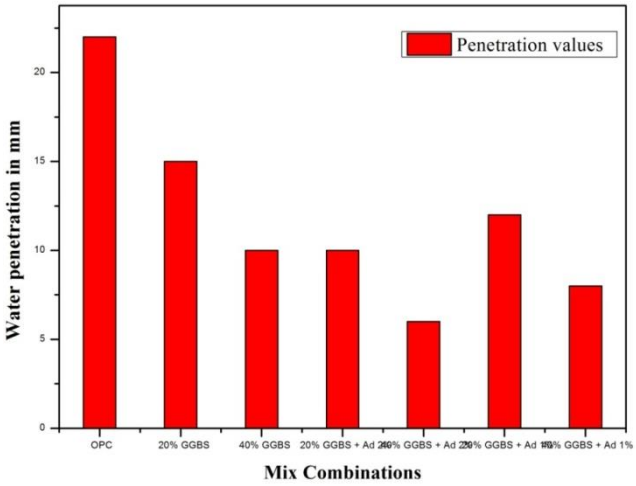


Fig.6 WPT Values of different concrete mix proportions

From the Fig6, it is observed that the water penetration in 20% GGBS and 40% GGBS concrete is 32% and 55% lesser than the control concrete. When crystalline admixtures are added with GGBS replacement concrete there is a significant change in water penetration [25]. The water penetration is 10mm and 6mm when admixture is added at 2% dosage with 20% and 40% GGBS which is 55% and 73% lesser than control concrete. Also, when admixture is added at 1% dosage with 20% and 40% GGBS the water penetration is 12mm and 8mm respectively which is 45% and 64% lesser than control concrete. Results indicates that GGBS reduces the porous in the concrete andalso admixture arrest the pores in the concrete due to the formation of crystals and made the concrete more dense and impermeable than control concrete.

3.6 Rapid chloride penetration test

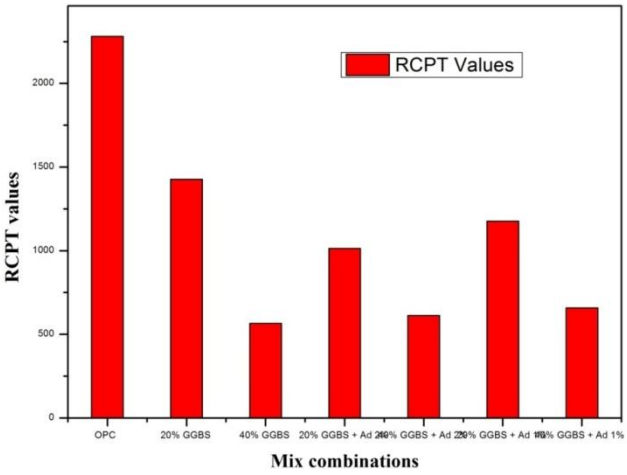


Fig 7 RCPT Values of different concrete mix proportions

From the Fig 7, it is observed that the rapid chloride penetration is significantly less in GGBS and Crystalline admixture concrete compared to control concrete. 20% GGBS concrete is 37 % less and 40% GGBS concrete is 75 % less RCPT values compared to Control concrete. Crystalline admixture added at 2% with 20% GGBS is 29 % less and 56 % less than 20% GGBS and control concrete respectively. Crystalline admixture added at 2% with 40% GGBS is 8% higher and 73 % lesser than 40% GGBS and control concrete respectively. Crystalline admixture added at 1% with 20% GGBS is 18% less and 48 % less than 20% GGBS and control concrete respectively. Crystalline admixture added at 1% with 40% GGBS is 16 % higher and 71% lesser than 40% GGBS and control concrete respectively. Results indicates that the GGBS used in

this study are more fineness than cement and resulted in less RCPT values than control concrete. From the results it is observed that the RCPT values are little lesser in 2% admixture dosage compared to 1% dosage. It means that the formation of crystals is high in 2% dosage compared to 1% dosage and the crystal formation is directly proportional to the admixture dosage level up to 2%.

3.7 Water absorption test

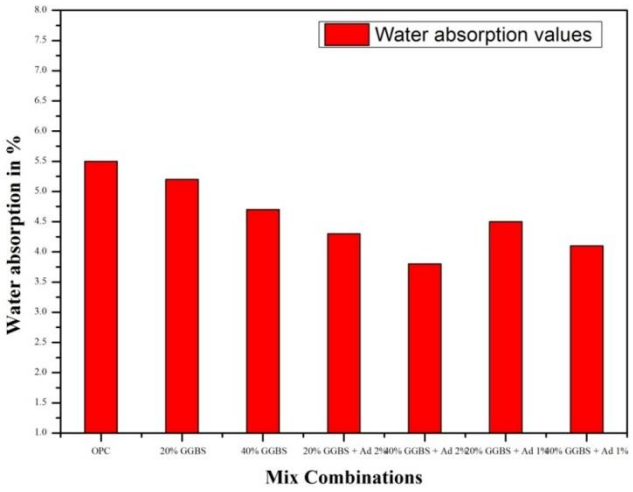


Fig 8 Water Absorption of different concrete mix proportions

From Fig 8, it is observed that the water absorption in 20% GGBS and 40% GGBS concrete is 5% and 15% lesser than the control concrete. When crystalline admixtures are added with GGBS replacement concrete there is a change in water absorption [26]. The water absorption is 22% and 31% less when admixture is added at 2% dosage with 20% and 40% GGBS than the control concrete. Also, when admixture is added at 1% dosage with 20% and 40% GGBS the water absorptionis 18% and 25% is less than control concrete respectively. Result indicates that GGBS reduces the porous in the concrete and crystalline formation due to added admixture arrest the pores in the concrete and hence the percentage of water absorption is lesser than control concrete.

4. Conclusion

From the test work completed and the investigation of the outcomes following conclusions appear to be legitimate as for the usage of GGBS and Crystalline admixture.

• The early strength is compared to less in GGBS and crystalline admixture concretes than control concrete.
• No significant strength reduction is observed in GGBS concretes when replaced with 20% and 40% of cement than control concrete.
• The results indicate that the strength benefits are increased as the age of GGBS concrete increases.
• Result indicates that the rate of strength gain is higher in 1% admixture added with GGBS concrete than conventional concrete.

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