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A Review on Impact of Polyethylene Glycol in Self Curing Properties of Concrete

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Abstract – *A Concrete is one of the most used material in the world. For its construction and curing large amount of water is utilized daily, and a lot of water get wasted and results in shortage of water. So the concept of self cuing comes into role. Curing plays very vital role in attaining the required characteristics of concrete strength and durability. Different materials and methods are suggested for this purpose. A polyether compound Polyethylene glycol derived from petroleum is hydrophilic in water. In concrete it makes hydrogen bond with the water and reduces the surface tension of water. Which leads to lowering the evaporation rate of water from concert and enhance the better hydration of cement. Addition of Polyethylene glycol also lower the plastic shrinkage in early age of concrete and result in better durable concrete enhancing mechanical properties. An overview of various published research of addition of Polyethylene Glycol in concrete and its impact on self curing properties, mechanical properties, are given in this paper.*

Key Words: **Self Curing, Polyethylene Glycol, Compressive strength, Flexure strength, Split tensile strength, Workability**

1. INTRODUCTION

Conventionally, curing the concrete means creating conditions such that water is not lost from the surface, which means curing is ought to happen from the outside to inside. Whereas in case of internal curing we are allowing curing from the inside to outside in the form of light weight aggregates, wood fibres and superabsorbent polymers as internal reservoirs which stores water in them. This Internal curing is often known as Self-curing. If the water is not readily available various failures like cracking may occur in the concrete. Internal curing refers to the process in which the hydration of cement occurs due of the availability of additional internal water that is not part of mixing water. In the process of cement hydration there is chemical shrinkage and empty pores are created within the cement paste which leads to reduction in its relative humidity and also to shrinkage which may cause cracking. It is not easy to provide curing water from the top surface at the required rate so that it can satisfy the ongoing chemical shrinkage due to extremely low permeability often achieved. Thus we use self-curing concrete.

Curing does not mean application of water, it also means creation of condition for promotion of uninterrupted and progressive hydration. The process in which the hydration of cement occurs due of the availability of additional internal water that is not part of mixing water is known as Internal Curing or Self-Curing.

Poly Ethylene Glycol is a chemical admixture which is water soluble. $C_{2n}H_{4n+2}O_{n+1}$ is the chemical formula of Polyethylene glycol. Depending upon the requirement different weight polyethylene glycol are there. Mostly PEG400 and PEG600 are there. Mostly PEG400 is used in concrete. Polyethylene Glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. Thus, it is a shrinkage reducing admixture. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules of water which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface potential of the molecules of water which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface.

2. Literature Review

Vikram M B , Vijay B V , Deepak Kumar , Rashmi R Ghali (2014) [1] In this study it was evaluated that for M25 grade of concrete the optimum dosage of PEG400 is 1% by weight of cement and for PEG600 the optimum dosage is 1%. The concrete with self curing showed better performance in compressive strength than conventional concrete. As compared to conventional concrete, self cured concrete was found less porous. From this study they concluded that for water deficient areas self curing concrete is the better option that normal concrete.

Ramalingam Malathy et al. (2020) [2] This paper presents an attempt of using bio materials namely Spincea oleracea (S. oleracea) & Calatropis gigantea internal curing agents in concrete. To confirm the presence of hydroxyl or ether group in S.oleracea like PEG for water retention, UV–visible and FT-IR studies are carried out on these plant extracts. To evaluate their internal curing property, FT-IR, XRD and SEM analysis are carried out on M20 grade fly ash based concrete powder sample. The

performance of polyethylene glycol is lower than the performance of S. oleracea but higher than the conventional water curing. This method of using self curing agents is very useful in pre fabrication units and in severe weather exposed conditions. During the construction work, if the self-curing agent is added to concrete there is no need of any manual care and maintenance. The bio admixtures are cost effective and eco-friendly and hence can be tried in concrete road pavements for which no water curing is required after laying

Sri Rama Chand Madduru et al. (2020) [3] The parameters in this study include type of curing chemical (Polyethylene Glycol 400, Liquid Paraffin Wax), dosage of curing chemical (0%, 0.1%, 0.5% and 1.0%) and curing temperature 27^0 C and elevated temperature is 60^0C. The performance of curing chemicals was determined by conducting tests, compressive strength, split tensile strength, flexural strength and rapid chloride permeability test. It was concluded that both curing chemicals performed better at both curing temperature conditions compared to no cured specimen. From the study it was concluded that the optimum dosage of Polyethylene Glycol and Liquid Paraffin Wax is 1.0% and 0.1% by weight of cement respectively.

Awham M. Hameed et al. (2017) [4] Studied the impact of addition of PEG400 and Polyacrylamide blend (PEG/PAA) on cement mortar. These additives alter the physical and mechanical properties of cement mortar. The studies demonstrate that polymer modified mortar possesses higher strength compared to reference mortar. Mortar with 1% and 3 % of PEG400 and (PEG/PAA) dosage gives higher compressive strength, as compared to conventionally cured mortar. It has been observed during testing, internally cured mortar PEG400 and (PEG/PAA) demonstrates lesser cracks than the mortar. Addition of PEG400 and (PEG/PAA) effectively enhances its tensile and flexural strength. Hence, PEG400 and (PEG/PAA) modifier can be a good candidate for infrastructure utilizes particularly those subjected to the flexural stress and interface shear stress, such as bridge overlays and pavements

Rizzuto, Joseph P., et al (2020) [5] In their study they performed experiment on self curing admixture role in concrete properties in hot climate conditions 40 to 50^0 C. For such region concrete curing was very difficult and also there was be rapid loss of water due to evaporation. The admixture PEG 400 in concrete resulted in an increase in workability of the fresh concrete along with the compressive strength, tensile and flexural strengths in comparison with normal concrete under all conditions. The mechanical properties for the concrete made with dry mate martials mixed at 50^0 C were inferior to those when the dry materials were mixed at 25^0 C. However, samples with PEG 400 were less affected by the increase in the dry materials temperature. The improved performance of the PEG 400 samples especially at hot conditions, as seen in the current investigation cannot be simply attributed to water retention in PEG 400 samples leading to better hydration. Thus for hot weather condition areas PEG400 use as self curing admixture is recommended.

Vijayan S.D. et al. (2020) [6] Used PEG1500 for their experimental work as self curing agent. In their work they replaced the normal river sand by manufactured sand by 50% and 100% replacement. Different dosage of additives are added 1%,1.5% and 2% by weight of cement. For the specimen with 1% of self curing agent, the mix showed highest compressive strength when compared to other mixes with self-curing agent (i.e. 1.5% and 2%). The mix with 1% of PEG showed compressive strength marginally greater than the compressive strength of conventional concrete. Split Tensile strength test was conducted on cylinder of M30 grade mix concrete. Cylinder with 1% dosage of PEG1500 shows the maximum split tensile strength as compared to the other specimens. Thus from the results it was concluded that mix with 1% PEG 1500 along with manufactured sand shows the best results in compressive strength, split tensile strength.

Agalya C. et al. (2018) [7] They studied the role of polyethylene glycol as a shrinkage reducing admixture on steel fiber reinforced concrete. In this 2% steel fibres by weight of cement were added. The aim of their study is to evaluate the Structural innovative concrete using Steel fiber and Polyethylene Glycol-400. The steel fibres used in this study had an aspect ratio of 50. The compressive strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber with increased strength in 25.94N/mm 2 compared with conventional concrete. The percentage increasing was 4.13% when compared with conventional mix. The Split Tensile Strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber with increased strength in 24.8N/mm 2 compared with conventional concrete. The percentage increasing was 4.49% when compared with conventional mix. The Flexural Strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber increased strength in 5.69N/mm 2 compared with conventional concrete. The percentage increasing was 4.49% when compared with conventional mix.

Sumayyath, M. M et al. (2016) [8] Their study involves the use of shrinkage reducing admixtures Poly Ethylene Glycol 200 (where 200 is the molecular weight of polyethylene glycol) as internal curing compound. Polyethylene glycol acts as curing compound and used in concrete, helps in self curing and helps in better hydration and hence good compressive strength. This admixture does not let the water to evaporate from the concrete and helps in better and continuous hydration. In this experiment the effect of curing compound on strength compressive, flexural and splitting tensile were studied. The percentage of PEG 0% to 1.5% by weight of cement are studied for M40 and M30 mixes. From the results optimum value of PEG 200 for

M30 and M40 mixes are obtained as 0.5% by weight of cement. The compressive strength was increased up to 9.5% at 0.5% PEG200 dosage for M30 mix and 6.57% for M40 mix. The flexural strength was increased up to 5.13% at 0.5% PEG for M30 mix and 5.76% for M40 mix which shows the better hydration of cement concrete. And in case of workability, as the percentage of Polyethylene glycol increases the workability also increases.

Sri Rama Chand Madduru et al. (2020) [9] The present experimental program evaluates the effect of hydrophilic and hydrophobic chemicals as self curing compounds in Self Compacting Concrete. The parameters in this study include type of curing chemical Polyethylene Glycol 4000 and Liquid Paraffin Wax, dosage of curing chemical (0%, 0.1%, 0.5% and1.0%) and curing temperature is around 27^0 C that was the room temperature. The durability of the concrete was tested by rapid chloride permeability test. The primary characteristics of self-curing concrete rely on the type of curing agent, particularly when this type of concrete is deemed to be workable and flow able. The water retention capacity of self-curing agents is higher than no curing specimens. With PEG 1.0% and LPW 0.1% SCC shown less weight loss compared to other dosages. In durable studies RCPT value are higher for no curing, which indicates that the chloride permeability is moderate. Whereas, water cured and self-cured specimen with optimum dosages have achieved low susceptibility to chlorine penetration. From current study, the optimum dosage of Polyethylene Glycol 4000 is 1.0% and Liquid Paraffin Wax is 0.1%.

3. CONCLUSIONS

By studying the previous research articles on Polyethylene Glycol and its role in enhancing the properties of concrete following conclusion are made-

1. Polyethylene Glycol is hydrophilic in nature and at optimum dosage it increases the workability of concrete. Higher dosage may lead to retardation of the mix at early ages
2. It helps in reduction of plastic shrinkage by reducing the evaporation from the concrete
3. Based upon its manufacturing different molecular weight polyethylene glycol are there like PEG200, PEG400, PEG600 and PEG1500. PEG 200 are more effective at lower dosages. The optimum dosage for PEG200 was 0.5 by weight of cement for M30 and M40
4. By addition of PEG, the compressive strength and split tensile strength of the concrete got increased due to the proper hydration by internal curing
5. From rapid chloride permeability test it was concluded that addition of PEG helps in improving the durability of concrete

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BIOGRAPHIES

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