

Experimental Study of Concrete by Using SAP and Vermiculite as Internal Curing Agents

Mahesh Sawant¹, Pradip shelke², Kapil Chounashtte³, Anshul Mishra⁴,

Shreedhar Patil⁵, Ashish Hakke⁶

UG Students, Department of Civil Engineering, Dr.D Y Patil School of Engineering &Technology,

Charholi (BK), Pune, Maharashtra, India^{1,2,3,4}

Professor, Department of Civil Engineering, Dr.D Y Patil School of Engineering &Technology, Charholi(BK),

Pune, Maharashtra, India^{5,6}

ABSTRACT: Concrete expands and contracts because of change in temperature, freezing and thawing cycle and environmental conditions. During early age hardening of concrete exhibits few crack due to its chemical nature. The main reason for crack development in paste fraction is the loss of water due to chemical reaction and environment. The crack development due to aggregate was mainly on its chemical composition and physical properties. There are many reasons for the crack development in concrete like cracks due to plastic shrinkage, drying shrinkage and settlement cracks. Shrinkage is a loss of excess water from the concrete leads to reduction in its volume and gets hardening. The most common crack formation in concrete was mainly due to plastic shrinkage. The crack due to plastic shrinkage could be reduced by adopting internal curing method. This internal curing agent supply absorbed water to concrete to minimize the crack effect due to plastic shrinkage. Internal curing does not replace conventional surface curing, but works with it to make concrete more robust. Internal curing can also help compensate for less than ideal weather conditions and poor conventional curing that is often seen in the real world. ACI defines internal curing (IC) as a process by which the hydration of cement continues because of the availability of internal water that is not part of the mixing water. The introduction of SAP as a new additive for the production of concrete materials presents a number of new possibilities in respect of water control, i.e., the purposeful water absorption and/or water release in either fresh or hardened concrete. Proper curing of concrete structures is important to ensure they meet their intended performance and durability requirements. In conventional construction, this is achieved through external curing, applied after mixing, placing and finishing. Internal curing (IC) is a very promising technique that can provide additional moisture in concrete for a more effective hydration of the cement and reduced self-desiccation. Internal curing implies the introduction of a curing agent into concrete that will provide this additional moisture.

KEYWORDS:SAP, Vermiculite, Internal curing, compressive strength, concrete.

I. INTRODUCTION

Concrete expands and contracts because of change in temperature, freezing and thawing cycle and environmental conditions. During early age hardening of concrete exhibits few crack due to its chemical nature. The main reason for crack development in paste fraction is the loss of water due to chemical reaction and environment. The crack development due to aggregate was mainly on its chemical composition and physical properties. There are many reasons for the crack development in concrete like cracks due to plastic shrinkage, drying shrinkage and settlement cracks. Shrinkage is a loss of excess water from the concrete leads to reduction in its volume and gets hardening. The most common crack formation in concrete was mainly due to plastic shrinkage. The crack due to plastic shrinkage could be reduced by adopting internal curing method. This internal curing agent supply absorbed water to concrete to minimize the crack effect due to plastic shrinkage. Internal curing does not replace conventional surface curing, but works with it to make concrete more robust. Internal curing can also help compensate for less than ideal weather

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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conditions and poor conventional curing that is often seen in the real world. ACI defines internal curing (IC) as a process by which the hydration of cement continues because of the availability of internal water that is not part of the mixing water. The even distribution of additional water sources within the concrete will lead to greater uniformity of moisture throughout the thickness of the section, and thus reduced internal stresses due to differential drying. While drying shrinkage may not be completely prevented in the long term, delaying it will allow the mixture to gain strength and be better able to resist the associated stresses.

II. INTRODUCTION OF INTERNAL CURING OF CONCRETE

The American Concrete Institute in 2010 defined internal curing as “supplying water throughout a freshly placed cementitious mixture using reservoirs, via pre-wetted lightweight aggregates, that readily release water as needed for hydration or to replace moisture lost through evaporation or self-desiccation”. Within the first decade of the 21st century this technology has been intentionally incorporated into concrete mixtures at the proportioning stage, using a variety of materials including pre-wetted lightweight aggregates, pre-wetted crushed returned concrete fines, superabsorbent polymers, and pre-wetted wood fibers. The ongoing exploration of extensions of the internal curing concept that employ the internal reservoirs to contain materials other than water are reviewed. Finally, the critical issue of sustainability is addressed. To reduce shrinkage cracking, a method named as internal curing is developed. In this method internal curing agents by means of LWA added to balance the reduction of water content. Hence LWA plays a major role in internal curing. And at the same time fabrication of heavy structure needs high strength concrete to hold the structure without failure. ACI defines internal curing (IC) as a process by which the hydration of cement continues because of the availability of internal water that is not part of the mixing water. The even distribution of additional water sources within the concrete will lead to greater uniformity of moisture throughout the thickness of the section, and thus reduced internal stresses due to differential drying. While drying shrinkage may not be completely prevented in the long term, delaying it will allow the mixture to gain strength and be better able to resist the associated stresses.

III. INTRODUCTION OF SAP AND VERMICULITE

1. SUPER ABSORBED POLYMER



Fig 1. Super Absorbed Polymer

The introduction of SAP as a new additive for the production of concrete materials presents a number of new possibilities in respect of water control, i.e., the purposeful water absorption and/or water release in either fresh or hardened concrete. Proper curing of concrete structures is important to ensure they meet their intended performance and durability requirements. In conventional construction, this is achieved through external curing, applied after mixing, placing and finishing. Internal curing (IC) is a very promising technique that can provide additional moisture in concrete for a more effective hydration of the cement and reduced self-desiccation. Internal curing implies the introduction of a curing agent into concrete that will provide this additional moisture. Superabsorbent polymer (also called slush powder) can absorb and retain extremely large amounts of a liquid relative to their own mass. Water-absorbing polymers, which are classified as hydrogels when cross-linked absorb aqueous solutions through hydrogen bonding with water molecules. A SAP's ability to absorb water depends on the ionic concentration of the aqueous solution. In deionized and distilled water, a SAP may absorb 300 times its weight (from 30 to 60 times its own volume) and can become up to 99.9% liquid, but when put into a 0.9% saline solution, the absorbency drops to approximately 50 times its weight. The presence of valence cations in the solution impedes the polymer's ability to bond with the water

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molecule. The total absorbency and swelling capacity are controlled by the type and degree of cross-linkers used to make the gel.

2. VERMICULITE



Fig 2.Vermiculite

Vermicular is an Italian word for worm from which it has consequent its name as vermiculite. Some establishment quotes the Latin word vermicular from which the name vermiculite might be implemented. Vermiculite is a hydrous phyllosilicate mineral group and is micaceous in environment. Vermiculite is formed by weathering or hydrothermal alteration of biotite or phlogopite. Exfoliated vermiculite is obtainable in five different grades, which are based upon weight rather than particle size. It undergoes significant expansion when heated. Vermiculite is chosen to replace fine aggregates in concrete because of its specific properties such as it is lighter in weight, improved workability, improved fire resistance, improved resistance to cracking and shrinkage and mainly inert chemical nature. Vermiculites take for concrete preparation which passes through 2.36mm sieve size.

IV. METHODOLOGY

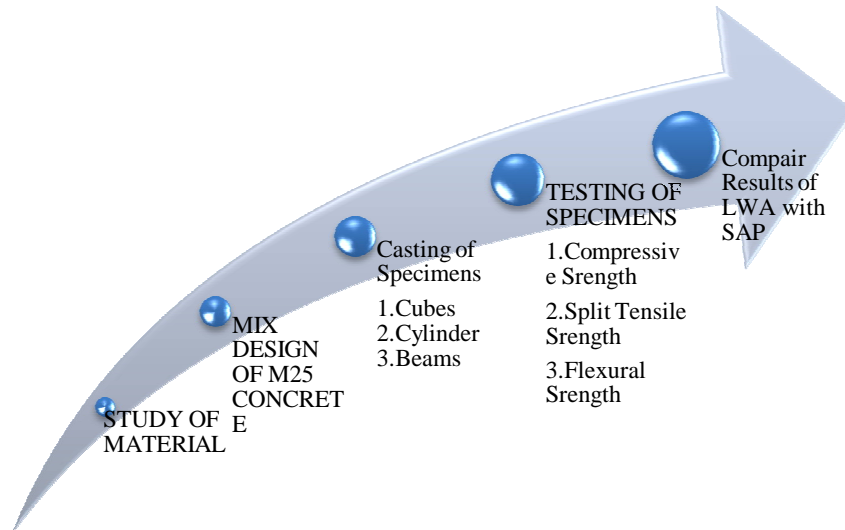


Fig 3.Flow Chart of Methodology

V. RESULT

Table No.1 Compressive Strength Results (N/mm²)

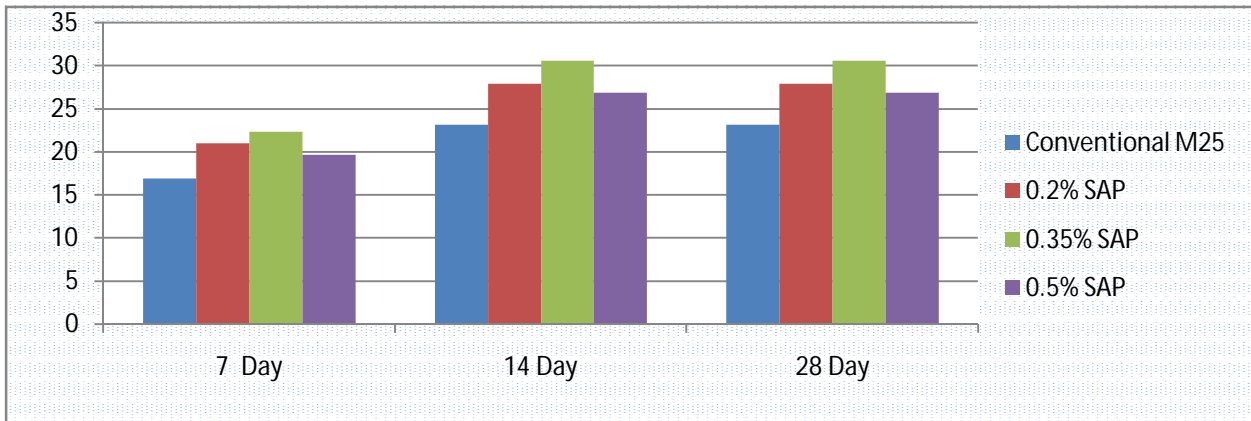
Compressive test taken after days	Conventional M25	0.2% SAP	0.35% SAP	0.5% SAP
7	16.87	20.96	22.29	19.63
14	23.15	27.91	30.52	26.87
28	26.51	32.26	34.30	30.21

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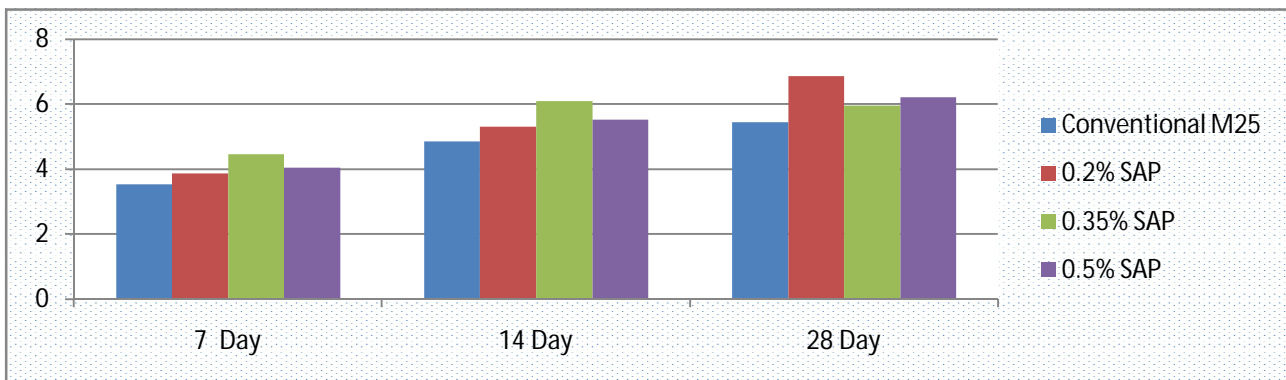
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Graph No.1 Compressive Strength Results (N/mm²)

Table No.2 Flexural Strength Results(N/mm²)

Flexural Strength test taken after days	Conventional M25	0.2% SAP	0.35% SAP	0.5% SAP
7	3.53	3.87	4.45	4.03
14	4.84	5.30	6.09	5.51
28	5.44	6.85	5.96	6.20



Graph No.2 Flexural Strength Results (N/mm²)

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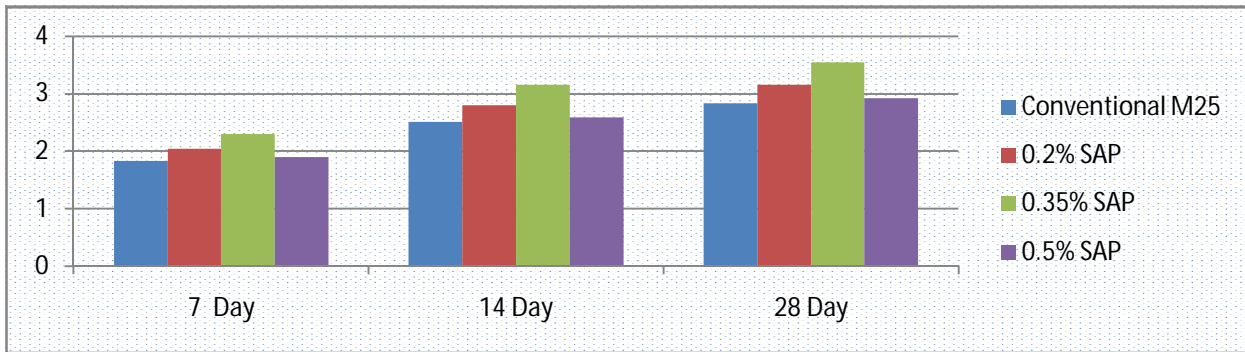
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Table No.3 Split Tensile Strength Results(N/mm²)

Split Tensile Strength test taken after days	Conventional M25	0.2% SAP	0.35% SAP	0.5% SAP
7	1.83	2.04	2.30	1.89
14	2.51	2.80	3.15	2.59
28	2.83	3.15	3.54	2.92

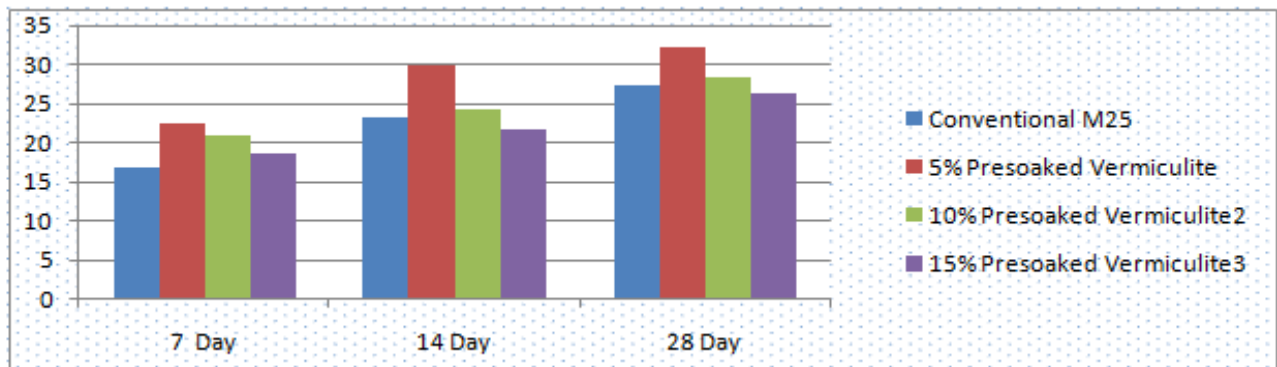


Graph No.3 Split Tensile Strength Results (N/mm²)

Table No.4 Compressive Strength Results(N/mm²)

Compressive test taken after days	Conventional M25	5% Presoaked Vermiculite	10% Presoaked Vermiculite	15% Presoaked Vermiculite
7	16.87	22.46	20.96	18.58
14	23.26	29.82	24.26	21.82
28	27.21	32.12	28.27	26.29

Graph No.4 Compressive Strength Results (N/mm²)



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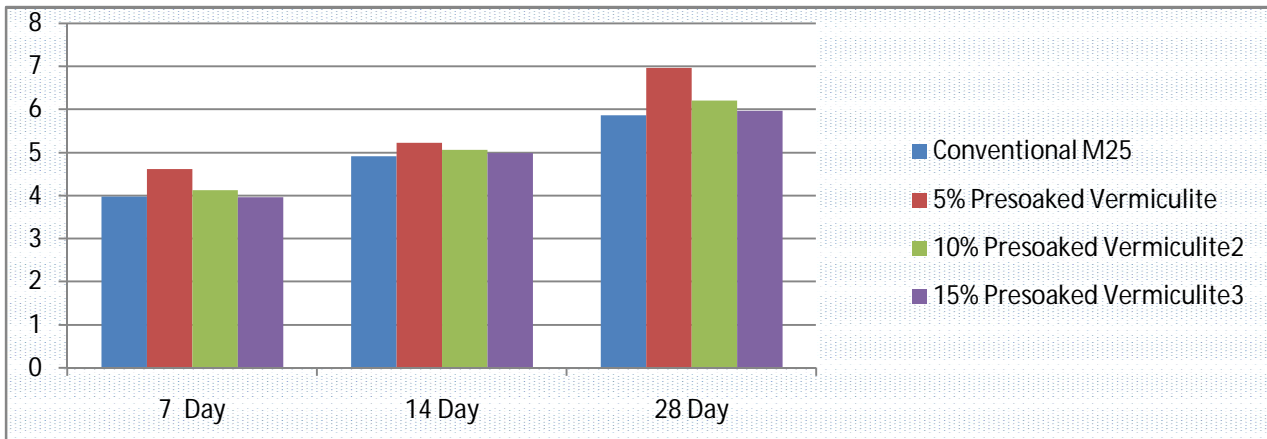
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Table No.5 Flexural Strength Results(N/mm²)

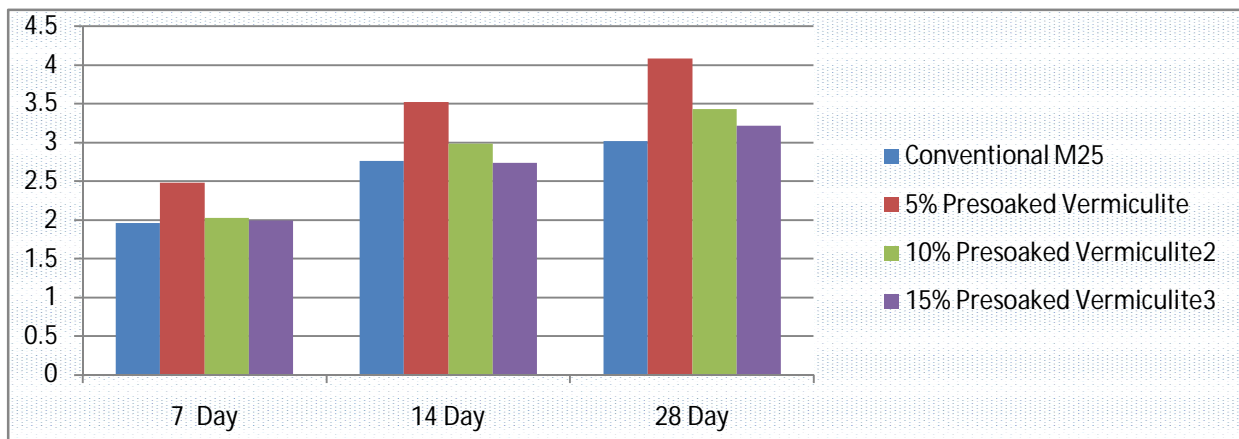
Flexural Strength taken after days	Conventional M25	5% Presoaked Vermiculite	10% Presoaked Vermiculite	15% Presoaked Vermiculite
7	3.98	4.61	4.12	3.96
14	4.92	5.23	5.06	4.98
28	5.86	6.96	6.21	5.96



Graph No.5 Flexural Strength Results (N/mm²)

Table No.6 Split Tensile Strength Results(N/mm²)

Split Tensile Strength taken after days	Conventional M25	5% Presoaked Vermiculite	10% Presoaked Vermiculite	15% Presoaked Vermiculite
7	1.96	2.48	2.02	1.99
14	2.76	3.52	2.98	2.73
28	3.01	4.08	3.43	3.21



Graph No.6 Split Tensile Strength Results (N/mm²)

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VI. PROBLEM STATEMENT

Primary focus of this experimental study is to investigate changes in properties of concrete when it is cured internally by replacement of fine aggregates with light weight aggregates in pre-soaked condition incorporating with different proportions. Also to study the changes when there is addition of super absorbent polymer for internal curing over the traditional way of curing.

VII. OBJECTIVES

- Analyse adoption of alternative materials as a aspect of sustainable concrete mix design.
- Study the concrete workability after replacement of aggregates.
- Study the effect of Light Weight Aggregate replacement with its changing proportion on various properties of concrete, replacing silica fume with cement and Vermiculite with fine aggregate in pre-soaked condition.
- Study effect of internal curing as a complement to traditional curing in conventional concrete.
- Casting of specimens with aggregate replacement and inclusion of SAP (Super Absorbent Polymer) with varying proportion as an internal curing agent and testing them for Compressive Strength, Flexural Strength and split tensile strength.
- Study the effect of reduced shrinkage on properties of internally cured concrete over conventionally cured concrete through tests for strength.

VIII. CONCLUSION

From experimental work and testing of specimen following conclusions have been concluded:

- After 28 day concrete attaining highest compressive strength when 0.35% of super absorbed polymer is added and increase compressive strength upto 29% and also using 5% of vermiculite added the compressive strength of concrete increase up to 18% as compare to conventional concrete.
- After 28 day concrete attaining highest Split Tensile strength when 0.35% of super absorbed polymer is added and increase Split Tensile strength upto 25% and also using 5% of vermiculite added the Split Tensile strength of concrete increase up to 35% as compare to conventional concrete.
- After 28 day concrete attaining highest Flexural strength when 0.35% of super absorbed polymer is added and increase Flexural strength upto 9% and also using 5% of vermiculite added the Flexural strength of concrete increase up to 18% as compared to conventional concrete.
- For the given interval of SAP the compressive strength of concrete increase upto 29% as compared to conventional concrete.
- For given interval of vermiculite the compressive strength of concrete increase upto 18% as compared to conventional concrete.

REFERENCES

- [1] Al-Nasra, Moayyad, and Daoud, Mohammad, "Investigating the use of Super Absorbent Polymer in plain concrete", IJETAE, Vol 3, Issue No. 8, August 2013, pages 598-603.
- [2] Jensen, M, "Use of superabsorbent Polymer in concrete", Concrete International, Vol 35, No. 1, January 1, 2013, pages 48-52.
- [3] IS 10262:2009 Recommended guidelines for concrete mix design.
- [4] A.V.V Sairam and K Sailaja (2017) " An Experimental Study on Strength Properties of Vermiculite Concrete Using Flyash as Partially Replacement of Cement and Silica Fume as Mineral Admixture" , International Research Journal of Engineering and Technology, Volume 4, Issue 5, pages 659-664.
- [5] Experimental study of vermiculite insulated samples with conventional samples in construction industry, Praveen Kumar.
- [6] Mechtcherine, Viktor, and Dudziak, Lukasz, and Schulze, Joachim "Internal curing by super absorbent polymers (SAP) – effects on material properties of selfcompactingfibre-reinforced high performance concrete" RILEM Publications SARL, ISBN : 2-35158-004-4, Year 2006, pages 87-96.