World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Characteristic strength of before and after self-healing concrete with the help of super absorbment polymer

Bimalesh Kumar * and Shrikant Mishra

Department of Civil Engineering, SSTC Junwani, Bhilai, Chattisgarh, India.

World Journal of Advanced Research and Reviews, 2023, 18(01), 001–005

Publication history: Received on 14 February 2023; revised on 30 March 2023; accepted on 02 April 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.18.1.0488

Abstract

Self-healing concretes are being widely recognized as a remedial technique to improve the durability of concrete. In this paper, experimental study of self-healing concrete technologies were completely reviewed. There view presents a new insight into our search for the treatment of unexpected cracking of concrete. Super absorbent polymer (SAP) is also used as a water absorbent agent. It can hold upto 20% of water and the strength of the normal concrete is as safe as a design mix. The Poly vinyl Alcohol is used as SAP chemical admixture in powder form at %. It will help the sustainable development concept which is widely recognized to enforce in the construction industry in India by increasing the lifetime of structure and postponing the demolition and repair works. As the conventional concrete used in the construction industry required a plenty of water as well as cement, the generation of CO_2 is 1.2 tonnes. Now a days the resources are present in less amount. As per the mix design, M-35 grade control and SAP concrete specimens are prepared and tested for compressive strength, split tensile strength and flexural strength up to 28 days of age. The specimens are cured for 14 days after initiating cracks in them for undergoing rapid self healing. The self healed specimens are tested and compared with that of control specimens. It is found that the addition of 1.5% PVA has enhanced the early stage strengths and improved the autogenous healing property of concrete.

Keywords: Self-healing concrete; Poly vinyl Alcohol; Super absorbent polymer; SAP chemical admixture

1. Introduction

Concrete is the most commonly used building material in the world. It is strong, durable, available and versatile. It is an inexpensive material to produce and is recyclable. Unfortunately, concrete is susceptible to many source of damage. Cracks can form at any stage of its life and most begin internally where they cannot be seen for years until major repairs are needed. Damage is caused by corrosion, extreme loads, chemical attacks and other environmental conditions. Consequently, maintenance to concrete structure is frequent and costly. Billions of dollars are spend every year on buildings, bridges and highways for maintenance.

Nick Buenfeld (2016) et al., the experimental study was conducted on Self healing in cement based material using super absorbent polymer. The flow of dilute sodium chloride solution through cracked cement paste and mortar specimens containing SAP was measured to assess the potential of SAP as an admixture for self-sealing cracks in concrete. The cumulative flow through specimens containing SAP was significantly lower than for the control. Paste specimens containing 5% SAP by weight of cement showed a reduction in the cumulative flow of up to 80%. The mortar specimens also achieved a significant reduction in the cumulative flow, about 85%, despite having a lower SAP content compared to the pastes. The results suggest that Poly (acrylate-co-acrylamide) is more effective than Poly (acrylate) for crack sealing. The results also suggest that a larger SAP particle size is beneficial for sealing cracks. However, a more detailed study is required to confirm these findings and to gain a better understanding of the effect of SAP on the mechanical properties and durability of cracked.

*Corresponding author: Bimalesh Kumar

Kyung-Lim Ahn et al., (2015).the experimental study was conducted aiming Effect of Superabsorbent Polymer (SAP) on the Performance of Polyvinyl Alcohol (PVA) Fiber- Reinforced Strain-Hardening Cement Composite. The addition of SAP into PVA-SHCC mixture with medium- strength of 40 MPA resulted in the reduction of compressive, flexural and direct tensile strength at early ages. However, at a curing age of 28 days, these strengths were equivalent to or exceeded that of conventional PVA- SHCC mixture without SAP. The enhancement of the strengths is due to the internal curing. Curing condition has an effect on the mechanical properties of PVA-SHCC mixtures at early age. Vivekharenderan et al., (2014). Experimental investigation on strength aspects of internal curing concrete using super absorbent polymer. Concrete mix M50 has been designed based on the experimental investigation. The concrete with various percentages of super absorbent polymers is used and the test results have been evaluated. The following conclusions are arrived at based on the experimental results of the study.

Ravindranathan et al., (2014) The experimental study was conducted aiming ,self healing bacterial concrete. The microbe proved to be efficient in enhancing the properties of the concrete by achieving a very high initial strength increase and thus we can conclude that the produced calcium carbonate has filled some percentage of void volume thereby making the texture more compact and resistive to seepage. When bacterial concrete is fully developed, it may become yet another alternative method to replace OPC and its hazardous effect on environmental pollution. Hence can be used for construction as it is resistant to corrosion as well.

2. Material and methods

OPC 43 Grade of cement is a prime brand cement with a remarkably high c3s (tri calcium silicate) providing long lasting durability to concrete structures. Gives more flexibility to architects and engineers to design sleeker and economical sections. Gives more flexibility to architects and engineers to design sleeker and economical section.develops high early strength so that form work of slabs and beams can be removed much earlier.

Resulting in faster speed of construction and saving in centering cost. Produces highly durable and sound concrete due to very low percentage of alkalis, chlorides magnesia and free lime in its composition. Almost negligible chloride contents result in restraining corrosion of concrete structures in hostile environment. Significant saving in cement consumption while making concrete of grades M15 M20 & M25 and precast segment due to high early strength.

2.1. Fine aggregate

Fine aggregate is natural sand which has been washed and sieved to remove particle larger than 5mm and coarse aggregate is gravel which has been crushed, washed and sieved so that the particle vary from 5 up to 15 mm in size. The fine and coarse aggregate are delivered separately. Because they have to be sieved, prepared mixture of fine and coarse aggregate is more expensive than natural all- in aggregate. The reason for using a mixture of fine and coarse aggregate that by combining them in correct proportion, a concrete with very few voids or spaces in it can be made and this reduces the quantity of comparatively expensive cement required to produce a strong concrete.

2.2. Coarse aggregate

Coarse aggregate are the important constituent in concrete. Aggregate are granular material derived from the most part from the natural rock, crushed stone or natural gravels and sands. Aggregate generally occupy about 70 % to 80 % of the volume of concrete and therefore be expected to have an important influence on it properties.

Coarse aggregate are divided into two main parts: - 1) Single size aggregate and 2) graded aggregate. Single size aggregate are based on nominal size specification. It contain up to 85 to 100 per cent of the material which passes through that specified size of the sieve and 0 to 25 per cent is retained in the next lower sieve. Graded aggregate contain more than the single size aggregate.

2.3. Poly-Vinyl alcohol

Poly- vinyl alcohol is used as polymer chemical which is commonly called as super absorbent polymer. The poly–vinyl alcohol is also called as water absorbing agent. it is having ph range 5to7 But we get, during test 5.68. it is available in two form liquid and powder form. Its colour appears generally white. It will heal the crack in generally. It will give the strength as equal as possible whatever before crack for the specimen.

2.4. Water

Water used in concrete whose pH should not less than 6, and also it must be portable water

2.5. Methodology

The materials and methods should be typed in Cambria with font size 10 and justify alignment. Author can select Normal style setting from Styles of this template. The simplest way is to replace (copy-paste) the content with your own material. Method and analysis which is performed in your research work should be written in this section. A simple strategy to follow is to use keywords from your title in first few sentences.

Various test are to be done listed below.

- Compression test
- Split Tensile test
- Flexural test

Figure 1 Casted Specimen

Figure 2 Compressive Strength of Concrete

Figure 3 Split Tensile Strength of Concrete

Figure 4 Flexural Tensile Strength of Concrete

3. Results and discussion

3.1. Compressive Strength

A material or structure's compressive strength is its ability to resist stresses that compress it rather than stretch it, as opposed to a material's or structure's tensile strength, which is its ability to withstand pressures that elongate it. Simply said, tensile strength can withstand pulling apart, whereas compressive strength can withstand being forced together (being pulled apart). Tensile strength, compressive strength, and shear strength may all be studied separately in the field of strength of materials.

3.2. Split Tensile Strength

Theability of a material to withstand longitudinal stress as determined by the stress level necessary to cause a rupture.

3.3. Flexural Strength test

The flexural modulus and flexural strength of a material may be measured using a flexural test. The cost of a flexure test is far lower than a tensile test's, and the findings are comparable. The material is first put out horizontally across two points of contact (lower support span), and then either one or two points of contact (upper loading span) are used to apply a force to the top of the material until the sample fails. A sample's flexural strength is equal to the force at which it breaks.

Table 1 Comparison Between Control and Special Specimen Brfore Healing in 7th,14th and 28th days

Days	Trial No.	Compressive Stength		Split Tensile Strength		Flextural Strength	
		Control (MPA)	Special (MPA)	Control (MPA)	Special (MPA)	Control (MPA)	Special (MPA)
7th Days	1	22.66	25.55	1.27	2.12	6.00	6.00
	2	23.33	24.44	2.40	2.40	5.50	5.50
	3	24.66	28.88	1.76	2.68	6.50	4.50
14thDays	1	28.88	30.00	2.54	2.97	7.00	7.00
	2	26.66	28.80	2.61	3.53	4.50	7.00
	3	30.66	31.11	2.26	2.75	8.50	6.00
28th Days	1	31.64	32.00	2.47	3.11	10.00	7.50
	2	32.66	33.33	3.11	3.53	10.50	8.50
	3	31.11	35.33	2.89	3.96	11.50	8.00

Table 2 Comparison Between Control and Special Specimen After Healing in 7th,14th and 28th days

Days	Trial No.	Compressive Stength		Split Tensile Strength		Flextural Strength	
		Control (MPA)	Special (MPA)	Control (MPA)	Special (MPA)	Control (MPA)	Special (MPA)
7th Days	1	20.00	30.00	1.69	2.12	6.00	7.50
14thDays	2	24.44	31.55	1.90	2.54	6.50	8.00
28th Days	3	26.66	33.75	2.05	3.11	7.00	8.50

4. Conclusion

- After 7 days, around 71% and 75% compressive strength is achieved on control and SAP specimen respectively.
- Around 4% of compressive strength is increased by adding 1.5% of PVA.
- After 14 days, around 82% and 85% compressive strength is achieved on control and SAP specimen respectively.
- Around 3% of compressive strength is increased by adding 1.5% of PVA.
- After 28 days, around 97% and 95.23% compressive strength is achieved on control and SAP specimen respectively.
- There is a decrease in characteristics compressive strength which denotes the strength in SAP concrete will be achieved in later stage.
- After 7 days, around 5.1% and 6.85% Split tensile strength is achieved on control and SAP specimen respectively.
- Around 1.75% of Split tensile strength is increased by adding 1.5% of PVA.
- After 14 days, around 7% and 8.8% Split tensile strength is achieved on control and SAP specimen respectively.
- Around 1.8% of Split tensile strength is increased by adding 1.5% of PVA.
- After 28 days around 8% and 10% Split tensile strength is achieved on control and SAP specimen respectively.
- Around 2% of Split tensile strength is increased by adding 1.5% of PVA.
- After 7 days around 17% and 17.5% Flexural strength is achieved on control and SAP specimen respectively.
- Around 0.5% of Flexural strength is increased by adding 1.5% of PVA.
- After 14 days around 19% and 19.02% Flexural strength is achieved on control and SAP specimen respectively.
- Around 0.02% of Flexural strength is increased by adding 1.5% of PVA.
- After 28 days around 30% and 22.22% Flexural strength is achieved on control and SAP specimen respectively
- Around 7.78% of Flexural strength is decreased by adding 1.5% of PVA.
- After self Healing for 14 days there is 50%,29% and 26% increases in compressive strength of both specimen on 7, 14 and 28 days respectively.
- After self Healing for 14 days there is 25%,33% and 52% increases in Split tensile strength of both specimen on 7, 14 and 28 days respectively.
- After self Healing for 14 days there is 25%,23% and 21% increases in Flexural strength of both specimen on 7, 14 and 28 days respectively

Compliance with ethical standards

Acknowledgments

The authors would like to thank for the support of SSTC JUNWANI BHILAI.

Disclosure of conflict of interest

The authors declare that no conflict of interest.

References

[1] Emily N. Herbert and Victor C. Li , “Self-Healing of Micro cracks in Engineered Cementitious Composites (ECC) Under a Natural Environment”, Materials 2013, pp- 2831-2845, (2013)

[2] Ahn Tae-Ho and Kishi Toshiharu, “Crack Self-healing Behavior of Cementitious Composites Incorporating Various Mineral Admixtures”, Journal of Advanced Concrete Technology Vol. 8, No. 2,pp. 171-186, June(2010).

[3] Hareendranvivek, v. Poornima and G. Velraj Kumar. “Experimental investigation on strength aspects of internal curing concrete using superabsorbent polymer”, International Journal of Advanced Structures and Geotechnical Engineering, Vol. 03, No. 02, pp. 2319-5347, (2014).

[4] Ravindranatha, Kannan .N and Likhit M. L, “self healing material bacterial concrete” International Journal of Research in Engineering and Technology Vol. 03 Special Issue: pp 656-659 (2014).

[5] Sikoma H, Ahn T.H, and Kishi T ,“ Verification of self healing mechanism in OPC incorporating carbonate"institute of Industrial Science, The University of Tokyo, Japan easec13-F-5-5.pdf pp 1-7, (2013).