Experimental study on properties of self-curing concrete incorporated with PEG and PVA

A. Mrs. Roopakala C. G[1], B. Shivaraju G.D[2], C. Mrs. Usha S.[3]
[1] *Student Final year M-tech, civil Engg Dept. Sri Siddhartha institute of technology*
[2]*Assistant Professor, Civil Engg. Dept. Sri Siddhartha institute of technology*
[3]*Assistant Professor, Civil Engg. Dept Sri Siddhartha institute of technology*

Abstract -**Curing of concrete is the process of maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. However good curing is not always practical in many cases the present study deals with the effect of polyethylene glycol (PEG)and poly-vinyl alcohol (PVA) on concrete and their contribution to strength which are carried out. The effect of admixtures in mechanical characteristic of concrete i.e., compressive strength, split tensile strength and flexural strength by varying the percentage of PVA, PEG-200, PEG-400, PEG-600 from 0% to 1.5% by weight of cement is studied for M30 grade of concrete and the optimum percentage of PEG and PVA in self curing concrete with conventional concrete with water curing is compared. The optimum percentage with PEG is coated with PVA and strength analysis is done. From the results it is analyzed that adding of PEG 600 will give more strength compared to PEG 200, PEG 400 and PVA and it is also observed that Coating of PVA made a very less impact in the strength of concrete.**

I. INTRODUCTION

Construction industry needs a plenty of water in the name of curing. The days are not so far that all the construction industries has to switch over to an alternative curing systemizes, not only to save water for the sustainable development of the environment but also to promote the indoor and outdoor construction activities even in remote areas where there is a paucity of water.

Curing is the name given to the procedures used for promoting the hydration of the cement by creating suitable environment, and it consists of controlling temperature and moisture movement from and into the concrete. Curing allows continuous hydration of cement and consequently continuous gain in the strength, once curing stops strength gain of the concrete also stops. Proper moisture conditions are critical because the hydration of the cement virtually ceases when the relative humidity within the capillaries drops below 80%. Proper curing of concrete structures is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing.

II. OBJECTIVES

- To study the mechanical characteristic of concrete i.e., compressive strength, split tensile strength and flexural strength by varying the percentage of PEG-200, PEG-400, PEG-600 from 0% to 1.5% by weight of cement.
- To study the mechanical characteristic of concrete i.e., compressive strength, split tensile strength and flexural strength by varying the percentage of PVA from 0% to 1.5% by weight of cement.
- Comprising optimum mix with conventional concrete
- To study the mechanical characteristics of optimum percentage of concrete coated with PVA.

III MATERIALS USED

Cement

The Ordinary Portland Cement of 53 grade conforming to IS: 12269-2013 was used. Initial setting time, standard consistency, specific gravity test and fineness modulus test were performed to find the properties of cement.

Coarse Aggregate

20 mm coarse aggregate, conforming to IS: 383 -1970 was used. The properties of coarse aggregates such as specific gravity and water absorption were obtained.

Fine Aggregate
The fine aggregate used in the study was manufactured sand. It was screened to eliminate over size particles. As per IS: 383-1970, the fine aggregate conforming to zone II was used.

Water
Potable water was used in the experimental work for mixing.

Polyethylene Glycol (PEG)
For the experimental PEG 200, PEG 400, PEG 600 was used. PEG consists of a distribution of polymers of varying molecular weights with an average of 200, 400, 600 respectively .The appearance of PEG is clear liquid. One common feature of PEG appears to be the water-soluble nature.

Polyvinyl Alcohol (PVA)
Polyvinyl Alcohol is the compound of Polyethylene Glycol. It is a water soluble synthetic soluble polymer. Polyvinyl alcohol is an odorless and tasteless, translucent, White color in Cristal form.

IV METHODOLOGY AND TEST

Mix proportion for M30 has been designed according to the basic material test and designed using IS: 10262:2000 method of mix design. Casting cubes, cylinder and beams has been casted for M30 grade in addition to PEG200, PEG400, and PEG600 with varying percentage of 0.5, 1 and 1.5.

Following strength tests are conducted on design mix.

- Compressive strength test
- Tensile strength test
- Flexural strength test

The strength tests are compared with conventional concrete.

Requirement of material per cubic meter of M30 grade concrete is given in the following table.

Grade of concrete	Cement	Fine aggregate	Coarse aggregate	W/C
M 30	1.00	1.56	2.70	0.45

V. EXPERIMENTAL RESULTS

A. Compressive strength

Table 1: compression strength test results of PEG 200

Duration	PEG 200 (%)	Compressive strength in N/mm^2
7 days	0	19.2
	0.5	19.7
	1	20.7
	1.5	19.1
14 days	0	22.1
	0.5	22.4
	1	23.1
	1.5	22.5
28 days	0	33.4
	0.5	34.7
	1	35.2
	1.5	33.5

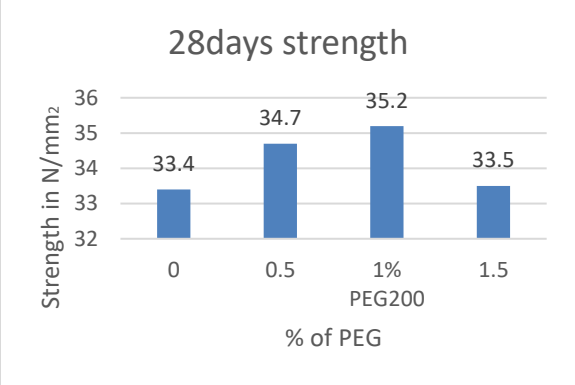

Fig 1: 28days Compressive strength of the concrete with PEG200

It is observed that There is 5.1% of increase in optimum compressive strength compared to nominal mix

Table 2: compression strength test results of PEG 400

Duration	PEG 400 (%)	Compressive strength in N/mm^2
7 days	0	19.2
	0.5	20.4
	1	22.4
	1.5	21.1
14 days	0	22.1
	0.5	24.4
	1	26.1
	1.5	25.5
28 days	0	33.4
	0.5	35.7
	1	37.7
	1.5	36.5

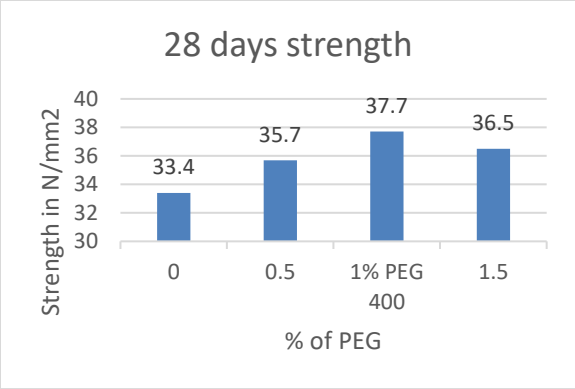

Fig 2: 28days Compressive strength of the concrete with PEG 400

There is 11.4% of increase in optimum compressive strength compared to nominal mix

Table 3: compression strength test results of PEG 600

Duration	PEG 600 (%)	Compressive strength in N/mm^2
7 days	0	19.2
	0.5	22.1
	1	25.2
	1.5	24.5
14 days	0	22.1
	0.5	25.4
	1	28.1
	1.5	26.5
28 days	0	33.4
	0.5	37.2
	1	42.7
	1.5	40.2

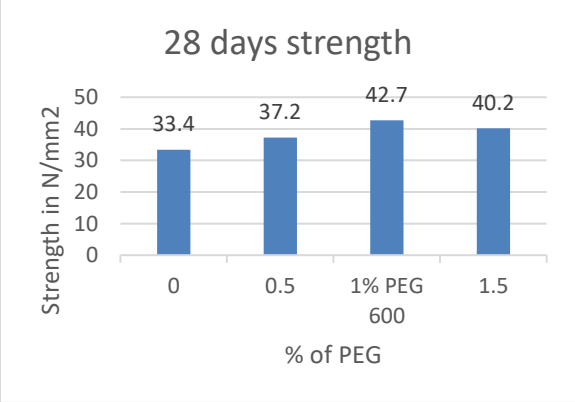

Fig 3: 28days Compressive strength of the concrete with PEG 600

It is observed that there is 27.8% of increase in optimum compressive strength compared to nominal mix

B. Split tensile strength

Table 4: Split tensile strength test results of PEG 200

Duration	PEG 200 (%)	Split tensile strength in N/mm^2
7 days	0	1.8
	0.5	2.1
	1	1.8
	1.5	1.6
14 days	0	2.3
	0.5	2.6
	1	3.1
	1.5	2.7
28 days	0	3.1
	0.5	3.9
	1	3.8
	1.5	3.5

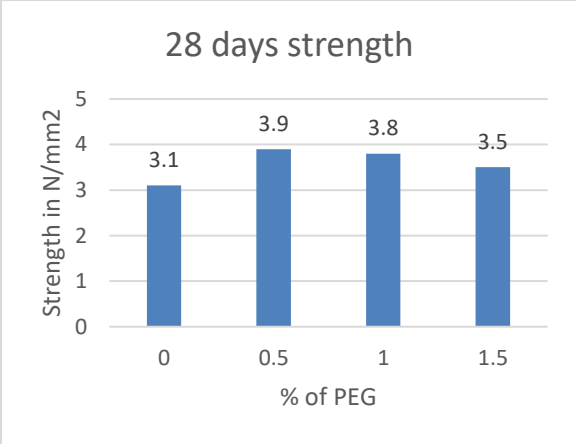

Fig 4: 28days Split tensile strength of the concrete With PEG 200

It is observed that there is 20.5% of increase in optimum Split tensile strength compared to nominal mix

Table 5: Split tensile strength test results of PEG 400

Duration	PEG 400 (%)	Split tensile strength in N/mm^2
7 days	0	1.8
	0.5	2.3
	1	2.2
	1.5	1.9
14 days	0	2.3
	0.5	2.7
	1	3.5
	1.5	2.9
28 days	0	3.1
	0.5	3.2
	1	3.9
	1.5	3.7

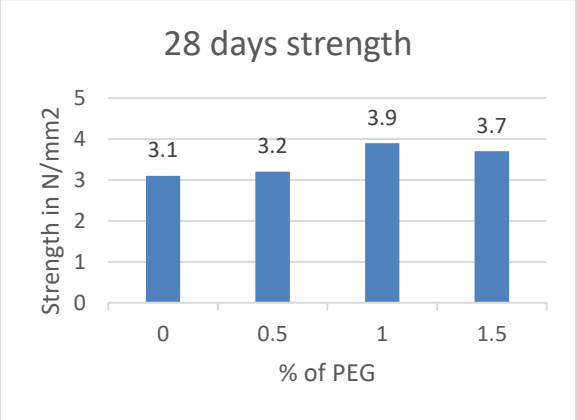

Fig 5: 28days Split tensile strength of the concrete With PEG 400

It is observed that there is 20.5% of increase in optimum Split tensile strength compared to nominal mix

Table 6: Split tensile strength test results of PEG 600

Duration	PEG 600 (%)	Split tensile strength in N/mm^2
7 days	0	1.8
	0.5	2.1
	1	2.4
	1.5	1.7
14 days	0	2.3
	0.5	2.9
	1	3.9
	1.5	3.1
28 days	0	3.1
	0.5	3.5
	1	4.5
	1.5	3.9

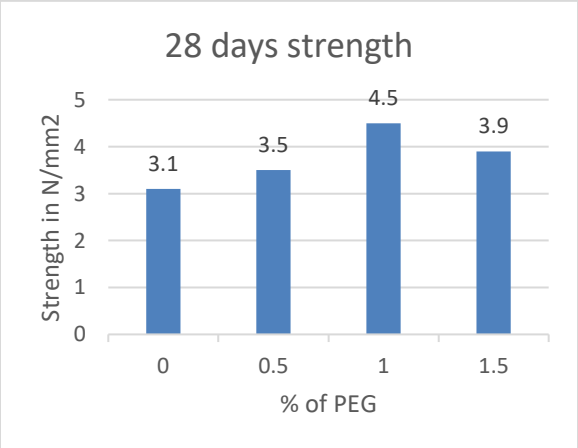

Fig 6: 28days Split tensile strength of the concrete With PEG 600

It is observed that there is 31.1% of increase in optimum Split tensile strength compared to nominal mix

C. Flexural strength

Table 7: Flexural strength test results of PEG 200

Duration	PEG 200 (%)	Flexural strength in N/mm^2
7 days	0	3.1
	0.5	3.4
	1	3.8
	1.5	3.6
14 days	0	4.4
	0.5	4.8
	1	5.1
	1.5	4.8
28 days	0	5.9
	0.5	6.4
	1	7.2
	1.5	6.6

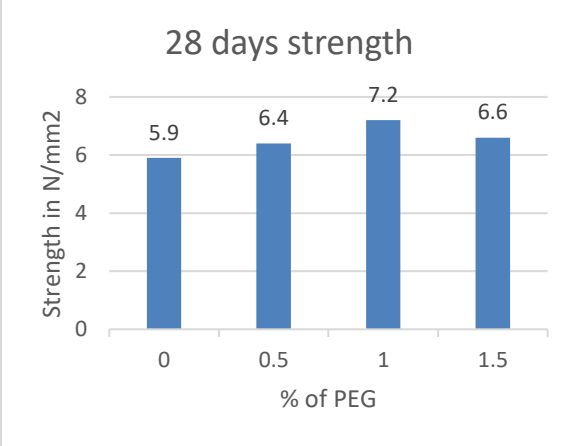

Fig 7: 28days Flexural strength of the concrete With PEG 200

It is observed that there is 18.1% of increase in optimum Flexural strength compared to nominal mix

Table 8: Flexural strength test results of PEG 400

Duration	PEG 400 (%)	Flexural strength in N/mm^2
7 days	0	3.1
	0.5	4.2
	1	4.4
	1.5	4.1
14 days	0	4.4
	0.5	4.9
	1	5.9
	1.5	5.1
28 days	0	5.9
	0.5	7.1

	1	7.4
	1.5	7.2

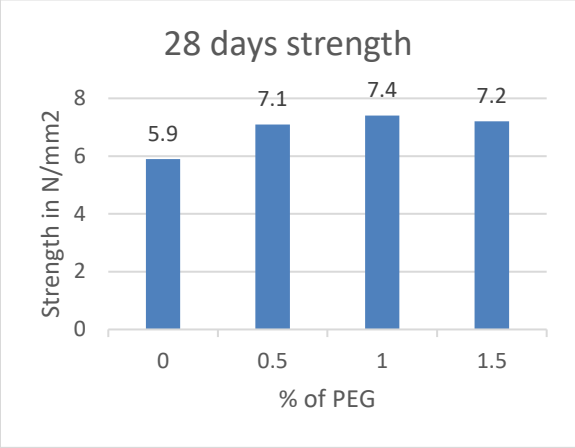

Fig 8: 28days Flexural strength of the concrete with PEG 400

It is observed that there is 20.2% of increase in optimum Flexural strength compared to nominal mix

Table 9: Flexural strength test results of PEG 600

Duration	PEG 600 (%)	Flexural strength in N/mm^2
7 days	0	3.1
	0.5	4.4
	1	5.1
	1.5	4.8
14 days	0	4.4
	0.5	5.9
	1	6.9
	1.5	5.5
28 days	0	5.9
	0.5	7.4
	1	8.6
	1.5	8.2

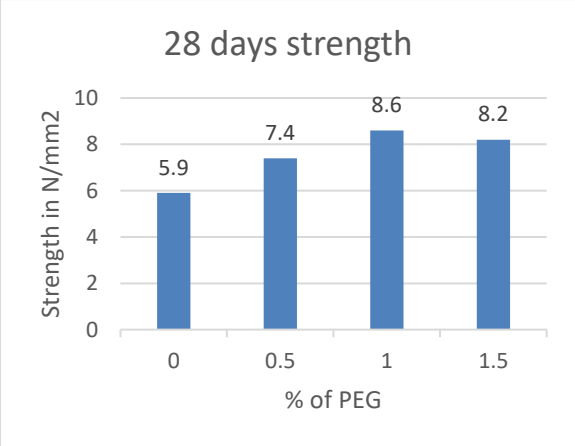

Fig 9: 28days Flexural strength of the concrete with PEG 600

It is observed that there is 31.3% of increase in optimum Flexural strength compared to nominal mix

D. Coating of PVA results for optimum percentage of PEG and to conventional concrete

I. Compressive strength

Table 10: Compressive strength test results of PEG 600 and PVA

Duration	PEG 600 and PVA (%)	Compressive strength in N/mm^2
7 days	0	19.2
	0% PEG+1% PVA	19.3
	1% PEG	25.2
	1% PEG+1% PVA	25.1
14 days	0	22.1
	0% PEG+1% PVA	23.2
	1% PEG	24.5
	1% PEG+1% PVA	23.4
28 days	0	33.4
	0% PEG+1% PVA	33.6
	1% PEG	42.7
	1% PEG+1% PVA	41.1

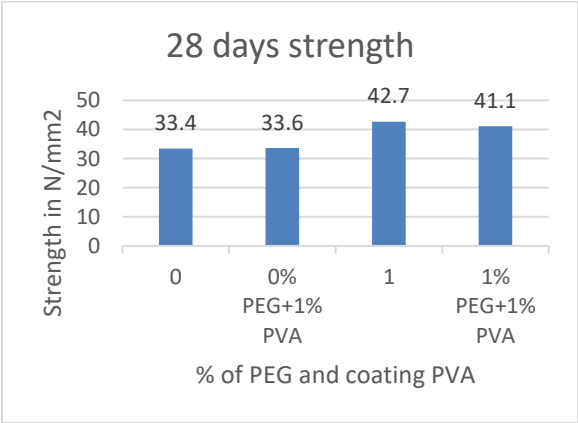

Fig 10: 28days Compressive strength of the concrete in addition of PEG-600 and PVA

II. Split tensile strength

Table 11: Split tensile strength test results of PEG 600 and PVA

Duration	PEG 600 and PVA (%)	Split tensile strength in N/mm^2
7 days	0	1.8
	0% PEG+1% PVA	1.81
	1% PEG	2.4
	1% PEG+1% PVA	2.3
14 days	0	2.3

	0% PEG+1% PVA	2.4
	1% PEG	3.1
	1% PEG+1% PVA	2.9
28 days	0	3.1
	0% PEG+1% PVA	3.2
	1% PEG	4.5
	1% PEG+1% PVA	4.1

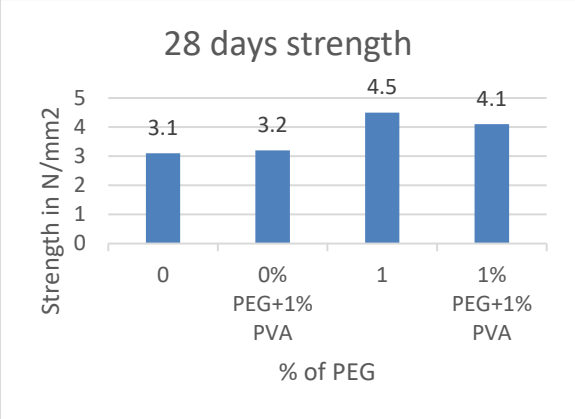

Fig 11: 28days Split tensile strength of the concrete in addition of PEG-600 and PVA

III. Flexural strength

Table 12: Flexural strength test results of PEG 600 and PVA

Duration	PEG 600 and PVA (%)	Flexural strength in N/mm^2
7 days	7 days	3.1
	0% PEG+1% PVA	3.3
	1% PEG	5.1
	1% PEG+1% PVA	4.9
14 days	0	4.4
	0% PEG+1% PVA	4.1
	1% PEG	5.9
	1% PEG+1% PVA	4.3
28 days	0	5.9
	0% PEG+1% PVA	5.7
	1% PEG	8.6
	1% PEG+1% PVA	8.2

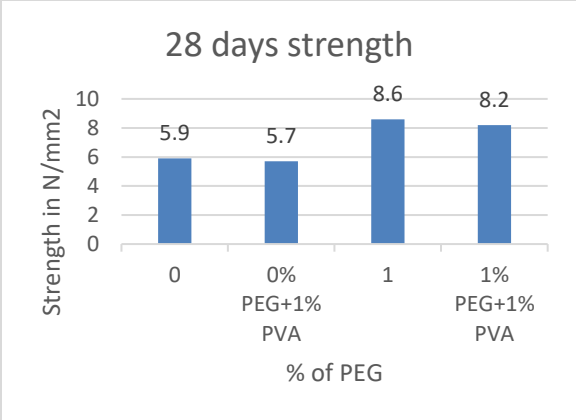

Fig 12: 28days Flexural strength of the concrete in addition of PEG-600 and PVA

E. Comparison of optimum strength of PEG-200, PEG-400 and PEG-600

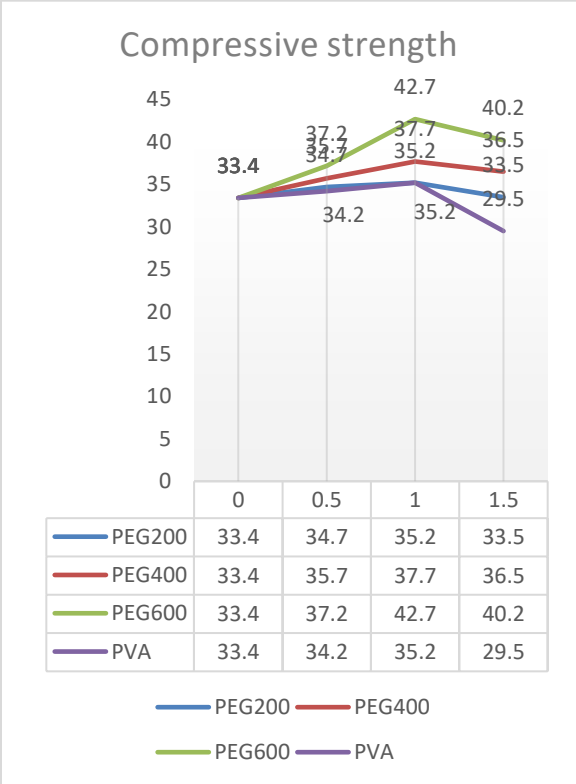

Fig: 13 Comparison of optimum compressive strength of concrete in addition of PEG and PVA

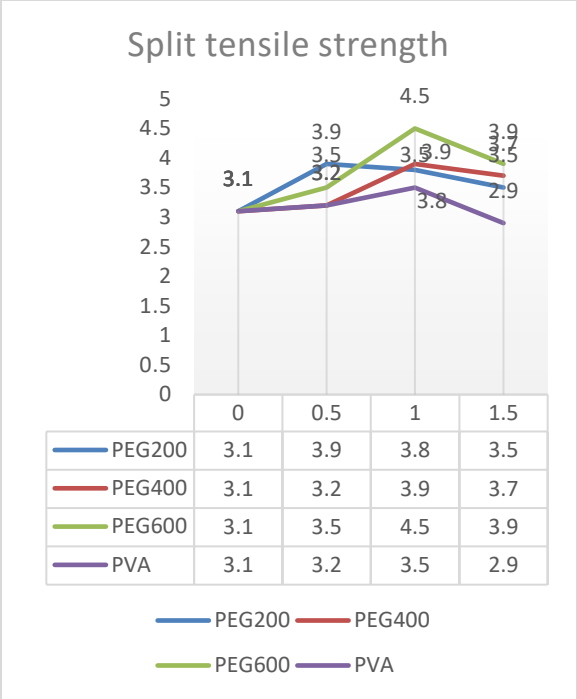

Fig: 14Comparison of optimum split tensile strength of concrete in addition of PEG and PVA

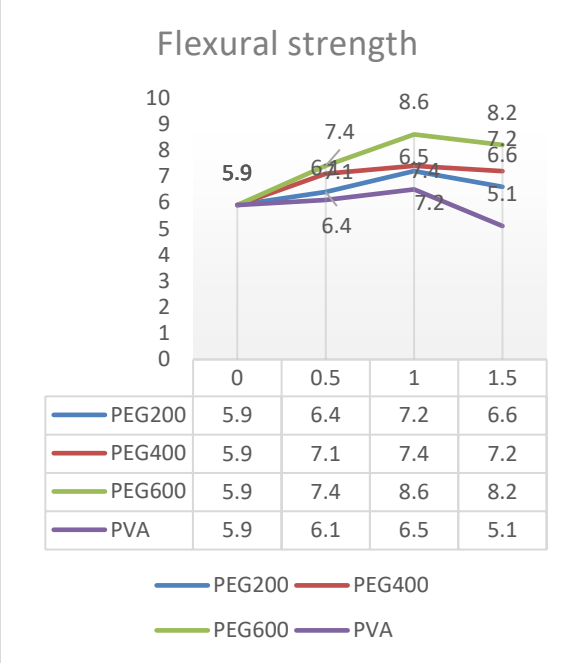

Fig: 15Comparison of optimum split tensile strength of concrete in addition of PEG and PVA

VII. CONCLUSION

1. It is found that PEG 600 gives the highest compressive strength, split tensile strength, flexural strength compared to PEG200 and PEG 400
2. From compressive strength, splitting tensile strength and flexural strength test results, it was found that self curing concrete has more strength results than that was found in water cured concrete.
3. Self cured concrete showed better hydration even under drying condition compared to conventional concrete.
4. Increase in percentage of self curing agent resulted in decrease in strength properties of concrete.
5. Cement content and w/c ratio affects the performance of self curing agent to a large extent.
6. 1% by weight of cement was found to be the optimum dosage of self curing agents.
7. Coating of PVA to the conventional concrete and optimum percentage of PEG, i.e. PEG600 did not give the high strength.
8. PVA coating increase the strength very slightly

LIMITATIONS

1. Variation in temperature from 24°C to 41°C during the experimental study resulted in variation of strength results than that was expected.
2. As the percentage of PEG increased, mix showed tendency of bleeding and in case of PVA the increase in percentage resulted in stiff and hard mixture.

REFERENCES

[1] Basil M Joseph, “Studies on Properties Of Self-Curing Concrete Using PolyEthylene Glycol” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334

[2] Sumayyath M M1, Jerry Anto2. “Experimental Study on Strength Properties of Self Curing Concrete by Using Polyethylene Glycol as Self Curing Agent”, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 10 | Oct -2016

[3] Daliya Joseph1, “Effect of Self Curing Agents on Mechanical Properties of Concrete”, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 5 Issue 09, September-2016

[4] Snehal Bhosale1,” Experimental Characterization of Strength of Self Curing Concrete”, IJARIIE-ISSN(O)-2395-4396 Vol-2 Issue-4 2016

[5] B. Ajitha (2017,”Selfcuring concrete properties investigation”, Volume 29, -ISSN: 2395-0052

[6] Dr. U. B. Choubey," A Study On Properties Of Self-Curing Concrete Using Polyethylene Glycol-400", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 10 | Oct -2017 p-ISSN: 2395-0072

[7] K V S Gopalakrishnasastry, "Self-curing concrete with different self-curing agents", IOP Conf. Series: Materials Science and Engineering 330 (2018) 012120 doi:10.1088/1757-899X/330/1/012120

[8] K.Nithya, "Investigation on Self Curing Concrete" , IJIRE Volume 12, June 2107

[9] K V S Gopalakrishnasastry, "Self-curing concrete with different self-curing agents", IOP Conf. Series: Materials Science and Engineering 330 (2018) 012120 doi:10.1088/1757-899X/330/1/012120

[10] SagarJamle "Use of Polyethylene Glycol as Self Curing Agent in Self Curing Concrete - An Experimental Approach" , November 2018

[11] K. Sumangala, M. BanuSulochana"A Review on Self Curing Concrete" review Papers ,Civil Engineering ,Volume 8 Issue 1, January 2019

[12] VaseemAkram.N(2018) "Experimental Study Of Self-Curing Concrete Engineering Science & Technology" Journal Volume 2, Issue 1, P. 1-19, March, 2020.

[13] Patel ManishkumarDahyabhai ," Review on - Self-Curing Concrete" Volume 8 Issue 1, January 2019

[14] Selvendiran, "Self-curing of concrete using Polyethylene Glycol 400 and Sanal fiber" international Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

[15] ShahzebKhuwaja "Early-Stage Performance of Self-Curing Concrete Using Poly Vinyl Alcohol" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 02 | Feb 2021 www.irjet.net p-ISSN: 2395-0072

[16] IS: 12269-1987 Specifications for 53-Grade Portland cement (New Delhi: Bureau of Indian Standards)

[17] IS: 383-1970 Specification for course and fine aggregates from natural sources for Concrete (New Delhi: Bureau of Indian Standards)

[18] IS: 10262-2009 recommended guidelines for concrete mix design (New Delhi: Bureau of Indian Standards)

[19] IS: 516:1959 Methods of tests for strength of concrete (New Delhi: Bureau of Indian Standards)

[20] IS 456 Plain and Reinforced concrete code of practice.