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Mechanical Behaviour of Self Compacting and Self Curing Concrete

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ABSTRACT: The objective of this study is to compare the mechanical behavior of self-compacting and self-curing concrete with the conventional concrete. This research is proposed to adding chemical admixtures and pozzolanic material for making self-compacting concrete (SCC). Also, it is proposed to use self-curing compound instead of conventional or ambient water curing. Many researchers studied about the self-compacting concrete only and not for self-compacting and self-curing concrete, but this study proposed a methodology for self-compacting and self-curing concrete. Self-Compacting Concrete (SCC) is achieved by reducing the volume ratio of aggregate to cementitious materials, increasing the paste volume by using fly ash and superplasticizer(SNF). Curing techniques and curing duration significantly affect "curing efficiency." Techniques used in concrete curing are mainly divided into two groups namely, Water adding techniques and Water retraining techniques. The self-curing technique is part of water retaining technique using various methods. In this paper self-compacting self-curing concrete (SCSCC) has been studied using Polyethylene Glycol 4000 (PEG4000). Mechanical properties such as compressive strength, split tensile strength and flexural behavior of the beam has been studied. The specimen with 1% PEG4000 performed well when compared to the conventional specimen.

KEYWORDS: Self compacting concrete, self-curing concrete, superplasticizer, PEG4000.

I. INTRODUCTION

Self-Compacting Concrete (SCC) is highly workable concrete with high strength and high performance that can flow under its own weight through restricted sections without segregation and bleed (EFNARC, European Federation of Producers and Applicators of Specialist Products for Structures, 2002). SCC has substantial commercial benefits because of ease of placement in complex forms with congested reinforcement. 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. Self Compacting Concrete (SCC) was first developed in 1988 by Professor Okamura intended to improve the durability properties of concrete structures. SCC is defined as concrete that can flow and consolidate under its own weight. SCC is considering to be one of the most successful innovations in the industry of construction.

Self-compacting concrete (SCC) is a highly flowable concrete which does not segregate and can spread into place, fill the formwork with heavily congested reinforcement without any mechanical vibration. 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 of 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. Many investigators have studied about the manufactured sand. Strength characteristics of SCC and use of waste products such as silica

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fume and the introduction of fibers in improving strength characteristics of SCC have been studied and reported in the literature.

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 first method is being adopted. The use of fly ash, blast furnace slag and silica fume in SCC reduces the dosage of superplasticizer needed to obtain similar slump flow compared to concrete mixes made with only Portland cement.

The scope of these admixtures is not limited to a single dimension. They are preferred in almost all high rise building constructions where high strength concrete is needed, which is not possible without the use of superplasticizers. In mass concreting such as dam construction, if the rate of hydration of cement is not controlled, there can be an excessively large temperature rise of the order of 500 c above the outer temperature which can lead to large cracks and damage to the structure. Hence suitable measures in the form of retarding superplasticizers should be taken, which not only retard the hydration rate but also increase the strength of the concrete. In ready mixed concrete construction concrete is to be kept fresh for a relatively larger time, made possible by the addition of retarders at the time of mixing concrete. There are many other usages of the admixtures such as in prestressed concrete, in concrete bridges, in congested reinforced concrete, and so many others. Hence proper experimental investigations are necessary for determining the effects of the admixture and determine the optimum dosage of the admixture. The main objective of this investigation is to determine the suitable percentage of sand, coarse aggregate, cement and influence of different proportioning of superplasticizers in SC that gives the highest value of concrete compressive strength. Inter curing agent provide internal water reservoir, increase relative humidity by making a thin film with the water that reduces the self-desiccation at strength.

II. MATERIAL

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

Table: 1 Properties of Cement

Test	Result	As per IS 4031-1993
Consistency	30%	30-35%
Initial setting time	One hr 40 min	Not less than 30 min
Final setting time	Two hr 20 min	Not more than 600 min

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.

Table: 2 Properties of Fine Aggregates.

Test	Results	As per IS 4031 1998
Fineness modulus	3.07	Grading zone II
Specific gravity	2.63	2.6-2.8

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 geosynthetic aggregates. Maximum coarse aggregate size used is 20 mm and the minimum coarse aggregate size used is 12 mm.

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Table: 3 Properties of coarse aggregates.

Test	Result	As per IS 4031-1998
Specific gravity	2.70	2.6-2.85
Fineness modulus	7.3	5-8

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

Figure 1 SNF Powder

Table: 4 characteristics of SNF powder

appearance	brownish
PH value (1:10)	6.5 to 8.5
Solubility	Complete Soluble in water
Sodium sulphate	Maximum 10%
Solid	Minimum 95%
Chloride content	Below 200 ppm

PEG4000: peg 4000 is used for the self-curing of concrete.

Table: 5 characteristics of PEG 4000

The range of Average Molecular Weight.	3600-4400
Range of Average Hydroxyl Number, mgKOH/g	25-32
Density, g/cm3 @ 600C	1.2926
Melting or Freezing Range (in ^{0}C)	53-69
Solubility in water at 20^{0}C, %by wt.	66
Viscosity at 100^{0}C,cST	140.4
Average number of repeating oxyethylene units	90.5
Average liquid specific heat, Cal/g/^{0}C	0.51

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 cementitious compounds.

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Table: 6 Chemical Composition of Fly Ash

Composition	%(percentage)
SiO_2	58.59
Al_2O_3	21.89
Fe_2O_3	9.31
S+F+A	89.79
CaO	4.4
MgO	1.4
So_3	0.41
K20	1.81
Na_2O	0.28
LOI	0.59
Binder Activity	89.40

III. MIX DESIGN

There is no standard method for SCC mix design and many academic institutions, admixture, ready-mixed, precast and contracting companies have developed their own mix proportioning methods. Our design was based on EFNARC specifications. All concrete batches were prepared in rotating drum mixture. First, the aggregates are introduced and then one-half of the mixing water is added and rotated for approximately two minutes. Next, the cement and fly ash were introduced with HRWR admixture already mixed in the remaining water. Most manufacturers recommend at least 5 minutes mixing upon final introduction of Admixture.

Table: 7 Final Mix Designs

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	.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

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IV. RESULTS AND DISCUSSION

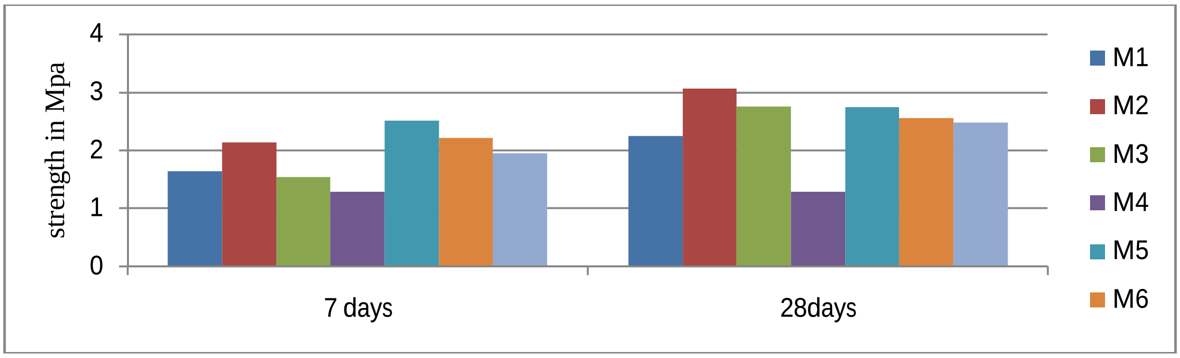

Figure 2 compressive strength of cubes

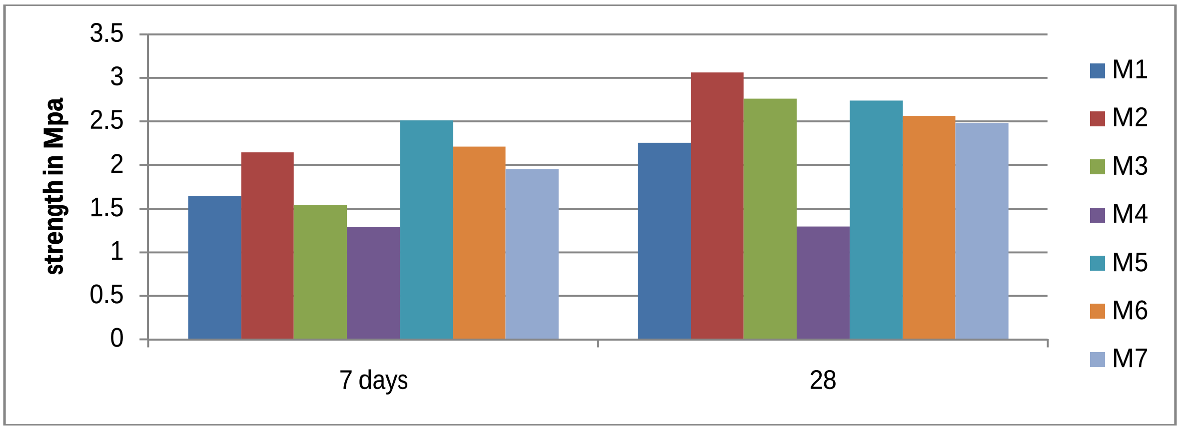

Figure 3 Splitting Tensile Strength of Cylinders

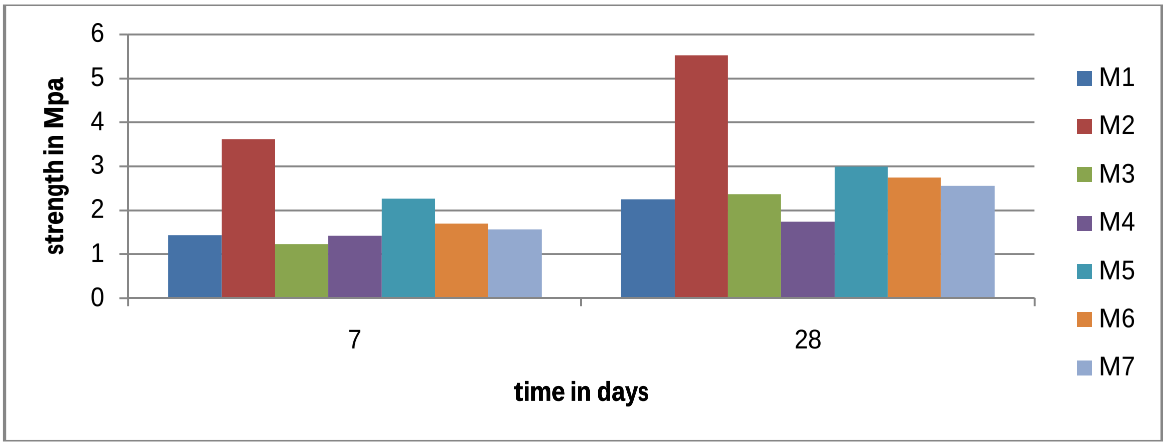

Figure 4 Flexural Tensile Strength Of Beams

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V. 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 with M40.
- From the seven days, compressive strength results in the specimen with 1% of PEG4000 increased with a conventional specimen with M40 by 8.27%.
- From the seven days splitting tensile strength results, the specimen with 1 % of PEG4000 increased with conventional specimen with M40 by 17.28%.
- From the 28 days, compressive strength results in the specimen with 1% of PEG4000 increased with a conventional specimen with M40 by 1.45%.
- From the 28 days splitting tensile strength results, the specimen with 1% of PEG4000 increased with a conventional specimen with by 22.22%.
- From 7 days flexural tensile strength results the specimen with 1% of PEG4000 decreased with a conventional specimen with M40 by 37.57%.
- From 28 days flexural tensile strength results the specimen with 1% of PEG4000 decreased with a conventional specimen with M40 by 45.65%.

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