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Feasibility studies on Fibrous Self Curing Concrete Using Polypropylene Fibre

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Abstract: -- **Today Water is the most required substance in the era. In common, Curing of concrete is maintaining moisture in the concrete during early ages specifically within 28 days of placing concrete, to develop desired properties. Proper curing of concrete is essential to obtain maximum durability, especially if the concrete is exposed to serve conditions where the surface will be subjected to excessive wear, aggressive solutions and severe environmental conditions. Poor curing practices adversely affect the desirable properties of concrete which make a major impact on the permeability of a given concrete. Unexpected shrinkage and temperature cracks can reduce the strength, durability and serviceability of the concrete. The surface zone will be seriously weakened by increased permeability due to poor curing. The development of concrete shrinkage is proportional to the rate of moisture loss in concrete. When concrete is properly cured, water retained in concrete would help continuous hydration and development of enough tensile strength to resist contraction stresses. The continuous development of strength reduces shrinkage and initial cracks or micro-cracks. As a part of this investigation of Fibrous Self Curing Concrete, proportion and addition of Polypropylene Fibre resulted in the formation of microcracks in order to reduce the autogenous shrinkage and improvement of durability.**

Keywords— Water scarcity; Autogenous shrinkage; Temperature cracks; Internal curing; Polyethlene Glycol; Polyproplene Fibre.

I. INTRODUCTION

This Concrete is a blend of Cement, Aggregates and water with or without appropriate admixtures. To achieve alluring quality and different properties, curing is fundamental. Curing is the way toward keeping up the correct dampness substance to advance ideal bond hydration instantly after arrangement. Proper moisture conditions are critical because water is necessary for the hydration of cementations materials.

As a result, adequate curing is essential for concrete to obtain advanced structural and durability properties and therefore is one of the most important requirements for optimum concrete performance in any environment or application. Curing techniques and Curing durability significantly affect curing efficiency.

As per IS 456: 2000, Curing is the process of preventing the loss of moisture from the concrete whilst maintaining a satisfactory temperature regime.

II. REVIEW OF LITERATURE

Álvaro Paul and Mauricio Lopez, (2011),[1] internal curing (IC), which has been extensively investigated in the last decade, has been shown to enhance hydration, diminish autogenous shrinkage, and mitigate early-age cracking due to self-desiccation in high-performance concrete. It also increases the internal porosity of concrete, however, which might reduce mechanical properties.

Ambily and Rajamane, (2009),[2] studied the different aspects of achieving optimum cure of concrete without the need for applying external curing methods excessive evaporation of water (internal or external) from fresh concrete should be avoided, otherwise, the degree of cement hydration would get lowered and thereby concrete may develop unsatisfactory properties. Curing operations should ensure that adequate amount of water is available for cement hydration to occur.

Dale P.Bentz, (2007),[7] in the twenty-first century, most high-performance concretes, and many other ordinary concretes, are now based on blended cements that contain silica fume, slag, and/or fly ash additions.

Because the chemical shrinkage accompanying the pozzolanic and hydraulic reactions of these mineral admixtures is generally much greater than that accompanying conventional Portland cement hydration, these blended cements may have an increased demand for additional curing water.

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The review of various literatures mentioned above has helped to understand the properties of self-curing concrete and addition of Super Absorbent Polymers and fibre improve the concrete's durability rather than conventional concrete.

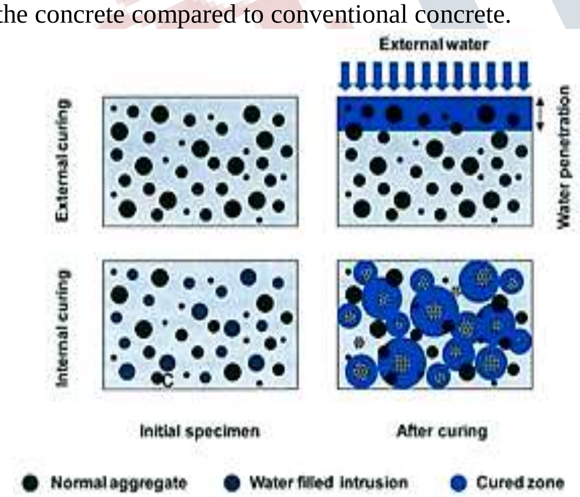
III. SCOPE AND OBJECTIVES

A comprehensive investigation has been undertaken to study the effects of self-curing agents such as Polyethelene Glycol PEG 400 and the addition of Polypropylene Fiber on the mechanical properties of concrete and its durability.

The test program was performed on concretes containing cement content, water cement ratio (0.4) cured in air 25°C and elevated temperature 50°C. Special attention was given to the enhancement in self-curing concrete properties cured in normal 25°C and elevated temperature 50°C, as well as its durability and wet/dry cycles in water as affected by the type and doses of self-curing agent along with the addition of Polyethylene Glycol PEG 400.

IV. PROPERTIES AND SIGNIFICANCE

A. Self Curing
The concept of self-curing is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete.



External and Internal curing

B.Benefits from Internal Curing
Internal Curing can be anticipated when
•Cracking of concrete provides passageways resulting in deterioration of Reinforcing steel
•Low early-age strength is a problem and Need for reduced construction time,
•Quicker turnaround time in precast plants, lower maintenance cost,
•Greater performance, predictability, Permeability/durability must be improved,
•Rheology of concrete mixture, modulus of elasticity of the finished product or durability of high fly-ash concretes are considerations

C. Effect of Fibres in Concrete
• Usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage.
• Reduce the permeability of concrete and thus reduce bleeding of water.
• Fibres produce greater impact, abrasion and shatter resistance in concrete.
• Fibres do not increase the flexural strength of concrete, and so cannot replace moment resisting or structural steel reinforcement
The amount of fibres added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibres), termed volume fraction (Vf). volume fraction typically ranges from 0.1 to 3%.

D. Benefits of Fibre Reinforced Concrete
• Improved impact & freeze-thaw resistance
• Improved resistance to explosive spalling in severe fire
• Increased resistance to plastic shrinkage during curing
• Improved structural strength
• Reduced steel reinforcement requirements & improved ductility
• Reduced crack widths and segregation

V. MATERIAL PROPERTIES

• As per IS 383– 1970, 'Indian Standard Code of practice for Specification for Coarse and fine aggregates from natural sources for concrete.

Material	Properties	Values
Cement	Fineness of Cement	7.5%
	Grade of Cement	43
	Specific Gravity	3.15
	Initial Setting time	28 min
	Final Setting time	600 min
Fine Aggregate	Specific Gravity	2.65
	Fineness Modulus	2. 25
Coarse Aggregate	Specific Gravity	2.77
	Size of Aggregates	20 mm
	Fineness Modulus	5.96
Water	Potable Water	6-6.5 P^H

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A. Polyethylene-Glycol (PEG)

Polyethylene glycol is produced by the interaction of ethylene oxide with water, ethylene glycol, or ethylene glycol oligomers The reaction is catalyzed by acidic or basic catalysts. It is used as water reducing agent.

The self-curing agent. Polyethylene-glycol which decreases the surface tension of the water and minimizes the water evaporation from concrete and hence increases the water retention capacity of the concrete. It has been found that water-soluble polymers (Polyethylene Glycol) can be used as self-curing agents in concrete.

In the new millennium, concrete incorporating self-curing agents will represent a new trend in the concrete construction.

The self-curing agent used in this study was water-soluble polymers (i.e; Polyethylene Glycol) conforming to molecular weight 400. The dosage of self-curing agent was kept at 0.3% by weight of cement. Concretes of grade M25 have been chosen for this experimental work.

Polyethylene Glycol

B. Polypropylene Fiber

Polypropylene is a100% synthetic fiber which is transformed from 85% propylene. The monomer of polypropylene is propylene. Polypropylene is a by-product of petroleum. Polypropylene (PP) is a thermoplastic. It is a linear structure based on the monomer CnH2n. It is manufactured from propylene gas in presence of a catalyst such as titanium chloride. Beside PP is a by-product of oil refining processes.

Most polypropylene used is highly crystalline and geometrically regular (i.e. isotactic) opposite to amorphous thermoplastics, such as polystyrene, PVC, polyamide, etc., which radicals are placed randomly (i.e. atactic). It is said that PP has an intermediate level of crystallinity between low density polyethylene (LDPE) and high density polyethylene (HDPE).

Properties	Values
Material	Virgin Homo polymer
Length	25 mm
Colour	White
Sp.Gravity	0.91
Acid Salt resistance	High
Tensile Strength	620-758 MPa
Absorption	Nil
Fibre content	4-9 kg/m3 of concrete
Melting point	164° C (328° F)
Young's modulus	3.5 kN/mm2
Alkali resistance	Alkali Proof

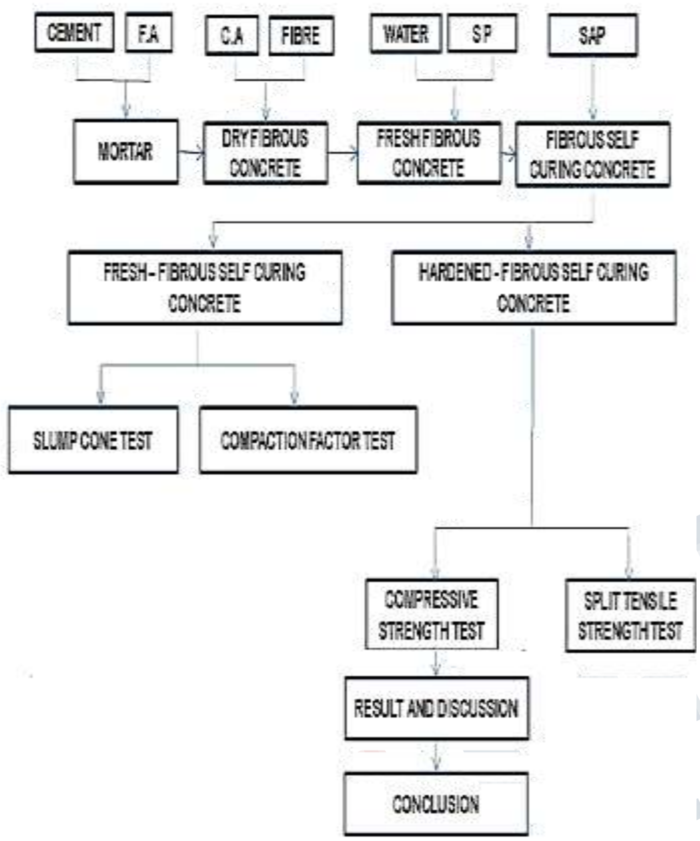
C. Super Plasticizer

The inter particle friction between fibers and aggregates controls the orientation and distributions of the fibers and consequently the properties of concrete. Therefore Napthalene-Formaldehyde Sulphonate based super plasticizer is added as a friction reducing admixture to improve the cohesiveness of mix

The normal dosage of conventional super plasticizers in HPC lies in the range of 5-20 liters per m3. Very high content of super plasticizer can affect the process of hydration. The important properties of these super plasticizers are,

- Excellent flow ability at low water cement ratio.
- High water reducing.
- Lower slump loss with respect to time.
- Shorter retardation time.
- Very high early strength

VI. METHODLOGY



VII. MIX DESIGN

A brief description on materials used and its properties, mix design for M25 based on IS10262 – 2009 [14] and experimental test setup in the present study is herewith:

Mix	C	FA	CA	PEG 400	FIBRE	W	SP
	Kg/m3						
CM SCC	429	680	1190	130	--	172	4.3
FSCC 0.1%	429	680	1190	130	0.9	172	4.3
FSCC 0.2%	429	680	1190	130	1.8	172	4.3
FSCC 0.3%	429	680	1190	130	2.7	172	4.3

Mix Ratio of Concrete – M25

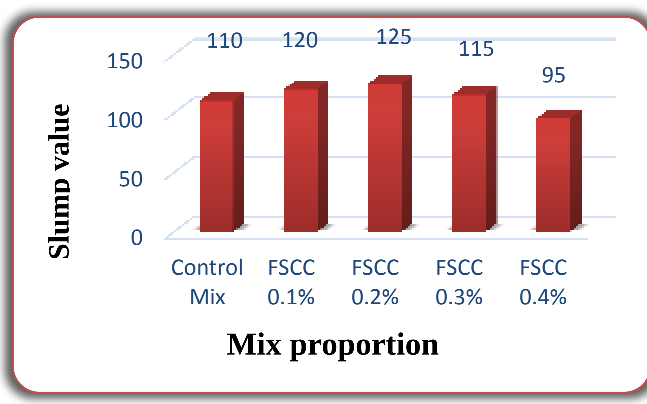
Water (kg/m³)	Cement (kg/m³)	Fine aggregate (kg/m³)	Coarse aggregate ` (kg/m³)	Super plasticizer (kg/m³)
172	429	680	1190	4.3
0.4	1	1.59	2.77	0.01

VIII. FRESH PROPERTIES OF FSCC

A. Slump Cone Test

Slump test is carried out to assess and compare the consistency that indicated the ease of flow or freshly mixed concrete. A higher slump implied better workability consistency and workability (IS1199-1959).

Mix Proportions	Slump Value in (mm)
CM SCC	110
FSCC 0.1%	120
FSCC 0.2%	125
FSCC 0.3%	115
FSCC 0.4%	95



IX. HARDENEDED PROPERTIES OF FSCC

A. Compressive Strength Test

The test is carried out on 150x150x150 mm size cubes, as per IS: 516-1959. The test specimens are marked and removed from the moulds and unless required for test within 24 hrs, immediately submerged in clean fresh water and kept there until taken out just prior to test.
A 2000 KN capacity Compression Testing Machine (CTM) is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 Kg/Cm2/min and the failure load in KN is observed from the load indicator of the CTM.

Compressive strength = Load / Area (MPa)

MIX	7 Days MPa	14 Days MPa	25 Days MPa
CM SCC	7.83	14.36	26.11
FSCC 0.1%	10.33	17.71	29.51
FSCC 0.2%	11.48	19.45	31.88
FSCC 0.3%	12.45	20.65	32.77
FSCC 0.4%	10.10	16.93	29.7

X. CONCLUSION

Being the part of this investigation, PEG 400 was used as self-curing agent with that Polypropylene Fibre of M25 grade of concrete is adopted for the investigation. Based on this investigation carried out, the conclusions were drawn:

•Water retention for the concrete mixes by incorporating self-curing agent is higher when compared to conventional concrete mixes, as found by the weight loss with respect to time.

•The effectiveness of internal curing by means of PEG applied to concrete is higher when 45 kg/ m3 water is added by means of 1 kg/m3 of PEG 400.

•The Self-cured concrete using PEG 400 was more economical than conventional cured concrete. The Performance of the self-curing agent is mainly affected by the cement content and the w/c ratio.

•The optimum dosage of PEG 400 is found to be 0.3%. By the addition of PEG 400 a significant increase in Compressive strength was found.

•Compressive strength for fibrous self-cured concrete for dosage of 0.3% was higher than self cured concrete about 6%.

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