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A Study on Mechanical Properties of Self Curing M65 Grade Concrete by Using Polyethylene Glycol

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Abstract:
Today concrete is most generally utilized development material in the world due to its strength and durability properties. Since the concrete is open to atmosphere, the water used in concrete evaporates and the water available in the concrete will not be sufficient to effective hydration. To attain good strength, curing of concrete is important so we introduce the concept of self curing to avoid the water scarcity. Self curing concrete is one type of concrete, which cure itself by retaining water in it. It was observed that water solvent polymers can be utilized as a Self curing agent, i.e. Polyethylene Glycol (PEG-400). Shrinkage reducing agent s like Polyethylene Glycol and Light weight aggregates such as Fly ash are used to achieve effective curing results. In this project we investigate the behaviour of concrete while replacing Fly ash in different proportions. The cement has been replaced with fly ash in the range of 20%, 25% and 30% by weight of M65 grade of concrete. In this we are using high strength concrete of M65 grade. High performance concrete is used to study the influences of water binder ratio, composition of setting and the influence of strength, slump and air content in the material. It will give optimized performance quality for the given set of materials, usage requirement of cost, service life and durability. The property such as Compressive strength and Split Tensile strength of concrete was examined with normal curing and self curing at 28 days for M65 grade of concrete.

Key words: Polyethylene Glycol (PEG-400), Fly ash, Compressive Strength, Split Tensile Strength, M65 grade

1. INTRODUCTION

Curing of concrete plays major role in improving the strength and hardness of concrete, which leads to development in durability and performance. The rate of reactions influences the properties of the hardened concrete. The concrete attain its strength through a series of chemical reactions, known as hydration. Proper curing of concrete structure is significant to meet performances and durability requirements. It can be either after it has been placed in position or during the produce of concrete products thereby providing time for the hydration of the cement to occur. Curing is the process of controlling the rate and extends of moisture loss from concrete during cement hydration. Curing may also encompass the control of temperature since this affect the rate at which cement hydrates. Construction industry needs a lot of water in the name of curing. The days are not so far that all the construction industry has to change over to an another curing systemizes, not only to save water for the sustainability growth of the environment but also to support the indoor and outdoor construction activities even in remote areas where there is scarcity of water. The advantages of internal curing are plentiful and consist of better hydration process, strength development, reduced autogenous shrinkage, cracking, reduced permeability and increases durability. For better performances and durability of concrete curing is necessary. The method uses Polyethylene glycol which reduces the evaporation of water from the surfaces of concrete and also helps in water retention. Self curing provides additional moisture in concrete for have better performance and durability. By comparing with conventional concrete the self curing decreases the water evaporation, increase the retention capacity of concrete and also it prevents early age cracking. Self curing is essential for desert area where the ease of use of water is very less or not available so it can help to have an economical construction. In addition to the normal concrete mix various additional compounds in proper dosage and materials such as fly ash is used to increase the durability and strength of concrete mix.

1.1. HIGH STRENGTH CONCRETE

High strength concrete is purely defined based on the compressive strength. High performance concrete is a term used to describe concrete with special properties attributed to normal concrete. High performances mean that the concrete has one or more of the following properties i.e. Low shrinkage, Permeability, a high modulus of elasticity or high strength. High performance concrete is the concrete that meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing and curing practices. High strength concrete can resist loads that normal strength concrete cannot. It is a concrete with a compressive strength class higher than C 50/60. It is made by lowering the water-cement ratio to 0.35 or lower. To compensate for the reduced workability, Super plasticizers are commonly added to high-strength mixtures.

1.2. FLY ASH

Fly ash is the fine powder collected from the exhaust gases from the combustion chambers of the boilers of power stations that burn milled or pulverised coal. Fly ash is known as pulverised fuel ash. The most important properties of fly ash are Fineness, loss of ignition, chemical composition, uniformity of these properties. Fineness is important as it affects the pozzolanic reactivity of the fly ash, the ability of the fly ash to fill voids in the concrete matrix and improvement of workability and pumpability of the concrete. the quality of fly ash is dependent on the coal type, burning conditions and method of collection

1.3.POLYETHYLENE GLYCOL

In this project we are using Polyethylene Glycol as Self curing agent Polyethylene Glycol is a liquid state polymer of ethylene oxide and water. The structure of Polyethylene glycol is expressed as H $(OCH_2CH_2)_n$ OH. The abbreviation indicates average molecular weight and n refers to oxyethylene group. The common feature of Polyethylene glycol appears to be water-soluble nature. Polyethylene glycol is non-toxic, odourless, neutral lubricating, on-volatile and used in manufacturing of medicines. It is a clear colourless, viscous liquid.

1.4. ADVANTAGES OF SELF-CURING

It is an alternate construction in desert regions where major scarcity of water is there. Provides water to keep the relative humidity high, keeping self desiccation from occurring. Eliminates largely autogenously shrinkage. Reduces autogenously cracking. Increase the strength of concrete in some extent. Largely eliminates autogenously shrinkage. Reduces Permeability. Protects reinforcement steel.

2. LITERATURE REVIEW

Sona K. S et.al (2015)[1] studied internal curing techniques that can be used to provide additional moisture in concrete for effective hydration of cement. The effect of variations in strength parameters i.e., compressive strength and split tensile strength were studied. The optimum dosage of PEG-400 for maximum compressive strength , split tensile strength was found to be 0.5% weight of cement for M60 and M65. He also determine self curing concrete was the best solution to the problems faced in the desert region due to lack of proper curing. **Dahyabhai et.al** (2014)[2] carried out the study on self curing concrete. Compressive strength of self curing concrete is increased by adding self curing admixtures. The optimum amount of PEG-400 for maximum effective compressive strength was found to be 1% of weight of cement for M65 grade of concrete. Self curing concrete is the best solution to the problem faced in the desert region due to lack of proper curing. **Edward and Charles** (2001)[3] studied the strength and durability response of cement replacement mixtures containing fly ash. It is concluded that concrete mixtures replacing by 20% and 30% of portland cement with pozzolans and alternative compressive strength of 100 MPA at age of 90 days.
Roland Tak Yong Liang, Robert Keith Sun (2003)[4] studied on internal curing composition for concrete which includes a polyethylene glycol. The invention provides for the first time an internal curing composition which was added to concrete.
Aitcin (2002)[5] describes about High performance concrete, it is a concrete, which acquire high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementitious material such as fly ash, silica fume or ground granulated blast furnace slag and commonly a super plasticizer. The term ' high performance' is rather exaggerated because the vital feature of this concrete is that its ingredients and proportions are exclusively chosen so as to have mainly appropriate properties for the normal use of the structure such as high strength and low permeability.

3. MATERIAL TEST

Cement

Normal Consistency of Cement is 30%

- Initial Setting time of Cement is 55 Minutes
- Final Setting time of Cement is 461 Minutes
- Specific Gravity of Cement is 3.15

Coarse Aggregate

1) Fineness modulus of Coarse Aggregate is 6.0
2) Specific Gravity of Coarse Aggregate is 2.69
3) Aggregate Crushing value of Coarse Aggregate is 19.68%
4) Aggregate Impact value is 16.38%
5) Los Angeles Abrasion Value is 32.26%
6) Bulk density on Coarse Aggregate without compaction is 1363.76%
7) Bulk density on Coarse Aggregate with compaction is 1478.22%

Fine Aggregate

1) Specific Gravity of Fine Aggregate is 2.61
2) Bulk density on Fine Aggregate without compaction is 14.25%
3) Bulk density on Fine Aggregate with compaction is 16.11%
4) Fineness Modulus of Fine Aggregate is 5.127
5) Percentage of bulking occurred is 16.66%

4. Mix Design

SIPILATION FOR PROPORTIONING
Grade of Designation: M65
Type of Cement: OPC 53 grade
Maximum size of aggregate: 10 mm
Water Cement ratio :0.34
Exposure condition :Severe
Method of concrete placing : Pumping
Type of the aggregate: Crushed angular aggregate
Degree of Supervision :Good

Step1: -
Target Strength for mix proportioning
Target Main strength
Fck' = Fck + (1.65 * s) S=6 N/mm2
(Standard Deviation) The experience has shown that Strength Tested under Ideal Field Conditions attain only 90% Strength
Fck' = [Fck + (1.65 * S)] / 0.9
Fck' = [65 + (1.65 * 6)] / 0.9 (Fck=65)
Fck' = 74.9/0.9 (S =6)
Fck' = 83.22 N/mm2

Step2:-
Slump
Slump =25to50mm (HRWR is added)(As per ACI 211.4R-93 Table 4.3.1)
Slump=50to100mm (HRWR is not added)
Adjust slump to that desired in the field through the addition of HRWR

Step3:-
Maximum Size of Coarse Aggregate
Strength < M60 → 20-25mm
(As per ACI 211.4R Table 4.3.2)
> M60 → 10-12.5mm
When Strength increase the size of Coarse aggregate decreases
Maximum Size = 10mm

Step 4:-
Recommended Volume of Coarse aggregate per unit volume of concrete
10mm → 0.65(As per ACI 211.4R-93 table 4.3.3)
Weight of Coarse aggregate
= Unit Volume of Coarse aggregate * Bulk density of Coarse aggregate
= 0.65 * 1484.35
Weight of Coarse aggregate = 964.827 Kg/m3

Step 5:-
Mixing water [for35% voids in Sand] (As per ACI 211.4R-93 table 4.3.4)
For Slump 2 to 3 in (50 - 75 mm)
Maximum Size of Coarse aggregate for 10mm = 320 lb/yd
= 320 * 0.59
(1Lb/yd3 = 0.59Kg/m3) = 188.8 Kg/m3
Mixing Water Adjustment (Lb/yd3)
=(V-35)*8 = (33- 35) * 8 Voids of Fine aggregate = 33%)
= (-2) * 8
= - 16 Lb/yd3
(1Lb/yd3 = 0.59Kg/m3)

= -16 * 0.59
= -9.44 Kg/m3
Water content = 188.8 - 9.44
= 179.36 Kg/m3

Step 6:-

Calculation of Cement weight
W/C for 28 days ⟶ 0.25 (As per ACI 211.4R-93 table 4.3.5(a))
w/c=0.34
c=w/0.34
c=179.36/0.34
Cement Weight c = 527.53

Step 7:-

Calculation of volume
Cement = Cement weight / (Specific gravity of Cement * Density of water)
= 527.53 / (3.15 * 1000)
Cement = 0.167
Coarse aggregate = Coarse aggregate weight / (Specific gravity of Coarse aggregate *Density of water)
= 964.827 / (2.62 * 1000)
Coarse aggregate = 0.368
Water = Water weight / (Specific gravity of Water * Density of water)
= 179.36 / (1 * 1000)
= 0.17936
Volume = Cement + Coarse aggregate + Fine aggregate
= 0.167 + 0.368 + 0.179
= 0.714
Total Volume of Fine Aggregate = 1 - Volume – Air Content = 1 - 0.714 - 0.02(Air Content = 0.02) Volume of Fine Aggregate = 0.266
Weight of Fine aggregate= Volume of Fine aggregate * Specific Gravity of Fine Aggregate * 1000
= 0.266 * 2.455 * 1000
Weight of Fine aggregate = 651.7

Mix Proportions

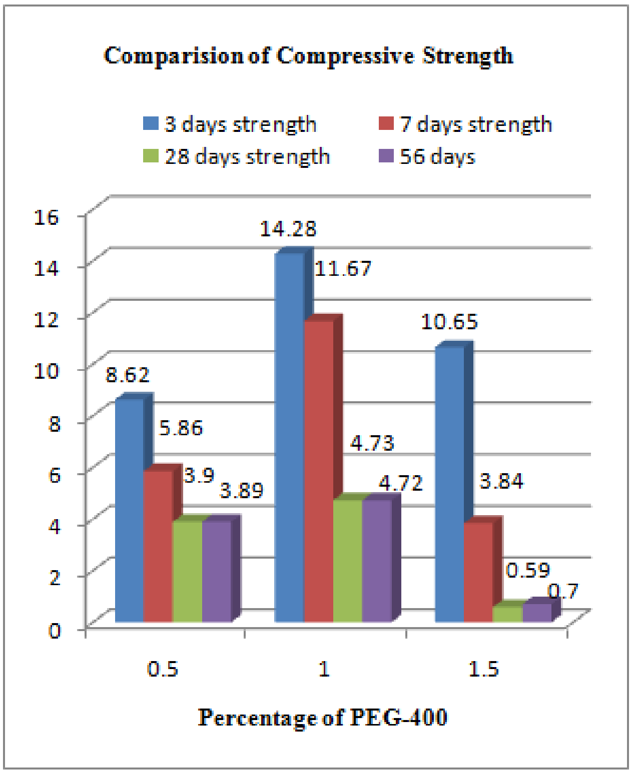
Cement	=527.53Kg/m^3
Fine Aggregate	=651.70Kg/m^3
Coarse Aggregate	=964.82Kg/m^3
Water	= 179.36 Kg/m^3

4. Test Results

COMPRESSIVE STRENGTH RESULTS

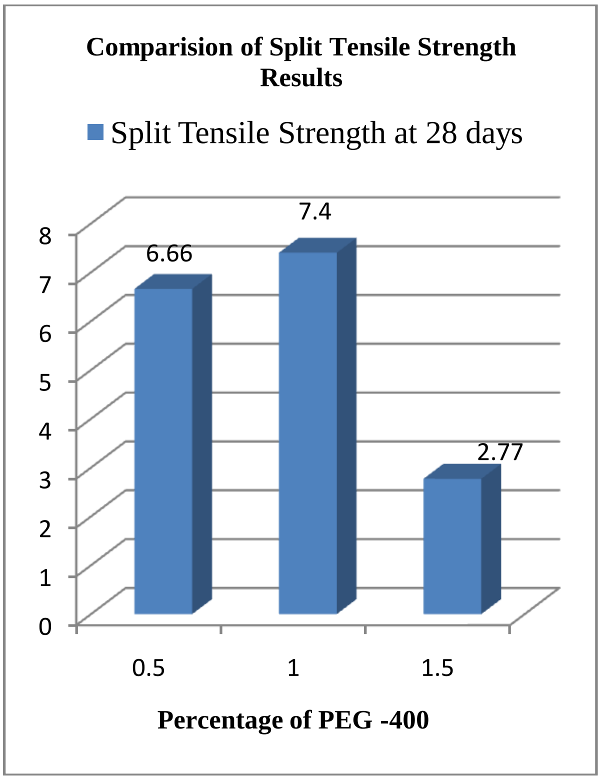
Sl no	Type Of Concrete	3days Strength (N/mm^2)	7days Strength (N/mm^2)	28days Strength (N/mm^2)	56days Strength (N/mm^2)
1	Normal Concrete	35	52	84.5	84.7
2	PEG- 400 (0.5%)	38.02	55.05	87.8	88
3	PEG- 400 (1.0%)	40	58.07	88.5	88.7
4	PEG- 400 (1.5%)	38.73	54	84	84.1

By considering the above strength results Conventional concrete is compared with PEG-400 and the results are shown in the graph



Sl no	Type Of Concrete	28days Split Tensile Strength (N/mm^2)
1	Conventional Concrete	5.4
2	PEG- 400 (0.5%)	5.76
3	PEG- 400 (1.0%)	5.8
4	PEG- 400 (1.5%)	5.55

By considering the above strength results Conventional concrete is compared with PEG-400 and the results are shown in the graph



5. CONCLUSIONS

Based on the experimental investigations, mechanical properties of concrete like compressive strength and tensile strength behaviour of Self curing concrete by using Polyethylene glycol (PEG-400). The following conclusions are drawn

- The compressive strength of Self curing concrete increases by adding Polyethylene Glycol (PEG-400) was found to be 11.67 % at 1% dosage for 7 days when compared to the conventional concrete.
- The compressive strength of Self curing concrete increases by adding Polyethylene Glycol (PEG-400) was found to be 4.73 % at 1% dosage for 28 days when compared to the conventional concrete.
- The compressive strength of Self curing concrete increases by adding Polyethylene Glycol (PEG-400) was found to be 4.72 % at 1% dosage for 56 days when compared to the conventional concrete.
- The Split tensile strength of Self curing concrete increases by adding Polyethylene Glycol (PEG-400) was found to be 7.40 % at 1% dosage for 28 days when compared to the conventional concrete.
- It is observed that the optimum dosage of Polyethylene glycol (PEG-400) for M_{65} mix concrete is found to be 1 %

6. REFERENCES

[1].ACI Committee 305R-99 "Hot Weather Concreting", Reported by ACI Committee 305, ACI Manual of concrete Practise, 2009.

[2].ACI Committee 211.4R-93 "Guide for selecting proportions for High-strength concrete with Portland Cement and Fly ash", Reported by ACI Committee 211, ACI Committee Report,1993.

[3].Mohammed Shafeeque, Strength comparison of Self-curing concrete and normal curing concrete, SSRJ-IJCE, Volume 3 Issue 3, 2016

[4]. Navinderdeep Singh, A Review paper on Self curing Concrete, IRJET, Volume 5 Issue 1, 2018

[5].Dhruv Vyas, Self-Curing Concrete, IJEDR, Volume 5 Issue 1, 2017

[6].Shikha Tyagi, An Experimental study of self curing concrete incorporated with Polyethylene glycol as Self curing agent, IRJET, Volume 2 Issue 6, 2015

[7].A. Karthik, study on uncontrolled properties of fly ash-ground granulated blast furnace slag depend on self curing concrete, Elsevier1 49 338-349, 2017

[8]. I. Mousa, Physical properties of Self curing concrete, HBRC 11, 167-175, 2015

[9].Ahmed H. Abdel-Reheem, Mechanical properties of self curing concrete, HBRC 11, 311-320, 2015

[10].Stella Evangeline, Self curing concrete and its Inherent properties, volume 4 issue 8, 2014