International Journal of Engineering

Journal Homepage: www.ije.ir

Effect of Super Absorbent Polymer on Workability, Strength and Durability of Self Consolidating Concrete

K. Venkateswarlu*, S. V. Deo, M. Murmu

Department of Civil Engineering, NIT Raipur, CG, India

PAPER INFO

Paper history:
Received 05 January 2021
Received in revised form 01 March 2021
Accepted 03 March 2021

Keywords:
Internal curing
Super absorbent Polymer
Workability
Compressive strength
Electrical resistivity

ABSTRACT

This study presents the effect of super absorbent polymer (SAP) as internal curing agent on workability, durability and compressive strength of self-consolidating concrete (SCC). In order to estimate the internal curing efficiency of SAP in different curing conditions and curing ages, compressive strength and electrical resistivity tests have been performed. Homogenous and denser microstructure was formed by gradual release of water from SAP into pores created by SAP. Further pozzolanic reaction of fly ash has enhanced the strength and durability properties. High desorption rate of water from SAP in air curing condition resulted in an increased electrical resistivity and compressive strength. Compressive strength of internal cured SCC mixtures increased to 15-25% at 7 days and 10-19% at 28 days. Electrical resistivity values were increased 11-30% in water curing condition and 16-53% in air curing condition. The costs for 0.35w/b and 0.40 w/b at optimum internal cured SCC mixtures compared to control SCC mixtures were reduced to 9.39 and 9.70%, respectively.

***doi**: 10.5829/ije.2021.34.05b.05*

NOMENCLATURE

W/C	Water cement ratio		**Greek Symbols**	
V_{water}	Volume of water (m^3/m^3)		$\propto_{max}$	The expected maximum hydration degree of hydration
C	Quantity of cement in the mixture (kg/m^3)		ρ_{water}	Unit weight of water (kg/m^3).
CS	Chemical shrinkage of cement paste (ml/g)		M_{SAP}	Mass of super absorbent polymer

1. INTRODUCTION

Presently self-consolidating concrete (SCC) has become high performable concrete by introducing concrete additives. SCC is high flowable concrete which can flow through every corner of heavy reinforced concrete sections with its own weight without external vibration [1]. In recent years construction industry is using significant amount of SCC in pre-cast elements due to many advantages [2, 3]. Past studies states that mineral admixtures can be used as fines which are required to achieve self compactability of SCC. Especially fly ash can enhance workability, durability and mechanical properties of SCC [4]. Higher requirement of cementitious material in SCC needs sufficient curing to complete the hydration especially at high temperature climatic regions. External curing is not adequate to achieve 100% hydration in practical conditions of site. Authors reviewed that internal curing by super absorbent polymers (SAP) can achieve full hydration which further increase the durability and reduce the shrinkage [5]. SAPs are cross linking chain polymers which can absorb the moisture 100 to 1000 times of their own mass. At the time of mixing, dry SAPs will absorb the moisture and becomes stable during placing, consolidation of concrete [6]. SAP addition affects the SCC in different manner in different properties which has shown by the following studies. Snoeck et al. [7] investigated that shrinkage can be eliminated by internal curing with SAP. They also reported that workability decreases when the dry SAP is

*Corresponding Author Email: venkateswar154@gmail.com (K. Venkateswarlu)

Please cite this article as: K. Venkateswarlu, S. V. Deo, M. Murmu, Robust Effect of Super Absorbent Polymer on Workability, Strength and Durability of Self Consolidating Concrete, International Journal of Engineering, Transactions B: Applications Vol. 34, No. 05, (2021) 1118-1123

added to concrete without additional water. However, additional water reduces the compressive strength of concrete. But, Pourjavadi et al. [8] reported that air curing results increase in compressive strength of concrete than reference concrete. Whereas workability decreases due to initial water absorption. Other studies shown that electrical resistivity values can assess the resistance to corrosion [9, 10]. Most of the researchers focused on reduction of shrinkage by using higher dosage of SAP [11, 12]. But lower amounts of SAP especially less than 0.2% of mass of cement can decrease the shrinkage and also enhance the mechanical and durability properties of concrete [13]. Hence in this study effect of SAP on self consolidating concrete was assessed by testing workability, compressive strength, and electrical resistivity of concrete. Pinheiro [14] found the importance of green and sustainable buildings and less CO_2 materials should introduce instead of cement. Rubberized concrete with waste rubber would also lead to sustainable and environmental friendly concrete [15]. Rath et al. [16] have confirmed the use of fly ash to reduce the corrosion of concrete by electrical resistivity values. Even in the fly ash and rice husk ash combination mixes also fly ash removed the difficulties of workability and particle packing of binding materials [17] where rice husk ash act internal curing agent. Joel [18] suggested that 30% fly ash replacement gives optimum compressive strength results. But, Kanthe et al. [19] specially conducted strength and durability experiments on fly ash from Bhilai steel Plant, India and quoted that 15% fly ash can give optimum results than higher fly ash percentages. Hence in the present investigation the mixtures having 85% cement in binder remaining 15% is fly ash which is from Bhilai steel plant, India. From the literature it was concluded that to eliminate the shrinkage higher SAP dosage has been used and SAP effect on SCC less literature is available. Hence lower dosages of SAP (0.05% to 0.15%) could enhance the strength and durability with addition to shrinkage reduction. Hot weather concretes present in India leads to increase the water demand and permeability. However, internal curing can be the best possible way to resolve this problem.

2. EXPERIMENTAL PROGRAM

2. 1. Materials

In the present investigation chemical oxide compositions of OPC-43 grade cement and fly are given in Table 1. The specific gravities of cement and fly were 3.05 and 2.20, respectively. Super plasticiser from BASF Company which is poly carboxylate ether based water reducing admixture used to achieve self-compactability. Specific gravity, pH, and chloride ion percentage of super plasticiser are 1.08, ≥6, <0.2%, respectively. Aggregates used in this project are confirming to IS: 383-2016. Zone-II locally available river sand and 10mm coarse aggregates with 2.6 and 2.7 specific gravities, respectively [20] was used. Commercially available sodium based poly acrylate was used as super absorbent polymer. Water absorption capacities of SAP is 36g/g in cement solution (solution prepared with W/C=5.0) and 170g/g in water calculated by Tea bag method which was given by Schröfl et al. [21]. Higher ionic concentration of Ca^{+2}, Na^{+} present in cement solution may decrease the water absorption of SAP. Even significant percentage of SiO_2 present in cement and fly ash but most of SiO_2 are immobile [22]. Hence SiO_2 ions cannot affect the water absorption of SAP.

2. 2. Required Amount of IC Water

To achieve maximum degree of hydration of concrete mixes, previous studies has given following equations to calculate the volume of water required for internal curing and to calculate the mass of SAP [23, 24].

$$Vwater * \rho water = C \times CS \times \propto max \quad (1)$$

$$M_{SAP} = \frac{C \times CS \times \propto \mathrm{max}}{S \times \emptyset SAP} \quad (2)$$

Volume of water required to get maximum degree of hydration is 32 kg/m^3 as per equation (2). However water supplied by SAP to SCC mixtures are 0, 38.86, 77.71, and 116.60 kg/m^3 for SAP0, SAP0.05, SAP0.10, and SAP0.15 respectively. But, these quantities were decreased to 0, 8.23, 16.44, 24.68 kg/m^3 in cement solution. Generally in practice W/C ratios would be in the range of 0.1-0.7. Hence SAP dosages has fixed according to absorption of SAP in pure water as shown in Table 2.

3. RESULTS AND DISCUSSIONS

3. 1. Workability

As shown in Figures 1 and 2 the flowability of SCC was decreased with increasing

TABLE 1. Chemical oxide composition of binders

Chemical Oxides	Cement (%)	Fly ash (%)
CaO	68.5	1.23
SiO_2	16.5	64.5
Al_2O_3	4.5	24.5
Fe_2O_3	3.7	5.01
MgO	1.68	0.55
SO_3	-	-
K_2O	2.36	2.51
Na_2O	0.4	0.10

TABLE 2. Mixture proportion of SCC in kg/m^3

Mix	Cement	Fly ash	W/B ratio	Water	Sand	Coarse aggregate	SAP	SP
35S0	389	69	0.35	160	928	840	0	6.9
35S5	389	69	0.35	160	928	840	0.23	6.9
35S10	389	69	0.35	160	928	840	0.46	6.9
35S15	389	69	0.35	160	928	840	0.69	6.9
40S0	372	66	0.4	175	912	821	0	6.6
40S5	372	66	0.4	175	912	821	0.22	6.6
40S10	372	66	0.4	175	912	821	0.44	6.6
40S15	372	66	0.4	175	912	821	0.66	6.6

SAP dosage but it is in limits. As comprared to control SCC mix internal cured SCC mixes were reduced the slump flow diameters 1-2% from Figure 2. It may be because of dry SAPs absorb the water initially from the SCC mix. These results are compatible with other researchers with the same fly ash additions [25, 26]. In this experimentation super plasticiser was restricted to1.5% of binder beyond these dose it could shows bleeding and reduction of strength. These super plasticiser dose leads to 610 to 640mm slump flow diameter. This range of slump flow classified SCC as SF1 as per IS 10262:2019 [27].

With increase in dosage of SAP from 0 to 0.15% both V-Funnel and T500 values were increased with increasing w/b ratio independent of SAP dose, as shown in Figure 3. The workability of SCC was decreased with increasing SAP dose from 0 to 0.15% as slump flow diameters decreased.

From flowability tests the relationship between viscosity and yield stress has been introduced based on T500 and V-Funnel time. As shown in Figure 4 T500 and V-Funnel times had R^2 value of 0.955 which shows strong correlation as other researchers observed [28].

3. 2. Compressive Strength

Internal curing affects compressive strength results in different curing conditions. As shown in Figure 5 as increase in SAP dose, almost similar compressive strength values have been observe in water curing condition. This lower compressive strength results due to early absorption of water by dry SAP from the specimen. It leads to permeable and porous structure in the concrete specimen [29]. However, internal curing with recycled aggregates lost their compressive strength by 7-19% compared to control concrete [30]. While in this research, an increase

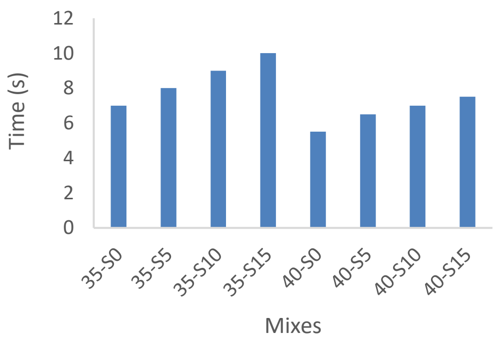

Figure 1. Slump flow time (T500) time of SCC

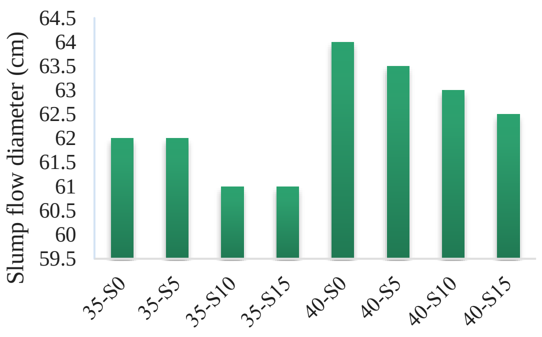

Figure 2. Max Slump flow diameters of SCC

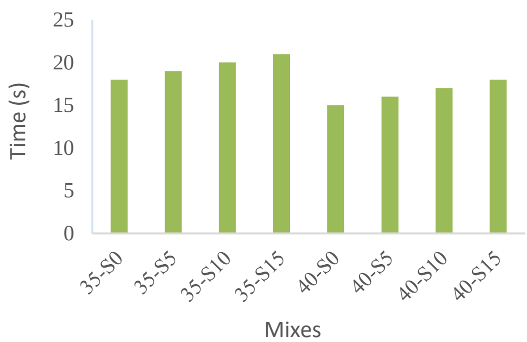

Figure 3. V-Funnel time of SCC mixtures

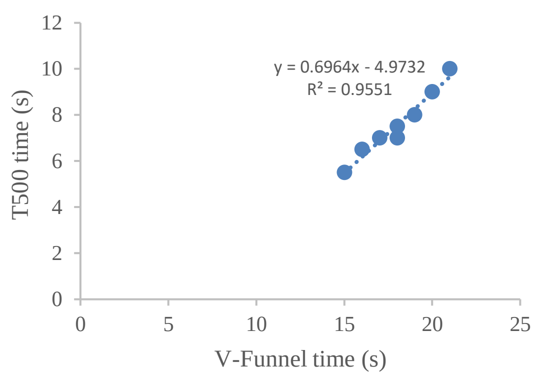

Figure 4. Relationship between T500 and V-funnel time for SCC

in the SAP dose increases the compressive strength of SCC in air curing condition. This increment was high at high w/b ratio at 7 days in air curing condition. From Figure 5 in air curing at 7 days, the compressive strength has increased by 21-26% and 15-25% for 0.4w/b, 0.35 w/b ratios, respectively. But at 28 days this enhancement of compressive strength higher in low w/b ratio in air curing. The compressive strength with respect control mixture at 28 days of air curing has increased by 6.75-13.5% and 10-19% for 0.4w/b and 0.35w/b ratios, respectively. This is due to increased hydration of binder material due to higher availability of moisture from SAP at 28 days as compared to 7 days curing. It leads to better hydration denser interfacial transition zone (ITZ) and concrete matrix. Hence further it gives higher compressive strength. Other researchers also stated that when relative humidity of concrete drops SAP can supply the water in air curing effectively [8]. Other studies shown that LWA could increase the compressive strength with 2-5% only while SAP has increased compressive strength 10-25% in air curing condition [31]. In case of water curing condition reduction in compressive strength observed compared to control SCC at 7 days but it was slightly improved at 28 days as shown in Figure 5. At 0.35w/b and 0.40 w/b ratio concretes at 28 days a slight improvement in compressive strength with 2-4% was observed while at 7 days slight reduction of compressive strength with 1-6% was observed. This is due to initially SAP pores at early age causes the reduction of compressive strength after that improvement of hydration has filled the pores which are created by SAP [32, 33].

3. 3. Electrical Resistivity Possible rate of corrosion of reinforcement can be interpret by electrical resistivity test of concrete [34]. In both curing conditions electrical resistivity values at 7 and 28 days were similar increasing rate with compressive strength values. From Figure 6, at 28 days in water curing, the electrical resistivity was increased by 11 to 30% and 19 to 53% for 0.35w/b and 0.4w/b ratio, respectively. By increasing SAP dose from 0 to 0.15%, this increment higher in air curing specimens as 16-53% and 25-70% for 0.35 w/b

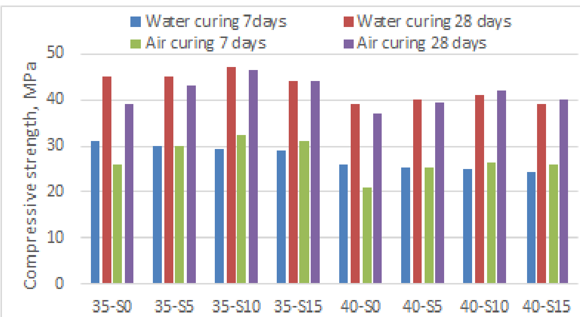

Figure 5. Compressive strength of SCC mixes under water and air curing at 7 and 28 days

and 0.40 w/b ratio concretes, respectively. Ramezanianpour et al. [35] showed higher the electrical resistivity concretes would show the higher resistance of corrosion of resistance due to discharging of electrons from anodic region to cathodic region. For 0.4W/C ratio the electrical resistivity values of SAP and fly ash combination given 16% higher than the rice husk ash and fly ash combination [17] and other researchers also confirmed that electrical resistivity in air curing increased by nearly 12% in 0.35 to 0.4w/b internal curing mixtures. Hence, the SAP can perform better than the other internal curing agents. As shown in Figure 6 electrical values were more than 20 kΩ-cm for 0.1% and 0.15% SAP dose which are in corrosion free zone.

Table 3 shows that risk of corrosion is having correlation with electrical resistivity values [9]. At 28 days for the above 0.1% of SAP dose electrical resistivity values were more than 20 kΩ-cm for 0.35w/b ratio concretes and for 0.15% of SAP dose electrical resistivity values were more than 20 kΩ-cm.

4. COST ANALYSIS OF CONCRETE

The cost analysis of control Self-consolidating concrete and internal cured self-consolidating concrete were worked out as per current market rate. Initially cost of control and internal cured concrete were the same. In curing stage cost would decreased for internal cured concrete due to spray curing or pond curing in the site. The cost was reduced to 9.39% and 9.70%, respectively for 0.35w/b and 0.40 w/b internal cured SCC mixtures

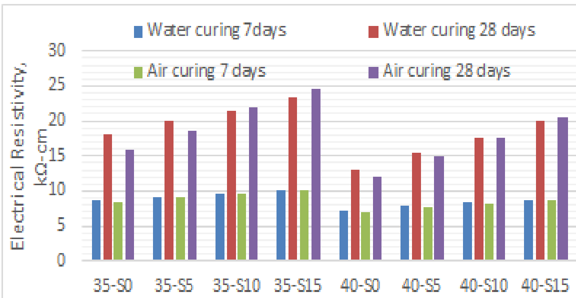

Figure 6. Electrical resistivity of SCC mixes under water and air curing at 7 and 28 days

TABLE 3. Corrosion risk range for different electrical resistivity values

Electrical Resistivity (kΩ -cm)	Corrosion risk
More than 20	Negligible
10 to 20	Low
5 to 10	High
Less than 5	Very high

compared to control SCC mixtures. Above internal curing SCC mixtures (SAP= 0.1% of mass of binder) were given optimum results of compressive strength and electrical resistivity.

5. CONCLUSIONS

1. Workability of SCC mixtures were decreased to 1-2% due to initial absorption of water from mix by dry SAP particles. However, these values were in permissible limits. Slump flow time and V-funnel time shows the same pattern and both have perfect correlation with R^2 of 0.95.
2. Compressive strength values were increased under air curing condition by 15-25% at 7 days and 10-19% at 28 days with internal effect by SAP while small decreasing of compressive strength results 1-2% was observed in water curing condition. In both the curing conditions 0.1% SAP dosage has given higher strength than other mixtures.
3. Electrical resistivity values were increased 11-30% in water curing condition and 16-53% in air curing condition. For 0.1% SAP dosage and above the electrical resistivity values were observed more than 20 kΩ-cm at 28 days in air curing and water curing. Hence SCC mixtures above 0.1% SAP dose could not subject to corrosion.
4. Based on test results of workability, compressive strength and electrical resistivity 0.10% dose of SAP is optimum for both w/b ratios.
5. The costs for 0.35w/b and 0.40 w/b for optimum internal cured SCC mixtures compared to control SCC mixtures were reduced to 9.39 and 9.70%, respectively.

6. REFERENCES

1. EFNARC, "Specification and Guidelines for Self-Compacting Concrete," (2002), 1-32.
2. M. F. Nuruddin, K. Y. Chang, and N. M. Azmee, "Workability and compressive strength of ductile self compacting concrete (DSCC) with various cement replacement materials," ***Construction and Building Materials***, Vol. 55, (2014), 153-157, doi.org/10.1016/j.conbuildmat.2013.12.094.
3. M. Tuyan, R. Saleh, T. Kemal, Ö. Andiç, and K. Ramyar, "Influence of thixotropy determined by different test methods on formwork pressure of self-consolidating concrete," ***Construction and Building Materials.***, Vol. 173, 189-200, (2018), doi.org/10.1016/j.conbuildmat.2018.04.046.
4. R. Siddique, "Properties of self-compacting concrete containing class F fly ash," ***Materials and Design,*** Vol. 32, No. 3, (2011), 1501-1507, doi:10.1016/j.matdes.2010.08.043
5. K. Venkateswarlu, S. V Deo, and M. Murmu, "Overview of effects of internal curing agents on low water to binder concretes," ***Materials Today Proceedings***, Vol. 32, (2020), 752-759, doi.org/10.1016/j.matpr.2020.03.479.
6. V. Mechtcherine, E. Secrieru, and C. Schröfl, "Effect of superabsorbent polymers (SAPs) on rheological properties of fresh cement-based mortars - Development of yield stress and plastic viscosity over time," ***Cement Concrete Research,*** Vol. 67, (2015), 52-65, doi.org/10.1016/j.cemconres.2014.07.003.
7. D. Snoeck, D. Schaubroeck, P. Dubruel, and N. De Belie, "Effect of high amounts of superabsorbent polymers and additional water on the workability, microstructure and strength of mortars with a water-to-cement ratio of 0.50," ***Construction and Building Materials,*** Vol. 72, (2014), 148-157, doi.org/10.1016/j.conbuildmat.2014.09.012.
8. A. Pourjavadi, S. Mahmoud, A. Khaloo, and P. Hosseini, "Improving the performance of cement-based composites containing superabsorbent polymers by utilization of nano-SiO_2 particles," ***Materials and Design,*** Vol. 42, (2012), 94-101, doi.org/10.1016/j.matdes.2012.05.030.
9. O. Sengul and O. E. Gjørv, "Electrical Resistivity Measurements for Quality Control during Concrete Construction," ***ACI Materials Journal,*** Vol. 105, (2008), 541-547.
10. K. Farzanian, K. Pimenta Teixeira, I. Perdigão Rocha, L. De Sa Carneiro, and A. Ghahremaninezhad, "The mechanical strength, degree of hydration, and electrical resistivity of cement pastes modified with superabsorbent polymers," ***Construction Building Materials,*** Vol. 109, (2016), 156-165, doi.org/10.1016/j.conbuildmat.2015.12.082.
11. [11] B. J. Olawuyi and W. P. Boshoff, "Influence of SAP content and curing age on air void distribution of high performance concrete using 3D volume analysis," ***Construction Building Materials,*** Vol. 135, (2017), 580-589, doi.org/10.1016/j.conbuildmat.2016.12.128.
12. V. N. Kanthe, S. V Deo, and M. Murmu, "Early Age Shrinkage Behavior of Triple Blend Concrete," ***International Journal of Engineering, Transactions B: Applications***, Vol. 33, No. 8, (2020), 1459-1464, doi: 10.5829/ije.2020.33.08b.03.
13. D. Shen, X. Wang, D. Cheng, J. Zhang, and G. Jiang, "Effect of internal curing with super absorbent polymers on autogenous shrinkage of concrete at early age," ***Construction and Building Materials***, Vol. 106, No. 1, (2016), 512-522, doi.org/10.1016/j.conbuildmat.2016.05.048 .
14. A. P. Pinheiro, "Architectural Rehabilitation and Sustainability of Green Buildings in Historic Preservation," ***HighTech Innovation Journal***, Vol. 1, No. 4, (2020), 172-178, doi.org/10.28991/HIJ-2020-01-04-04.
15. A. Abdulameer and H. M. K. Al-mutairee, "An Experimental Study on Behavior of Sustainable Rubberized Concrete Mixes," ***Civil Engineering Journal***, Vol. 6, No. 7, (2020), 1273-1285, doi.org/10.28991/cej-2020-03091547.
16. B. Rath, S. Deo, and G. Ramtekkar, "Durable Glass Fiber Reinforced Concrete with Supplimentary Cementitious Materials," ***International Jounal of Engineering, Transactions A: Basics,*** Vol. 30, No. 7, (2017), 964-971, doi: 10.5829/ije.2017.30.07a.05.
17. V. Kanthe, S. Deo, and M. Murmu, "Combine Use of Fly Ash and Rice Husk Ash in Concrete to Improve its Properties," ***International Jounal of Engineering Transactions A: Basics,*** Vol. 31, No. 7, (2018), 1012-1019, doi: 10.5829/ije.2018.31.07a.02.
18. S. Joel, "Compressive Strength of Concrete using Fly Ash and Rice Husk Ash : A Review," ***Civil Engineering Journal,*** Vol. 6, No. 7, (2020), 1400-1410, doi.org/10.28991/cej-2020-03091556.
19. V. N. Kanthe, S. V Deo, and M. Murmu, "Effect of fly ash and rice husk ash on strength and durability of binary and ternary blend cement mortar," ***Asian Journal of Civil Engineering,*** Vol. 6, (2018), doi.org/10.1007/s42107-018-0076-6.
20. Indian and Standard, "Coarse and Fine Aggregate for Concrete - Specification (Third Revision)," (2016).

21. C. Schröfl, V. Mechtcherine, and M. Gorges, "Relation between the molecular structure and the ef fi ciency of superabsorbent polymers (SAP) as concrete admixture to mitigate autogenous shrinkage," ***Cement Concrete Research,*** Vol. 42, (2012), 865-873, doi:10.1016/j.cemconres.2012.03.011.
22. G. T. T. Trang, N. H. Linh, N. T. T. Linh, and P. H. Kien, "The Study of Dynamics Heterogeneity in SiO_2 Liquid," ***HighTech Innovation Journal,*** Vol. 1, No. 1, (2020), 1-7, doi.org/10.28991/HIJ-2020-01-01-01
23. D. Shen, H. Shi, X. Tang, Y. Ji, and G. Jiang, "Effect of internal curing with super absorbent polymers on residual stress development and stress relaxation in restrained concrete ring specimens," **C*onstruction and Building Materials*,** Vol. 120, 309-320, (2016), doi.org/10.1016/j.conbuildmat.2016.05.048.
24. B. Y. D. P. Bentz, P. Lura, and J. W. Roberts, "Mixture Proportioning for Internal Curing," ***Concrete international*** 27, No. 2, (2005), 35-40.
25. P. Dinakar, M. Karthik Reddy, and M. Sharma, "Behaviour of self compacting concrete using Portland pozzolana cement with different levels of fly ash," ***Materials and Design***, Vol. 46, (2013), 609-616.
26. A. Pourjavadi, S. M. Fakoorpoor, P. Hosseini, and A. Khaloo, "Interactions between superabsorbent polymers and cement-based composites incorporating colloidal silica nanoparticles," ***Cement Concrete Composites***, Vol. 37, No. 1, 196-204, (2013), doi.org/10.1016/j.cemconcomp.2012.10.005.
27. Bureau of Indian standards, "Concrete Mix Proportioning-Guidelines (Second Revision)-IS 10262:2019," (2019).
28. H. Azarijafari, A. Kazemian, M. Rahimi, and A. Yahia, "Effects of pre-soaked super absorbent polymers on fresh and hardened properties of self-consolidating lightweight concrete," **C*onstruction and Building Materials*.**, Vol. 113, (2016), 215-220, doi.org/10.1016/j.conbuildmat.2016.03.010.
29. B. Fazelabdolabadi and M. Hossein, "Towards Bayesian Quantification of Permeability in Micro-scale Porous Structures - The Database of Micro Networks," ***HighTech Innovation Journal,*** Vol. 1, No. 4, (2020), 148-160, doi.org/10.28991/HIJ-2020-01-04-02.
30. N. Yadav, D. S. V. Deo, and D. G. D. Ramtekkar, "Workable and robust concrete using high volume," ***International Journal Technology***, Vol. 3, (2018), 537-548, doi.org/10.14716/ijtech.v9i3.1126.
31. J. Hyung, S. Woo, K. Myong, and Y. Cheol, "Influence of internal curing on the pore size distribution of high strength concrete," **C*onstruction and Building Material*s.**, Vol. 192, (2018), 50-57, doi.org/10.1016/j.conbuildmat.2018.10.130.
32. A. J. Klemm and K. S. Sikora, "The effect of Superabsorbent Polymers (SAP) on microstructure and mechanical properties of fly ash cementitious mortars," ***Construction and Building Materials,*** Vol. 49, (2013), 134-143, doi.org/10.1016/j.conbuildmat.2019.01.206.
33. F. C. R. Almeida and A. J. Klemm, "Efficiency of internal curing by superabsorbent polymers (SAP) in PC-GGBS mortars," ***Cement Concrete Composites,*** Vol. 88, (2018), 41-51. doi.org/10.1016/j.cemconcomp. 2018.01.002.
34. A. A. Ramezanianpour, A. Kazemian, M. A. Moghaddam, F. Moodi, and A. M. Ramezanianpour, "Studying effects of low-reactivity GGBFS on chloride resistance of conventional and high strength concretes Studying effects of low-reactivity GGBFS on chloride resistance of conventional and high strength concretes," ***Material sand Structures***, Vol. 49, (2015), 2597-2609, DOI: 10.1617/s11527-015-0670-y.
35. A. A. Ramezanianpour, A. Kazemian, M. Sarvari, and B. Ahmadi, "Use of Natural Zeolite to Produce Self-Consolidating Concrete with Low Portland Cement Content and High Durability," ***Jounal of Materials in Civil Engineering***, Vol. 25, (2013), 589-596, DOI: 10.1061/(ASCE)MT.1943-5533.0000621 .

Persian Abstract

چکیده

این مطالعه اثر پلیمر فوق جاذب (SAP)به عنوان عامل بعمل آوری داخلی بر کارایی ، دوام و مقاومت فشاری بتن خودتراکمی (SCC)را ارائه می دهد. به منظور برآورد بازده ترمیم داخلی SAP در شرایط مختلف و مدت بعمل آوری ، آزمون مقاومت فشاری و مقاومت الکتریکی انجام شده است. ریزساختار همگن و متراکم تر با انتشار تدریجی آب از SAP به منافذ ایجاد شده توسط SAP تشکیل شد. واکنش پوزولانی بیشتر خاکستر باعث افزایش خواص مقاومت و دوام می شود. میزان بالای جذب آب از SAP در شرایط پخت هوا منجر به افزایش مقاومت الکتریکی و مقاومت فشاری می شود. مقاومت فشاری مخلوط های درمان شده SCC داخلی در ۱۵ روز به ۲۵–۲۵ درصد و در ۲۸ روز به ۱۰–۱۹ درصد افزایش یافت. مقادیر مقاومت الکتریکی در شرایط پخت آب ۱۱–۳۰٪ و در شرایط پخت هوا ۱۶–۵۳٪ افزایش یافته است. هزینه های w / b۰.۳۵ و w / b ۰.۴۰ در بهینه مخلوط SCC پخته شده داخلی در مقایسه با مخلوط SCC شاهد به ترتیب به ۹/۳۹ و ۹/۷۰ درصد کاهش یافت.