

Early Stage Performance of Self-Curing Concrete Using Poly Vinyl Alcohol

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Abstract - Curing is one of the most important factors for achieving maximum desirable strength in concrete, concrete should be cured properly so that it is fully hydrated and loss of moisture inside the concrete should be reduced. Poly vinyl alcohol is locally available chemical which can be used as a self-curing agent in concrete so that moisture in the concrete can be maintained and concrete can be fully hydrated. In this paper Poly vinyl alcohol has been added to concrete by weight of cement at the dosage of 0%, 1%, 1.1%, 1.2%, 1.3%, 1.4%, 1.5%, 1.6% and then the mechanical properties of concrete were tested such as compressive and split tensile strength. It is observed that workability is increasing with increasing the dose of poly vinyl alcohol and there is no significant increase in compressive and split tensile strength relative to conventional concrete.

Key Words: Concrete, Curing, Compressive Strength, Poly Vinyl Alcohol, Self-Curing Concrete

1.INTRODUCTION

When water is added to the concrete heat of hydration is released then concrete begins to harden, and as it hardens the water begins to evaporate mainly due to high temperature and then the water present inside concrete is not sufficient for concrete to achieve full hydration this reduces its strength, the rate of evaporation depends on the outside temperature. Now in order to achieve desired strength the rate of evaporation must be reduced and proper quantity of water should be provided so that it can be fully hydrated. Proper hydration in concrete can only be achieved when the relative humidity inside the concrete should be about 80%.in concrete which cure itself the external water curing is no more needed because the inner water is kept up by joining the agent (self-curing) polyvinyl alcohol (PVA) which gives the ability to the concrete to dissipate less quantity of water from it, subsequently expanding the water maintenance capacity of concrete. The advantages of inner curing are increased

hydration process and quality improvement, decreased autogenous shrinkage and splitting, decreased permeability and expanded durability. So, in areas where there is hot climate and also there is lack of water, then self-curing concrete is the most appropriate solution to get concrete of desired strength without any loss. Poly vinyl alcohol is locally available material Poly vinyl alcohol is a derivative of Poly vinyl acetate it is prepared by hydrolysis of poly vinyl acetate, its physical appearance is colorless to white solid in various forms, it has a specific gravity 1.3, Its PH range is 5.0 - 6.5, it is water soluble, its Molecular formula is $[CH_2CH(OH)]$. Experimental work indicates that Addition of 0.24 percent of PVA through weight of cement as a self-curing agent offers the maximum compressive force. The concrete combine is extra achievable when 0.24% of PVA added to concrete mix by means of weight of cement because the slump values and compacting factor values are high when compared to traditional mix [1]. Poly vinyl alcohol is a gel like substance when it is dissolved in water due to this nature the water inside the concrete is enclosed inside this gel so that moisture loss can be reduced. the more amount of self-curing agents is added the workability also increases proportionally, in research works it was found out that among the self-curing agents that they have used the maximum mechanical strength was obtained when 1.5% of self-curing agent (PEG) was added [2]. So, the self-curing agent such as Poly Vinyl Alcohol also affects the workability of concrete.

Self -curing concrete (SCC) is the solution to many problems occurred due to lack of suitable curing. SCC is an alternative way to conventional curing in desert and hot regions where the major problem is shortage of water. Slump value rise with increase in the quantity of curing agent. and through one research it is observed that there is an increase in compressive strength by using curing agent and light weight fine aggregate [3]. In research study it is

also found out that at 2% PVA the compressive strength decreases[4] It is also found out that water retention of concrete by self-curing is more than that of conventional curing, PVA provides higher compressive strength than that of conventional curing [5]. Self-curing concrete gives better results in areas where there is not enough water available and the crepe formation is also reduced with addition of self-curing agents.[6]

From the above discussion it is noted that self-curing of concrete plays significant role in concrete construction because it is due to curing of concrete we can achieve maximum strength of concrete, this research aims to show that Poly vinyl alcohol can be used as self-curing agent in concrete or not for achieving desired strength without conventional curing.

2. MATERIALS AND METHODOLOGY

2.1 MATERIALS USED IN CONCRETE MIX:

Cement: Sealed Ordinary Portland Cement was used in this study, Cement is binding material which binds the sand and coarse aggregate together to provide a compact mix of concrete.

Fine Aggregate: Locally available fine aggregate was used from a dealer in Jamshoro and it was sieved by passing from 4.75mm sieve and the fineness modulus was found 3 with specific gravity of 2.44

Coarse Aggregate: Aggregates with irregular shapes not larger than 20mm were used in this study. Specific gravity of coarse aggregates was found out to be 2.62

Polyvinyl Alcohol: Poly Vinyl Alcohol (PVA) as shown in figure below was obtained from Shabbir Scientific company in Hyderabad as a local material used for papermaking



Fig 1: Poly Vinyl Alcohol

2.2 MIX PROPORTION

When designing, several trial mix were done to check the desired strength and workability, Mix was finally confirmed with water to cement ratio of 0.49 by weight of cement. The following table shows the mix design

Table 1: Mix Proportion

Batch	OPC kg/m ³	F.A kg/m ³	C.A kg/m ³	Water kg/m ³	PVA%
1	359.75	593.59	896.21	176.28	c.c
2	359.75	593.59	896.21	176.28	0
3	359.75	593.59	896.21	176.28	1
4	359.75	593.59	896.21	176.28	1.1
5	359.75	593.59	896.21	176.28	1.2
6	359.75	593.59	896.21	176.28	1.3
7	359.75	593.59	896.21	176.28	1.4
8	359.75	593.59	896.21	176.28	1.5
9	359.75	593.59	896.21	176.28	1.6

2.3 WORKABILITY TEST:

Slump test was conducted to determine the workability of the mix, This test is conducted according to the methods mentioned in ASTM-143 in united states. The test is performed using a mold in shape of a conical frustum also known as slump cone, the base of cone is 200mm wide and top diameter is of 100mm and the total height of the slump cone is 300mm In this test concrete is poured into the slump cone in three layers and each layer is compacted

with tamping rod 25 times, then the slump cone is lifted and concrete mix begins to slump or fall down, this decrease in height relative to slump cone is measured. slump of concrete and slump cone is shown in the following picture



Fig 2: Slump test

2.4 CASTING OF SPECIMEN

9 mixes were adopted out of them 6 Cylinder with diameter of 4" (100 mm) and height of 8" (200 mm) was used for each mix, in total 54 cylinders were casted,

Table 2: Casting Schedule

Batch No.	Specimen Details	No. of cylinders
		3 days
1	Specimen with no admixture /conventional curing	03 + 03 = 06
2	Specimen with admixture 0% of PVA	03 + 03 = 06
3	Specimen with admixture 1% of PVA	03 + 03 = 06
4	Specimen with admixture 1.1% of PVA	03 + 03 = 06
5	Specimen with admixture 1.2% of PVA	03 + 03 = 06
6	Specimen with admixture 1.3% of PVA	03 + 03 = 06
7	Specimen with admixture 1.4 % of PVA	03 + 03 = 06
8	Specimen with admixture 1.5 % of PVA	03 + 03 = 06
9	Specimen with admixture 1.6 % of PVA	03 + 03 = 06
TOTAL MOULDS		54

6 cylinders of each trial were tested at 3 days, 3 cylinders for compressive strength and 3 cylinders for split tensile strength. For each mix, pouring and compaction were done according to ASTM, after 24 hours the cylinders were withdrawn from molds.



Fig 3: casted cylinders

Only 1 mix out of 9 mixes was externally cured and one mix was neither cured externally nor internally in order to compare them with self-cured concrete, and the other 7 mixes were cured internally using Poly Vinyl Alcohol.

2.5 COMPRESSIVE STRENGTH TEST:

After Curing of the Specimen, the strength of these cylinders were determined using Universal Testing Machine (UTM). The Load was applied at the rate of 500 N/sec, Then at failure the value of load is recorded and then the strength of the cylinder is determined by dividing the load to cross section area of the cylinder



Fig 4: Universal Testing Machine (UTM)

S NO.	PVA (%)	Slump (mm)
1	c.c	65
2	0	60
3	1	70
4	1.1	85
5	1.2	90
6	1.3	100
7	1.4	105
8	1.5	115
9	1.6	128



Fig 6: Concrete Cylinder is being tested for Split Tensile Strength in UTM

3. RESULTS AND DISCUSSIONS

3.1 WORKABILITY TEST:

Workability is one of the most important properties of fresh concrete, workability indicates the ease of placement of concrete, in concrete to achieve compaction the amount of useful internal work to remove the friction in less effort indicates a highly workable concrete, Slump test was conducted to determine the workability of concrete the results of the slump test are given below in Table 3 and Fig 7,

Table 3 : PVA vs Slump

S No.	PVA (%)	Compressive strength (N/mm ²)
		3 days
1	c.c	18.04
2	0	12.83
3	1	13.09
4	1.1	12.81
5	1.2	13.22
6	1.3	13.98
7	1.4	13.85
8	1.5	15.19
9	1.6	14.46



Fig 5: Concrete Cylinder is being tested for compressive strength

2.6 SPLIT TENSILE STRENGTH TEST

For split tensile strength the cylinder has to be placed in UTM in such a way that the axis of specimen should be carefully aligned with center of thrust with the seated platen, The specimen should be placed horizontally between loading surfaces of a compression testing machine along its vertical diameter, then loading at the failure is noted, the split tensile strength is given by this formula $T = \frac{2P}{\pi DL}$

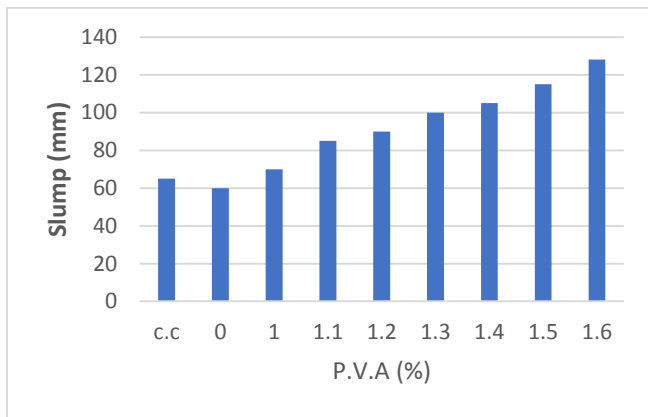


Fig 7: workability increases with increasing dose of PVA

3.2 COMPRESSIVE STRENGTH TEST:

Concrete is known by its compressive strength, the compressive strength test was conducted by using Universal Testing Machine and The load at failure were recorded and then the compressive strength was determined, the Test results are presented in the graph. compressive strength test was carried with curing period of 3 days, the Compressive strength has decreased compared to conventionally cured concrete.

Table 3: Compressive Strength Test

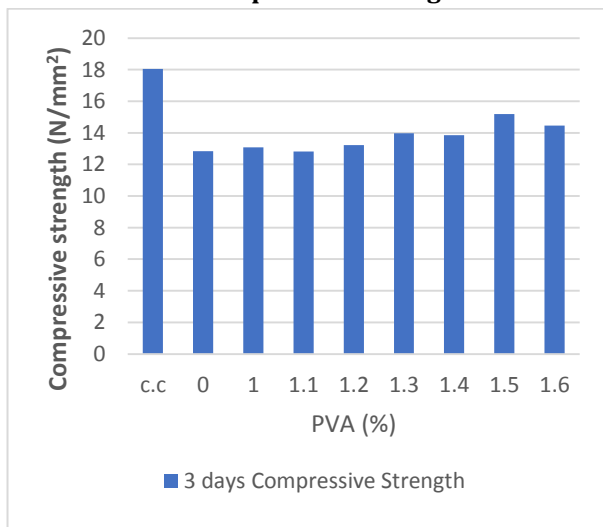


Fig 8: Compressive Strength Test

3.3 SPLIT TENSILE STRENGTH TEST:

Tensile strength is the ability of a material to resist tensile load that tends to increase its size, concrete is weak in tension and it will likely fail early because it shows very little resistance to tensile loads. For this test universal testing machine is utilized and concrete cylinder is placed in UTM in horizontal direction, The split tensile test results for 3 days is determined, the graph of the result is

provided below. The Tensile stress has decreased compared to conventionally cured concrete.

Table 4: Split Tensile Strength Test Results

S No.	PVA (%)	Split Tensile strength (N/mm ²)
		3 days
1	c.c	2.38
2	0	1.64
3	1	1.83
4	1.1	1.88
5	1.2	1.95
6	1.3	2.03
7	1.4	2.11
8	1.5	1.97
9	1.6	1.86

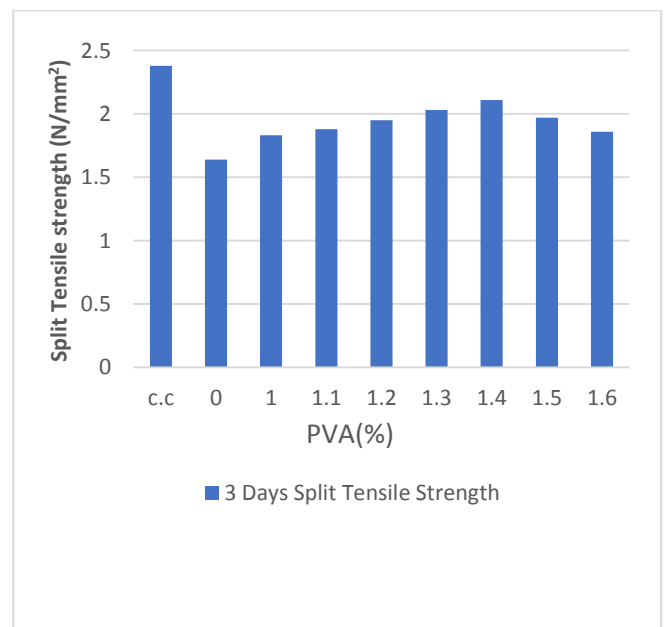


Fig 9: Split Tensile Strength Test

4. CONCLUSIONS

The Following conclusions were drawn from this study

- [1] It was observed that workability of concrete mix increases with increasing dose of Polyvinyl alcohol.
- [2] It is observed that there is no significant increase in compressive strength relative to conventional concrete which might be due to some error.
- [3] The strength of concrete increases relative to non-cured concrete as the dosage of PVA increases from 0% to 1.5% of PVA by weight of cement.
- [4] The self-curing concrete gives optimum compressive strength at 1.5% of PVA by weight of cement compared to uncured concrete, which is 80.20% of conventional curing concrete and the optimum split tensile strength of self-curing concrete is observed at 1.4% of PVA by weight of cement compared to uncured concrete, which is 88.65% of conventionally cured concrete.

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