

# AN EXPERIMENTAL INVESTIGATION ON EFFECT OF MECHANICAL PROPERTIES OF M50 GRADE CONCRETE WITH PARTIAL REPLACEMENT OF SAND WITH COPPER SLAG

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**Abstract** - *The creative mind of a world without concrete is unthinkable. Concrete is a spirit of frameworks. Concrete is important to acquire strength in structures. Traditional cement, which is the combination of concrete, fine aggregate, coarse aggregate, and water, needs relieving to accomplish strength. Thus, it is expected to solution for a base time of 28 days for good hydration and to accomplish target strength. Absence of appropriate relieving can gravely influence the strength and toughness. Self-curing concrete is one sort of current cement, which fix itself by holding water (dampness content) in it. The utilization of polyethylene glycol in conventional concrete as an admixture helps better hydration and subsequently the strength of concrete. In this undertaking review, to concentrate on the mechanical characteristics of concrete like compressive strength, tensile strength, and flexural strength by fluctuating the measurements of 1 %, 1.5%, 2%, and 2.5% of PEG - 4000 by weight of concrete for M50 grade of cement. This paper covers an exploratory program to examine the impact of utilizing copper slag as a substitution of sand on the properties of Self curing concrete (SCUC). Concrete mixes were assessed for compressive strength, tensile strength, and flexural strength. This current review plans to decide the most reasonable level of PEG-4000 to be included self-curing concrete. For testing M 50 grade concrete is to be utilized.*

**Key Words:** Self-curing concrete, Polyethylene glycol-4000, Copper slag, M 50, Strength.

## 1.INTRODUCTION

Concrete is perhaps of the most consumed and least expensive material in development field among any remaining materials. The desire of interest for the substantial in development and modern field made the exploration to foster the high performing concrete with greater practicality. The relieving of cement is predominantly expected to keep up with the dampness content to guarantee the persistent hydration of the concrete. Accordingly, the ceaseless hydration process

begins to dial back when the inside relative moistness content abatements and for all intents and purposes stops when it diminishes under 80 %.

Self-Curing concrete is a sort of substantial which will fix exclusively by dampness content. Internal Curing is the methodology is adding/giving additional water to restoring. Concrete consolidating self-Curing represent a recent fad in the substantial development in the new thousand years because of the expanded utilization of superior execution concrete. A few strategies may, possibly be utilized for fuse of inner restoring water in concrete.

A few scientists have proposed the utilization of soaked light weight totals to give interior restoring to concrete. Then again, different analysts utilized poly-glycol items in substantial blends as self-curing agent. The usage of self-curing concrete actually took on in water shortage regions. Presently two significant strategies can be taken on for inward restoring of cement. One is LWA-lightweight total. Water supplanted by compound shrinkage during concrete hydration, another sort is utilization of Polyethylene Glycol, which decline the dissipation cycle from substantial surface and helps in water keeping progress.

Essentially great restoring of cement isn't attainable as a rule because of inaccessibility of reasonable nature of water and numerous other common-sense hardships. During the most recent twenty years, substantial innovation has been going through fast Improvements. With ordinary fixings it is feasible to configuration sensibly great quick track substantial combination utilizing admixtures. Inside restored cement can be accomplished by adding Self Curing Agents. Water dissolvable polyether's are by and large utilized as self-curing agents. The objective of inner curing is to furnish water in the legitimate sum with a legitimate spatial dissemination so the whole three-layered microstructure of hydrating cementitious glue stays immersed and autogenous tranquil.

Fine total is a crucial part of cement. The chief generally used fine total is regular stream sand. The interest of regular waterway sand is exceptionally tall in created countries attributable to infrastructural improvement. The non-accessibility of sufficient measure of customary stream sand for making concrete cement is impacting the development of development industry in various pieces of the country.

Copper slag is gotten as waste from the Sterlite business. In the ongoing conditions, consideration has been attracted to the ecological dangers presented via fossil fuel by-products and sand mining and the serious uneven characters in biological systems. Different examinations have been led to decrease the serious effect on the climate, the utilization of side-effects, for example, copper slag as halfway substitutes for fine totals. Have there is an abundance of involvement with utilizing copper slag an alternative for fine totals.

In present day situation, vehicle transmissions and sand extraction have turned into an overwhelming test due to environmental risks and real off-kilter nature in the organic framework. Some assessment has been finished to bind the certified influence the earth, the usage of results, for instance, copper slag as a partial choice for faultless sums. There is various experiences in utilizing copper slag as an improvement of current sums. It is a consequence of the copper cleaning and refining process. In the event that the copper slag is used as a trade for regular sand, we can prevail with regards to giving a substitute material to normal sand, which can be eco-friendly and conservative concerning concrete.

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## 2.SELF-CURING CONCRETE

A self-curing concrete is given to retain water from environment to accomplish better hydration of concrete in concrete. It takes care of the issue that the level of concrete hydration is brought due down to no restoring or ill-advised relieving and in this way unacceptable properties of cement. Oneself restoring specialist can retain dampness from climate and afterward discharge it to concrete. One self-curing substantial implies that no curing is expected for cement, or even there is no outside provided water is expected in the wake of setting. The properties of this self-curing concrete of this innovation are essentially

equivalent to and, surprisingly, better than those of cement with conventional curing. The inward water is kept up with by in participating oneself restoring specialist which decreases the dissipation of water from the substantial, in this manner expanding the water maintenance limit of cement. In past many years, the impact of Self Curing Concrete has further developed properties while contrasting with indistinguishably restored controls. It was found that, underlying surface retention, chloride entrance, carbonation, consumption potential and freeze and defrost obstruction attributes were similarly better via air relieved self-cure concrete than the air restored control.

## 3.MECHANISMOFINTERNALCURING

Consistent dissipation of dampness happens from a presented surface because of the distinction in synthetic possibilities (free energy) between the fumes and fluid stages. The polymers included the blend predominantly structure hydrogen securities with water particles and decrease the synthetic capability of the atoms which thusly lessens the fumes pressure, subsequently diminishing the pace of vanishing from the surface.

## 4.SIGNIFICANCEOFSELF CURING

At the point when the mineral admixtures respond totally in a mixed concrete framework, their interest for restoring water (outer or inside) can be a lot more prominent than that in a traditional normal Portland concrete cement. At the point when this water isn't promptly free, critical autogenous disfigurement and (early-age) breaking might result. Because of the synthetic shrinkage happening during concrete hydration, void pores are made inside the concrete glue, prompting are duction in its inside relative stickiness and furthermore to shrinkage which might cause early-age breaking.

## 5. OBJECTIVE

The goal is to concentrate on the mechanical attributes of cement by shifting the level of PEG-4000 from 1% to 2.5% by weight of concrete for M50 grade concrete. To find the ideal extent of copper slag that can be utilized as a trade/substitute material for fine total. To track down the compressive strength, split rigidity, and flexural strength of copper slag supplanted substantial examples.

## 6.0 RESEARCH SIGNIFICANCE

Magda I. Mousa et al., have concluded that the indirect rigidity was in the scope of 6.4% to 8.5% for all self-curing concrete and flexural strength addressed 10-14.5% of compressive strength of all self-curing concrete.

Ahmad Mustafa Saboon and Navinderdeep Singh have concluded that Utilization of self-curing specialist in cement can expand the strength of concrete contrasting with ordinary concrete

Ankit Nainwal et al., have concluded that with the expanded percentage of copper slag, concrete density is moved along.

Mahesh V. Patil and Yogesh D. Patil have concluded that at 30% substitution the modulus of elasticity is found 9.52 and up to 90% substitution it continues expanding then conventional concrete. The permeability test result shows that it decreased up to 30% and after that it is expanded from 40 to 100 percent.

Madhura Sridharan and T. Ch. Madhavi have concluded that the ideal substance of copper slag that can be utilized as an elective for river sand in concrete for upgraded mechanical behavior is 40%.

Dr. U. B. Choubey and Gajendra Raghuvanshi have concluded that PEG- 400 was viewed as compelling as a self-curing agent. It was found that each grade of cement has one ideal level of dose which it requires to invigorate the greatest. It was viewed that as the ideal dose of PEG-400 for M20 was 1%, for M30 it was 1% and for M40 it was 0.5%.

## 7.0 EXPERIMENTAL PROCEDURE

Blending of concrete parts was finished utilizing a level blender. Every one of the dry constituents were blended for 2 min to guarantee consistency of the blend. A big part of the blending water was added step by step during blending. Anyway, on account of SCUC, self-curing agent such as polyethylene-glycol and 40 % of copper slag was added continuously during blending. Blending of all fixings went on for a time of 2 min. In the wake of blending, two sizes of examples were projected utilizing (150 X 150 X 150) mm cubic molds and (150 X 300 ) chamber molds. After the molds had been filled of cement and compacted, the outer layer of cement was evened out, and afterward, demolded examples were kept in dry air (25 C) during the trial in a research center. Compressive and tensile were done on cubes and cylinders specimens while flexural strength was performed on beam specimens (150 X 150 X 750 mm) which loaded at the center third with two equivalent packed loads in flexural test. Compressive strength, tensile strength and flexural strength were examined at 7 days and 28 days

## 8.0 MATERIALS

### A. CEMENT

Portland concrete cement is the most comprehensively involved advancement material in underlying planning exercises all over the planet. The assessment was coordinated using standard Portland cement of 53 grade,

which is by and large available in the close by market. The properties of concrete are: Specific gravity of 3.12, initial setting season of 28 minutes, Final setting time 532 minutes, Consistency of 33% and fineness modulus of 2.5

### B. FINE AGGREGATE

M-sand is an improvement complete made by crushing hardstones into little sand estimated jaunty formed particles, then, washing and authoritatively inspecting them. It is a better choice conversely, than river sand or advancement. The properties of Fine aggregate are as follow: Grading of sand as Zone II, Specific gravity of 2.62, fineness modulus of 2.46 and water absorption of 1.5%

### C. COARSE AGGREGATE

The most outrageous absolute size is regularly 10mm and is confined to 20mm. Utilizing a particularly evaluated cubical or then again changed aggregate is better. Absolute ought to be of dependable quality with respect to shape and assessing. The properties of coarse aggregate are specific gravity of 2.70, water absorption of 2% and fineness modulus of 6.2

### D. WATER

Development requires the utilization of water. The Ph of water ought to be something like 6. All through the examination, compact water was used as per IS 456-2000 rules.

### E. POLYETHYLENE GLYCOL - 4000

Polyethylene glycol is a polymer created by buildup of ethylene oxide and water having an overall substance recipe of  $(\text{OCH}_2\text{CH}_2)_n \text{OH}$ , where n is the typical number of rehashing oxyethylene bunches commonly going from 4 to around 180. The condensing (PEG) is utilized in mix with a numeric postfix which demonstrates the typical sub-atomic weight. PEG- 4000 is utilized in this review. It is liberated from chlorides and produces an inside film, which safeguards and forestalls new cement against over quick water dissipation. One normal element of PEG seems, by all accounts, to be the water-solvent substance. Stake is non-harmful, scentless, greasing up, unbiased, non-unpredictable and non-disturbing and is utilized in different pharmaceutical works.



FIG- 1: PEG-4000

**F. COPPER SLAG**

Copper slag utilized in this work was purchased from Sterlite businesses (India) ltd, Tuticorin, Tamil Nadu, India. At the point when the copper settles down in the smelter, it has a higher thickness, pollutants stay in the top layer and afterward are moved to a water bowl with a low temperature for hardening. The finished result is a strong, hard material that goes to the smasher for additional handling. Copper slag is generally disposed of in landfills; nonetheless, it very well may be securely reused in concrete as a piece of fastener or total stage. One of the significant elements of copper slag is its smooth and shiny surface, which can prompt improvements in the functionality of new concrete or mortar.



FIG- 2: COPPER SLAG

**9.0 FRESH CONCRETE PROPERTIES**

Slump cone test is completed to decide the workability of concrete. The shape for the test is as the frustum of a cone having level 30 cm, base measurement 20 cm and top width 10 cm. The packing pole is of steel 16 mm breadth and 60cm long and adjusted toward one side.

Replacement of PEG 4000(%)	Trial No	Slump value (mm)	Average slump value (mm)	Type of Slump
1.0	1	105	100	True or High Slump
	2	95		
1.5	1	110	105	
	2	100		
2.0	1	105	110	
	2	115		
2.5	1	110	115	
	2	120		

Table -1: Slump cone test values



FIG-3: Slump cone test on concrete

**10.0 Hardened concrete properties**

The concrete properties including compressive strength, tensile strength and flexural strength were examined.

**10.1 Compressive strength**

Concrete is ready in the necessary extents and the examples are made by filling the substantial in the ideal form state of (15cm x 15cm x 15cm) with appropriate compaction. The element of the example was taken to the nearest 0.2m. The bearing surface of the testing machine is cleaned. The example is put inside the machine in such a style that the

heap will be applied to different sides of the solid shape fashioned. The example is adjusted halfway on the base plate of the machine. Then the versatile part is pivoted tenderly the hard way, so it contacts the most noteworthy surface of the example. A definitive burden at which the substantial gets disappointment is noted.

**Table -2:** Compressive strength at 7 and 28 days

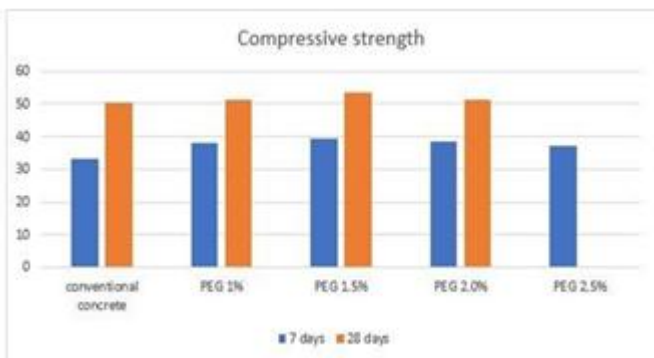
PEG 4000 (%) by cement	Copper slag (%) by fine aggregate	Compressive strength at 7 days N/mm <sup>2</sup>	Compressive strength at 28 days N/mm <sup>2</sup>
0	40	33.21	50.39
1.0	40	37.87	51.23
<b>1.5</b>	<b>40</b>	<b>39.60</b>	<b>53.58</b>
2.0	40	38.53	51.14
2.5	40	37.12	50.95



**FIG-5:** Compressive strength test on concrete

### 10.2 Tensile strength

Concrete is ready in the necessary extents and the example is made by filling the substantial in the ideal form state of 15cm x 30cm chamber with appropriate compaction. Example is set in the pressure testing machine for the predetermined fluctuate. The compressed wood strips are kept on the lower plate and the example is put. The example is adjusted so the lines set apart on the finishes square measure vertical and designated over extremely modest plate. Other pressed wood strip is put over the example. The upper plate is brought down to contact the pressed wood strip. The breaking load(P) is noted.



**FIG- 4:** Average compressive strength at 7 and 28 days



**Table -3:** Tensile strength at 7 and 28 days

PEG 4000 (%) by cement	Copper slag (%) by fine aggregate	Tensile strength at 7 days N/mm <sup>2</sup>	Tensile strength at 28 days N/mm <sup>2</sup>
0	40	3.12	4.39
1.0	40	3.29	4.59
<b>1.5</b>	<b>40</b>	<b>3.73</b>	<b>4.98</b>
2.0	40	3.58	4.75
2.5	40	3.46	4.60

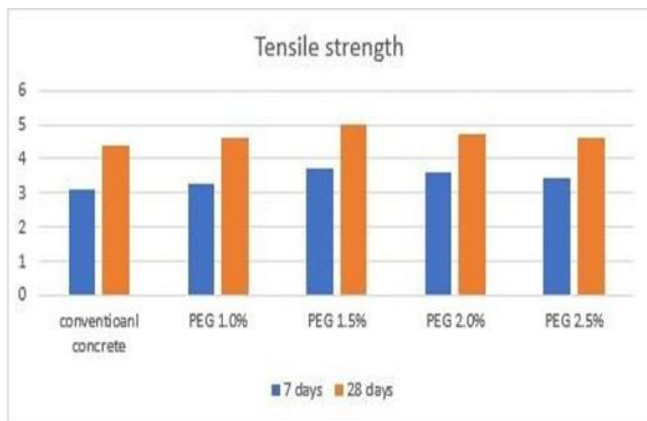


FIG- 6: Average tensile strength at 7 and 28 days

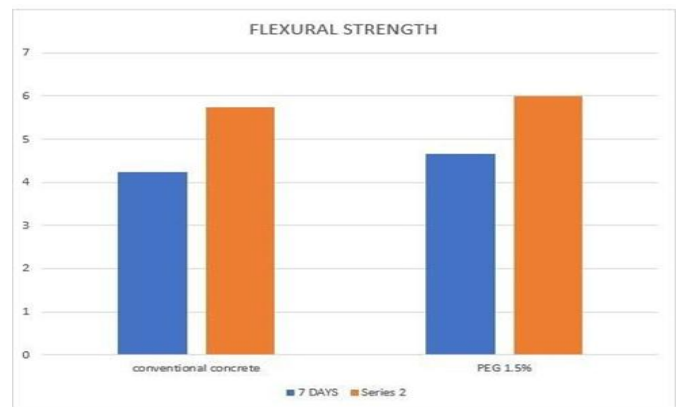


FIG- 8: Average flexural strength at 7 and 28 days



FIG- 7: Average tensile strength at 7 and 28 days



Fig-9: Flexural strength test on concrete

### 10.3 Flexural strength

It tests the capacity of unreinforced cement footer or chunk to endure disappointment in bowing. The consequences of flexural test on concrete communicated as a modulus of burst which means as (MR) in MPa or psi. The flexural test on cement can be directed utilizing either three-point load test (ASTM C78) or focus point load test (ASTM C293).

PEG 4000 (%) by cement	Copper slag (%) by fine aggregate	Flexural strength at 7 days N/mm <sup>2</sup>	Flexural strength at 28 days N/mm <sup>2</sup>
0	40	4.25	5.74
1.5	40	4.66	5.99

### 11.0 CONCLUSION

In Self curing concrete the greatest outcomes accomplish at 1.5 % of PEG 4000 with 40% of copper slag as a fractional trade for fine aggregate. Strength of self-curing concrete with incomplete substitution of copper slag as fine aggregate is moderately high when contrasted and conventional concrete. The most extreme compressive strength at 28 days in self curing concrete (53.58N/mm<sup>2</sup>) at 1.5% of PEG is more than that of the ordinary concrete. The most extreme tensile strength at 28 days in self curing concrete (4.98N/mm<sup>2</sup>) at 1.5% of PEG is more than that of the ordinary concrete. The most extreme flexural strength at 28 days in self curing concrete (5.99N/mm<sup>2</sup>) at 1.5% of PEG is more than that of the ordinary concrete. Self-curing concrete is the feasible response to numerous issues looked because of absence of legitimate curing

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