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Experimental Study on Strength Properties of Self Curing Concrete by Using Poly Ethylene Glycol as Self Curing Agent

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Abstract - *The present study involves the use of shrinkage reducing admixtures like Poly Ethylene Glycol 200 (PEG-200) as internal curing compound .This curing compound used in concrete which helps in self curing and helps in better hydration and hence good compressive strength. They trap the moisture within the structure and prevent it from evaporation which normally occurs due to the hydration process.. In the present study, the effect of curing compound on strength(compressive,flexural and splitting tensile). In this study, the percentage of PEG(0% to 1.5% by weight of cement) are studied for M40 and M30 mixes.Different test specimens of conventional concrete and self curing concrete are casted and tested in the laboratory .The properties can be compared with the help of different strength tests.*

Key Words: **PEG-200,Self curing concrete,compressive strength,flexural strength,splitting tensile strength.**

1.INTRODUCTION

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

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position or during the manufacture of concrete products, thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time days and even weeks rather than hours curing must be undertaken for a reasonable period of time.

1.1 Self Curing Concrete

Concrete is the second most consumed material in the world after water and it is used most widely in the construction industry due to its high compressive strength and durability.Conventional concrete (a mixture of cement, fine aggregate, coarse aggregate and water)needs proper curing and moisture contents for a minimum of 28 days for good heat of hydration and high strength. Lack of proper curing can badly affect the strength and durability.

Self-curing concrete is one type of special concrete which is mitigated insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete.

1.2 Advantages of Self-Curing (Internal Curing)

- Helps to overcome from deficiencies of external curing generated by both human and hydration.
- Helps to eliminate shrinkage (most probably autogenous shrinkage).
- Provides moisture contents to keep continue hydration of cement.
- provides the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.
- Increase/maintain the strength of concrete if the optimum dosage of self-curing admixtures is used.
- When properly applied, provides a premium-grade film, which optimizes water retention.
- Protects by reflecting the sun rays to keep the concrete surface cooler and prevent
  excessive heat buildup, which can cause thermal cracking.
- Offers a compressive strength significantly greater than improperly or uncured concrete.
- Improves resistance to the abrasion and corrosive actions of salts and chemicals.

1.3 PolyEthylene Glycol (PEG)

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180.The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the

water-soluble nature. Polyethylene glycol is non toxic, odourless, neutral, lubricating and non-volatile.

Fig1-: Polyethylene glycol 200

2. LITERATURE REVIEW

Shikha Tyagi (2015) in his study, the effect of curing compound on workability (slump and compaction factor) and compressive strength is studied. In this study the percentage of PEG by weight of cement from 0% to 2% as the dosage of internal curing compound was fixed .The test results were studied both for M25 and M40 mixes . It is found through this experiment study that PEG 400 help in self curing by giving strength on par with that of the conventional curing method and also improved workability. The optimum dosage of PEG400 for maximum strength was found to be 1% for M25 and 0.5%for M40 grade. As percentage of PEG400 increased slump increased for M25 and M40grades of concrete.

Vishnu Kumari M aim to compare strength of M30 grade concrete achieved by conventional curing method and self-curing method.The present study involves the use of shrinkage reducing admixture polyethylene glycol in concrete which helps in self-curing and helps in better hydration and hence strength.Both PEG-400 and PEG-200 are used in the study in 0% to 2% by weight of cement. The compressive strength of concrete mix increased by 12.04% by adding 1.0% of PEG 400 and 9.18% by adding 0.5% of PEG 200 as compared to the conventional concrete.The optimum dosage of PEG400 for maximum compressive strengths was found to be 1% of weight of cement for M30 grades of concrete. The optimum dosage of PEG200 for maximum compressive strengths was found to be 0.5% of weight of cement for M30 grades of concrete.

Patel Manish Kumar Dahyabhai,Prof. Jayesh Kumar R. Pitroda presented the results of an experimental investigation carried out to find out the effect of admixture (PEG400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% to 2% . M20 grade concrete is considered for the study.The study shows that PEG400 could help with self-curing by giving strength on par with conventional curing. It was also found that 1% of PEG400 by weight of cement was optimum for M20 grade concrete for achieving maximum strength without compromising workability. The test result indicates that use of water soluble polymers in concrete has improved performance of concrete.

Sreenivasa kumar A ,Dr.Suresh Babu T studied the effect of admixture (PEG-200) on compressive strength, split tensile strength at one percentage for M25 mix was studied and it compared with the properties of PEA(PolyEthylene Alcohol). Also studied the mechanical characteristics of concrete such as compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG and PEA from 0% to 2% by weight of cement of M25 grade concrete.He concluded that the optimum strength values for both the self curing agents were found and among both the agents PEG-200 is a best and good self curing agent because in the durability and normal compressive strength aspects it was giving good results when compared with both conventional concrete and PolyEthylene Alcohol (PAE). It was found that Poly Ethylene Glycol-200 is a good self curing agent when compared with Poly Ethylene Alcohol.

3.METHODOLOGY

3.1 Determination of Material Properties

- Cement – Specific Gravity, Standard consistency, initial setting time, Final setting time
- Fine Aggregates – Sieve analysis, Specific gravity, water content and water absorption, , Bulk density and Percentage voids
- Coarse Aggregates – Sieve analysis, Specific gravity, water absorption, Bulk density and Percentage voids,
- Super Plasticizer – Master Glenium SKY 8233
- Water

A. Mix Proportioning (M30 and M40)

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as possible. The mix design is carried out as per IS 10262:2000. M30 and M40 grades of concrete are adopted for the study.

B. Mix Preparation And Specimen Preparation

- Preparation of control mixes (M30 and M40)
- Preparation of concrete specimens with different percentages of PEG-200(0.5%,1%,1.5%) and find out the optimum percentage of PEG-200 for both mixes.

C. Tests

a) Fresh properties
- Slump Test
- Compaction factor test

b) Mechanical properties
- Compressive strength
- Flexural strength
- Splitting tensile strength

4. MATERIAL TESTING

4.1 Cement

An OPC 53 grade Dalmia cement was used in this study. The physical properties of the cement used were found based on the respective IS codes.

TABLE 1- :Properties of Cement

Sl.No	Property	Result
1	Specific gravity	3.125
2	Standard consistency	35%
3	Initial setting time	240 minutes
4	Fineness of cement	Residue 5%

4.2 Fine Aggregate

Aggregates are important constituents in concrete. Manufacture sand was used as fine aggregates.

TABLE 2-: Properties of Fine Aggregate

SL.NO	PROPERTY	MAGNITUDE AND UNIT
1	Specific gravity	2.69
2	Sieve Analysis	Zone II.
4	Bulk Density	1.22
5	Percentage Air Voids	54.44%
6	Water absorption	1.5%

4.3 Coarse Aggregate

Coarse aggregate with 20mm size was used for the study. The tests for specific gravity, bulk density, void ratio, % voids and water absorption were conducted as per IS 2386-1970.

TABLE 3- :Properties of coarse aggregate

Sl.No	Property	Magnitude and unit
1	Specific gravity	2.67
2	Water Absorption	0.8%
3	Bulk density of aggregate (kg/l)	1.4kg/l

5. 5. MIX PROPORTIONING

TABLE 4-: Mix Proportioning for M40 Grade Concrete

Mix grade	M40
Mix designation	CM40
Water-cement ratio	0.38
Cement	414kg/m^3
Fine aggregate	801kg/m^3
Coarse aggregate	1095kg/m^3
Chemical admixture	1.24
Water	178kg/m^3

TABLE 5- :Mix Proportioning For M40 Grade Concrete

Mix grade	M30
Mix designation	CM30
Water-cement ratio	0.45
Cement	350kg/m^3
Fine aggregate	850kg/m^3
Coarse aggregate	1105kg/m^3
Chemical admixture	0.7
Water	180kg/m^3

5.TESTING OF CONCRETE

5.1Compressive Strength Test

The compression test is carried out on a specimen cubical or cylindrical in shape. For compressive strength, cubes of size 150mm x 150mm x 150mm were casted.Cubes for compressive strength are tested at 3 day, 7 days, and 28 days using compression testing machine.

TABLE 6- :Average Compressive Strength Of CM40

Mix ID	Average compressive strength(N/mm2)		
	3-day	7-day	28-day
CM40	28.9	39.99	50.22

TABLE 7-: Average Compressive Strength Of CM30

Mix ID	Average compressive strength(N/mm2)		
	3-day	7-day	28-day
CM30	21.05	27.40	40.90

Mixes are prepared by adding PEG-200 in different percentages (0.5%,1%,1.5% by weight of cement) and 28 day strength values are tabulated below.

TABLE 8-: Compressive Strength Values Of M30 And M40 Mixes At Different % PEG-200

% PEG-200	Compressive strength(N/mm²)	
	M30	M40
0	40.9	50.2
0.5	44.8	53.5
1	44.1	52.9
1.5	43.6	52.7

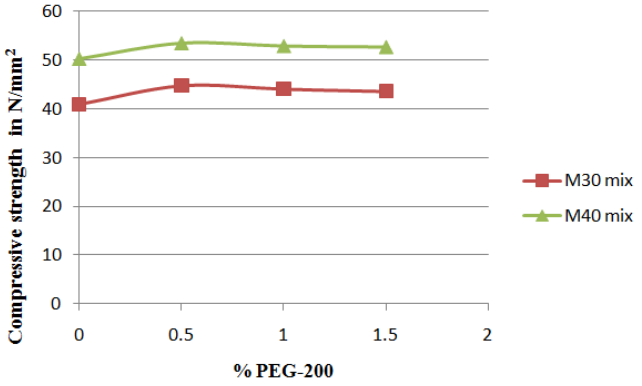

Chart 1- :Variation of compressive strength of M30 and M40 mixes with different % of PEG-200

The result shows that, for mixes with 0.5% PEG compressive strength increases at all ages compared with CM. The obtained value of compressive strength for the 0.5P30 and 0.5P40 mixes are more than the theoretical value. But by increase in % of PEG there is decrease in compressive strength. The optimum dosage of PEG-200 for maximum compressive strengths was found to be 0.5% of weight of cement for both M30 and M40 grades of concrete.

5.2 Flexural Strength

For flexural strength test, beams of size 100mm x 100mm x 500mm were casted and they were tested on 7 day and 28 day.

TABLE 9- :Average Flexural Strength for CM30

Mix ID	Average flexural strength(N/mm2)	
	7 day	28 day
CM30	7	9.15

TABLE 10- :Average Flexural Strength for CM40

Mix ID	Average flexural strength(N/mm2)	
	7 day	28 day
CM40	7.5	10.5

Mixes are prepared by adding PEG-200 in different percentages (0.5%,1%,1.5% by weight of cement) and 28 day strength values are tabulated below.

TABLE 11-: Flexural Strength Values Of M30 And M40 Mixes At Different % PEG-200

% PEG-200	Average flexural strength(N/mm2)	
	M30	M40
0	9.15	10.5
0.5	9.62	11.1
1	9.43	11.0
1.5	9.36	10.8

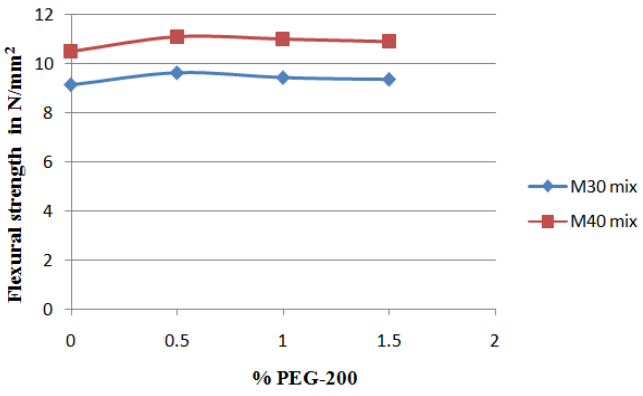

Chart 2-: Graph showing variation of flexural strength of M30 and M40 mixes at different % PEG-200

The result shows that, for mixes with 0.5% PEG flexural strength increases at all ages compared with CM. The obtained value of flexural strength for the 0.5P30 and 0.5P40

mixes are more than the theoretical value. But by increase in % of PEG there is decrease in flexural strength. The optimum dosage of PEG-200 for maximum flexural strength was found to be 0.5% of weight of cement for both M30 and M40 grades of concrete.

5.3 Splitting Tensile Strength

For Splitting Tensile strength test, cylinders of 150mm diameter and 300mm height were casted and they were tested on 7 day and 28 day.

TABLE 12- :Average Splitting Tensile Strength of CM30

Mix ID	Average splitting tensile strength(N/mm2)	
	7 day	28 day
CM30	1.6	2.8

TABLE 13- :Average Splitting Tensile Strength of CM40

Mix ID	Average splitting tensile strength(N/mm2)	
	7 day	28 day
CM30	2.26	3.2

Mixes are prepared by adding PEG-200 in different percentages (0.5%,1%,1.5% by weight of cement) and 28 day strength values are tabulated below.

TABLE 14- :Splitting Tensile Strength Values Of M30 And M40 Mixes At Different % PEG-200

% PEG-200	Splitting tensile strength(N/mm2)	
	M30	M40
0	2.8	3.2
0.5	3.2	3.52
1	3.1	3.45
1.5	3.0	3.3

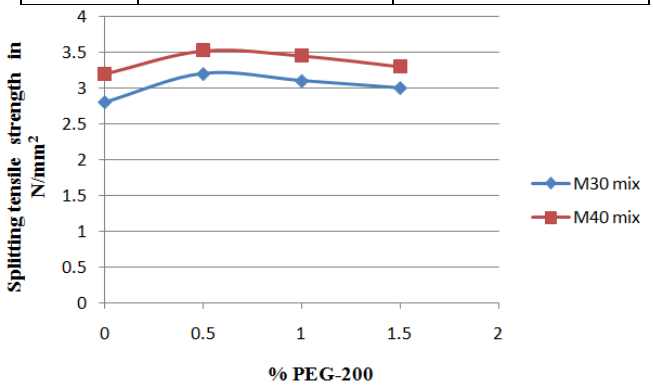

Chart 3-: Variation of splitting tensile strength of M30 and M40 mixes with different % of PEG-200

The result shows that, for mixes with 0.5% PEG splitting tensile strength increases at all ages compared with CM. The obtained value of splitting tensile strengths for the 0.5P30 and 0.5P40 mixes are more than the theoretical value. But by increase in % of PEG there is decrease in splitting tensile strength.The optimum dosage of PEG-200 for maximum splitting tensile strength was found to be 0.5% of weight of cement for both M30 and M40 grades of concrete.

6.CONCLUSIONS

Based on the investigation conducted for the study of behavior of self -cured concrete the following conclusions are arrived.

1. The optimum value of PEG 200 for M30 and M40 mixes are obtained as 0.5% by weight of cement.
2. The result found out for specimen contains PEG-200 shows better strength than conventional mixes in compressive, split tensile, and flexural strengths.
3. The compressive strength was increased upto 9.5% at 0.5% PEG for M30 mix and 6.57% for M40 mix.
4. The splitting tensile strength was increased upto 14.28% at 0.5%PEG for M30 mix and 10% for M40 mix .
5. The flexural strength was increased upto 5.13% at 0.5% PEG for M30 mix and 5.76% for M40 mix.
6. The usage of PEG 200 helped to overcome the scarcity of water.
7. By the usage of optimum level of PEG 200 the strength of concrete has increased.
8. PEG 200 provides the water to hydrate all the cement, accomplishing what the mixing water alone cannot do and that's why there is increase in strength properties of self curing concrete.
9. Normally large amount of water is required for curing purpose.Here that can be saved by using PEG 200.
10. From both the workability tests (Slump test and compacting factor test), it is evidentthat as the percentage of PEG increases workability also increases.So PEG has an influence on workability of concrete.

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