Comparative Study on Self Curing Concrete with Super Absorbent Polymer and Glycerine

G. Ramya Priya[#1], P. Shalini Devi [#2], A. Shanthini[#3],
M. Sirajul Firthousi[#4], Guide Name; S. Kamaraj, M. TECH[#5]
Civil Department, Kings College of Engineering,
Punalkulam, Gandarvakottai Taluk, Pudukottai District,
Tamil Nadu State, India.

Abstract :- **Concrete is one of the widely consumed material in the field of construction. But it involves the use of a huge quantity of water. Due to unavailability of water we need to save the water and find some methods to reduce the use of water in construction. Curing of concrete plays a major role in developing the concrete microstructure, pore structure which improves its durability and performance. To mitigate this problem self-curing distributes the extra curing water (uniformly) throughout the entire 3-D concrete microstructure so that it is more readily available to maintain saturation of the cement paste during hydration, avoiding self-desiccation (in the paste) and reducing autogenous shrinkage. The present study involves self-curing agents such as Super Absorbent Polymer (SAP) and glycerin were used in concrete and gives better hydration and strength. Sodium polyacrylate is a super absorbent polymer which is used to absorb water and convert it into gel. Glycerine is a simple polyol compound. A direct plasticizing effect is produced in most applications for glycerin as a humectant-plasticizer because glycerine and water act together to promote softness and flexibility and to prevent drying out. Effect of these agents on strength properties of concrete such as compressive strength, split tensile strength, flexural strength were studied. M20 grade concrete is considered as reference mix and strength properties of reference mix were determined. Self-curing agents SAP (0.3%, 0.5%, 0.7%) and glycerin (0.3%, 0.5%, 0.7%) by weight of cement were added separately in the reference mix and their strength properties were studied.**

Keywords: Self curing concrete – Super absorbent polymer – Glycerin – Compressive strength – Split tensile strength – Flexural strength

I.INTRODUCTION

General

Curing of concrete is maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties and therefore it is one of the most important requirements for optimum concrete performance in any environment or applications. However good curing is not always practical in many cases. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. Therefore the method of using self-curing agents will be a good alternative. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. Self-curing agents mainly help in the retention of water in concrete by reducing evaporation because of hydration of concrete. When compared to conventional concrete self-cured concrete holds water from evaporation.

The SAP absorbs water and converts it into gel, then releases it slowly with time. This property was very useful when it comes to watering plants over time. This study showed similarity between concrete and plants when it comes to the need of continuous water supply. Excess amount of SAP will leave the concrete with large amounts of voids, which in turn reduces the concrete strength and durability. Small amount of SAP, on the other hand, will have negligible effect on the concrete performance. The most common admixture used nowadays is the superplasticizer which is water reducer and at the same time retarder. The water gel created in concrete by the use of SAP provides cushioning and lubrication in the concrete mass which in turn improves the concrete workability as well as concrete stability.

A direct plasticizing effect is produced in most applications for glycerin as a humectant-plasticizer because glycerin and water act together to promote softness and flexibility and to prevent drying out. These applications include promotes softness personal products such as cosmetic creams, lotions, capsules, and dentifrices, and flexibility edibles such as candy and cough drops, cigarette tobacco, and industrial materials such as cellophane, paper products, cork and gasket compounds, glues, textiles, and printing supplies. The plasticizing effect, however, is more than merely the result of glycerin’s holding water. Even when conditions are such that little or no water is present, the glycerin itself may perform a direct plasticizing function. The closest in technical essence is the addition of glycerol introduced into the concrete mixture to increase the strength of concrete. The additive is introduced into the concrete mixture in an amount of from 0.05 to 0.6% by weight of cement.

METHODS OF CURING

Curing of concrete can be done by adopting following method:-

- Water curing.
- Membrane curing.
- Curing by applying heat.

These methods are later subdivided into as follows:-

- Water curing :-
  Immersion

Ponding
Spraying
Wet covering

- Membrane curing

The various membrane forming compound are
Bituminous & Asphaltic emulsion.
Rubber latex emulsion.
Emulsions of waxes & resins.
Water repellent chemicals, viz. Silicon.
Emulsions of paraffin.
Plastic sheeting.

- Curing by applying heat

Steam curing
Curing by infrared radiations

METHODS OF SELF CURING

There are two major methods available for internal curing if concrete.

- Light weight aggregate (LWA)
- Shrinkage reducing admixtures (SRA)

II. LITERATURE REVIEW

M. Manoj Kumar, studied the effects of addition of using different ratios of superabsorbent polymer on the various mechanical properties of concrete, like Compressive Strength, Splitting Tensile Strength and Flexural Strength and compared them to conventional concrete. The following conclusions were drawn from their study, 1. Water retention for the concrete mixes incorporating self-curing agent is higher compared to conventional concrete mixes, as found by the weight loss with time. 2. The optimum dosage is 0.3% addition of SAP leads to a significant increase of Compressive and Splitting tensile strength and decrease in flexural strength.

Dayalan J had used super absorbent polymers as a self-curing agent in concrete. He was added 0.0-0.48% of super absorbent polymer by weight of cement for M25 grade concrete. He was found that super absorbent polymer 0.48% by the weight of cement provides higher compressive, tensile as well as flexural strength than the strength of conventional mix.

S.Rajeswari this paper explained Super absorbent polymer is able to absorb a significant amount of Table 2 properties of fine aggregate and coarse liquid from its surroundings and will retain the liquid with its structure without dissolving. SAP's are added at rate of 0-0.6 wt% of cement. M 30 grade if concrete was produced using Super Absorbent Polymer from 0.1 to0.4% by weight of cement as an internal curing agent and studied the characteristics of self-curing concrete with addition of 2% steel fibers by volume if concrete.

Abhishek Singh Deshmukh concluded that the specimen can be used with SAP to increase their strength to a great extent. The 0.3% SAP specimens to increase the result in this test compare to the 0%, 0.2% and 0.4% SAP specimens. This material may be used in RCC compression members and pre-stress concrete. This material is used where water problem presence in civil engineering construction.

III.EXPERIMENTAL PROGRAMME
MATERIALS USED

Cement

Coromondal cement can be used in the present study. Results of various tests should be conducted are summarized below.

S.NO	TEST	RESULTS
1.	Normal Consistency	35%
2.	Initial Setting time	50 min
3.	Final Setting time	250 min
4.	Specific gravity	3.15
5.	Fineness of cement	2.14

Table 1: Properties of cement

Sand

The sand used for this experimental investigation is locally available river sand and it confirms to Indian Standard Specifications IS: 383-1970 and their by confirms zone II. The sand was primarily sieved through 4.75 mm sieve to separate any particles greater than 4.75 mm.

Aggregates

Crushed granite was used as coarse aggregate and it conforms to Indian Standard Specification IS: 383-1970 was used. Maximum size of coarse aggregate in the present study was 20 mm. The properties of fine aggregate and coarse aggregate are shown in table 2.

Table 2 properties of fine aggregate and coarse aggregate

S.NO	TEST	RESULTS FOR COARSE AGGREGATE	RESULTSFOR FINE AGGREGATE
1.	Fineness modulus	3.2	6.22
2.	Specific Gravity	2.82	2.86

Self-curing agents

1. *SODIUM POLYACRYLATE*

Sodium polyacrylate, also known as water lock, is a sodium salt of polyacrylic acid with the chemical formula [-CH2-CH(COONa)-]n and broad application in consumer products. It has the ability to absorb as much as 200 to 300 times its mass in water. Sodium polyacrylate is anionic polyelectrolytes with negatively charged carboxylic groups in the main chain. Sodium polyacrylate is a chemical polymer that is widely used in a variety of consumer products for its ability to absorb several hundred times its mass in water. Sodium polyacrylate is made up of multiple chains of acrylate compounds that possess a positive anionic charge, which attracts water-based molecules to combine with it, making sodium polyacrylate a super-absorbent compound. Sodium polyacrylate is used extensively in the agricultural industry and is infused in the soil of many potted plants to help them retain moisture, behaving as a type of water reservoir. Florists commonly use sodium polyacrylate to help keep flowers fresh.

Fig 1 Sodium polyacrylate

PROPERTIES OF SAP

Chemical formula	[-CH_2-CH(CO_2Na)-]n
Form-dry	Crystalline white powder/granular
Form-wet	Transparent gel
Particle size	125 micron
Water absorbing with distilled water	170-200
pH	Neutral
Density	1.08 (g/cm3)
Bulk density	0.85 (g/cm3)

2. GLYCERINE

A direct plasticizing effect is produced in most applications for glycerine as a humectant-plasticizer because glycerin and water act together to promote softness and flexibility and to prevent drying out. These applications include promotes softness personal products such as cosmetic creams, lotions, capsules, and dentifrices, and flexibility edibles such as candy and cough drops, cigarette tobacco, and industrial materials such as cellophane, paper products, cork and gasket compounds, glues, textiles, and printing supplies. The plasticizing effect, however, is more than merely the result of glycerin's holding water. Even when conditions are such that little or no water is present, the glycerin itself may perform a direct plasticizing function. The closest in technical essence is the addition of glycerol introduced into the concrete mixture to increase the strength of concrete. The additive is introduced into the concrete mixture in an amount of from 0.05 to 0.6% by weight of Cement.

PROPERTIES OF GLYCERIN

Chemical formula	$C_3H_5(OH)_3$
Molecular Mass	92.09382g/mol
Density	1.261 g/cm
Viscosity	1.3 Pa/s
Melting point	18.2 °C
Boiling point	290 °C
Surface tension	64.00 N/m
Temperature coefficient	-0.0598 K

Preparation and casting of specimens

The standard size of specimens such as cubes (150 mm × 150 mm × 150 mm) to determine compressive strength, cylinders (150 mm diameter and 300 mm length) to determine split tensile strength and beams (100 mm × 100 mm × 500 mm) to determine flexural strength were cast. All the inner surfaces and base plates of moulds were coated with oil for easy removal of form and smooth finish. At-most care was taken while batching, mixing and casting operations were done. The specimens are shown in fig 2.

Fig 2 Cast Specimens

Experimental procedure

Experimental investigation was carried out with reference to the M20 grade concrete mix. Self-curing agents such as glycerin and SAP were used in this study. Different concrete mixes were cast using glycerin and SAP at different percentages 0.3, 0.5, 0.7. Mix proportions of reference mix M20 grade concrete.

MIX	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER(L)
M20	436	654	872	240

Table 3 Mix proportions of M20 grade concrete kg/m^3

Compression strength test

Cube specimens were tested for compression and the ultimate compressive strength was determined from failure load measured using the compression testing machine as shown in Fig. 3. The average values of compressive strength of 3 specimens for each category at the age of 28 days are shown in table 4. From these values it was observed that the increase in strength of M20 grade concrete with the addition of 0.3% SAP and the remaining mix strengths were decreased. The compressive strength of M20 grade concrete with the addition of 0.3%, 0.5%, 0.7% of SAP and glycerin was found out.

Fig 3 compressive strength test

Split Tensile Strength Test

It is a common test used to determine the tensile strength of concrete indirectly when the cylindrical specimen is kept horizontally and loaded in compression, the specimen is subjected to tensile stress along the plane perpendicular to the line of loading the cylinder. The average values of specimens for each category at the age of 28 days. The experimental setup was carried out in fig 4. From these values it was observed that the increase in strength of M20 grade concrete with the addition of 0.3% SAP over the glycerin and the remaining mix strengths were decreased. The split tensile strength of M20 grade concrete with the addition of 0.3%, 0.5%, 0.7% of SAP and glycerin was found out.

Fig 4 Split tensile strength test

Flexural Tensile Strength Test

Flexural tensile strength test for 28 days was carried out on concrete beams. The experimental setup was shown in Fig. 5. The average values of specimens for each category at the age of 28 days are shown in table 6. The strength of M20 grade concrete with the addition of SAP for 0.3% was observed to be equal, and the remaining mix strengths were decreased. The flexural tensile strength of M20 grade concrete with the addition of 0.3%, 0.5%, 0.7% of SAP and glycerine was found out.

MIX	0.3%	0.5%	0.7%
GLYCERINE	31.12	29.86	25.62
SAP	32.92	30.55	27.88

Table 4: Compression Strength values for GLYCERIN and SAP

MIX	0.3%	0.5%	0.7%
GLYCERINE	2.85	2.76	2.42
SAP	3.76	3.16	2.86

Table 5: Split tensile strength values for GLYCERINE and SAP

MIX	0.3%	0.5%	0.7%
GLYCERINE	2.52	2.35	2.24
SAP	3.14	2.86	2.56

Table 6: Flexural strength test values for GLYCERINE and SAP

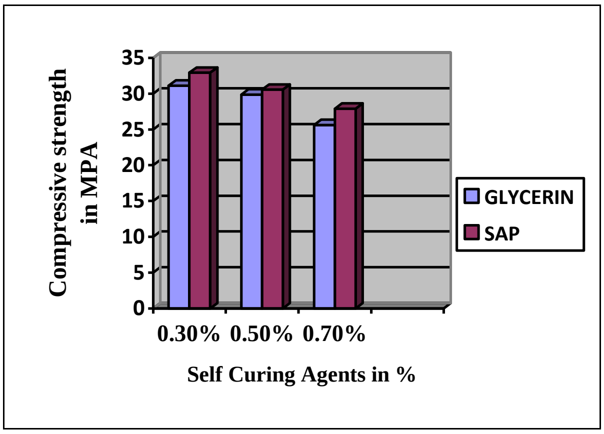

Fig 6. Variation of Compressive strength

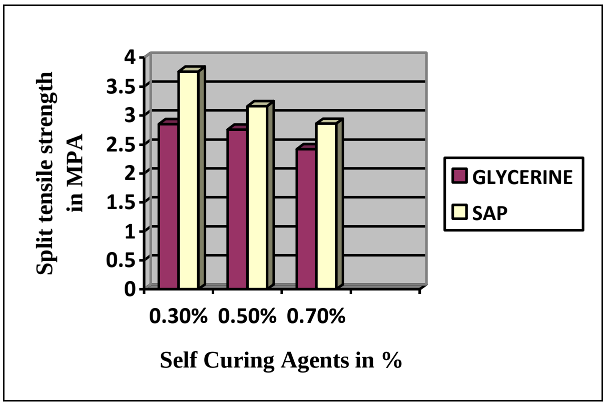

Fig 7. Variation of Split tensile strength

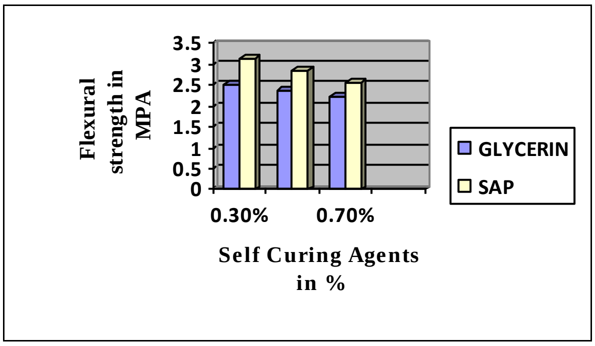

Fig 8. Variation of Flexural strength

V. CONCLUSION

From the experimental work, it can be concluded that the concrete with self-curing agent SAP attained strength equal to normal curing concrete over glycerin cured concrete.

The optimum dosage of SAP for maximum strength properties was found to be 0.3% by the weight of cement for M20 grade of concrete.

As we compared the SAP and Glycerin the compressive strength of concrete increased by 5.63% with SAP over M20 grade on glycerin cured concrete.

As we compared the SAP and Glycerin the split tensile strength of concrete increased by 5.26% with SAP over M20 grade glycerin cured concrete.

The flexural tensile strength was attained with PVA.

Strength of self -curing concrete is relatively high when compared with conventional concrete.

Self -curing concrete is the viable answer to many problems faced due to lack of proper curing.

REFERENCES

[1] Patel Manish Kumar Dahyabhai, Prof. Jayeshkumar, R. Pitroda “Self-curing concrete: new technique for concrete curing - a literature review”. Journal of International Academic Research for Multidisciplinary volume 1, Issue 9, October [2013].

[2] M.V.Jagannadha Kumar, M. Srikanth, K. Jagannada Rao “strength, Characteristics of self-curing concrete” IJRET, Vol: 1, Issue: 1, pp 51-57, September [2012].

[3] Nirav R Kholia, Prof. Binita A Vyas, Prof. T.G. Tank “Effect on concrete by different curing method and efficiency of curing compounds – a review”. International Journal of Advanced Engineering Technology vol.2, Issue 2, E-ISSN 0976-3945 April-June [2013].

[4] Amal Francis k, Jino John “Experimental investigation on mechanical properties of self-curing concrete”. International Journal of Emerging Trends in Engineering and Development, vol.2, Issue 3, ISSN 2249-6149, March [2013].

[5] Fi Kamatham Radhakrishna, K. Rajasekhar “An experimental investigation on self-cured concrete”. International Journal of Advanced technology in engineering and science vol. No.3, issue 09, September [2015].

[6] P.Muthukumar, K. Suganyadevi “Flexural behaviour of self-compacting self-curing concrete beam”. International Journal on Engineering Technology and K. Bala Subramanian, A. Siva, S. Swaminathan, Arul. M. G. Ajin, “Development of High Strength Self Curing Concrete Using Super Absorbing Polymer”, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol:9, No:12, Dec-2015.

[7] VivekHareendran, V. PoornimaAnd G. Velrajkumar, “Experimental investigation on strength aspects of internal curing concrete using super absorbent polymer”, International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 02, April 2014.

[8] Abhishek Singh Deshmukh&Dr. Rajiv Chandak, “Split Tensile Strength Study of Self-Curing Concrete and Conventional Concrete” International Journal for Scientific Research & Development Vol. 3, Issue 07, 2015.

[9] Abhishek Singh Deshmukh and Dr. Rajiv Chandak, “COMPRESSIVE STRENGTH STUDY OF SELFCURING CONCRETE AND CONVENTIONAL CONCRETE” International Journal for Scientific Research & Development, Sep 2015. [Sciences – IJETS™ ISSN (P): 2349-3968, ISSN (O): 2349-3976 Volume 2 Issue 4, April [2015].