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Experimental Strength Analysis of Different Membrane Curing Methods

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Abstract:
Curing plays an important role on strength development and durability of concrete. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability, resistance to freezing and abrasion and scaling resistance. A process of controlling the curing of concrete by sealing the moisture that would be lost to evaporation, the process is accomplished by using different membranes as sealing agent.

Different types of curing using in our project are:
- Wax curing
- Intermediate curing
- Fully curing
- Water proofing agent as membrane.

To avoid the voids in the concrete mix we added the super-plasticizer in the mix.

Key Words:
Curing, Durability, Freezing, Moisture, Stability, etc.,

INTRODUCTION:

Concrete:
Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time. When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid mass that is easily molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses.

Strength of Concrete by Membrane Curing:
Water is most commonly and frequently used raw material in construction field for aspects such as mixing and curing. This natural resource is also one of the important commodities used in many industries as well as in day to day needs in human life. As a result of this, water is about to become scarce. If this situation prevails, then the cost construction will reach to a point where common man cannot afford to build a home. Hence to mitigate this water problem in construction field, self-curing concrete came into existence. According to the ACI Code-308 "the internal curing is the procedure which involves in the hydration of cement which takes place due to the availability of excessive internal water (which is not part of the mixing water)". „Internal curing" is also known as 'Self Curing'.

The Self curing concrete means that no labour work is required to provide water for concrete or even no external curing is required after placing, where the properties of this concrete are at least comparable to and even better than those of concrete with traditional curing. In other words membrane curing is defined as the process of controlling the curing of concrete by sealing in the moisture that would be lost to evaporation. The process is accomplished either by spraying a sealer on the surface or by covering the surface with a sheet film. In this project we are using types of curing those are explained below,

1. Curing of concrete by paraffin wax
2. Curing of concrete by using waterproofing material as membrane
3. Intermediate curing of concrete
4. Complete curing in water.

OBJECTIVES OF THE PROJECT

- The main objective of our project is to reduce the water utilization used in mixing of concrete.
- Generally water required for curing is 100 times more than water required for mixing of concrete.
- In these project we experimentally compared four types of curing methods
- In our project we taken two types of membrane curing those are
- Curing of concrete by using paraffin wax
- Curing of concrete by using water proofing material as membrane.
- This type of curing is used where availability of water is less.
- In our project we are taken 2 other types of curing methods those are

1. Intermediate curing
2. Full curing or ordinary curing

From above four methods we aimed to find the best method which gives the realistic applicability.

Fig Mixing of concrete

Fig casting of cubes

CURING:

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 plays an important role on strength development and durability of concrete. It takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability, resistance to freezing and thawing, and abrasion and scaling resistance.

The length of adequate curing time is dependent on the following factors:

- Mixture proportions
- Specified strength

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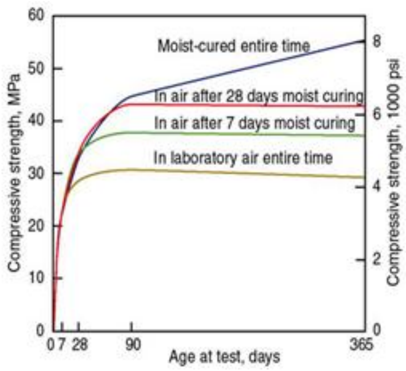
- Size and shape of concrete member
- Ambient weather conditions
- Future exposure conditions.

Slabs on ground (e.g. pavements, sidewalks, parking lots, driveways, floors, canal linings) and structural concrete (e.g. bridge decks, piers, columns, beams, slabs, small footings, cast-in-place walls, retaining walls) require a minimum curing period of seven days for ambient temperatures above 40 degrees Fahrenheit. American Concrete Institute (ACI) Committee 301 recommends a minimum curing period corresponding to concrete attaining 70 percent of the specified compressive strength. The required strength level can be reached sooner when concrete cures at higher temperatures or when certain cement/admixture combinations are used. Similarly, longer time may be needed for different material combinations and/or lower curing temperatures. For this reason, ACI Committee 308 recommends the following minimum curing periods.

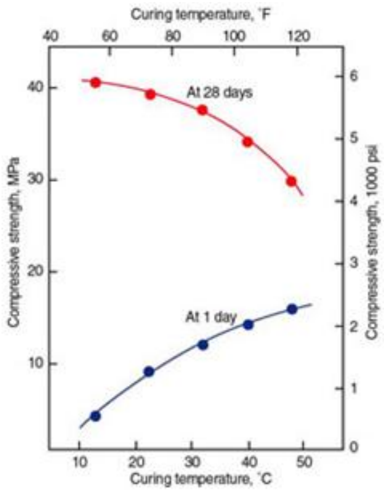
- ASTM C 150 Type I cement seven days
- ASTM C 150 Type II cement ten days
- ASTM C 150 Type III cement three days
- ASTM C 150 Type IV or V cement 14 days
- ASTM C 595, C 845, C 1157 cements variable

Effect of curing duration on compressive strength development is presented in Figure 1.



Graph1: Moist Curing Time and Compressive Strength Gain

Higher curing temperatures promote an early strength gain in concrete but may decrease its 28-day strength. Effect of curing temperature on compressive strength development is presented in Figure 2.



Graph 2: Effect of Curing Temperature on Compressive Strength

CURING OF CONCRETE BY DIFFERENT MEMBRANES:

Method of curing concrete usually in pavements by which a material in liquid form is sprayed over the exposed surface shortly after the concrete is finished after which the material solidifies and becomes essentially impervious and thus holds the mixing water in the concrete so that it can hydrate the cement over a period of time. Most authorities agree that the most feasible and economical means of curing concrete properly is the spray application of a liquid membrane curing compound. These materials are sprayed onto the finished concrete as soon as the final troweling has been completed. A suitable liquid membrane curing compound is capable of maintaining a minimum of 95 percent of the original moisture content in a concrete mix. It is also economical and easy to apply. The liquid membrane method of concrete curing inhibits the loss of mix water by forming a protective membrane of the surface of the slab as soon as it is applied. This membrane is seldom more than 2/1000th of an inch thick and it is capable of maintaining a minimum of 95 percent of the mix water present in the concrete mass at the time of application.

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5.1.Curing of concrete by paraffin wax:

Curing of concrete involves maintaining satisfactory moisture content during early stages to develop the desired properties. Properly cured concrete has improved durability and surface hardness, and is less permeable. Prevention of loss of moisture is important not only for strength development but also to prevent plastic shrinkage, for decreased permeability and to improve resistance to abrasion. Good and complete curing is not always practical for several reasons, particularly in higher grade concretes. Using self-curing agents can solve this problem. The concept of self-curing agents is to reduce water evaporation from concrete, and hence increase its water retention capacity compared to conventional curing. Several materials, including paraffin wax, can act as self-curing compounds.

Properties of paraffin wax:

Paraffin wax is mostly found as a white, odorless, tasteless, waxy solid, with a typical melting point between about 46 and 68 °C (115 and 154 °F), and a density of around 900 kg/m3. It is insoluble in water, but soluble in ether, benzene, and certain esters. In this project we applied paraffin wax on the outside of the cubes, we tested those cubes of different days, those are 7, 14, and 21 days respectively. And also we made the cylinders and to those cylinders, we applied the paraffin wax. To avoid the voids in the cubes and cylinders, we added the super-plasticizer in the concrete mix. To maintain minimum moisture content in the cubes and cylinders, we kept those cubes and cylinders one day in complete curing.

Fig 15: Applying of wax and after application of wax to the cubes

Fig 17: After application of paraffin wax to the cube

5.2.Curing of concrete by using water proofing material as membrane:

This is one of the types of membrane curing. In this type of curing we use the waterproofing material as membrane. We use the water proofing material Dr. Fixit for our project. We kept those cylinders and cubes for one day to maintain minimum water content in those cubes and cylinders. We added 100 ml of water and 150 grams of cement and also 10 ml of water proofing material (Dr.fixit). And then we applied those mix on the cubes and cylinders, after the curing of one day in the water. And we tested those cubes on 7,14and 21days. And we tested those cylinders for 7 and 14 days

Fig:18-Application of water proofing material to the cube.

5.3. Intermediate curing of concrete:

This is a widely used method of curing, particularly for structural concrete. Thus exposed surface of concrete is prevented from drying out by covering it with hessian, canvas or empty cement bags.

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The covering over vertical and sloping surfaces should be secured properly. These are periodically wetted. The interval of wetting will depend upon the rate of evaporation of water. It should be ensured that the surface of concrete is not allowed to dry even for a short time during the curing period. Special arrangements for keeping the surface wet must be made at nights and on holidays. In this type of curing we used to apply water to the cubes and cylinders twice a day. These type of curing used where water availability is less. We uses gunny bags to cover the cylinders and cubes. Why we used those because to maintain the minimum water content in the cubes and cylinders. We applied water to those cubes and cylinders twice a day. And tested those cubes after 7,14and 21 days, cylinders are tested on 7 and 14 days.

Fig An example for Intermediate curing

5.4. Ordinary curing:

Ordinary curing is nothing but complete water curing. Cubes and cylinders are immersed in the water bath. And those are left alone until test to be conducted. On the day of test sample is removed from water bath before one hour, surface is rinsed with dry cloth and oven dried for minimum one hour, later test is conducted.

Figure 21: ordinary curing

TESTS ON HARDENED- CONCRETE
COMPRESSIVE STRENGTH TEST:
TRAIL 1(FOR 7 DAYS CURING):

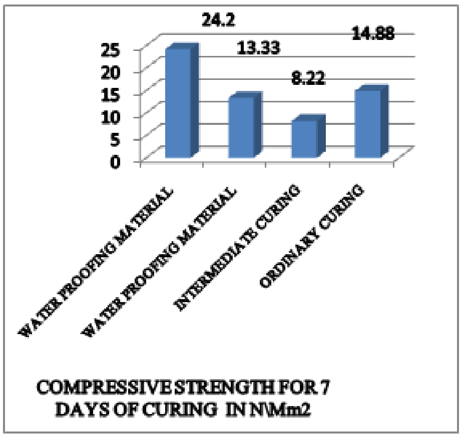
From figure: 22no

1→ordinary curing 2→waterproofing curing
3→intermediate curing 4→wax curing

Table 3:-compressive strength for 7 days curing

Type of Curing	Compressive LOAD (P)in KN	COMPRESSIVE STRENGTH{P /area}N\Mm2
WATER PROOFING MATERIAL	545	24.2
WATER PROOFING MATERIAL	300	13.33
INTERMEDIATE CURING	185	8.22
ORDINARY CURING	335	14.88

Graph :3- Compressive Strength for 7 days Curing



Graph 3: Compressive Strength for 7 days Curing

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TRAIL 2(FOR 14 DAYS CURING):

Fig 25: crushing of intermediate curing

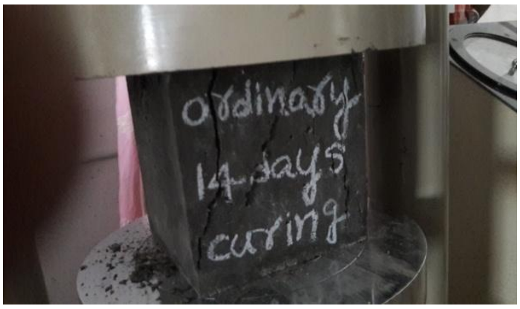
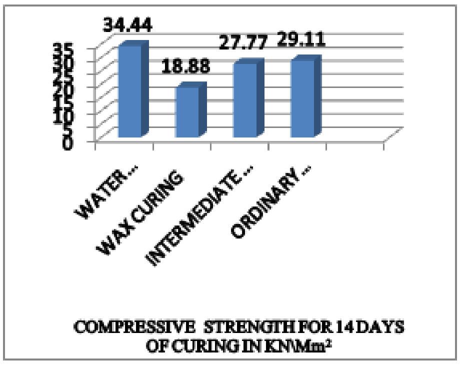


Fig 26: crushing of ordinary curing

Table 4:Compressive strength for 14 days

TYPE OF CURING	COMPRESSIVVE DTRENGTH IN KN
WATER PROOFING MATERIAL	775
WAX CURING	425
INTERMEDIATE CURING	625
ORDINARY CURING	655

Graph :4- Compressive Strength for 14 days



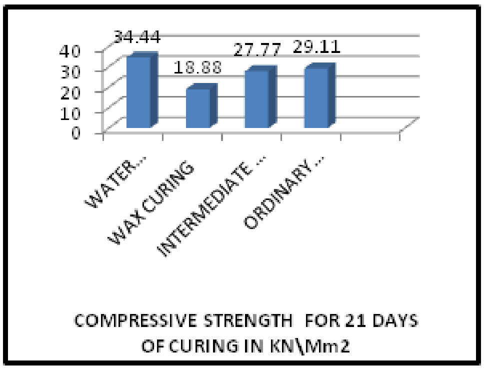
Graph4: Compressive Strength for 14 days

TRAIL 3 (FOR 21 DAYS CURING):

Table 5: Compressive strength for 21 days

TYPES OF CURING	COMPRESSIVE LOAD IN KN	COMPRESSIVE STRENGTH{P/area} N\Mm2
WATER PROOFING MATERIAL	780	34.66
WAX CURING	430	19.11
INTERMEDIATE CURING	630	28
Ordinary curing	660	29.33

Graph:5- Compressive strength for 21 days



Graph 5:Compressive strength for 21 days

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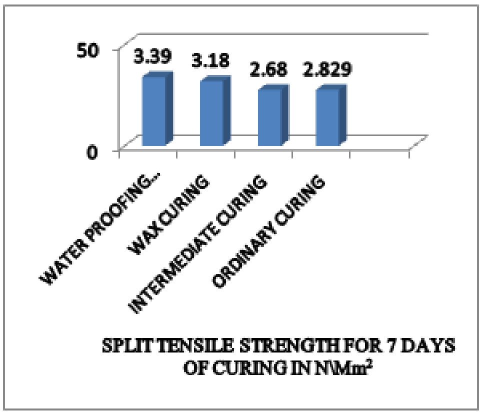
SPLIT TENSILE STRENGTH:

TRAIL 4 (FOR 7 DAYS CURING (CYLINDERS)):

Table 6:-Split tensile test for 7 days of curing

TYPES OF CURING	SPLIT TENSILE LOAD (P)IN KN	SPLIT TENSILE STRENGTH IN N\Mm2
WATER PROOFING MATERIAL	240	3.39
WAX CURING	225	3.18
INTERMEDIATE CURING	190	2.68
ORDINARY CURING	200	2.829

Graph :6- split tensile test for 7 days of curing



Graph 6 :-split tensile test for 7 days of curing

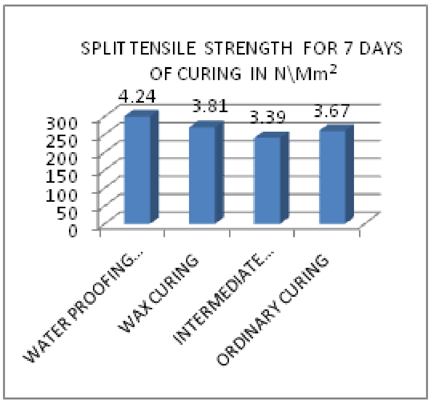
Figure :27- Split test of water proofing material curing specimen

6.2.2.TRAIL 5(FOR 14 DAYS CURING (CYLINDERS)):

Table 7:-split tensile test for 14 days of curing

TYPES OF CURING	SPLIT TENSILE LOAD IN KN	SPLIT TENSILE STRENGTH IN N\Mm2
WATER PROOFING MATERIAL	300	4.24
WAX CURING	270	3.81
INTERMEDIATE CURING	240	3.39
ORDINARY CURING	260	3.67

Graph 7:-split tensile test for 14 days of curing



CHAPTER -7: RESULTS

TABLE: 8-COMPRESSIVE STRENGTH FOR DIFFERENT DAYS OF CURING

TYPES OF CURINGS	compressive strength for 7 days	compressive strength for 14 days	compressive strength for 21 days
WATERPROOFING MATERIAL	24.2	34.44	34.66
WAX CURING	13.33	18.88	19.11

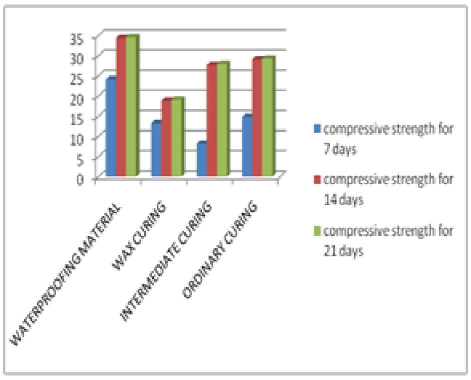
INTERMEDIATE CURING	8.22	27.77	28
ORDINARY CURING	14.88	29.11	29.33

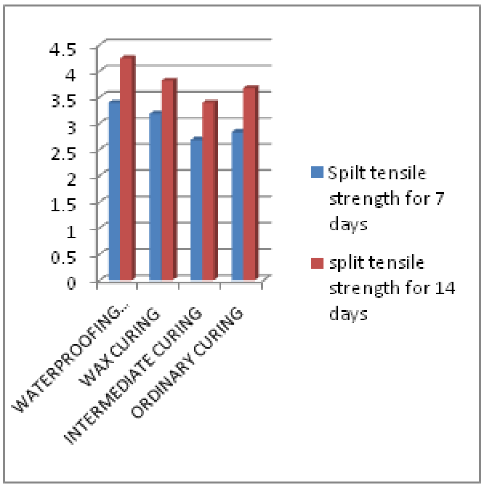
Graph:-8- COMPRESSIVESTRENGTH FOR DIFFERENT DAYS OF CURING

TABLE :9:-SPLIT TENSILE STRENGTH FOR DIFFERENT DAYS OF CURING

TYPES OF CURINGS	Spilt tensile strength for 7 days	split tensile strength for 14 days
WATERPROOFING MATERIAL	3.39	4.24
WAX CURING	3.18	3.81
INTERMEDIATE CURING	2.68	3.39
ORDINARY CURING	2.829	3.67

GRAPH:9:- SPLIT TENSILE STRENGTH FOR DIFFERENT DAYS OF CURING





Chapter-8 CONCLUSION:

By observing the above results we can easily will conclude that waterproofing material has a high strength then all the 4 comparatives we are taken in this project. For the waterproofing material cubes and cylinders have same high strength as compared to ordinary curing or complete curing, and for cylinders wax curing had strength as compared to intermediate curing. Intermediate curing had a high strength as compared to ordinary curing. This methods of curings does not need constant supervision. It is adopted with advantage at places where water is not available in sufficient quantity for wet curing. This method of curing is not efficient as compared with wet curing because rate of hydration is less.

Moreover the strength of concrete cured by any membrane is less than the concrete which is moist cured. When membrane is damaged the curing is badly affected. the day-by-day level of the water table is going down. If water has to be purchased for construction works, the cost of construction rises much higher. Also, in case of concreting works done at heights, vertical members, sloped roofs and pavements, continuous curing is very difficult. Where the thickness of concreting is large, the percolation of water in the concrete is difficult especially in the case of high-strength concrete.

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In the case of high-performance concrete/self-compacting concrete, where the surface pores and mixing water are minimized, complete curing of cement particles does not take place Membrane Curing should be uniform and easy to maintain in a thoroughly mixed solution. They should not sag, run off peaks, or collect in grooves. They should form a tough film to withstand early construction traffic without damage, be no yellowing, and have good moisture-retention properties.

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9.2 CODES USED IN OUR PROJECT:

1.BIS (1970) IS 383-1970: Specification for coarse and fine aggregates from natural sources for concrete. Bureau of Indian

2.Standards, New Delhi, India. BIS (1987) IS 12269-1987: Specifications for 53 grade ordinary Portland cement. Bureau of Indian Standards, New Delhi, India.

3. IS 456-2000

4.Membrane Curing should conform to ASTM C 309 (AASHTO M 148).

5.Membrane Curing with sealing properties are specified under ASTM C 1315.

6.ACI Committee 308

7.IS:9013-1978Indian Standard,METHOD OF MAKING, CURING AND DETERMININGCOMPRESSIVE STRENGTH OFACCELERATED-CURED CONCRETETEST SPECIMENS

8.IS: 12269 – specifications for 53 grade OPC.

9.IS: 2386 – methods of tests for aggregate for concrete

10. IS: 516 – methods of test for strength of concrete.

9.3. Future Scope of the Project:

In general water is very needed liquid for any work for human being, there is no hope of water for future generations due the effect of global warming which have seeing in daily life so we think the utilization water is reduced in construction by making alternatives without changing the strength which explained in previous chapters. In this project we got the best results for water proofing material. Actually we add cement to the combination of water proofing material. So as future we need to find different chemical combinations like water proofing material as sealing agent. And also we need to find standard mix of cement and proofing liquid. Another material paraffin wax which shown less sealing agent to concrete we need to find why the material is not acting like other sealing materials.

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