AN EXPERIMENTAL INVESTIGATION ON STRENGTH PARAMETERS OF HIGH STRENGTH CONCRETE BY SELF-CURING

Gnana Venkatesh.S[1], Sangeetha A[2]

[1]Assitant Professor, Department of Civil Engineering, Nandha Engineering College, Erode, Tamilnadu, India.
[2]PG Student, Department of Civil Engineering, Nandha Engineering College, Erode, Tamilnadu, India.

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ABSTRACT

Conventional concrete need water curing for a minimum of 28 days to achieve its target strength .Hence water curing is very much essential to prevent unsatisfactory properties of cement concrete. In order to have good curing, excess of evaporation from the surface need to be prevented. This kind of curing technique can widely be practiced in places where there is scarcity of water. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non- irritating and is used in a variety of pharmaceuticals. Thus, it is a shrinkage reducing admixture. The aim of this investigation is to study the strength and durability properties of concrete using water soluble Polyethylene Glycol (PEG 400) 2% as self-curing agent using for M60 grade concrete. The compressive strength at 7 days, 14 days and 28 days have been obtained with normal curing and self curing condition. The cement hydration problem due to improper curing, which can be successfully overcome by using self curing concrete. Hence no traditional way of curing is required in self curing concrete.in this experiment we add the partial replacement of silica fume as cement and steel slag as fine aggregate.

Key words: polyethylene glycol, durability, odorless, neutral ,hydration

INTRODUCTION

Curing is the name given to the procedures used for promoting the hydration of the cement, and consists of a control of temperature and of moisture movement from and into the concrete. Curing allows continuous hydration of cement and consequently continuous gain in the strength, once curing stops strength gain of the concrete also stops. Proper moisture conditions are critical because the hydration of the cement virtually ceases when the relative humidity within the capillaries drops below 80%. 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. When concrete is exposed to the environment evaporation of water takes place and loss of moisture will reduce the initial water cement ratio which will result in the incomplete hydration of the cement and hence lowering the quality of the concrete.. Evaporation in the initial stage leads to plastic shrinkage cracking and at the final stage of setting it leads to drying shrinkage cracking. Curing temperature is one of the major factors that affect the strength development rate. At elevated temperature ordinary concrete losses its strength due to the formation of the cracks between two thermally incompatible ingredients, cement paste and aggregates Steel slag is the viable alternative to cement, which can be mixed and poured to make concrete with strength of concrete. In reality, Steel slag is actually quite a bit stronger than Portland cement, by far the leading type in use today. Steel slag hardness comes from the fact that as it dries, the material absorbs and irreversibly binds large amounts of atmospheric CO_2.

LITERATUREREVIEW

Ole and Hansen describe a new concept for the prevention of self-desiccation in hardening cement- based materials using fine, super absorbent polymer (SAP) particles as a concrete admixture. The SAP will absorb water and form macro inclusions and this leads to water entrainment, i.e. the formation of water-filled macro pore inclusions in the fresh concrete. Consequently, the pore structure is actively designed to control self-desiccation. In this work, self-desiccation and water entrainment are described anddiscussed.

Roland Tak Yong Liang, Robert Keith Suncarried work on internal curing composition for concrete which includes a glycol and a wax. The invention provides for the first time an internal curing composition which, when added to concrete or other cementitious mixes meets the required standards of curing as per Australian Standard AS 3799.

Wen-Chen Jaustated that self-curing concrete is provided to absorb water from moisture from air to achieve better hydration of cement in concrete. It solves the problem when the degree of cement hydration is lowered due to no curing or improper curing by using selfcuring agent like poly-acrylic acid which has strong capability of absorbing moisture from atmosphere and providing water required for curing concrete.

A.S. El-Dieb investigated water retention of concrete using water-soluble polymeric glycol as self-curing agent. Concrete weight loss and internal relative humidity measurements with time were carried out, inordertoevaluatethewaterretentionofself-curing concrete. Water transport through concrete is evaluated by measuring absorption%, permeable voids%, and water sorptivity and water permeability. The water transport through self-curing concrete is evaluated with age. The effect of the concrete mix proportions on the performance of self-curing concrete were investigated, such as, cement content and water/cementratio.

PietroLura The main aim of his study is to reach a better comprehension of autogenous shrinkage in order to be able to model it and possibly reduce it. Once the important role of self-desiccation shrinkage in autogenous shrinkage is shown, the benefits of avoiding self desiccation through internal curing become apparent.

MATERIALS

The basic tests are conducted on various materials like fine aggregate with partial replacement of steel slag in various percentage namely 5%, 10%, 15%, 20%, coarse aggregate, Cement with partial replacement of silica fume in various percentage namely 2.5 %, 5%, 7.5% ,10% ,Polyethylene Glycol (PEG 400) 2% as self-curing agent for M60 grade concrete to check their suitability for making concrete. The experimental investigation has been carried out on the test 3 specimens of Cubes, Cylinders, and Prisms each to study the strength properties.

EXPERIMENTALINVESTIGATION OFMATERIALS

Cement: Ordinary Portland cement of 53 Grade conforming to IS 12269-1987, and the cement should be clean, dry and free from impurities The specific gravity of cement is 3.14. The initial and final setting times were found as 35 minutes and 370 minutes respectively. Standard consistency of cement is 34%.

TABLE I

Physical Properties of Cement

S.No	Properties	Obtained values
1	Consistency test	34%
2	Initial setting Time	35 Minutes
3	Final setting time	370 Minutes
4	Fineness test	6%
5	Specific gravity	3.14

Fine aggregate: The M-sand is used as fine aggregate conforming to the requirements of IS: 383-1970, having specific gravity of 2.88 and fineness modulus of 3.25 has been used as fine aggregate for this study. and steel slag is partially replaced in various percentage namely 5%, 10%, 15%, 20%, 25% used in the concrete specimen

S.No	Properties	Obtained values
1	Specific Gravity	2.88%
2	Silt Content	5.8%
3	Finess Modulus	3.25

Coarse Aggregate: Coarse aggregate obtained from local quarry units has been used for this study, conforming to IS: 383-1970 is used. Maximum size of aggregate used is 20mm with specific gravity of 2.89 and water Absorbtion 0.5%. The aggregates were tested as per IS: 2386- 1963.

S.No	Properties	Obtained values
1	Specific Gravity	2.89
2	water Absorption	0.5%
3	Bulk Density	1785 Kg/m^3

Water: According to IS 3025, Water to be used for mixing and curing should be free from injurious or deleterious materials. Potable water is generally considered satisfactory. In the present investigation, available water within the campus is used for mixing and curingpurposes.

Steel slag: Steel slag is obtained from Agni Steels Private Limited, Ingur, TamilNadu, India and its specific gravity in fine form is found to be 2.95.The predominant compounds are dicalcium silicate, tricalcium silicate, dicalcium ferrite, merwinite, calcium aluminate, calcium-magnesium iron oxide, andsome free lime and free magnesia (periclase).

TABLE II
Chemical Composition of Steel Slag

Constitution	Composition (%)
CaO	40-52
SiO_2	10-19
FeO	10-14
MnO	5-8
MgO	5-10
Al_2O_3	1-3
P_2O_3	0.5-1
S	<0.1
Metallic Fe	0.5-10

Silica Fume:

Silica fume is a by product in the reduce of high- purityquartz withcoke in electric arc furnaces in the manufacture of silicon and ferrosiliconalloys.

Micro silica consist of fine element with a surface area on the order of 215,280 ft²/lb (20,000 m²/kg) when particular by nitrogen adsorption techniques, with particle just about one hundredth the size of the average cement Because of its excessive fineness and
high silica content, micro silica is a very efficient pozzolanic materialparticle.

Micro silica is added to Portland cement concrete to enhance its properties, in particular its compressive strength, bond strength, andabrasionresistance.

These improvement stems from both the mechanical improvements resulting from addition of a extremely fine particle to the cement paste mix as well as from the pozzolanic reactions between the micro silica and liberated calciumhydroxide in the paste.

Addition of silica fume also decrease the permeability of concrete to chloride ions,which protect the reinforcing steel of concrete from corrosion, especially in chloride-rich environment such as coastal region. It has been reported that the pozzolanic reaction of silica fume is very important and the no evaporable water content decreases between 90 and 550 days at low water/binder ratios with the addition of silica fume.

TABLE III
Physical properties of Silica Fume

S.No	Physical Properties of Silica Fume	
1	Colour	Dark grey
2	Specific gravity	2.2
3	Finess modulus	20000m2/kg
4	Bulk modulus	240kg/m³

Polyethylene Glycol-400(PEG-400) :

The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules of water which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface. The physical and chemical properties of PEG-400 are shown in Table IV.

TABLE IV
Physical properties of PEG-400

S.No	Physical Properties of PEG-400	
1	Odour	Mild colour
2	Solubility	Soluble in water
3	Density range	1.1 to 1.2 (increase as molecular weight increases)

CONCRETEMIX PROPORTIONS: The mixes were designed in accordance with IS 10262-2009 mix design method. Based on the result, the mix proportions M60is designed. Concrete mix with the W/C ratio of 0.35 is prepared. The details of mix proportion and materials required for 1m³ of concrete.

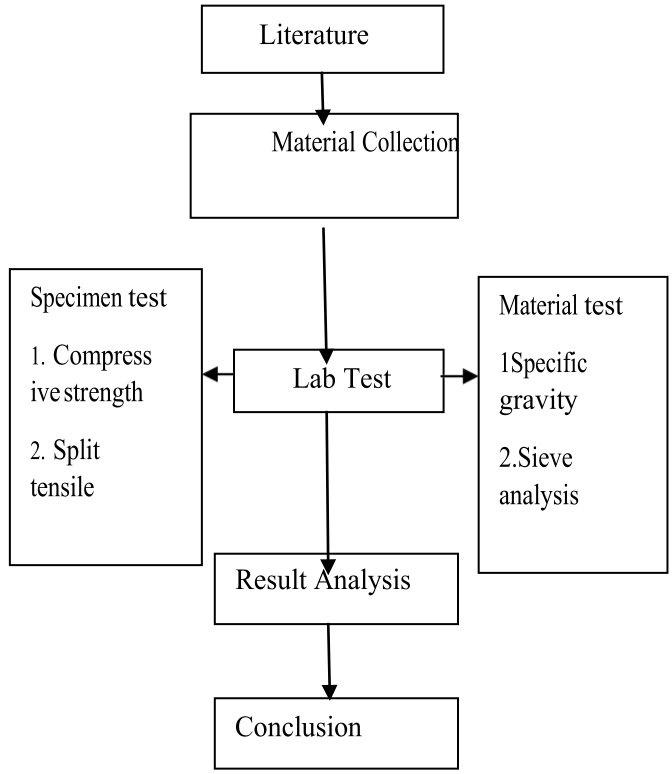
Cement = 446 Kg/m³ Water = 156 litre

Fine aggregate = 856 Kg/m³ Coarse aggregate = 1171 Kg/m³ Chemical admixture = 1.784 Kg/m³ Water-cement ratio = 0.35

MIX RATIO = 1:1.92:2.62:0.35

MIX DESIGN	SILICA FUME	STEEL SLAG	PEG (400)
M 1	2.5%	5%	2%
M 2		10%	
M3		15%	
M4		20%	
M5	5%	5%	
M6		10%	
M7		15%	
M8		20%	
M9	7.5%	5%	
M10		10%	
M11		15%	
M12		20%	
M13	10%	5%	
M14		10%	
M15		15%	
M16		20%	

METHODOLOGY



V. TEST RESULTS

Comparison of Compressive Strength at 7 days,14 days & 28 days

S.NO	Type of Concrete	Compressive Strength (N/mm²)		
		7 Days	14 days	28 days
1	Conventional	34.98	40.25	49.91
2	M 1	35.9	41.35	52.90
3	M 2	37.85	41.72	54.81
4	M3	38.05	42.01	56.03
5	M4	38.98	43.06	58.26
6	M5	40.02	43.52	58.96
7	M6	41.53	44.91	59.47
8	M7	41.61	45.62	60.94
9	M8	41.74	47.26	61.15
10	M9	42.01	48.31	61.94
11	M10	42.73	49.40	62.88
12	M11	42.88	50.48	63.81
13	M12	42.93	51.53	64.86
14	M13	43.14	51.99	65.28
15	M14	43.58	52.71	66.92
16	M15	43.69	53.02	67.83
17	M16	43.74	53.73	68.92

Comparison of Flextural Strength

at 7 days,14 days & 28 days

S.NO	Type of Concrete	Flextural Strength (N/mm²)	
		7 Days	28 days
1	Conventional	7.95	9.38
2	M 1	7.98	9.91
3	M 2	8.00	10.99
4	M3	8.03	10.23
5	M4	8.03	10.54
6	M5	8.08	10.88
7	M6	8.11	11.09
8	M7	8.19	11.77
9	M8	8.23	12.05
10	M9	9.41	12.33
11	M10	9.63	12.76
12	M11	9.98	13.01
13	M12	10.5	13.04
14	M13	10.91	13.51
15	M14	11.23	13.97
16	M15	11.59	14.23
17	M16	11.7	14.8

Comparison of Split Tensile Strength

at 7 days,14 days & 28 days

S.NO	Type of Concrete	Split Tensile Strength (N/mm²)	
		7 Days	28 days
1	Conventional	2.16	3.3
2	M 1	2.21	2.52
3	M 2	2.33	2.71
4	M3	2.45	2.92
5	M4	2.57	3.03
6	M5	2.59	3.08
7	M6	2.60	3.11
8	M7	2.60	3.14
9	M8	2.61	3.17
10	M9	2.63	3.18
11	M10	2.67	3.20
12	M11	2.70	3.21
13	M12	2.74	4.03
14	M13	2.76	4.11
15	M14	2.79	4.22
16	M15	2.81	4.38
17	M16	2.83	4.41

CONCLUSION

1) In this project ,the mix design for concrete grade of M60 the concrete with various percentage replacement level of steel slag and silica fume & chemical admixture (PEG) used.

2) From this compressive strength ,tensile, strength, and flexural strength of concrete with replacement 20% SS is higher than the normal concrete.

3) The natural sand demand also reduced by introducing the m sand as it provides greater strength and being economical.

4) Concrete can be obtained by reducing water content by adding the super plasticizer.

5) The PEG level must not be greater than 2% of Cementitious material.

6) This experimental investigation work can be used further experiments on the potential of replaced silica fume as cement for concrete and steel slag as Fine aggregate.

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