International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 03 | Mar 2023 www.irjet.net p-ISSN: 2395-0072

A Study on Durability Properties of Silica Fume Blended Self Curing High Strength Concrete

B. Baby[1], Surekha.P[2], Y. P Janardhan[3], D. Lakshmikar[4], P. Sarala[5], K. Vinay[6]

[1] Assistant Professor, Department of Civil Engineering, Annamacharya Institute of Technology and Sciences, Tirupati, - 517501

[2-6]Department of Civil Engineering, Annamacharya Institute of Technology and Sciences, Tirupati, - 517501

ABSTRACT:

Today, concrete is the most widely used engineering material in the world due to its strength and durability properties. Cement, fine aggregate, coarse aggregate and water are mixed in specified proportions to produce conventional concrete. Because the concrete is open to the atmosphere, the water used in the concrete evaporates and the water available in the concrete is insufficient for effective hydration.

In order to achieve good strength, hardening of concrete is important, so we introduce the concept of self-hardening to avoid the water shortage. Self-concrete is a type of concrete that hardens itself by retaining water in it. It has been observed that water-soluble polymers can be used as a self-curing agent, i.e, Polyethylene Glycol (PEG-4000). Shrinkage reducing agents such as polyethylene glycol and silica fume 15% each increase the autogenous shrinkage of the concrete by 50%. The effect of silica fume on autogenous shrinkage can be explained by its influence on the pore structure and pore size distribution of concrete and its pozzolanic reaction. We use high-strength concrete (HSC) of quality M70. High-performance concrete is used to study the influences of water-binder ratio, setting composition and the influence of strength, slump and air content in the material. There will be an optimized quality of performance for the given set of materials, usage requirements for cost, life and durability. The American Concrete Institute declares high-strength concrete as a concrete with unique performance. In this project we investigate the behaviour of concrete pavements when replacing cement with silica fume. The cement was replaced with silica fume in the range of 15% by weight of M70 concrete. Polyethylene glycol (PEG-4000) is used as a self-curing agent in varying proportions, i.e0% ,0.5%, 1%, 1.5%,by weight of cement. The durability properties such as water absorption and conventional concrete were compared to self-hardening concrete after 7 days, 14 days and 28 days for class M70 concrete and observed that concrete has rate of water absorption values are getting low up to 1% mix of PEG-4000,but increasing the PEG -4000 in concrete is increasing the rate of voids in concrete as the same way reducing the durability properties of concrete.

KEY WORDS: Self-curing concrete, Poly-ethylene Glycol (PEG-4000), High strength concrete (HSC), Water absorption.

INTRODUCTION:

Self-curing concrete is a type of concrete that is designed to reduce the need for external curing methods, such as water curing or covering with membranes. This type of concrete typically includes additives that promote self-curing, such as Polyethylene Glycol **(**PEG-4000) (H(OCH2CH2)n OH) and silica fume. Polyethylene Glycol **(**PEG-4000), is a water-soluble polymer that can absorb moisture from the air and retain it within the concrete. When added to concrete, it helps to keep the concrete hydrated and prevent shrinkage and cracking during the curing process. Silica fume, also known as micro silica, is a by product of the production of silicon and ferrosilicon alloys. It is a highly reactive pozzolan, which means it reacts with calcium hydroxide in the presence of water to form additional cementitious compounds. This reaction results in denser and more durable concrete, as well as reducing the permeability of the concrete. When used together in concrete. This can save time and money during the construction process, as well as reduce the risk of human error in the curing process. Additionally, the resulting concrete can be stronger, more durable, and less permeable than traditional concrete. When self-curing concrete contains silica fume at 15% by weight of cementitious materials and PEG-4000 at varying dosages of 0.5%, 1%, or 1.5%, it can improve the durability properties of the concrete in several ways.

Overall, the combination of silica fume and PEG-4000 in self-curing concrete can lead to a more durable and long-lasting final product. The specific dosage of

Polyethylene Glycol (PEG-4000) may vary depending on the specific application and desired properties of the concrete, but in general, higher dosages of Polyethylene Glycol (PEG-4000) can lead to better self-curing properties and improved durability.

POLYETHYLENE GLYCOL BEING USED IN CONCRETE:

PEG-4000 (Polyethylene glycol4000) is a water-soluble polymer that is commonly used as a plasticizer, a binder, and a viscosity modifier in various industrial applications. While it has not been specifically designed for use in concrete, PEG-4000 can be used as an additive in concrete to improve its workability, reduce its water demand, and enhance its durability. When PEG-4000 is added to concrete, it forms a film around the cement particles, which reduces their surface energy and enhances their dispersion in the mixture. This results in a more uniform and stable concrete mixture, which is easier to pump and place. The use of PEG-4000 in concrete can also improve its freeze-thaw resistance, reduce shrinkage and cracking, and increase its compressive strength. However, the amount of PEG-4000 that can be added to concrete depends on various factors, such as the type of cement used, the water-cement ratio, and the environmental conditions. Therefore, it is essential to consult with a concrete expert before using PEG-4000 or any other additive in concrete to ensure that the desired properties are achieved without compromising the quality or durability of the concrete.

LITERATURE REVIEW:

Gunasekar and Helen Santhi (2019): The researcher examines the use of industrial waste up to the possible amount present in the concrete. Polyethylene glycol (PEG-400), blast furnace slag (GGBS) and super-plasticizer are used and various mechanical tests are performed to demonstrate their properties as self-hardening and self-curing concrete. The optimum value observed for grade M25 was 1% PEG-400, 50% GGBS and slag as a partial replacement of cement and coarse aggregate to increase the compressive strength of concrete.

EI-Died and EI- Maaddawy(2018): The experimental investigation was done on 25 MPa to describe self-curing concrete against corrosion. Two unlike chemical agents were investigated using polyethylene glycol 100 (PEG) and polyacrylamide (PAM). Reinforcement protection in concrete linked with chloride ion penetrability, electrical resistivity, and water permeability. The results narrate the affective usage of self-curing concrete against corrosion protection than those of air-cured control mix.

Zameer (2018): Used PEG-400 as self-hardening admixture (0.5, 1, 1.5 and 2) wt % of cement in grade M25 and 30% fly ash was partially replaced with OPC cement. The result observed on the hardened properties of the self-hardening concrete shows that 1% PEG 400 and 10% fly ash show an improvement in the strength properties of concrete

Dadaji (2017): carried out experi-ments to study the effect of PEG4000 on compressive strength and water retention by varying the percentage of PEG from 0% to 1% by weight of cement for self-compacting concrete and compare it with conventional SCC. The optimum polyethylene glycol PEG dosage at lower w/c ratio was found to be 0.1%. The weight loss increased by increasing the percentage dosage of PEG-4000. Compressive strength of self-compact concrete with lower w/c ratio improves with the addition of PEG-4000.

Indrajith et. al (2016): carried out comparative experimental tests between self-curing concrete (both external self-curing and internal self-curing by using PEG and conventional concrete for M20,M25 and M40grade. Self-curing concrete resulted in better hydration with time under drying condition compared to conventional concrete. Slump value increases with increase in the quantity of PEG. It was studied that the strength increases at different proportions of PEG i,e, 1% is optimum for M20 and M25 grade 0.5% for M40 grade and 0.3% for high strength self-curing concrete.

MATERIALS:

CEMENT: Ordinary Portland cement (OPC 53) grade cement is required. OPC 53 grade provides high strength and durability to structures because of its optimum particle size distribution and superior crystallized structure. according to IS 8112-1989 codes.

FINE AGGREGATE: fine aggregates generally consist of natural sand with most particles passing through a 4.75mm sieve was used then free of all organic contamination.

COARSE AGGREGATE: coarse aggregates refer to irregular and granular materials such as gravel, or crushed stone. coarse aggregate passing through 12.5 mm

and 10mm retained aggregates are used for self-curing concrete.

WATER: water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. Freshwater used in concrete ideal ph range in mixing water for concrete is slightly basic i,e, between 7.2 and 7.6.

SUPERPLASTICIZER: Here using polycarboxylate superplasticizer, is a new generation of high-performance concrete admixture. It is a water reducing agent with excellent performance that integrates water reduction, shrinkage and environmental protection.

SILICA FUME: Silica fume (SiO2) is a by-product of the production of silicon metal and ferrosilicon alloys. It is a highly reactive, amorphous material that is used to enhance mechanical and durability properties of concrete.

Materials used for self-curing concrete or internal curing (IC) concrete material.

POLYETHYLENE GLYCOL: Poly -ethylene glycol (PEG- 4000), is a water-soluble polymer that is commonly used as an additive in the concrete industry. It is used to improve the performance and quality of concrete by reducing the amount of water required to mix it, while maintaining its workability. Chemical structure for PEG-4000 is (H(OCH2CH2)n OH) linear poly-ethylene glycol polymer that consists of repeating units of ethylene oxide. PEG 4000 is a useful additive in the concrete industry that can improve the water reducing properties, freeze-thaw resistance, and air entrainment of concrete. Its low toxicity and solubility in water make it a safe and convenient choice for use in concrete production.PEG-4000 also increases the durability properties of concrete.

EXPERIMENTAL SET UP:

The following is a general procedure for preparing self-curing concrete with 0.5%, 1%, and 1.5% (PEG-4000) and 15% silica fume:

Prepare the necessary materials including cement, water, fine aggregate (sand), coarse aggregate, water, polyethylene glycol (PEG-4000), superplasticizer(poly-carboxylate).Mix the dry ingredients (cement, sand). coarse aggregate and silica fume in the appropriate proportions to prepare the concrete mix . Add water to the mixture and mix thoroughly until desired consistency is achieved. Add PEG to the mix in an amount equal to 0.5%, or 1% or 1.5% of the total weight of cement used in the mix based on mix proportion. Mix the PEG thoroughly into the concrete to ensure it is evenly distributed throughout the mix. Add a water-reducing superplasticizer blend to the mix to improve workability and reduce water requirements. replace silica fume in cement as 15% constantly in concrete in every mix. Mix the ingredients thoroughly with a cement mixer for at least 5-7 minutes to ensure an even mix.

Pour the concrete mix into the cylinders and level the surface with a tamping rod. Vibrate the concrete with a vibrating machine to remove air gaps in the concrete. Use a trowel or hand trowel to smooth and finish the concrete surface. Pour the concrete mix into the desired shape and compact to remove air pockets. Allow concrete to cure on its own without the need for external curing methods. The PEG-4000 will gradually release water over time to keep the concrete moist and allow it to harden. After the concrete has been mixed.

DETAILS OF SPECIMEN PREPARATION:

Cylinders of size 100 x 200mm were poured to determine the strength of Self-curing concrete. Cylinders with a size of 100 x 200 mm were cast by replacing cement with silica fume in different proportions, i,e. 15%, was replaced. Cylinders measuring 100 x 200 mm were cast to determine the strength and durability of self- curing concrete by adding different proportions of polyethylene glycol 4000.The experiment the study was carried out for three different proportions of polyethylene glycol 4000, i,e. 0.5%, 1%, 1.5%.The different proportions of polyethylene glycol(PEG-4000)were calcu-lated by weight from cement to concrete. Cylinders with three different percentages of polyethylene glycol 4000 were made with concrete. Finally, the results were tabulated.

TESTS CONDUCTED:

WATER ABSORPTION TEST:

Water absorption test has the 100 mm x 50 mm height cylinder after casting were placed in a dry place for self-curing at 7,14 and 24 days after curing these specimens were then oven dried for 24 hours at the temperature 80°c until the mass became constant and again weighed. this weight was noted as the dry weight(w1) of the cylinder. after that the specimen was kept in water at 27°c for 4 hours. then this weight was noted as the wet weight (w2) of the cylinder.

- **% water absorption = [(w2– w1) / w1] x 100**

Where,

w1 = oven dry weight of cylinder in grams

w2 = after 4 hours wet weight of cylinder in grams.

RESULTS AND DISCUSSIONS:

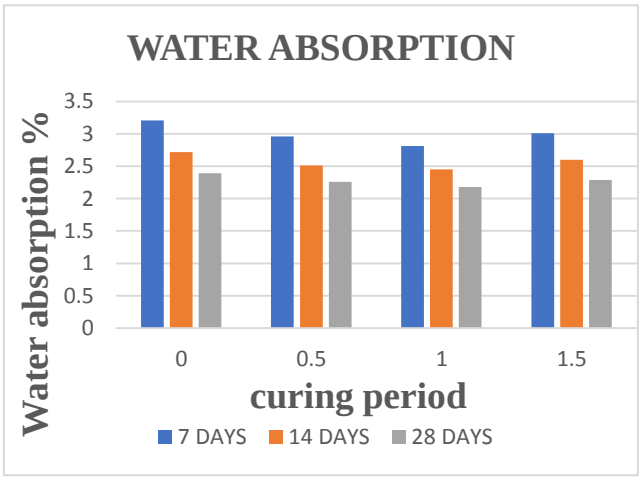
WATER ABSORPTION TEST:

In general, a water absorption rate of less than 5% is considered good for most concrete applications. However, for high-performance concrete, the acceptable rate may be lower. The water absorption test is used to evaluate the durability of concrete. A high-water absorption rate indicates that the concrete is more porous and may be susceptible to damage from freeze-thaw cycles, chemical attacks, and other forms of deterioration. general, if the water absorption rate exceeds the acceptable range for a given application, it is an indication of poor durability. It is important to note that water absorption is just one factor to consider when evaluating the durability of concrete , and it is often used as an indicator of concrete's permeability. self-curing agent in reducing water absorption and increasing durability. This test can help determine whether the self-curing agent has been applied properly and whether it is providing the intended benefits.

Fig: water absorption test

Table: Water absorption for 1.50% PEG-4000 results.

PEG RANGE	UNITS	7 DAYS OF CURING	14 DAYS OF CURING	28 DAYS OF CURING
0%	%	3.21	2.72	2.39
0.5%	%	2.96	2.51	2.26
1%	%	2.81	2.45	2.18
1.5%	%	3.01	2.60	2.29



Graph 1: Water absorption test for (PEG-4000) 0%,0.5%,1%, and 1.5%.

CONCLUSION:

Based on experimental investigation concerning the water absorption the following observations are made regarding the resistance of partially replaced by silica fume for M70 concrete.

- Water absorption of self-curing concrete shows lower water absorption in concrete for 0.5% and 1% of Polyethylene Glycol(PEG-4000),but increasing the PEG-4000 quantity more than 1% in concrete increases the water absorption rate in concrete.

REFERENCES

[1] K. Zameer, Strength study on strength characteristics of self-curing concrete incorporated

with fly ash, Int. Res. J. Eng. Technol. (IRJET) 05 (05) (2018)

[2] K. Gangadhar, E. Gupta, Physical properties of self-curing concrete by using polyethylene glycol, Int. J. Eng. Technol. Sci. Res. (IJETSR) 4 (8) (2017)

[3] A.S. El-Dieb, T.A. El-Maaddawy, Assessment of reinforcement corrosion protection of self-curing concrete, J. Build. Eng. 20 (2018) 72–80

[4] K. Zameer, Strength study on strength characteristics of self-curing concrete incorporated with fly ash, Int. Res. J. Eng. Technol. (IRJET) 05 (05) (2018)

[5] .J. Krishna, R. Jaipal, Comparative and experimental study on self, Int. J. Res. Sci. Adv. Eng. [IJRSAE] 2 (19) (2017) 118–129.

[6] S. Tyagi, An experimental investigation of self-curing concrete incorporated with polyethylene glycol as self-curing agent, Int. Res. J. Eng. Technol. (IRJET) 02 (2015) Issue: 06

[7] S. Gunasekar, M. Helen Santhi, Self-compacting self-curing low-density concrete using cinder aggregate and PEG, Int. J. Civ. Eng. Technol. 10 (01) (2019) 1030–1039