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Effect of Polyetheylene Glycol (PEG) as Curing Agents in Concrete

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***Abstract*—Concrete is the most widely used construction material. Depending upon the nature of work, the constituent materials such as cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce concrete. Concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. The problems can occur in not practicing of proper curing techniques which can affect in the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence and inaccessibility of structures in difficult terrains. In the present study, the effect of admixture such as Poly Ethylene Glycol (PEG) are studied with proportions of PEG 0-2% in M_{25} grade of concrete. The comparison of strength properties of normal concrete and concrete mix with effect of admixture is studied.**

***Index Terms*— Curing, Self-curing concrete, Poly-Ethylene Glycol (PEG).**

I. INTRODUCTION

Concrete is the most appropriate production material used broadly all over the world for the construction of engineering works. It plays an essential role in shaping our surroundings and sustainability of production industry. Efforts to enhance the residences of concrete are continuously being made with the aid of researchers. In the final decade, the trouble of curing has led to the drastic reduction inside the power and sturdiness of concrete. When cement is introduced to water, hydration response occurs and this hydration system is essential for hardening of concrete. Curing is the method to keep away from moisture content deficiency from concrete all through the process of hydration. Effect from curing has a strong impact on the characteristics of hardened concrete such because it will increase the sturdiness or durability, quantity stability, abrasion resistance, strength, impermeability and resistance to freezing and thawing. If water isn't provided then shrinkage of concrete takes vicinity which leads to cracking. Internal curing provides a modern twist on good curing practice by providing water to the cementitious matrix after setting and it improves the performance of concrete by increasing the reaction of the cementitious materials. This can be achieved by adding certain admixtures to the concrete. Use of PEG admixtures may be very useful from the factor of view that water assets are becoming valuable each day. It is not possible to provide curing by external supply of water from top surface at the rate required to satisfy the ongoing chemical shrinkage. The polymers added in the mix mainly form hydrogen bonds with water molecules

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and reduce the chemical potential of the molecules which in turn reduces the vapour pressure. Internal curing is especially beneficial for mixtures containing high volumes of supplementary cementitious materials that may require longer times to hydrate.

II. Literature Review

Dayalan J, investigated on-Compressive Strength and Durability of Self Curing Concrete, the objective was to determine the weight loss and physical properties of self-curing concrete and to determine the compressive, split tensile and flexural strength of SCC. The result is use of SAP (0.48% by the weight of cement) as self-curing agent Provides higher compressive, tensile as well as flexural strength than the strength of conventional mix. **Ahmad Mustafa Sabaoon, Navinder deep Singh,** investigated on-A Review Paper on Self Curing Concrete, from studying of many papers it found that strength of self-curing concrete is more than conventional concrete. The results as a self-curing agent the PEG is a good admixture and by adding of 1% of this admixture the concrete had good result on addition of 2% the strength reduced. **Kaustuv Sarkar, Bishwajit Bhattacharjee**, investigated on-Application of SAP and PEG as curing agents for ordinary cement-based systems, the use of SAP and PEG as curing agents for ordinary cement-based system with water-to cement ratio of 0.4 and above has been investigated. The results are doses of SAP distinctly improve water retention. Higher SAP and PEG dosages improve the degree of hydration of cement.

III. Materials and their Properties

The following are the materials used,

A. Cement

The cement used was OPC-53 grade cement which conforms to the specifications of IS:12269-1987. The properties of the cement are shown in Table.I.

Table I. Properties of Cement

Sl. No	Tests performed	Results
1	Specific Gravity	3.13
2	Initial Setting Time	35 minutes
3	Final Setting time	275 minutes
4	Consistency	31%

B. Fine Aggregate

The fine aggregate used was manufactured sand (M-sand). The fine aggregate confirming to zones is IS: 383-1970. The properties of the Fine Aggregate are shown in Table.II.

Table II. Properties of Fine Aggregate

Sl. No	Tests performed	Results
1	Specific Gravity	2.65
2	Fineness Modulus	3.60
3	Moisture Content	1%

C. Coarse aggregate

Crushed stone was used as Coarse Aggregate confirming to IS: 383-1970. Maximum coarse aggregate size used was between 10-20mm. The properties of the coarse aggregate are shown in Table.III.

D. Admixture- Poly-Ethylene Glycol (PEG)

Poly Ethylene Glycol (PEG) is a water-soluble linear polymer created by the additional reaction of ethylene oxide along with mono-ethylene glycol or diethylene glycol forms into poly-ethylene glycol. The generalised

TABLE III. PROPERTIES OF COARSE AGGREGATE

Sl. No	Tests performed	Results
1	Specific Gravity	2.8
2	Moisture Content	0.1%
3	Impact Value	14.1%
4	Crushing Strength	25%

forms of the poly-ethylene glycol are H(OCH2CH2) nOH. The term 'n' refers to the number of repeating ethylene oxide groups. There are many ranges of products providing the flexibility in choosing the properties of the product as per the need of requirements. In this particular experiment the PEG-400 was used, where 400 is the distribution of the polymers of varying molecular weights with an average of 400 in the product. The main common features of PEG are that they are odourless, non-volatile, non-toxic, non-reactive(neutral). They mainly used widely in the pharmaceutical products.

TABLE IV. PROPERTIES OF ADMIXTURE

PEG -Poly Ethylene Glycol
Carbon compound containing Ethylene Oxide group
Colourless
pH: - 5 to 7

IV. EXPERIMENTAL INVESTIGATIONS

The experiment consists of the process of design the concrete mix as per the Indian Standards (S: 10262-2009). After the process of designing the mix proportions, then was the addition of the self-curing admixture in certain proportion to the concrete mix. PEG was added in the proportions of 0.5%,1.0%,1.5%,2.0%. The Table 5 represents the mix design for the M25 grade concrete. The materials for the concrete i.e., cement, fine aggregate, coarse aggregate and the self-curing agents were mixed at the dry state before addition of the water. Then the calculated amount of water was added to it and thoroughly mixed to have a homogenous mix. The slump factor test was conducted as per the IS code for the concrete mixes in order to know the workability of the concrete mix. The specimen was casted to the respective Indian Standards. For the compressive test procedure, the specimens were casted to the size of 150x150x150mm typical size cubes. For the split tensile test, the specimens were casted in the size of cylinders of 150mm in diameter and 300mm in height. All the specimens were tested in the same testing machine.

V. MIX DESIGN

The mix design was designed for M_{25} grade concrete done according to the IS 10262:2009 design method to obtain the optimum mix. Since the mix design for the optimum mix was determined. It was used to produce concrete with varying percentage of admixtures that was to be added to the concrete mix. The percentages were that of 0.5-2% of Poly-Ethylene Glycol (with the increase of 0.5%) in the concrete mixes. The weight of the admixtures added are the percentage dosages to the weight of cement in concrete mixes. The mix properties are kept constant for all the varying dosages of 0.5,1.0,1.5,2.0% of PEG-400 mixes into the mixes.

VI. RESULTS AND DISCUSSION

The test results show that a very small increase in compressive strengths and spilt tensile strengths were observed with the addition of PEG in different percentages. Though the increase in strengths were very small, it was observed that the admixtures involve complete internal curing of the concrete and helps to achieve a strength very nearer to the full strength of conventional normal concrete as the reference mix.

TABLE V. MIX PROPORTIONS FOR POLY-ETHYLENE GLYCOL

Mixes	CC	Mix-1	Mix-2	Mix-3	Mix-4
PEG- % of Cement	0	0.5	1.0	1.5	2.0
Cement	394	394	394	394	394
Fine aggregate	790.55	790.55	790.55	790.55	790.55
Coarse aggregate	1063.1	1063.1	1063.1	1063.1	1063.1
Water	197.16	197.16	197.16	197.16	197.16

A. Slump Test

Increasing the percentage of admixture PEG, the slump value is found to increase and the value is more than that compared with conventional concrete.

B. Compressive Strength

According to the IS standards the compressive strength test was conducted for the ages of 7 and 28 days of specimen of 150x150x150mm size. The observation was that the maximum value of the strength was obtained at the optimum dosages of 1% of PEG.

TABLE VI. COMPRESSIVE STRENGTH VALUES FOR MIXES WITH PEG

MIX-TYPE	PEG (%)	COMPRESSIVE STRENGTH (N/mm2)	
		7 days	28 days
NC	0	21.85	32.625
MIX - 1	0.5	22.7	34.25
MIX – 2	1.0	23.15	35.01
MIX – 3	1.5	22.23	32.32
MIX - 4	2.0	20.52	30.62

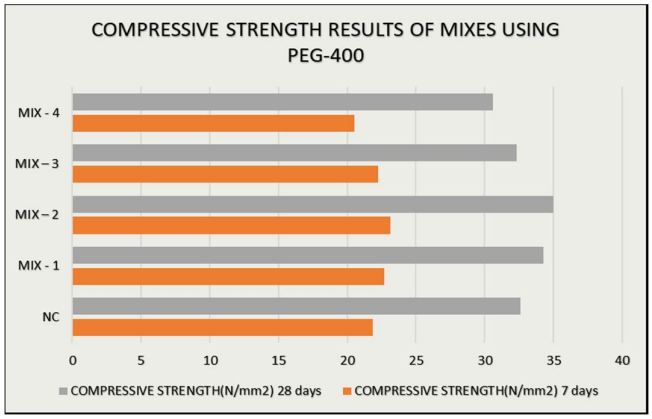

Fig.1: Compressive strength results of Mixes with PEG

C. Split Tensile Strength

The split tensile strength test was conducted in accordance with the IS standards on the cylindrical specimens of 150mm diameter and 300mm in height. These tests are conducted for the ages of 7 and 28 days. The observation is that the maximum value of the strength was obtained at the optimum dosage of 1% of PEG.

TABLE VII. TENSILE STRENGTH VALUES FOR MIXES WITH PEG

MIX-TYPE	PEG (%)	TENSILE STRENGTH (N/mm2)	
		7 days	28 days
NC	0	1.63	2.36
MIX - 1	0.5	1.71	2.45
MIX – 2	1.0	1.81	2.53
MIX – 3	1.5	1.62	2.42
MIX - 4	2.0	1.61	2.29

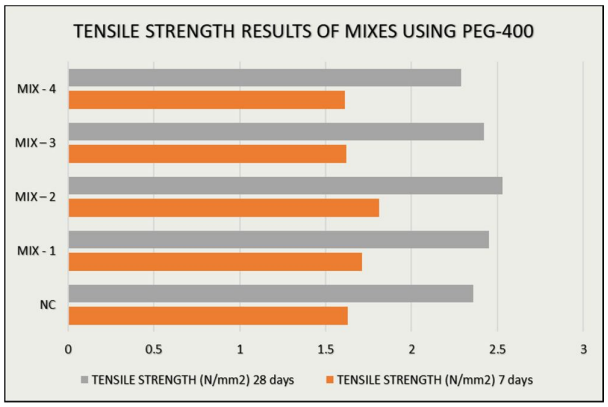

Fig.2: Tensile strength results of Mixes with PEG

VII. CONCLUSIONS

The examination explored the practicality of executing a high atomic mass PEG as restoring admixtures for normal cementitious mixes, in view of the exploratory perceptions,

- The self-curing admixtures as PEG in the concrete mixes helps to increase the properties of the concrete of which due to good water retention.
- The optimum dosage of polyethylene glycol PEG-400 (expressed in percentage by weight of cement) for M25 grade concrete was to be at 1%.
- The further increase of the in the dosages with the concrete mixes tends to the depletion of the strength of the concrete mixes.
- It is observed that as grade increases workability decreases in self-curing concrete mixes. Similarly, as dosage of polyethylene glycol (PEG) increases, workability increased.
- There is a significant increase (at optimum dosages) in the compressive, split-tensile strength properties self-curing concrete mixes at all ages of curing when compared to normal externally cured concrete mixes.

SCOPE FOR FUTURE WORK

- It can become a new practice in construction field of replacing conventional concrete with internally cured concrete to skip curing process.
- Additional field trials are underway to examine the potential use of internally curing of concrete and it can become a new practice in construction field of replacing conventional concrete with internally cured concrete to skip curing process.
- It can be used for normal concrete, light weight concrete as well as high strength concrete. More of research can be done such as self-compacted internally cured concrete.

- Research on internally cured concrete in hot and cold weather condition can be done. That is mainly in case of construction of rigid pavements.

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