AN EXPERIMENTAL COMPARATIVE STUDY BETWEEN WATER BASED ACRYLIC POLYMER CURING COMPOUND AND CONVENTIONAL CURING PROCEDURE FOR HIGH STRENGTH CONCRETE.

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ABSTRACT

Concrete is an essential building material which is widely used in construction industry all over the world due to its compressive strength. Curing of concrete plays a vital role in durability and other performance necessities. Improper curing can affect the performance and durability easily.

Conditions where scarcity of water prevails, and accessibility of structure for external curing becomes difficult, it becomes essential to seek for alternative means of curing. This work thrust for an alternative procedure of curing by using external curing compound. Concrete curing compound consist essentially of waxes, natural and synthetic resins, and solvents of high volatility at atmospheric temperatures. The compound forms a moisture retentive film shortly after being applied on fresh concrete surface. White or gray pigments are often incorporated to provide heat reflection and to make the compound visible on the structure for inspection.

The research work consist of i) Development of high strength concrete using OPC53 grade cement and locally available coarse aggregate and fine aggregate and using super plasticizer as admixture. ii) Casting of concrete samples and adopting different curing methods as wet pond curing, in air dry curing, alternative dry and wet curing and using curing compound. iii) Casted samples were tested for compressive strength, tensile strength, iv) Results of tested samples were tabulate and discussed over the result of achieving the strength in 3, 7, 28 days by different curing methods.

Keyword:-. *Curing compound, curing methods, high strength concrete, compressive strength, tensile strength, MasterGlenium SKY 8566, Master Kure 185*

1. INTRODUCTION

Concrete is an extremely solid, adaptable and mouldable material which is most broadly utilized everywhere throughout the world because of its great compressive strength. On an average around four tons of concrete is produced per individual every year. Concrete is a mixture of cement as a binding material, fine and coarse aggregates, water is used for hydration of cement. Distinctive sorts of admixtures are utilized to enhance the concrete properties.

Today high strength concrete is used in mega projects where loading criteria are more on the structural members. More than M40 grade is touted as high strength concrete. Production of high strength concrete need different type of admixtures such as mineral or chemical admixtures. Concrete having strength up to M70 can be produced by using normal conventional material keeping the w/c ratio less and for workability superplasticizer can

be used. Production of high strength concrete should ensure good bond strength between cement paste and aggregates. Quality of materials and strength of aggregates varies the ultimate required compreesive strength.

1.1 Introduction to curing

Curing of concrete plays an essential role particularly in achieving strength, sturdiness & different performances. Irregular curing can have an effect on mainly strength, durability & different performances. Today various techniques of curing is adopted in construction relying on requirement. As water is a sporadic material today, there is a pressing need to save the water in production enterprise. Water is especially used in making concrete and its usage is extra in the curing procedure. So the exceptional techniques of curing is very important from the point of saving water. Every 1cum of concrete require 3cum of water in construction, maximum of that's used for curing. While areas like scarcity of water, structures isn't always access by humans, external curing cannot be execute. So non-obligatory techniques are can be through internal curing or use of numerous curing compounds. Curing the concrete reduce the chances of concrete scaling, surface dusting, concrete cracking and allows to improve the strength and abrasion resistance. Now a day, many researches are happening approximately the extraordinary sorts of curing and other strategies to improve the concrete sturdiness and other strength parameters.

Curing encourage the hydration of the cement, it consists control on temperature and moisture motion inside the concrete. Curing lets in non-stop hydration of cement and consequently non-stop strength gaining, as soon as curing stops strength gaining of the concrete also stops. Due to early drying of the concrete micro-cracks or shrinkage cracks could develop on surface of the concrete.

1.2 Significance of the research

Curing the concrete may be a method of maintaining the right moisture conditions to incite cement hydration right away once putting concrete. Maintaining the right moisture conditions are essential as a result of water is important for the hydration method of cementitious materials. Insufficient water within the concrete combine won't proceed the hydration process that ensuing that concrete might not be achieving the fascinating strength and alternative properties. An adequate set is important for concrete to get the specified structural and sturdy properties. Thus set is one among the foremost vital demand for optimum concrete performance in any setting.

Curing ways and hardening period considerably have an effect on hardening potency. Current standards and specifications fail to point an optimum curing system for every application. Consequently, several ways are used by trial and error to assist stop evaporation and supply an honest cure, as well as covering the freshly placed concrete with water, or fabric. What is more, application of liquid membranous curing compounds has been wide used for concrete pavements. However, restricted analysis has been done to investigate the effectiveness of the numerous activity techniques and their application technologies. What's a lot of, no reliable traditional testing technique is obtainable to gauge the effectiveness of hardening at the world.

2. EXPERIMENTAL INVESTIGATIONS

2.1 Cement

In this investigation 53grade normal Portland cement (OPC) with brand Bharathi cement was used for all concrete mixes. The testing of cement was done as per IS: 12269-1987.

2.1.1 Fine aggregate

Locally available sand was used as fine aggregate. Sand used was having fineness modulus 2.507 and conformed to grading zone-III as per IS: 383-1970 specification.

2.1.2 Coarse aggregate

The crushed stone combination were collected from the native quarry. Coarse aggregates employed in the experimentation were 20mm and 10mm down size and tested as per IS: 2386-1963 specifications.

2.1.3 Water

Ordinary potable water free from organic content, turbidness and salts; was used for mixture and for curing throughout the investigation.

2.1.4 Chemical admixture

High-performance super plasticizer, based on PCE (polycarboxylic ether) for concrete MasterGlenium SKY 8566 is a chemical 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. MasterGlenium SKY 8566 is free of chloride &low alkali. It is compatible with all types of cements.

Performance Test Data

- Aspect: Reddish brown liquid
- Relative Density: 1.10± 0.02 at 25°C
- pH: > 6 at 25°C
- Chloride ion content: < 0.2%

Test Certification/Approvals

- ASTM C494 TypeG
- EN 934-2 T3.1/3.2
- IS 9103: 1999

2.1.5 Curing Compound

Master Kure 185 is a non-degrading, membrane forming liquid based on specially formulated acrylic polymer for curing newly placed or freshly de-shuttered concrete; assists in the retention of water during hydration. The resultant film retains sufficient moisture in the concrete to ensure full hydration of the cement; essential for optimum strength development.

Performance test data (ASTM E1347)

- Dry film appearance: white / Clear
- Loss of Water (ASTM C156):< 0.55 kg /m2
- Drying time (ASTM C309): Less than 3 Hours
- Appearance: Clear / White liquid
- Specific gravity Clear: 1.04 ± 0.02 @ 25º C.
- Specific gravity White: 1.07 ± 0.02 @ 25 o C.
- Day light reflectance :> 60%.

Test certification/approvals

- Clear version - ASTM C 309 Type I Class B
- White version - ASTM C 309 Type II Class B
- Clear version - ASTM C 1315 Type I Class A
- White version - ASTM C 1315 Type II Class A

Table -1: Physical properties of cement

Sl.no	Characteristics	Values obtained	Standard value
1	Normal consistency	33%.	-
2	Initial setting time (minutes)	48 min	Not less than 30
3	Final setting time (minutes)	240 min	Not greater than 600
4	Fineness (%)	3.5%	<10
5	Specific gravity	3.03	2-6
6	Compression strength (Mpa)		
	3 Days	27.6	20 Mpa
	7 Days	41.5	30 Mpa
	28 Days	58.6	50 Mpa

Table -2: Physical properties of sand

Sl.no	characteristics	Values
1.	Type	Uncrushed (natural)(River sand)
2.	Specific gravity	2.53
3.	Moisture content	0.19%
4.	Water absorption	2.1%
5.	Bulking of sand	26.64%
5.	Fineness modulus	3.13
6.	Grading zone	III

Table -3: Physical properties of coarse aggregate

Sl.no	Characteristics	Value
1.	Type	Crushed
2.	Maximum size	20mm
3.	Fineness modulus	7.68
4.	Specific gravity	3.06
5.	Moisture content	0.7%
6.	Water absorption	2.7%
7.	Crushing value	21.2%
8.	Impact value	35.2%

2.2 Mix design for M50 grade of concrete as per (IS 10262-2009)

Design stipulations

1. Grade designation : M50.
2. Type of cement : OPC 53 Grade
3. Maximum size of aggregate : 20 mm
4. Type of aggregate : Crushed angular
5. Degree of supervision : Good
6. Type of exposure : Mild.
7. Maximum cement content : 450 kg/$m^{3.}$
8. Workability : 125mm (slump).
9. Method of concrete placing : Manually.
10. Chemical admixture type : Superplasticizer.

Test data for material

a. Cement:
   - Specific gravity: 3.03

b. Fine aggregate:
   - Gradation: confirming to zone-III
   - Specific gravity: 2.53.

c. Coarse aggregate:
   - Gradation: uniformly graded
   - Specific gravity: 3.06.

d. Chemical Admixture:
   - Superplasticizer.
   - Specific gravity: 1.10.

Mix proportion

Cement = 450 Kg/m^3

Water = 142 Kg/m^3

Fine aggregate = 640 Kg/m^3

Coarse aggregate = 1400 Kg/m^3

W/C ratio = 0.28

Chemical admixture = 4.5 Kg/m^3

Proportions of ingredients are as follows

Table -4 Mix proportion

CEMENT	F.A	C.A	ADM.	W/C
1	**1.42**	**3.11**	**0.01**	**0.28**

2.2 Casting of concrete specimens

The concrete ingredients particularly cement, fine mixture (sand) and coarse mixture were weighed in step with their proportion and that they were dry mixed on non- absorbent platform. Supported the water cement quantitative relation the standard of water is adscititious. For workability superplasticizer were used. When even admixture of concrete it absolutely was poured into the concrete moulds, all concrete moulds were clean from the present concrete stain and oil was applied within the moulds.

The fresh concrete was placed into the moulds with the assistance of scoop. The moulds were crammed with concrete in 3 layers every being compacted by normal tamping rod totally associate degreed vibrated victimization. Table vibrator is used to attain an adequate compaction. After 24 hours, the specimens were demoulded and transferred to numerous action ways. All the specimens were cured for 3, 7 and 28 days. When completion of 3, 7 and 28 days of action, they were tested for compaction and tensile strength test.

2.3 Curing procedure

2.3.1 Pond curing

In this method specimens are immersed in water for a period of 3, 7 and 28 days in a pond.

2.3.2 Dry curing

In this method specimens are kept in open area after demoulding. No water is used for curing. Specimens are in actual environmental conditions.

2.3.3 Alternative wet and dry curing

In this method specimens are kept in actual environment condition and alternatively morning and evening 2 times in a day water is sprayed.

2.3.4 Curing by curing compound

After demoulding of specimens, concrete surface is cleaned by water removing oil strains and any foreign matters. Then concrete surface is applied by curing compound by means of spraying or by brush. Evenly concrete surface is applied by curing compound and kept in natural environmental conditions.

2.4 Testing of concrete specimens

2.4.1 Compressive strength test

The compressive strength test was conducted on 150X150X150 mm cube specimens after the concrete specimens were cured for 3,7 and 28 days. The test procedure was carried out in accordance with IS: 516-1959 specification.

The compressive strength of concrete was calculated using the following formula:

$F = P/A$

Where: F = Compressive strength of concrete (in MPa)

P = Maximum load applied to the specimen.

A = Perpendicular cross sectional area of the specimen.

2.4.2 Split tensile strength test

The specimens were placed with its axis horizontal, between the platens of a universal testing machine. Load was applied until the specimen failed in its vertical diameter. The test procedure was carried out in accordance with IS: 516-1959 specification.

The indirect tensile strength of concrete was calculated using the following formula:

$F = 2P/ (\pi \times L \times D)$

Where,

F = Split tensile strength of concrete (in MPa)

P = Maximum load applied to the specimen

L = Length of the specimen

D = Diameter of the specimen

Fig -1: Compressive strength test

Fig -2: Split tensile strength test

3. RESULTS AND DISCUSSION

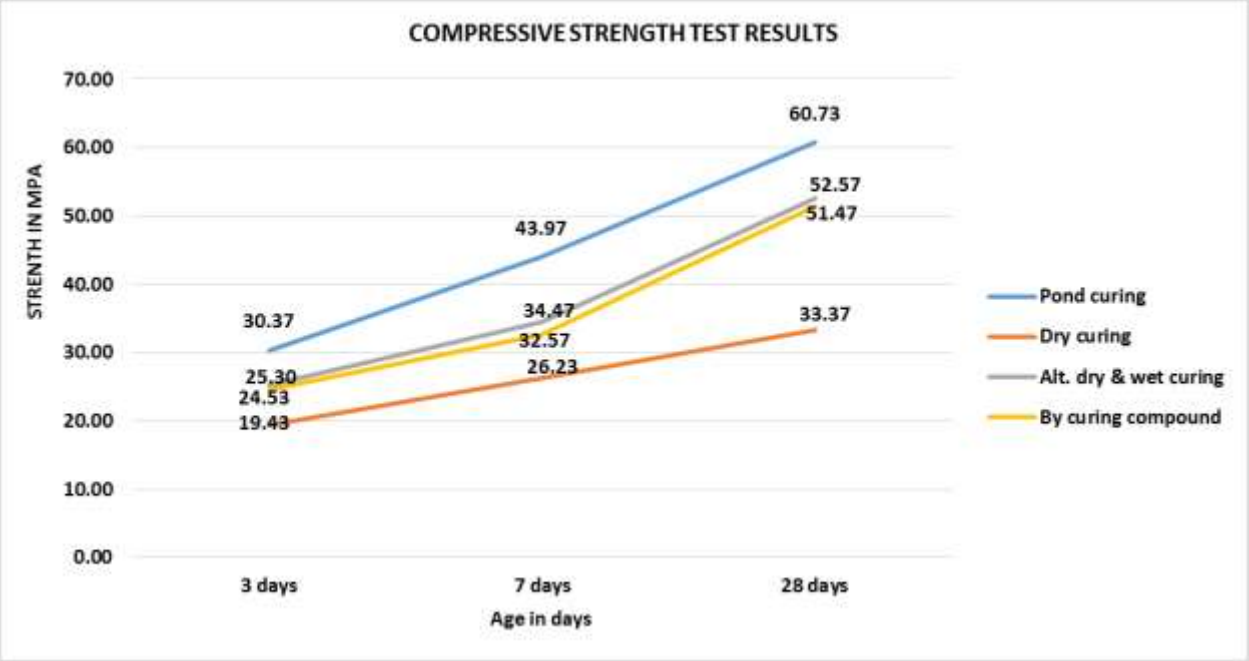

Chart -1: Compressive strength results

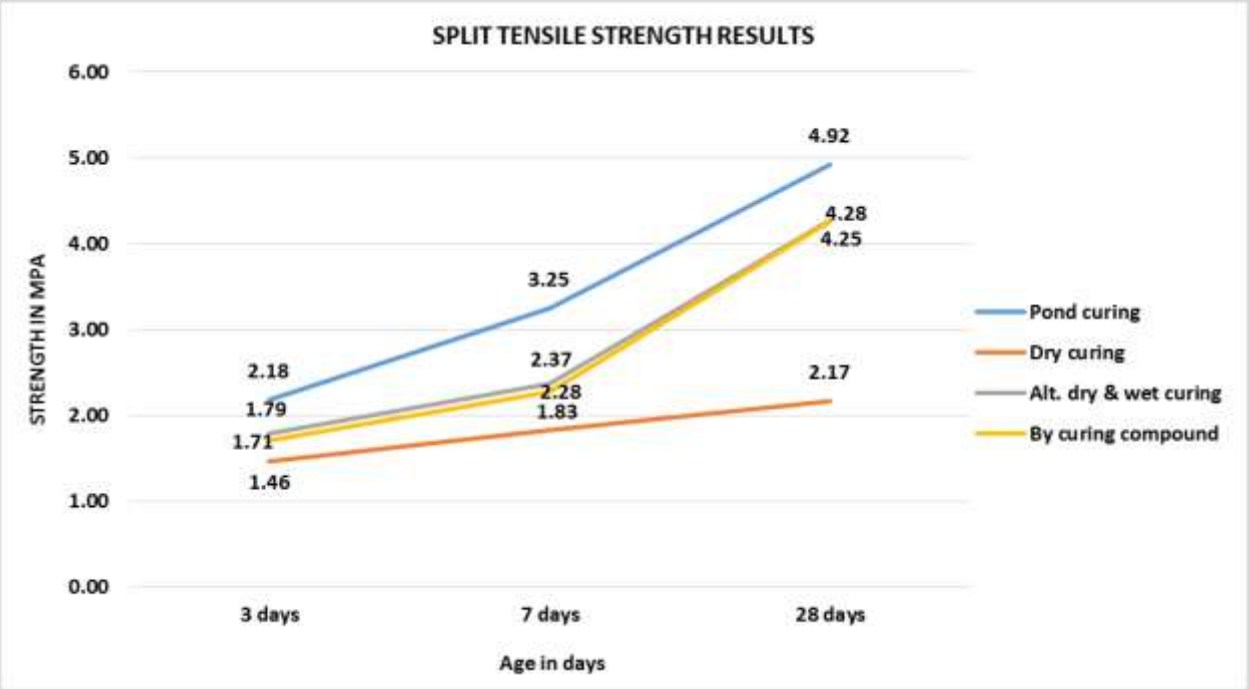

Chart -2: Tensile strength results

3.1 Compressive strength test results

Discussion

1. Chart 1 showing the results of average compressive strength at 3,7 & 28 days with various curing methods, it can be observed pond curing method giving the highest compressive strength 60.73 MPa whereas dry curing giving the least strength 33.37 MPa.
2. Alternative dry and wet method giving efficiency of 86% of pond curing.
3. Curing compound achieving 85% strength of pond curing showing good compreesive strength in 28 days.
4. Curing compound giving strength near to alternative dry and wet method.

3.2 Split tensile strength test results

Discussion

1. Chart 2 showing the result of average tensile strength at 3,7 & 28 days with various curing methods, it can be observed pond curing method giving the highest tensile strength 4.92 MPa whereas dry curing giving the least strength 2.17 MPa.
2. Alternative dry and wet method giving efficiency of 87% of pond curing.
3. Curing compound achieving 86% strength of pond curing showing good tensile strength in 28 days.
4. Curing compound giving strength near to alternative dry and wet method.

4. CONCLUSIONS

1. As water is scarce material today there is a need of saving water in construction so there is a need of alternative materials in construction to save water. Curing of concrete by means of water needs more amount of water. So use of curing compound may save water and also reducing labour works.
2. By observing 28 days compressive and tensile strength of high strength concrete pond curing method gives the highest strength results and most efficient method of curing. But pond curing method is not suitable in-situ for all component of the structure.
3. Dry curing is to be avoided at the development site because designed target strength **i**sn't achieved by this method.
4. Alternative dry and wet method is most commonly adopted method of curing in site. Results shown that; by this method the target strength can be achieved. This curing method giving overall 85% efficiency compare to pond curing. But this method cannot be executed in all type of works.
5. Water based acrylic polymer curing compound shown the overall 83% efficiency compare to pond curing and achieved the target strength in 28 days. It's giving strength nearer to the alternative dry and wet method.
6. The information developed during this study indicate that curing compounds is utilised in things wherever curing with water is tough and curing compounds effective in larger area like concrete pavement, bridges, dams, flyover etc.

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BIOGRAPHIES

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