IMPACT OF SELF CURING AGENT WITH VARYING PERCENTAGES ON STRENGTH OF SELF COMPACTING CONCRETE

[1]**Ch Sruthi (PG Scholar)** [2]**V S N Sai**, M Tech, Assistant Professor

[1,2]Srinivasa Institute Of Engineering And Technology, Cheyyeru, East Godavari, Andhra Pradesh, INDIA

[1]sruthichevala7729@Gmail.Com [2]nagasai079@Gmail.Com

ABSTRACT

Concrete is one of the most widely used materials in the construction industry due to its good compressive strength and durability. Present-days there is an endless prominence on performance aspect of concrete. One such thought has motivated the growth of Self Compacting Self Curing Concrete. It is reflected as "the most innovative development in concrete construction field". Self-Compacting Concrete has gained wide use for placement in congested reinforced concrete structures with difficult casting conditions while Self Curing Concrete absorb water from atmosphere to achieve better hydration of cement in concrete. Any negligence in compaction and curing will badly affect the strength and durability of concrete. This investigation is aimed at utilizing the combination of these two types together which provides a suitable solution for the curing and compacting processes.

This study aimed to use chemical admixtures and mineral admixtures in concrete to improve the strength properties of concrete like compressive strength, split tensile strength along with slump cone test to determine the workability at various percentages of self curing agent for grade of M20. And lime stone powder was replaced by 10% and fly ash 20%with cement, quarry dust was replaced by 20% of fine aggregates. SNF powder is used for making self compacting concrete 0.7% of weight of cement and PEG4000 is used for the self curing of concrete with varying percentages(0.5%, 1%, 1.5%, 2%, 2.5%, 3%) for 7,14,28 days are analyzed.

Key Words: Self-Compacting concrete, Self-Curing concrete, Curing, PEG4000, SNF powder, mineral admixtures.

1.INTRODUCTION

In SCC, the aggregates contribute 60–70% of the total volume. Proper choice of Aggregates has a significant influence on the fresh and hardened properties of concrete. aggregate characteristics such as shape, texture and grading influence workability, finish ability, bleeding, pumping ability, segregation from fresh concrete and strength, stiffness, shrinkage, creep, density, permeability, and durability of hardened concrete. The advantages of SCC are: Improved quality of concrete and reduction of onsite repairs; Faster construction times; Lower overall costs; Facilitation of introduction of automation into concrete construction; Improvement of health and safety is also achieved through elimination of handling of vibrators; Possibilities for utilization of “dusts”, which are currently waste products; Easier placing; Thinner concrete sections; Greater Freedom in Design.

In this study compressive strength and spilt tensile strength of self curing concrete with varying percentages (0.5%,1%,1.5%,2%,2.5%,3%) for 7,14,28 days are analyzed. SCC has substantial commercial benefits because of ease of placement in complex forms with congested reinforcement.

1.2 Self-compacting concrete

Self-compacting concrete (SCC) represents one of the most outstanding advancement in concrete technology during the last decade. SCC is another sort of concrete with huge deformability and segregation resistance. SCC was first developed in 1988 by professor Okamura intended to improve the durability properties of concrete structures.

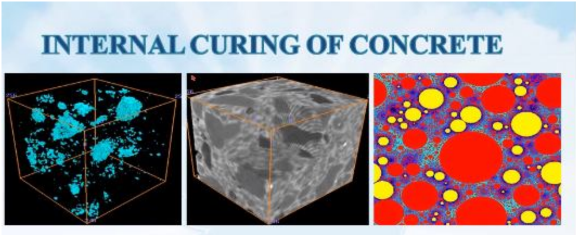
1.3 Self-curing concrete

Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. There are two major methods available for internal curing of concrete. The first method uses saturated porous lightweight aggregate (LWA) to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second method uses polyethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention. In the present study, the second method is being adopted.

1.3.1 Methods of self curing concrete

1) External self curing of concrete
2) internal self curing of concrete

1.3.2 Materials Used For Internal Curing



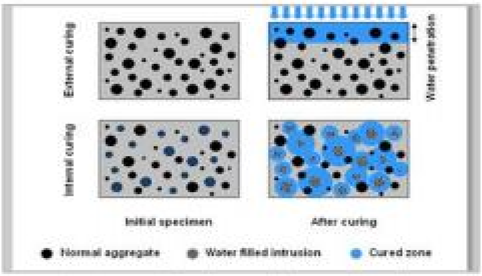
- Natural or Synthetic Light Weight Aggregate Fines
- Expanded shale with higher water absorption capacity
- Super Absorbent Polymers (SAP)
- Sodium salts of poly-acrylic acid, polyacrylamide, ethylene malefic anhydride, cross-linked carboy methyl cellulose, polyvinyl alcohol
- Shrinkage Reducing Admixture (SRA) - polyethylene glycol
- Saturated Wood powder

1.3.3 Basic Concept of The Self-Curing Concrete

The basic concept of the self curing concrete technology is to provide water for concrete, so that it can continue the curing process on its own. This is performed by encapsulating the water inside the ingredients used to make concrete.

1.3.4 Mechanism of Self Curing

It is important to know the mechanism behind the process of internal curing. In normal concrete what usually happens is the continuous evaporation of moisture from an exposed surface takes place due to the difference in chemical potentials (free energy) between the vapour and liquid phases. However when polymers are added in the mix they tend to form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure thereby reducing the rate of evaporation from the surface.



Mechanism of internal curing

1.4 Experimental investigation

Tests on fresh concrete were performed to study the workability of SCC with various proportions of rock dust and silica fume. The tests conducted are listed below:

1. Slump flow test
2. V- funnel flow test
3. U-tube test
4. J- Ring test
5. L-box test

Tests on hardened concrete were also conducted for mixes with various proportions of rock dust. An investigation for the optimum percentage of replacement of FA with rock dust was performed.

1.5 SCOPE OF STUDY

1. This type of concrete can be used in areas where the water is insufficient during construction and the vibrators are not accessible.

2. The replacement cement by fly ash reduces the co_2 emission to the atmosphere Which in turn reduces the greenhouse effect.

3. As a result it does not requires any vibration and any external curing.

4.To study the mechanical properties of self-compacted concrete (SCC) with self - curing agents (SCA) by conducting the hardened test.

1.6 uses

- Ready mix concrete where workability retention coupled with retardation of initial set is beneficial.
- Water reduction significantly improves compressive strength at all ages.
- Enhances durability through the production of low permeability concrete.
- Reduces placing problem in hot weather concreting by improving workability and workability retention.
- Chloride free, safe for use in prestressed and reinforced concrete.

1.7 Objectives

The objective of this paper is aimed to use chemical admixtures and mineral admixtures in concrete to improve the strength properties of concrete like compressive strength, split tensile strength along with slump cone test to determine the workability at various percentages of self curing agent for grade of M20. And lime stone powder was replaced by 10% and fly ash 20%with cement, quarry dust was replaced by 20% of fine aggregates. SNF powder is used for making self compacting concrete 0.7% of weight of cement and PEG4000 is used for the self curing of concrete with varying percentages(0.5%, 1%, 1.5%, 2%, 2.5%, 3%) for 7,14,28 days.

1.8 Need for study

- Can reduce 10% of water consumption at least
- Can improve mixture of the concrete
- Compression strength improves by more than 15% equally on 3-28 days
- Have no function of corroding on the reinforcing bar.

2. LITERATURE REVIEW

Self-compacting concrete was first developed in 1988 so that durability of concrete structures can be improved. Since then, various investigations have been carried out and the concrete has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix- design method and self-compact ability testing methods have been carried out from the viewpoint of making it a standard concrete. Recommendations and manuals for self compacting concrete were also established. The Some of studies about self- compacted and self curing concrete are disused in this chapter. This research is proposed to replace the constituent materials by mineral Admixtures and adding chemical admixtures. Also it is proposed to use self curing compound instead of conventional water curing. Mechanical properties such as modulus of concrete have been found out and compared with controlled beams, self compacting concrete beams, self-curing concrete beams and admixture beams. Compressive strength of self-compacting.

3. MATERIALS

3.1 Cement

Ordinary Portland Cement (OPC) of 53 grade is the most common type of cement in general Usage,with Specific Gravity of 3.15, is available in local market.

3.2 Fine Aggregate

Fine aggregate is the inert or chemically inactive material, most of which passes through a 4.75 mm IS sieve and contain not more than 5 percent coarser material.

3.3 Coarse Aggregates

Construction aggregate, or simply "aggregate," is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. Maximum coarse aggregate size used is 20 mm and the minimum coarse aggregate size used is 12 mm.

3.4 SNF Powder

SNF, a high range water reducer with no air entraining component. SNF powder is used for making self-compacting concrete.

3.5PEG4000

PEG 4000 is used for the self-curing of concrete.

3.6 Fly Ash

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash require a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water to react and produce cementations compounds.

3.7Rock dust

The granite fines obtained as by-product in the production of concrete aggregates are referred as quarry or rock dust [4]. Rock dust of specific gravity 2.37 passing through 150-micrometer sieve was used in this study

3.8Lime stone powder

lime stone powder is one of the mineral materials in concrete due to its wide availability and low cost. The effect of limestone powder depends on its particle size and content. Using LS to replace fine aggregate improves the properties of concrete. Locally available lime stone powder is used as 10% replacement of LS powder with fine aggregate.

4. MIX DESIGN

4.1 Experimental Work

From the calculations the design mix was obtained as 1:1.84:3.33 with a w/c ratio of 0.5 for M20 mix concrete. The total amount of material required for 1m³ concrete is shown.

Amount of materials required for 1m³ concrete in table 4.1.1

Water	Cement	Fine aggregate	Coarse aggregate
197 L	394 Kg	726.544 Kg	1314.88 Kg
0.5	1	1.84	3.33

Final different concrete mixes cast in table 4.1.2

Mix no.	PEG4000	Cement (kg/m3)	Water (kg/m3)	Fine aggregate (kg/m3)	Coarse aggregate (kg/m3)	SNF(%)
M1	-	419.5	188.8	554	1195	-
M2	-	465	186	646.47	1070	-
M3	0%	550	198	880	720	0.7
M4	0.5%	550	198	880	720	0.7
M5	1%	550	198	880	720	0.7
M6	1.5%	550	198	880	720	0.7
M7	2%	550	198	880	720	0.7

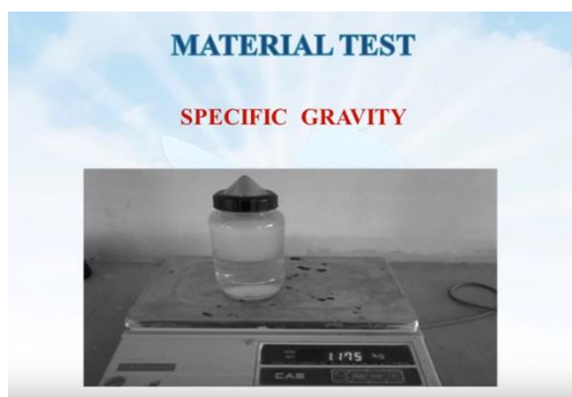
4.2 Mechanical Properties

The mechanical properties like compressive strength, flexural strength, split tensile and modulus of elasticity of SCC were obtained from 150 x 150 x 150 mm cubes, 100x 100 x 500 mm prism and 150 x 300 mm cylinders and the results are summarized in Table IV.

4.2.1Compressive Strength of Specimens: Compressive strength tests were carried out on cubes of 150 mm size on a compressive testing machine of 2000 kN capacity as per IS516:1959.

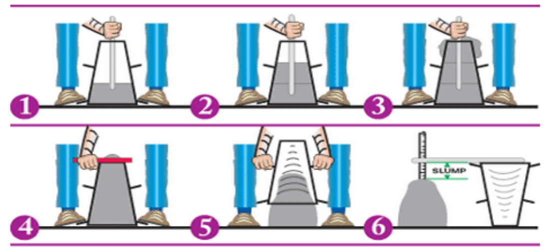
4.2.2 Tensile Strength of Specimens: Tensile strength tests were carried out on cubes of 150 mm size on a compressive testing machine of 2000 kN capacity as per IS516:1959.

4.2.3 The Modules of Elasticity of Concrete: compression rests were carried out on cylinders of 150mm diameter and 300mm height on a testing machine of 2000 kN capacity as per IS516:1959.



4.3 Procedure for Concrete Slump Cone Test

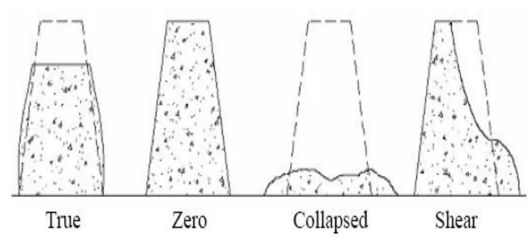
1. Clean the internal surface of the mould and apply oil.
2. Place the mould on a smooth horizontal non- porous base plate.
3. Fill the mould with the prepared concrete mix in 4 approximately equal layers.
4. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
5. Remove the excess concrete and level the surface with a trowel.
6. Clean away the mortar or water leaked out between the mould and the base plate.
7. Raise the mould from the concrete immediately and slowly in vertical direction.
8. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.



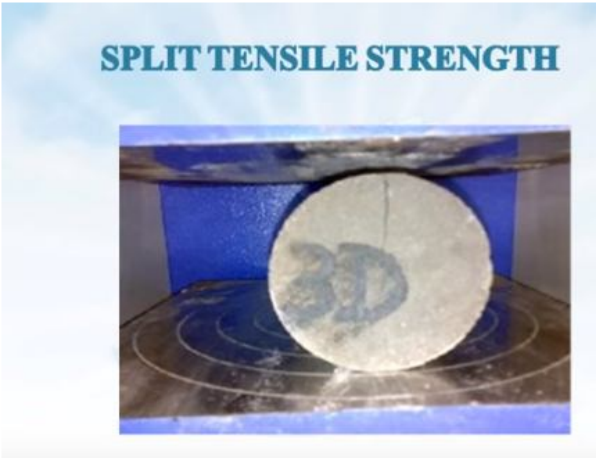
SLUMP CONE TEST VALUES IN TABLE 4.3.1

Percentage of self curing concrete	Slump values
Conventional	100
0.5	130
1	146
1.5	153
2	175
2.5	220
3	251

When the slump test is carried out, following are the shape of the concrete slump that can be observed:



4.4 Procedure for split tensile strength test



PROCEDURE:

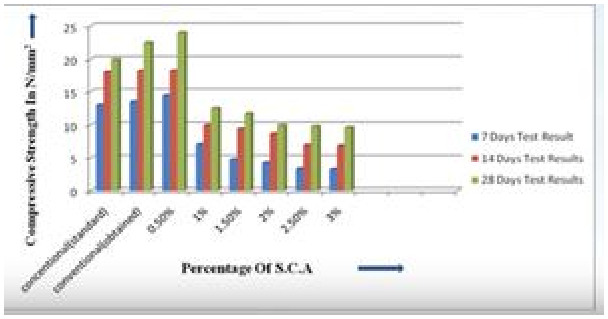
1. Sampling of materials
2. Proportioning
3. Weighing
4. Mixing concrete
5. Mould
6. Compacting
7. Curing
8. Placing the specimen in the testing machine
9. Two bearings strips of nominal (1/8 in i.e. 3.175 mm) thick plywood, free of imperfections, approximately (25 mm) wide, and of length equal to or slightly longer than that of the specimen should be provided for each specimen.
10. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine or between the specimen and the supplemental bars or plates.
11. Draw diametric lines an each end of the specimen using a suitable device that will ensure that they are in the same axial plane. Centre one of the plywood strips along the centre of the lower bearing block.
12. Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and cantered over the plywood strip.
13. Place a second plywood strip lengthwise on the cylinder, cantered on the lines marked on the ends of the cylinder. Apply the load continuously and without shock, at a constant rate within, the range of 689 to 1380 kPa/min splitting tensile stress until failure of the specimen
14. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

5. RESULTS

Compressive strength Test results in table 5.1

Percentage of S.C.A	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
Conventional (standard)	13.0	18.0	20
Conventional (obtained)	13.5	18.2	22.5
0.5	14.44	18.22	24
1	7.1	10	12.5
1.5	4.8	9.43	11.7
2	4.2	8.7	10
2.5	3.3	7	9.8
3	3.2	6.9	9.65

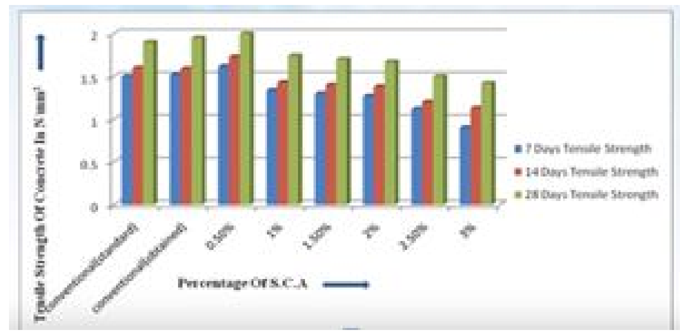
COMPARISON BETWEEN COMPRESSIVE STRENGTH WITH DIFFERENT PERCENTAGES OF SELF CURING AGENT



Split tensile strength Test results in table 5.2

Percentage of S.C.A	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
Conventional (standard)	1.50	1.60	1.90
Conventional (obtained)	1.52	1.59	1.95
0.5	1.62	1.73	2.00
1	1.34	1.43	1.74
1.5	1.30	1.40	1.70
2	1.27	1.38	1.67
2.5	1.12	1.20	1.50
3	0.90	1.13	1.42

COMPARISON BETWEEN SPLIT TENSILE STRENGTH WITH DIFFERENT PERCENTSGES OF SELF CU RING AGENTS



6. Conclusions

The following conclusions were drawn from this study.

- The strength of the specimen with 1% of PEG4000 increased when compared to the conventional specimen.
- The seven days compressive strength of the specimen with 1% of PEG4000 increased with conventional specimen by 8.27%.
- The seven days split tensile strength of the specimen with 1 % of PEG4000 increased with conventional specimen by 17.28%.
- The 28 days compressive strength of the specimen with 1% of PEG4000 increased with conventional specimen by 1.45%.
- The 28 days split tensile strength of the specimen with 1% of PEG4000 increased with conventional specimen by 22.22%.

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