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IJIEMR Transactions, online available on 19th Aug 2020. Link :http://www.ijiemr.org/downloads.php?vol=Volume-09&issue=ISSUE-08

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Volume 09, Issue 08, Pages: 33-42

Paper Authors

D.NAVYA, BH.SAICHAITANYA, K MARIMUTHU

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A STUDY ON MECHANICAL PERFORMANCE OF SELF CURING SELF-COMPACTING CONCRETE BY USING GLYCERINE

D.NAVYA [1], BH.SAICHAITANYA[2] K MARIMUTHU [3]

1,2 M Tech Student, Department of Civil Engineering, Srinivasa Institute of Engineering and Technology, Cheyyuru, East Godavri ,Andhra Pradesh

3 Assistant Professor , Department of Civil Engineering, Srinivasa Institute of Engineering and Technology, Cheyyuru, East Godavri ,Andhra Pradesh

ABSTRACT: In this study strength parameters of Self-compacted self-curing concrete of M50 grade are compared with self-compacting concrete. Mechanical properties of the concrete specimens such as compressive strength, split tensile strength and young's modulus are to be performed. Self-compacting concrete describes concrete with the ability to compact itself by means of its own weight the requirement for vibration. It is proved to fill all recesses reinforcement spaces and voids even in highly reinforced concrete members. Self- compacting concrete incorporating self-compacting agents have been studied and tests are performed using self-compacting agents. The Self-curing of concrete is maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. The concept of self-curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. The chemical admixtures used in this study are Master Glenium SKY 8233 for self-compacting concrete and Glycerin as self-curing agents. The mechanical properties are found by testing the casted specimens such as cubes and cylinders of standard sizes for varying proportions of Glycerin as 0.5%, 1%, 1.5% and 2%. The percentage of Master Glenium SKY 8233 is kept constant as (0.95%) with reference to literature studies. The objective of this study is to compare the mechanical propertiesof self-compacting self-curing concrete, with self-compacting concrete.

A self-curing concrete is provided to absorb water from atmosphere from air to achieve better hydration of cement in concrete. It solves the problem that the degree of cement hydration is lowered due to no curing or improper curing, and thus unsatisfactory properties of concrete. The self-curing agent can absorb moisture from atmosphere and then release it to concrete. The self-curing concrete means that no curing is required for concrete, or even no any external supplied water is required after placing. The properties of this self- cured concrete of this invention are at least comparable to and even better than those of concrete with traditional curing.

1. INTRODUCTION

As known, self-compacting concrete (SCC) is highly flowable, non-segregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation. It doesn't require any vibration for compaction and can

flow through narrow spaces without segregation and excessive bleeding. Therefore SCC is one of the greatest innovations of concrete technology. It was introduced in construction industry in early 1990s. Similar to the normal vibrated concrete (NVC), SCC
mixtures consist of aggregate, cement, water, admixtures and some mineral additions. Unlike NVC, SCC has high quantity of fillers (eg. silica fume, fly ash, limestone powder etc.) andsuper plasticizer (high-range water reducing admixture) added to improve its flowing property.

Use of SCC in construction industry is getting more and more popularity all over the world because of inherited advantages and studies on its hardened properties. SCC can be classified mainly into 3 different types

1. powder type
2. viscosity type and
3. Combination type

- The first type has a high amount of powder (all material <0.15 mm) ranging from 550–650 kg/m3, which provides the plastic viscosity and thus resistance to segregation whereas the yield point is determined by the addition of suitable super plasticizers
- In the second type there is less powder content ranging from 350–450 kg/m3. In this type additional minerals or fillers are not used for segregation resistance. An admixture called viscosity modifying agent (VMA) is used to control the segregation, while yield point is controlled by the super plasticizer.
- The third type has a powder content of 450–550 kg/m3, but additionally rheology is controlled by the use of appropriate dosage of VMA and super plasticizer.

CURING

Proper curing of concrete structures is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. 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. Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time. If the concrete is to achieve its potential strength and durability Curing may also encompass the control of temperature since this affects the rate at which cement hydrates.

METHODS OF CONVENTIONAL CURING

Methods of curing concrete fall broadly into the following categories:

1 Ponding or spraying
2. By using covering of wet hessian.
3. Reducing the rate of evaporation of water from concrete surface by covering with a relatively impermeable membrane.

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4. Delaying the removal of formwork can also be used to retain some water.
5. Steam curing.

SELF-CURING CONCRETE

The concept of curing and recognition of its contribution to obtain desirable properties of concrete is not novel. This technique has been adopted to maintain moisture and temperature conditions in a freshly placed cementious mixture to allow hydraulic cement hydration and pozzolanic reactions to occur so that the potential properties of the mixture may develop.

The principal contribution of self-curing results in the reduction of permeability that develops from a significant extension in the time of curing. Self-curing reduces plastic shrinkage cracking and settlement. Also a life-cycle cost reduction was estimated when internally cured high performance concrete is used instead of normal concrete.

MECHANISM AND SIGNIFICANCE OF SELF CURING

Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (Free energy) between the vapour and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface. When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete.

POTENTIAL MATERIALS FOR SELF CURING

The following materials can provide internal water reservoirs

1. Lightweight Aggregate (natural and synthetic, expanded shale)
2. LWS Sand (Water absorption =17%)
3. LWA 19mm Coarse (Water absorption = 20%).
4. Super-absorbent Polymers (SAP)(60-300 mm size) SRA (Shrinkage Reducing Admixture) (propylene glycol typei.e. polyethylene- glycol)
5. SRA (Shrinkage Reducing Admixture) (propylene glycol typei.e. polyethylene-glycol)
6. WOOD POWDER
7. GLYCERINE.

SELF COMPACTING CONCRETE

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent in concrete brought a revolution in applications of concrete. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it is very competitive building material There are many types of scc available, created by varying the proportions of the main ingredients. By adding or by substitution for the cementitious and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties

The use of pozzolanic materials in scc paved a solution for

- Modifying the properties of the scc
- Controlling the SCC production cost
- To overcome the scarcity of cement
- The economic advantage of disposal of industrial wastes

ADMIXTURE

Admixtures are those ingredients in concrete other than Portland cement, water, and aggregates that are added to the mixture immediately before or during mixing. About 80% of concrete produced in North America have one or more admixtures. About 40% of ready-mix producers use fly ash. About 70% of concrete produced contains a water-reducer admixture. One or more admixtures can be added to a mix to achieve the desired results

The reasons to use admixtures are

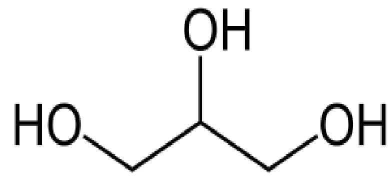
1. Increase slump flow and workability;
2. Reduce or prevent shrinkage;
3. Modify the rate or capacity for bleeding;
4. Reduce segregation;
5. Improve pumpability and finishability;
6. Accelerate the rate of strength development at early ages;
7. Decrease permeability of concrete;
8. Increase strength(compressive, tensile, or flexural);
9. Gas-forming;
10. Foaming;

There are two main groups of admixtures

1. Chemical admixtures
2. Mineral admixtures

Chemical Admixtures

They reduce the cost of construction, modify the properties of concrete and improve the quality of concrete during mixing,



transportation, placing and curing

Some of the chemicals admixtures are:

1. Air-entrainment
2. Water-reducing
3. Set-retarding
4. Accelerating
5. Super-plasticizers
6. Corrosion-inhibitors

Glycerine

Glycerol also called as glycerine. It is simple poly compound. It is colorless, odorless, viscous liquid that is sweet-tasting and non-toxic. The glycerol backbone is found in all lipids known as triglycerides. It is widely used in the food industry as a sweetener and humectant and in pharmaceutical formulations. Glycerol has three hydroxyl groups that are responsible for its solubility in water and its hygroscopic nature.

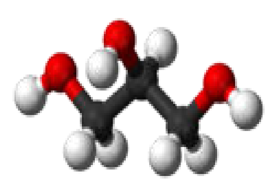


Figure 1: Structure of Glycerol

PRODUCTION

Glycerol is generally obtained from plant and animal sources where it occurs as triglycerides. Triglycerides are esters of glycerol with long-chain carboxylic acids. The hydrolysis, saponification, or transesterification of these triglycerides

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produces glycerol as well as the fatty acid derivative

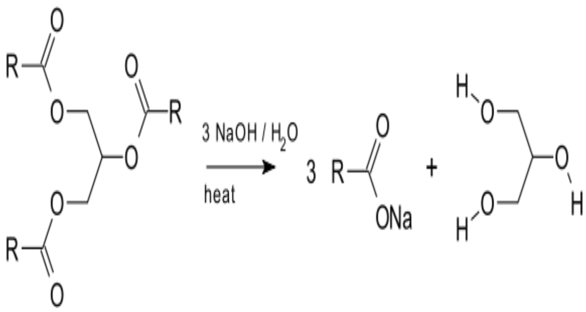

Figure 2: Reactive of Glycerol

Triglycerides are treated with an alcohol such as ethanol and with catalytic base to give ethyl esters of fatty acids and glycerol

Glycerol from triglycerides is produced on a large scale, but the crude product is of variable quality, with a low selling price of as low as 2-5 U.S. cents per kilogram in 2011. It can be purified, but the process is expensive. Some glycerol is burned for energy, but its heat value is low.Crude glycerol from the hydrolysis of triglycerides can be purified by treatment with activated carbon to remove organic impurities, alkali to remove unreacted glycerol esters, and ion exchange to remove salts. High purity glycerol (> 99.5%) is obtained by multi-step distillation; vacuum is helpful due to the high boiling point of glycerol (290°C).

SYNTHETIC GLYCEROL

Although usually not cost-effective, glycerol can be produced by various routes from propylene. The epichlorohydrin process is the most important; it involves the chlorination of propylene to give allyl chloride, which is oxidized with hypochlorite to dichlorohydrins, which reacts with a strong base to give epichlorohydrin. This epichlorohydrin is then hydrolyzed to give glycerol. Chlorine-free processes from propylene include the synthesis of glycerol from acrolein and propylene oxide.

Because of the large-scale production of biodiesel from fats, where glycerol is a waste product, the market for glycerol is depressed. Thus, synthetic processes are not economical. Owing to oversupply, efforts are being made to convert glycerol to synthetic precursors, such as acrolein and epichlorohydrin.

MINERAL ADMIXTURES

These are inorganic materials that also have pozzolanic or latent hydraulic properties. These very fine-grained materials are added to the concrete mix to improve the properties of concrete (mineral admixtures), or as a replacement for Portland cement (blended cement).

Fly ash:

A by-product of coal-fired electric generating plants which is used to partially replace Portland cement (by upto 60% by mass). The properties of fly ash depend on the type of coal burnt. In general, siliceous fly ash is pozzolanic, while calcareous fly ash has latent hydraulic properties.

Ground Granulated Blast Furnace Slag (GGBFS or GGBS):

A by-product of steel production is used to partially replace Portland cement (by upto 80% by mass). It has latent hydraulic properties.

Silica Fume: a by-product of the production of silicon and ferrosilicon alloys. Silica fume is similar to fly ash, but has a particle size 100 times smaller. This results in a higher surface to volume ratio and a much faster pozzolanic reaction. Silica fume is used to increase strength and durability of concrete, but generally requires the use of super plasticizers for workability.

Metakaolin: Metakaolin produces concrete with strength and durability similar to concrete made with silica fume. While silica fume is usually dark gray or black in colour, metakaolin is usually bright white in color, making it preferred choice for architectural concrete where appearance is important.

2. MATERIALS

CementCement is a binder, a substance that sets and hardens independently, and can bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to ascementum, cimentum, cäment, and cement.

Portland slag cement (ACC) was used. Physical properties of cement are shown in table

Table1: Physical Properties of cement (Portland slag cement

Property	**Value**
Specific gravity	2.92
Fineness of cement (By sieving)	0.5%
Standard consistency	32%
Setting TimeInitial Setting time	135 min
Final setting time	230 min

Coarse Aggregate

Crushed granite material with 60% passing 20mm and retained on 10mm sieve and 40% passing 10mm and retained on 4.75mm sieve having a specific gravity of 2.84 was used. The details about the coarse aggregate and their properties are shown in Table

Table 2: Physical Properties of coarse Aggregate: IS: 383, IS: 2386

property	**Value**
Specific gravity	2.78
Bulk density Loose state Compacted state	 1435.02kg/m^3 1692.11kg/m^3
Water Absorption	0.90%
Flakiness Index	14.13%
Elongation Index	21.29%
Crushing value	21.33%
Impact Value	15.40%
Fineness Modulus	7.3075

Fine Aggregate: River sand of zone-II was used as fine aggregate. The details of fine aggregate properties are shown in Table

TABLE 3:Fine Aggregate Properties

property	**Value**
Specific gravity	2.65
Bulk density Loose state Compacted state	 1680.65kg/m^3 1708.06kg/m^3
Grading of sand	ZONE

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	III as per IS 383
Fineness module	3.40
Silt content	1%
Surface moisture	0.7%

Water:: Potable fresh water available at Andhra University, Visakhapatnam, which is free from concentration of acid or organic substances, was used for mixing the concrete

MasterGlenium Sky 8233: MasterGlenium SKY 8233 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required

Table 4: physical properties of Master Glenium SKY 8233

Aspect	Reddish brown liquid
Relative Density	1.08 □ 0.02 at 25°C
Ph	>6
Chloride ion content	< 0.2%

Glycerol:

Pure glycerol has a melting point of 17.8°C. Its boiling point is 290°C but it also decomposes at that temperature. The presence of three hydroxyl groups makes the compound hygroscopic, with a tendency to absorb moisture from the air. This also makes it useful as a humectant in cosmetics and food, retaining water and preventing the substance from drying out. Glycerol is easily soluble in water, due to the ability of the polyol groups to form hydrogen bonds with water molecules. Glycerol is slightly denser than water with a specific gravity of 1.26. This means that when glycerol is poured into a container of water, it will sink to the bottom. However, due to its solubility, over time and with mild agitation, glycerol will form an aqueous solution

Table 5 :Physical properties of Glycerol

Density	1.261g/cm³
Water	0.5% max
Physical form	Viscous Liquid
Molecular formula	$C_3H_8O_3$
Vapor pressure	0.003mbar at 50°C
Boiling point	>290°C
pH	5
Colour	Clear

3. RESULTS & DISCUSSION

Slump Flow Test

The slump flow test of concrete is determined by placing of fresh concrete in slump- cone (inverse direction) for all proportions SCC & SCSCC

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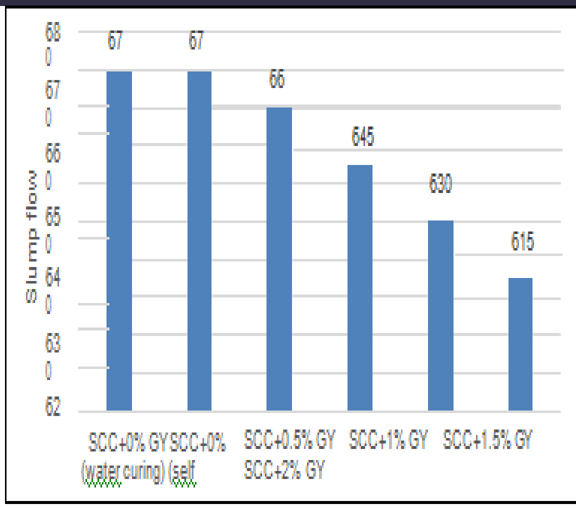

Figure 3: Slump flow values of SCC & SCSCC of various percentage of GLYCEROL

,It is observed that flow has been affected with increasing of % glycerol when compared with to 0% glycerol

COMPRESSIVE STRENGTH

The compressive strength of concrete is determined by crushing three cubes at the age of 7 and 28 days for SCC & SCSCC

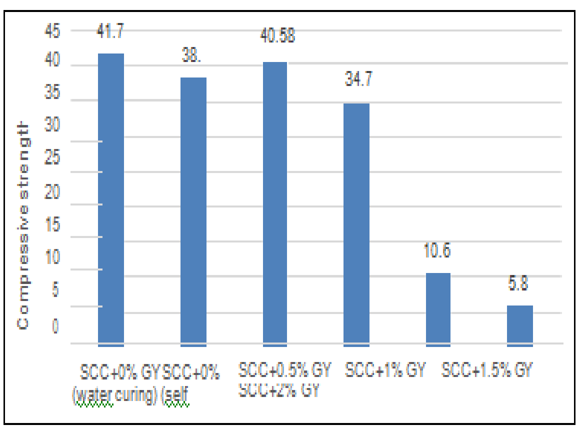

Figure 4 : Variation of compressive strength SCC & SCSCC at various percentage of GLYCEROL of 7 days

it is observed that the compressive strength of SCC has been declined from 41.77 N/mm^2 (water cured) at 0% GY to 40.58 N/mm^2 at 0.5% GY but when compared with 38.5 N/mm^2 (self-cured) at 0% GY has increases.

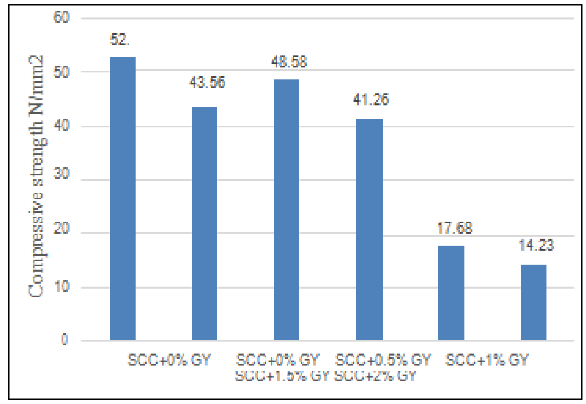

Figure 5: Variation of compressive strength SCC & SCSCC at various percentages of GLYCEROL of 28 days

Variation of compressive strength SCC & SCSCC at various percentages of GLYCEROL of 28 days.

It is further observed that the compressive strength of SCC has drastically reduced from 48.58 N/mm^2 at 0.5% GY to 14.23 N/mm^2 at 2% GY. So, finally we notified that concrete has become more brittle with further increases of % Glycerol.

SPLIT TENSILE STRENGTH

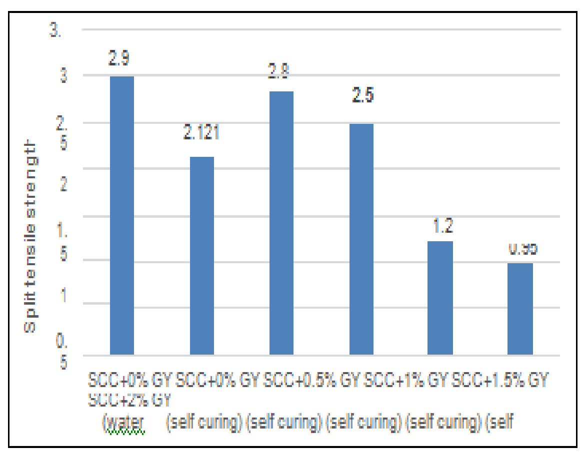

Figure 6: Variation of Split tensile strength SCC & SCSCC at various percentages of GLYCEROL of 7 days.

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it is observed that the split tensile strength of SCC has been declined from 2.96 N/mm^2 (water cured) at 0% GY to 2.82 N/mm^2 at 0.5% GY but when compared with 2.121 N/mm^2 (self-cured) at 0% GY has increases

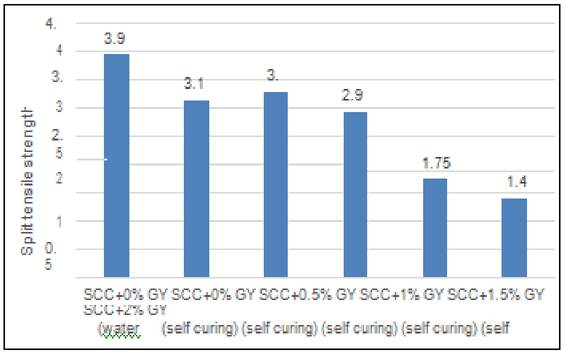

Figure 7: Variation of split tensile strength SCC & SCSCC at various percentages of GLYCEROL of 28 days.

It is further observed that the compressive strength of SCC has drastically reduced from 3.3 N/mm^2 at 0.5% GY to 1.4 N/mm^2 at 2% GY. So, finally we notified that concrete has become more brittle with further increases of % Glycerol.

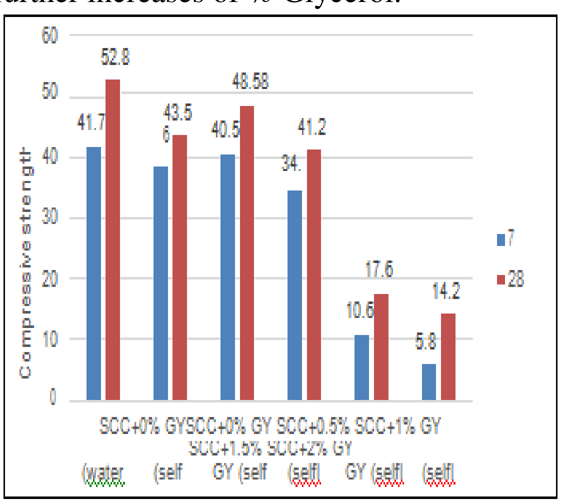

Figure 8: Comparison values of compressive strength SCC & SCSCC at various percentage of GLYCEROL of 7 & 28days

it is observed that the early strength (compressive) of 0% SCC (Water cured) is higher when compared to 0.5% SCSCC, but the early strength of the 0.5% SCSCC is higher when compared to 0% SCC (Self cured).

It is further observed that the increasing the percentage of Glycerin has been effected on the early strength.2% SCSCC has more better when compared to 0% SCC

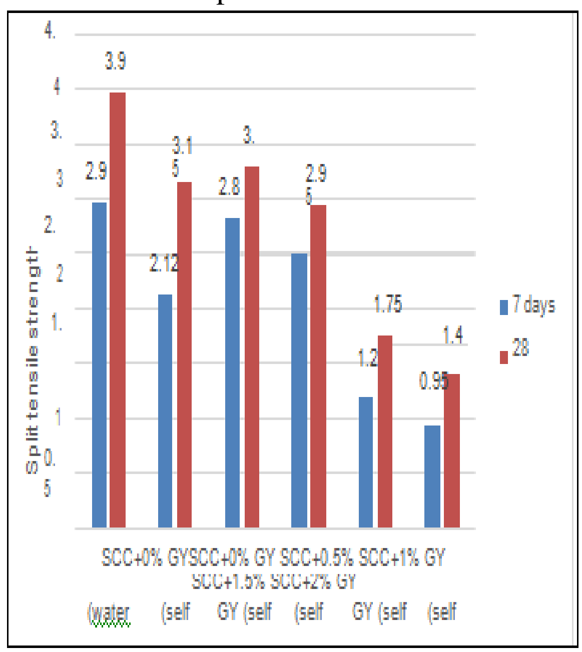

Figure 9 :Comparison values of split tensile strength SCC & SCSCC at various percentage of GLYCEROL of 7 & 28days

4.CONCLUSION

The following conclusion was drawn from this study:

1. It was observed that >1% GLYCERIN gives lower compressive strength and spilt tensile strength compared to 0.5% GLYCERIN. Thus it is found that addition of GLYCERIN in high dose over 1% of cement would not give expected results in strength and those cannot be used

practically.

2. The optimum dosage of GLYCERIN for maximum strength (compressive, tensile and elastic modulus) was found to be 0.5% for the M50.

3. 0.5% GLYCERIN gives higher compressive strength and spilt tensile strength compared to the normally used self -cured specimens without self-curing chemicals.

4. Self-Curing Chemical Admixture (SCCA) ie. GLYCERIN can promote effective hydration of cement without any externally applied curing procedure.

5. As percentage of GLYCERIN increased, the slump workability values has minor changes for M50 grade of concrete.

6. Compressive Strength of self-curing self-compacted concrete is on par with self - compacted concrete

7. Self-curing concrete is the answer to many problems faced due to lack of proper curing.

8. As percentage of GLYCERIN increased, the degree of hydration is escalated without effect of early age cracking and autogenous shrinkage.

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