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A Research Experiment on Investigating Self–Curing Characteristics in Concrete

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***Abstract-** Concrete serves as the backbone of infrastructure, emphasising its necessity for structural strength. In detailing conventional concrete, the outline of the composition involving cement, fine aggregate, coarse aggregate and water. The necessity of curing for a minimum of 28 days is highlighted to ensure good hydration and achieve the targeted strength we introduce the concept of self-curing concrete, which autonomously retains water (moisture content) to facilitate hydration. The incorporation of polyethylene glycol (PEG400) as an admixture in conventional concrete is present as a mean to enhance hydration and overall strength. The specific dosage of PEG 400, ranging from 1 to 2% by weight of cement, is emphasised for optimal result the experimental program's objectives, focusing on the study of compressive strength, split tensile strength, and flexural strength. Ordinary Portland cement, aggregate, water, and PEG 400 are identified as the experimental materials used. The overall content reflects a comprehensive understanding of concrete properties, curing techniques, and the innovative use of PEG 400 in improving concrete strength through meticulous experimental analysis.*

***Index Terms:** Self curing concrete (SCC), Polyethylene glycol (PEG400) Self curing compound*

1. INTRODUCTION

Proper curing is vital for concrete structure to meet performance and durability standards. In conventional methods, external curing is applied after mixing, placing, and finishing. self-curing, or internal curing involves providing extra moisture within the concrete to enhance cement hydration and minimize self-desiccation according to the ACI-308code, internal curing is the process where cement hydrates due the additional internal water beyond the mixing water. Typically, small amounts of saturated, lightweight polyethylene glycol are used to supply the additional internal water, contributing to improved concrete performance and durability.

1.1 SELF-CURING

Self-curing in concrete is a process that relies on the incorporation of water-retaining or internal curing agents into the concrete mix. These specialized agents have the capability to release water gradually over time. By doing so, they facilitate effective hydration and curing of the concrete without the need for external water sources. This innovative method aims to reduce the risk of cracking, a common issue during the curing process. Moreover, the gradual release of water helps maintain optimal conditions for concrete strength development. The utilization of self-curing agents not only mitigates the need for traditional external water curing but also contributes to the overall durability of the concrete structure.

1.2 METHODS OF SELF CURING

To enhance self-curing in concrete, consider incorporating water-retaining or internal curing agents into the mix. These agents release water gradually, facilitating effective hydration and curing without relying on external water curing. This approach helps mitigate cracking and improves the overall durability of the concrete.

2. LITERATURE SUMMARY

The increase in admixtures leads to increase in strength and also admixtures help to reduce shrinkage and reduce the usage of water. As compared with external curing, internal curing can increase the strength and durable properties. The cost of internal curing is cheaper as compared with the external curing. It can resist corrosion, increase the strength of concrete, reduce shrinkage. Strength can be increased up to a certain limit for the help of PEG and decrease after the limit. PEG plays an important role in strengthening the concrete and according to the mix ratio the strength also gets increases. Self-curing can be done in normal and self-compacting concrete also increase durability & workability. Light weight aggregate has the ability to absorb moisture content due to its process form and act as self-curing the strength of concrete.

3. EXPERIMENTAL INVESTIGATIONS

3.1MATERIAL USED:

Cement: ordinary Portland Cement (OPC-53 grade) conforming to IS:269-1987. The specific gravity of cement is 3.15.

Fine aggregate: Locally available M sand IS used. The specific gravity of fine aggregate IS 2.89

Coarse aggregate: 20mm size crushed granite stone obtained from the local quarry with specific gravity 2.69.

Water: Potable tap water available in laboratory with pH value of 7.0± 1

Polyethylene glycol 400: PEG 400 is a specific form of polyethylene glycol with a molecular weight around 400 Daltons. The general formula PEG (400) is $H(OCH_2CH_2)_nOH$, where n is the average number of repeating oxyethylene groups typically from 4 to about 180.This transparent, colourless, and odourless liquid seamlessly mixes with water.

3.2 MIX PROPORTIONS:

The mix ratio of m_{20} grade concrete is 1:1.5:3. The mixes were obtained by adding PEG 400 content 0.5%,1%,1.5% and 2% by the weight of cement. Additional water added to the mix depend upon the amount of PEG added.

4. METHOD OF TESTING MATERIAL

4.1 COARSE AGGREGATE

The weight of coarse aggregate retains in each sieve size the percentage weight retained, cumulative percentage of weight retained and the present cumulative amount passed through various sieve. The maximum size of aggerate is used for this investigation is 20mm.

Table 1 Material Test for Coarse Aggregate

SL.NO	PROPERTIES	VALUE
01	Specific gravity	2.23
02	Finess Modulus	4.97
03	Water Absorption (24 hours)	0.3%

3.2 FINE AGGREGATE

Table 2 Material Test for fine Aggregate

SL.NO	PROPERTIES	value
01	specific Gravity	2.67%
02	Fineness Modulus	7.6
03	Water absorption (24 hr)	2.5%.

The weight retained cumulative percentage of weight retained and the present cumulative amount passed through various Weight of fine aggregate retained in each sieve the percentage Sand passing through 4.75mm sieve provisions are used as fine aggregate.

3.3 CEMENT

Ordinary Portland Cement of grade 53 is used throughout the investigation.

Table 3 Material Test for cement

SL.NO	PROPERTIES	value
01	specific Gravity	2.66
02	Fineness	95%
03	Normal consistency	28
04	Insial setting time	30MINS
05	Final setting time	600MINS

5 .PREPARATION, CASTING AND TESTING OF SPECIMENS:

The 150mm concrete cubes were tested for compressive strength at 28 days for grade. the specimens were stored at room temperature and were kept for self-curing.

Table 4 Mix Proportion Ratio per m3 for M20 grade

Sl.no	Peg-% of Cement	Cement (kg)	PEG (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (lit)
MIX-1	0	383	0	546	1188	192
MIX-2	0.5	383	0.05	546	1188	223.5
MIX-3	1.0	383	0.10	546	1188	239.3
MIX-4	1.5	383	0.15	546	1188	255
MIX-5	2.0	383	0.20	546	1188	270.6

6. EXPERIMENTAL PROGRAM

Mechanical properties studies were conducted at 28 days for M20 grade. The mix to find the compressive strength, split tensile strength and flexural strength.

COMPRESSIVE STRENGTH TEST**:** As per IS: 516-1959, the testing is conducted on cubes with dimensions of 150x150x150 mm. The specimens are marked, taken out of the mould and unless needed for testing within in 24 hours, promptly immersed in clean fresh water until right before the test. A 2000 KN capacity Compression Testing Machine (CTM) is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 Kg/Cm2/min and the failure load in kN is observed from the load indicator of the CTM, positioned between the steel plates of the CTM, the specimen undergoes loading at a rate of 140kg/cm2, and the failure load in kN is then observed using the CTM's load indicator.

SPLIT TENSILE STRENGTH TEST: The compression testing machine, with a 3000KN capacity, tested cylinder specimens. The machine's bearing surface was cleaned, free from sand or other materials. The load increased steadily until the specimen's resistance gave way and could no longer be sustained.

FLEXURAL STRENGTH TEST: The concrete prism's flexural strength, following IS: 516 –1959, was assessed. The specimen, positioned to apply load on its uppermost surface as moulded, experienced force along two lines spaced 13.3cm apart, at a rate of 180 kg/min, gradually increasing until failure occurred.

7. RESULTS AND DISCUSSIONS

Mechanical property studies have been undertaken on self-curing concrete, focusing on compressive strength, split tensile strength, and flexural strength. The results of these studies are discussed below.

COMPRESSIVE STRENGTH

Table 5 presents cube compressive strength results at various ages, including 28 days, for different percentage levels (0%, 0.5%, 1%, 1.5%, and 2%). These levels correspond to mix designations: NM, PEG 0.5%, PEG 1%, PEG 1.5%, and PEG 2%. Graphs in Fig 1 illustrate the development of compressive strength with ages for the aforementioned mixes. Notably, test results indicate that the maximum compressive strength is achieved with a 1% dosage for M 20 and 0.5% for M 30. It was also observed that to preserve the workability of concrete mixes, an increase in the dosage of superplasticizer is necessary.

Table 5Compressive Strength Test Results at 28 days

S NO	PEG	Ft at 28 days M20 (N/mm^2)
Mix-1	0%	1.83
Mix-2	0.5%	1.96
Mix-3	1%	2.07
Mix-4	1.5%	1.98
Mix-5	2%	1.85

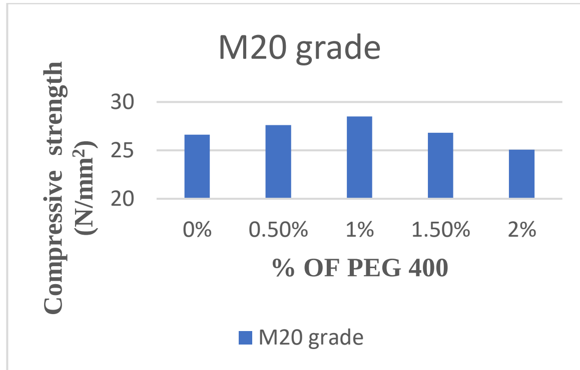

Fig 1 Compressive Strength for various replacement levels of PEG

SPLIT TENSILE STRENGTH

It appears that Table 4 contains split tensile strength results at various ages (e.g., 28 days) for different percentage levels (0%, 0.5%, 1%, 1.5%, and 2%), represented by mix designations such as NM, PEG0.5%, PEG1%, PEG1.5%, and PEG2%. Additionally, Figure 2 illustrates the development of compressive strength over time for these mixes.

Sl no	PEG	Fc at 28 days M20 (N/mm2)
Mix-1	0%	26.62
Mix-2	0.5%	27.63
Mix-3	1%	28.52
Mix-4	1.5%	26.81
Mix -5	2%	25.08

Table 6 Split Tensile Strength Test Results at 28 days

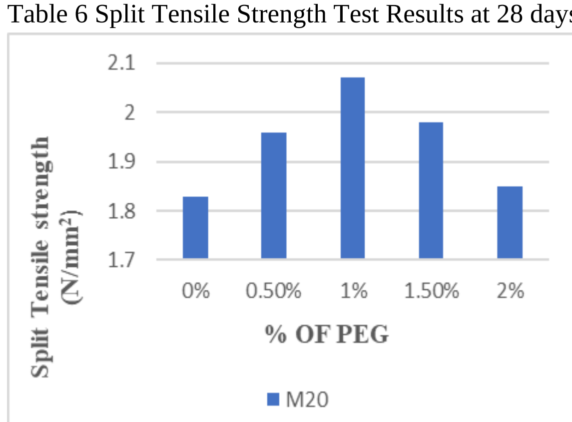

Fig 2 Compressive Strength for various replacement levels of PEG

FLEXURAL STRENGTH TEST:

Table 5 presents flexural strength results at various ages (e.g., 28 days) for different percentage levels (0%, 0.5%, 1%, 1.5%, and 2%), denoted by mix designations such as NM, PEG0.5%, PEG1%, PEG1.5%, and PEG2%. Furthermore, Figure 3 depicts the progression of compressive strength over time for the mentioned mixes**.**

Table 7 Flexural Strength Test Results at 28 days

S.NO	PEG	M20(N/mm^2)
MIX-1	0%	5.1
MIX-2	0.5%	5.0
MIX-3	1%	5.3
MIX-4	1.5%	4.9
MIX-5	2%	4.7

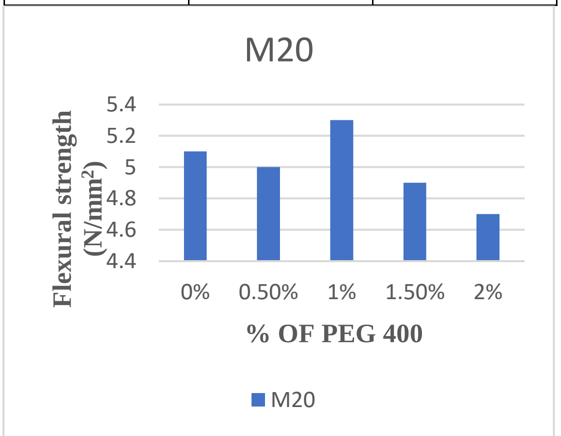

Fig 3 Flexural Strength for various replacement levels of PEG

8.CONCLUSION

The optimum dosage of PEG400 for maximizing compressive, tensile, and flexural strengths in M20 self-curing concrete is 1%. Concrete with internally cured PEG exhibits superior strength and durability compared to alternative methods, surpassing the performance of external curing. The cost of internal curing is also more economical than external curing, while self-curing concrete matches the strength of conventional concrete. Mix proportions, particularly cement content and water-cement ratio, significantly influence the performance of the self-curing agent.

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