Self-Curing by using of Super Absorbent Polymer and Shrinkage Reducing Admixture for M-40

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Abstract

Concrete is the most important material of the construction industry due to its durability and strength. As the present consumption of concrete in infrastructure and other construction industry is approximately 10 to 12 billion every year. The strength of concrete depends upon its constituent like the Cement, fine sand, coarse sand, fine aggregate & coarse aggregate. The cement is a calcareous material also known as binding material which reacts with water, gives strength and produces heat. Concrete gives their design strength when the proper curing is been done. Curing requires a large amount of water and the major portions of this water get evaporated due to heat hence more and more water is required for curing. If the curing is not done properly then it makes adverse effect on concrete. It is very challenging to do proper curing in water scare areas like desert areas, high rise building etc. This problem can be eliminated by the self-curing in place of conventional curing. Self-curing is done by the some admixtures like super Absorbent polymer and shrinkage reducing admixture. This research work is covers the use of Super Absorbent polymer and shrinkage reducing admixture in concrete for better hydration cementations material and gaining strength of concrete.

Keywords: Poly Ethylene Glycol-400, Poly Vinyl Alcohol, Internal curing, self-curing, Shrinkage Reducing Admixture, Super Absorbent Polymer

I. INTRODUCTION

The word concrete is obtained from Latin word "concretus" which means compactor condensed. When water is mixed with constituent of concrete like cement then by the process of hydration concrete gets solidified and hardens. In this hydration process concrete takes their design strength and release heat. This heat is responsible for cracking in concrete. To avoid this problem, conventional curing or external curing can be done but due to evaporation of water the problem of Shrinkage may occur. It is also observed that water soluble alcohols have a tendency to retain water and release it after some time. These alcohols can be used as "Self-Curing Agent". Poly Vinyl Alcohol (PVA) is a shrinkage Reducing Admixture while Poly Ethylene Glycol (PEG) works as super absorbent polymer. Self-Curing also provides the ability to absorb wetness from air and help in hydration of strengthened concrete. M.V. Jagannadha kumar et al, conclude the optium dosage of PEG 400 for maximum strength obtained to be 0.5 % for M40 grade of concrete. Peddaraju Naveen Kumar et al conclude that the strength of concrete increase with the increase of PVA up to 0.24 % and decrease with the higher percentage value of PVA. The benefit of self-curing is to maintain the wetness and hydration process in water scare areas, war zone, high rise buildings etc.

As per bureau of Indian standards it is necessary to keep concrete moist for 28 days. But nowadays it is not possible in many places due to shortage of time and water as per the conditions of site. Then another recommendation is to keep concrete moist for at least 14 days and according to IS 456:2000 concrete should be cured at least 7 days regularly in most worst conditions.
Thus, the requirement of self-curing concrete arises because it helps in saving water, time and helps in the process of hydration and to achieve the desired strength.

II. RAW MATERIALS

A. Portland pozzolana cement

1) Manufacture: Ultratech Cement
Portland pozzolana cement confirming to IS: 269-1976 was used throughout the investigation. Different tests were performed on the cement to ensure that it confirms to the requirements of the IS specifications. The physical properties of the cement were determined as per IS: 4031-1968 and are presented in Table 1.

Table – 1
Properties of Cement

Sl. No.	*Characteristics*	*Values*
1	*Standard consistency*	*35*
2	*Initial setting time*	*38minutes*
3	*Specific gravity*	*3.0*

B. Aggregate

1) Fine Aggregate:
When the aggregate is passes through sieved 4.75mm sieve, it called as fine aggregate. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. Properties of fine aggregate are presented in table 2.

Table – 2
Properties of fine aggregate

Property	*Value*
Specific gravity	*2.41*
water absorption	*1.2%*
Silt content	*4.5%*

2) Coarse Aggregate:
When the aggregate is passed through 4.75mm sieve, it is called as coarse aggregate. The Properties of coarse aggregate are presented in table 3

Table – 3
Properties of coarse aggregate

Property	*Value*
Specific gravity	*2.69*
water absorption	*0.48*

C. Water

The water used in the mix design was potable drinking water, locally available and it's free from organic materials and suspended solids, which might have affected the properties of the fresh and hardened concrete.
Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard.

D. Admixtures

1) Super Plasticizer:
Super plasticizer reduces the quantity of water 3 to 4 times in the concrete mixes. So, they are known as high range water reducing admixtures. They can be added to a certain limit of 2% of cement to the concrete mix to stop bleeding and segregation. The strength of concrete increases as water cement ratio decreases. Workability is greatly achieved by adding super plasticizer. In this study, AURA MIX -400 is used as super plasticizer at a dosage of 2% by weight of cement.

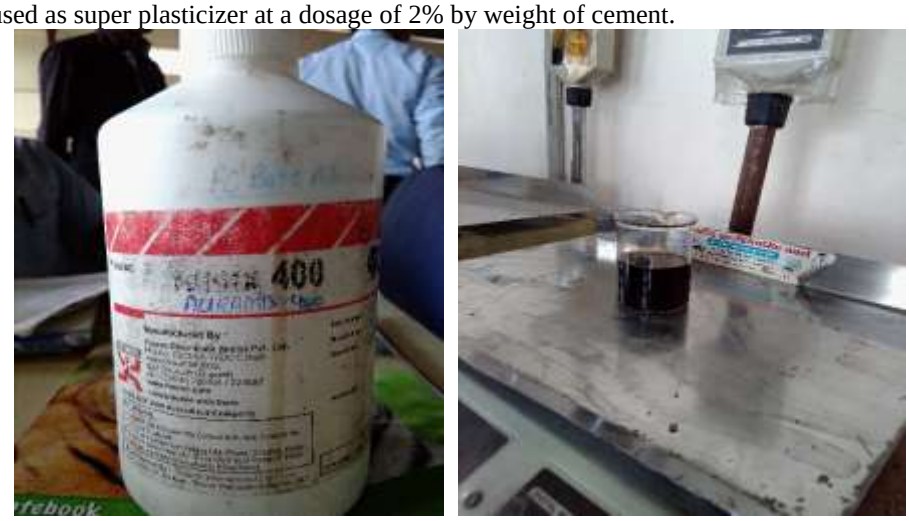

Fig. 1: AAURA MIX-400

2) Polyethylene glycol-400:
The condensed polymer of ethylene oxide and water is polyethylene glycol. PEG 400 is used in this study where 400 is the molecular weight. It has general formula H (OCH_2CH_2) nOH. It is soluble in water. It is nontoxic, odorless, nonvolatile and non-irritating.

PEG 400 is a low-molecular-weight grade of polyethylene glycol. It is a clear, colorless, viscous liquid.
Density: 1.13 g/cm³
Formula: $C_{2n}H_{4n+2}O_{n+1}$

Fig. 2: Polyethelene Glycol-400

Fig. 3: Poly Vinyl Alcohol

3) Poly Vinyl Alcohol:
Polyvinyl alcohol is formed commercially from polyvinyl acetate, regularly by a continuous process. Polyvinyl alcohol is a neutral and flavorless translucent, white or cream colored granular powder. Polyvinyl alcohol contains two OH groups. It helps to retain water from concrete. It is soluble in stream, slightly soluble in ethanol, but insoluble in other natural solvents.

III. METHODOLOGY

A. Mix Design for M-40 Grade

The mix design procedure adopted to obtain a M-40 grade concrete is in accordance with IS 10262- 2009. The M-40 grade of concrete are designed and the material for 1 cubic meter is shown in table 4.

Table – 4
Quantity for 1 cubic meter

Description	*By weight*
Cement	*455kg*
Sand	*653.77kg*
Coarse aggregate	*697.356kg*
Fine aggregate	*508.49kg*
Water	*150.2kg*
Admixture	*2.95kg*

IV. TESTING

A. Slump Test:

The slump test conforming to IS: 1199:1959. To check the workability of concrete slump test is the best method in laboratory as well as at work-site. All workability factors cannot be measured by slump test but it is conveniently as a control test and gives the workability result.

B. Compressive Strength:

The compressive strength test is conforming to IS: 516:1959. The cube specimen for conventional concrete as well as self-curing concrete are tested on machine capacity of 2000 KN. The cubes are clearly wiped off and also freed from dust and sand. The axis of specimen will be aligned at the center of loading frame. The maximum load read carefully and recorded.
Strength of cube specimen =P/A
Where P is applied load and A is area of specimen (150 cm x 150 cm)

V. RESULT AND DISCUSSION

A. *Slump Test:*

The slump test is represented in table 5 and graphical representation shown in figure 4.

Table – 5
Slump Value

S.N.	*Sample*	*Slump Value (MM)*
1	*Conventional Concrete*	*110*
2	*0.5 PEG*	*110*
3	*1 .0PEG*	*115*
4	*1.5 PEG*	*113*
5	*2.0 PEG*	*119*
6	*0.12 PVA*	*114*
7	*0.24 PVA*	*112*
8	*0.36 PVA*	*116*
9	*0.48 PVA*	*117*
10	*0.24 PVA+ 0.5 PEG*	*120*

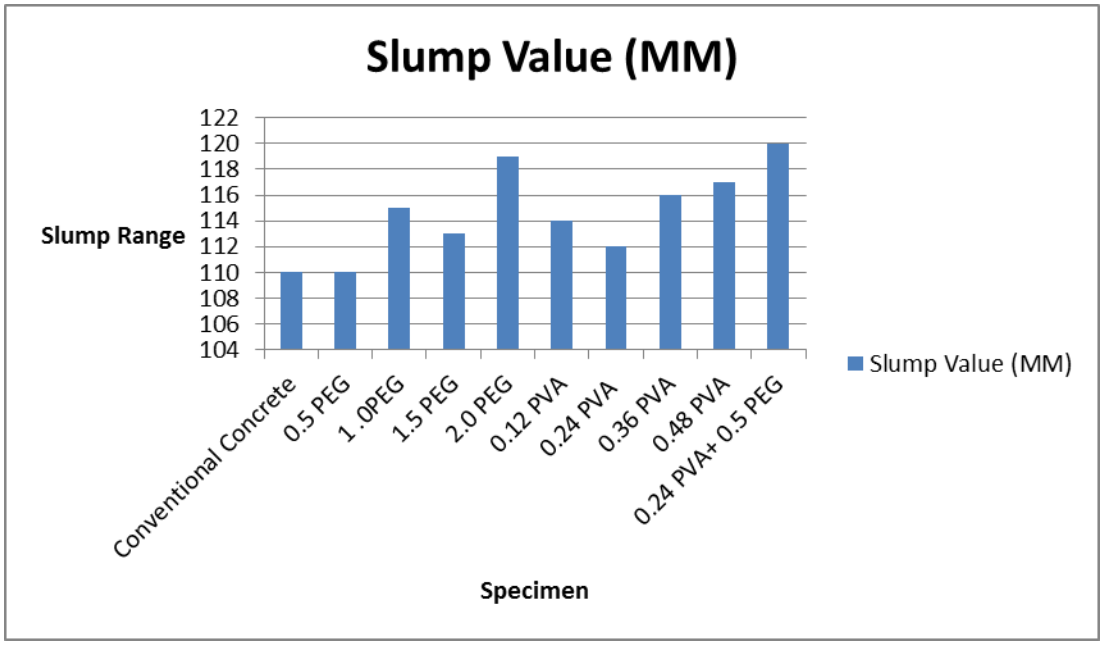

Fig. 4: Graphical representation of Slump Value

B. *Compressive Test:*

The compression test is represented in table 6 and graphical representation shown in figure 5.

Table – 6
Compressive Strength

Design Mix-M40				
S.N.	*Sample*	*Compressive Strength in Mpa*		
		7 days	*14 days*	*28 days*
1	*Conventional Concrete*	*26.71*	*37.22*	*42.22*
2	*0.5 PEG*	*24.23*	*36.33*	*43.87*
3	*1 .0PEG*	*23.95*	*34.55*	*42.97*
4	*1.5 PEG*	*25.09*	*34.25*	*42.11*
5	*2.0 PEG*	*25.32*	*33.87*	*41.27*
6	*0.12 PVA*	*24*	*35.26*	*42.37*
7	*0.24 PVA*	*21.11*	*30.9*	*44.39*
8	*0.36 PVA*	*22*	*32.45*	*42.18*
9	*0.48 PVA*	*33.56*	*39.11*	*41.23*
10	*0.24 PVA+ 0.5 PEG*	*25.67*	*36.89*	*44.89*

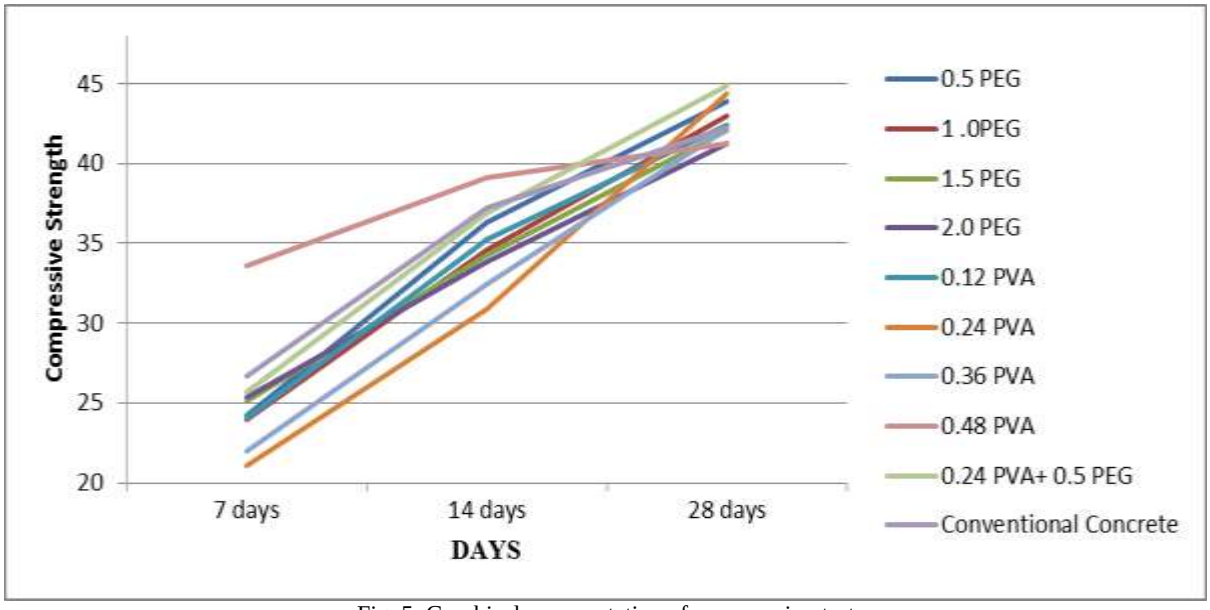

Fig. 5: Graphical representation of compression test

VI. CONCLUSION

- The Optimum quantity of PEG-400 for M-40 Concrete is 0.5% weight of cement.
- The initial strength of conventional concrete is more but after 28 days 0.5%PEG and 0.24 % of PVA gives more strength.
- As the self-curing admixture increases, the slump value increases.
- Self-curing is good option for water scare areas.

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