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Effects of different methods of curing on strength of concrete

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CHAPTER 1

INTRODUCTION

Curing is the name given to the procedures used for promoting the hydration of the cement and consists of 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 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%. With insufficient water, the hydration will not proceed and the resulting concrete may not possess the desirable strength and impermeability. The continuous pore structure formed on the near surface may not allow the ingress of deleterious agents and would cause various durability problems.

Curing is defined as maintaining satisfactory moisture content and temperature in the concrete for a specified period of time immediately after placing and finishing so that the desired properties may be develop. Curing plays a crucial role in concrete strength development and durability. After adding water to the dry mixed concrete (Cement, Sand, & Aggregate), the exothermic reaction (hydration) takes place, which assists the concrete to harden. Hardening of concrete is not a quick process and continues for a longer period in which the concrete kept moist to prevent it from loss of moisture due to atmospheric temperature.

Curing must be undertaken for useful period of time if concrete is to attain its potential strength and durability. Curing is necessary if concrete is to achieve its intended function over the design life of the structure. Curing can be done in a number of methods while the most suitable means of curing may be dictated by the site conditions or the construction method. The need for adequate curing of concrete cannot be overemphasized. Proper curing will increase durability, volume stability, strength, water tightness, abrasion resistance, and resistance to freezing and thawing. The exposed slab surfaces are particularly sensitive to curing as strength development and freeze thaw resistance of the surface of a slab can be reduced considerable when curing is defective. If temperature is favorable, hydration is relatively rapid in the first few days after concrete is placed. Curing of concrete is done by various methods depending on the type of structure, site location and site conditions and sometimes due to various errors at the construction site, the process of

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curing may be defective or may not be sufficient or may not be done at all. In this project work, we are intending to study the effects of different types of curing methods on the strength parameters of concrete.

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CHAPTER 2

2.1 OBJECTIVES

- To study the effects of different methods of curing on M20 grade concrete.
- To determine the Compressive strength of M20 grade concrete after curing period of 7, 14, 28 days.
- To determine the Split tensile strength of M20 grade concrete after curing period of 7, 14, 28 days.

2.2 SCOPE

In this work we are studying the following methods of curing of concrete:

- Immersion curing
- Sprinkling of water
- Sheet curing
- Impervious paper curing

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CHAPTER 3

LITERATURE REVIEW

3.1 P.L. Jadhav, Paraji Kale, Shubham Gawade, Shivraj Tanpure, Professors, Zeal Polytechnic Pune, their work on "**Experimental strength analysis of concrete by using different curing methods** " vol. 04, No. 05, May 2022.

- Different methods are usually adopted to cure concrete. Concrete strength partly depends on the method and duration of curing. The structural use of concrete depends largely on its strength, especially strength.
- This study uses three curing methods to determine their effects on the compressive strength and density of concrete. These methods are immersion of concrete cubes in curing tank (Ponding), Covering of cubes with wet rug (Continuous wetting) and the use of polythene sheet (Water-barrier).
- Normal concrete was prepared with a water-cement ratio of 0.50. cube specimens were cast for Testing the compressive strength at 7 and 28 days of curing respectively using three curing methods namely Immersion, sprinkling and Plastic sheeting, curing to cure the cube specimens until the day of testing.
- Test Results indicates that water curing as well as sprinkling (spraying) curing provided much better Results than membrane (Plastic Sheeting) method of curing. The rate of drying was significant when the Specimens were subjected to membrane (Plastic sheeting) method of curing.
- This thus hampered the Hydration process and thus affected the compressive strength property of the hardened concrete.
- The Overall finding of this study suggests that concrete should be cured by water curing to achieve a better Compressive strength.

3.2 Daniel yaw Osei, Zakari Mustapha, Mohammed D.H. Zebililla. Study on "**Compressive strength of concrete using different curing methods**" vol.10, No.3, September 2019.

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- The structural use of concrete depends largely on its strength, especially compressive strength. Various tests were carried out to ascertain the properties of concrete materials, whereas test performances of the concrete with different mix ratios at specific ages of curing were undertaken.
- The study determined the compressive strength of concrete using different curing methods. Four different methods of curing (ponding, continuous wetting, open air curing and sprinkling with water) were used (72) cubes were cast using a mix ratio of 1:2:4 and 1:3:6 with 0.5 water cement ratio and with 0.6 waters cement ratio respectively.
- The compressive strengths were determined after 7 days, 14 days and at 28 days of curing. Findings show that for 1:2:4 concrete, maximum of 28day compressive was the highest for concrete cured by ponding and the least was by sprinkling water.
- Further findings show that for 1:3:6 concrete, maximum of 28day compressive strength was obtained using ponding and the least was open air curing.
- Despite ponding method producing the highest compressive strength of concrete, it is practically impossible to cure cubes above ground structural elements. Wet-covering method is recommended for structural elements, such as columns, beams and slabs in other to produce concrete of a required compressive strength

3.3. P Balamurugan, Assistant professor their work on **"Experimental study on curing methods of concrete"** vol. 5, Issue 1, 2017.

- The study shows that concrete has great influence on its strength properties on different curing methods.
- Curing methods such as pack curing, cacl2, immersion and oven curing are discussed.
- Use of cacl2 resulted in strength up to 73% to 75% of conventional curing.
- Pack curing shows increased compressive increased strength compered to air drying, it attains 16% increased strength than air drying and 22% than compound curing.

3.4. Dr Sanjeev, in his work **"To study effect of different curing methods on compressive strength of concrete"** vol. 8, Issue 10, October-2017.

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- Conducted a study on different methods of curing such as ponding, sprinkling, membrane, steam curing.
- Sprinkling methods of curing produces higher compressive strength than plastic sheeting.
- Greater moisture movement occurs under membrane sheeting and it significantly affected the strength property of concrete.
- Normal concrete should be cured by water curing (immersion) method in order to achieve good hardened properties. Water curing produces no loss of moisture and enhances cement hydration reaction. In case of water shortage, sprinkling curing can be adopted.

3.5 D. Hari Prakesh and K. Prasanthi, their "**Study on concrete strength parameters under different curing conditions** " vol. 09, No. 6, June 2018.

- This investigation thought about the impact on strength qualities of concrete under various techniques for curing conditions.
- Here in this paper, we report two solid blocks with the blend of 1:1.6:3.35 and 1:1.35:2.19 which were set up with the water cement ratio as 0.45 and 0.29 respectively.
- The cast concrete specimens were cured utilizing six techniques (air curing, water submerged curing, polythene curing, sand curing, lime curing and burlap curing) until testing ages of 7 and 28 days when its strength qualities are resolved.
- The paper reports that by observing the test results of M30 grade concrete in case of 7days, water curing is giving optimum values whereas for the 28days lime curing gives maximum values in compression strength.
- For M60 grade concrete in 7days test water curing gives maximum values and for 28days moist sand curing gives maximum value in compression strength.

3.6 Dr. Elson John and Princy K.P their "**Study on the Effectiveness of various curing methods on the properties of concrete** " vol. 04, No 11, November 2015.

- Concrete is the most widely used man-made material in the world. Concrete derives its strength by the hydration of cement particles.

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- The curing allows continuous hydration of cement and consequently continuous gain in the strength. Scarcity potable water increases day by day. The use of membrane curing compound is very important from the point view that water resources are getting valuable every day.
- The advancements in the construction and chemical industry have paved way for the development of the new curing techniques and construction chemicals such as membrane curing compounds, self-curing agents, water proofing compounds etc.
- This study considered the effectiveness of various curing methods on the properties of concrete. Curing has a strong influence on the properties of hardened concrete.
- The parameter of the study includes various curing period and various curing methods (Dry curing, immersion technique, liquid membrane curing compound, water proofing compound).

3.7 Akeem Ayinde Raheem worked on "**Effect of curing methods on density and Compressive strength of concrete"** vol. 3, No.4, April 2013

- Laboratory methods of curing such as water submerged curing, spray curing, polythene curing is discussed.
- Materials used for production of concrete test specimens are ordinary Portland cement, sharp sand, granite and tap water.
- A standard mix ratio 1:2:4 was used.
- The density of specimens ranged from 2432.59 to 2502.72kg/m3. The moist sand curing methods produced concrete specimen with highest mean density, followed by polythene and water submerged methods. The polythene curing method produced the highest range of density indicating the methods are highly unreliable.
- All methods of curing except air curing produced concrete specimen that met the minimum compressive strength of 21N/mm2 at 28 days. Air curing with compressive strength of 17.8N/mm2 has the lowest strength while moist sand curing recorded the highest strength of 305 N/mm2.

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3.8 T. James, A. Malachi, E.W. Gad Zama, their work on "**Effect of curing methods on the compressive strength of concrete**" vol. 30, No. 3, October 2011.

- This study reports the laboratory results of the effects of curing methods on the compressive strength as well as the density of concrete. A total of 72 cubes of mix ratio 1:2:4 was investigated after subjecting them to various curing conditions, with the aim of finding which of the curing method is best.
- The results obtained showed that the average compressive strength values for 7, 14, 21 and 28 days, vary with curing methods.
- Compressive strength when arranged in descending order for all the curing methods, it could be seen that ponding gave the highest results for the curing periods. This is due to improved pore structure and lower porosity resulting from greatest degree of cement hydration and pozzolonic reaction without any loss of moisture from the concrete cubes.
- It could also be seen that the ponding method of curing, recorded the highest value for cube density of concrete cube is a function of curing method.
- In an attempt to evaluate the advantages associated with the various curing method used in this study, that ponding method was ranked first, because water is best suitable water and this reduces the wastage of water. Sprinkling and plastic sheet method ranked third, because large volume of water was wasted during curing process.

3.9 O. James, P.N. Ndoke and S.S. Kolo, their work on "**Effect of different curing methods on the compressive strength of concrete**" vol. 38, 18 December 2011.

- Normal concrete was prepared with a water-cement ratio of 0.50. cube specimens were cast for testing the compressive strength at 7 and 28 days of curing respectively using three curing methods namely immersion, sprinkling and plastic sheeting, curing to cure the cube specimen until the day of testing.
- Test results indicates that water curing (WAC) as well a sprinkling (spraying) curing provided much better results than membrane (plastic sheeting) method of curing. The rate

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of drying was significant when the specimens were subjected to membrane (plastic sheeting) method of curing.

- This thus hampered the hydration process and thus affected the compressive strength property of the hardened concrete. The overall finding of this study suggested that concrete should be cured by water curing to achieve a better compressive strength.

3.10. Nuruddeen Usman and Muhammad Nura Isa, worked on "**Curing methods and their effects on the strength of concrete.**"

- There is lot of arguments on which method of curing concrete gives good strength. These different opinions result into this study, which aim at investigating the effects of different curing methods on the strength of concrete.
- Laboratory test was employed for this study. Normal concretes were prepared using specified mix ratio of 1:2:4 and 1:3:6. The cubes tested for compressive strength 3, 7, 21 and 28 days of curing respectively using four curing methods namely immersion, sprinkling, polythene sheeting and sharp sand coating. Testing indicates that water immersion curing method as well as sprinkling (spraying) methods of curing, provides better results than membrane (polythene sheeting) method of curing. While sharp sand gives least strength.
- The rate of drying was significant when the specimens were subjected to curing with polythene sheet method of curing. This thus hampered the hydration process and thus affected the compressive strength property of the hardened concrete.
- The overall finding of this study suggests that concrete should be cured by water immersion or spraying to achieve a better compressive strength in concrete.
- This thus hampered the hydration process and thus affected the compressive strength property of the hardened concrete. The overall finding of this study suggested that concrete should be cured by water curing to achieve a better compressive strength.

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CHAPTER 4

MATERIALS AND METHODOLOGY

4.1 Cement: -

In this project Ordinary Portland Cement of grade 43 will be used. The following tests will be conducted on cement,

- Specific gravity of the cement.
- Fineness of the cement (as per IS 4031 part-1 1996).
- Initial setting time (as per IS 4031-part V).

4.1.1 Specific gravity of cement

Procedure

- Weigh a clean and dry Le Chatelier flask or specific gravity bottle with its stopper (W1).
- Place a sample of cement up to half of the flask (50 g) and weigh with its stopper (W2).
- Add kerosene to the cement in flask till it is about half full. Mix thoroughly and continue stirring and add more kerosene till it flush with the granulated mark. Dry outside and weigh (W3).
- Empty the flask, clean it refill with clean kerosene flush with the granulated mark wipe outside and weigh (W4).

SL. No	Observations	Readings
1	Empty of flask with stopper, W1	53
2	Weight of flask+cement, W2	103
3	Weight of flask+kerosene+cement, W3	173
4	Weight of flask+kerosene+, W4	137
5	Weight of flask+kerosene, W5	157

Table 4.1: Specific gravity test on cement

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Observation and calculation

1. Specific gravity of cement = {[W2 - W1]/[(W2-W1) - (W3-W4)]} ×sg of kerosene

= {[103-53]/ [(103-53) - (173-137)]} ×0.8

= 2.85

Results: The specific gravity of cement is = 2.85

4.1.2 Fineness of cement

Procedure

- Weigh accurately 100 gram of cement in a clean dry 90 micron IS sieve break down the lumpsif any and note down the weight (W1 in grams).
- Close the sieve bottom by pan and top by lid and hold the assemble in both the hands andsieve it slowly in circular motion for 15 minutes.
- Remove the pan slowly and clean bottom of the sieve by using brush and open the lidcarefully.
- Transfer the residue from sieve to a plate carefully and weigh accurately and note down the weight (W2 in gram).
- Finally find the fineness of cement by using the formula (W2/W1) × 100

Sl No	Weight of the cement taken in (W1 in grams)	Cement residue (W2 in grams)	(W2/W1) × 100	% of fineness
1.	100	3	(3/100) ×100	3
2.	100	3	(3/100) ×100	3
3.	100	3	(4/100) ×100	3

Table 4.2: Fineness test on cement

AVG = 3%

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Result: Fineness of the given cement is = 3%

4.1.3 Initial setting time

Procedure

- Prepare a paste of 300 g of cement with 0.85 times the water required to give a paste of standard consistency.
- The time of gauging in any case shall not less than 3 minutes not more than 5 minutes.
- Count the time of gauging from the time of adding water to the dry cement until commencing to fill the mould.
- Fill the vicat mould with this paste making it level with top of the mould.
- Slightly shake the mould to expel the air.
- In filling the mould, the operator hands and the blade the gauging trowel shall only be used.

Initial setting time

- Immediately place the test block with the non-porous resting plate, under the rod bearing the initial setting needle.
- Lower the needle and quickly release allowing it to penetrate in to mould.
- In the beginning the needle will completely pierce the mould.
- Repeat the procedure until the needle fails to pierce the mould for 5 ± 0.5 mm.
- Record this period elapsed between the times of adding water to the cement to the time when needle falls to pierce the mould by 5 ± 0.5 mm as the initial setting time.

Sl No	Setting Time (min)	Depth of penetration (mm)
01	5	0
02	10	1
03	15	1

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04	20	2
05	25	2
06	30	3
07	40	5

Table 4.3: Initial setting time test on cement

Result: The initial setting time of cement = 40 minutes

4.2 Fine aggregate:

It includes the particles that pass through 4.75 mm sieve and retain on 0.075 mm. Manufactured sand will be used in the current study

The following tests will be carried out on M-sand

- Specific gravity
- Sieve analysis
- Zoning of sand

4.2.1 Specific gravity of fine aggregates

Procedure

- Take the empty weight of pycnometer and note down as W1 (g).
- Add sand 1/3rd of the weight of the pycnometer to its weight W2 (g) and note down the reading.
- Add the water to pycnometer having sand, weight it and note down the weight W3 (g).
- Now add water to empty pycnometer weight it and note down the weight W4 (g).

Sl No	Observations	Readings (g) 1	Readings(g) 2	Readings(g) 3

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1	Weight of the pycnometer, W1	608	608	608
2	Empty weight of pycnometer + 1/3rd of fine aggregate, W2	1150	1162	1165
3	Empty weight of pycnometer + 1/3rd of fine aggregate + water, W3	1838	1835	1832
4	Empty weight of pycnometer + full of water, W4	1501	1500	1500

Table 4.4: Specific gravity test on fine aggregates

Specific gravity of fine aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

= [1150-608]/ [(1150-608) -(1838-1501)]

= 2.64 1. Specific gravity of fine aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

= [1162-608]/ [(1162-608) -(1835-1500)]

= 2.52

2. Specific gravity of fine aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

= [1165-608]/ [(1165-608) -(1832-1500)]

= 2.59

Result: The Specific gravity of fine aggregate = 2.58

4.2.2 Fineness modulus of fine aggregate Procedure

- Take 200 g of given sample of sand.
- Arrange the standard sieve analysis in descending order of their size i.e., 4.75 mm at top and 150 µ at bottom and pass after it.
- The sample is placed in the top and it is sieve thoroughly for 15 min, shaking can be done mechanically.
- The weight of the sand on each sieve is taken and noted down.

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- Percentage of weight retained, and cumulative weight retained are calculated by which fineness modulus is obtained. Before calculating correction, factor is applied for each other weight.

Sieve size	Weight retained in (g)	Percentage weight retained	Cumulative percentage weight retained	Percentage weight passing %
4.75 mm	6	0.6	0	0
2.36 mm	5	0.5	1.1	98.9
1.18 mm	34.3	34.3	35.4	64.6
600 µ	160	16	51.4	48.6
300 µ	360	36	87.4	12.6
150 µ	121	12. 1	99.5	0.5
Pan	5	0.5	100	0

Table 4.5: Fineness modulus test on fine aggregates

4.2.3 Zoning of sand

Fine aggregate (as per clause table no 9 IS383- 2016):

Procedure:

- Take the given sample of sand.
- Arrange the standard sieve analysis in descending order of their size i.e., 10 mm at top.
- 0.15 mm at bottom respectively.
- The sample is placed in the top and it is sieve thoroughly for 15 min, shaking can be done mechanically.
- The weight of the sand on each sieve is taken and noted down.
- Percentage of weight retained, and cumulative weight retained are calculated by which zone of sand can be found.

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Sieve sizes	Weight retained in g	Percentage weight retained	Cumulative percentage weight retained	Percentage weight passing %	Zone II (as per IS383-2016)
4.75 mm	6	0.6	0	100	90-100
2.36 mm	5	0.5	1.1	98.9	75-100
1.18 mm	34.3	34.3	35.4	64.6	55-90
600 µ	160	16	51.4	48.6	35-90
300 µ	360	36	87.4	12.6	8-30
150 µ	121	12.1	99.5	0.5	0-10
Pan	5	0.5	100	0	0

Table 4.6: Zoning of sand

Results: By comparing the results obtained to the values of zones as per IS 383: 2016, this sandsample falls under zone II.

4.3 Coarse aggregates:

The aggregates which are greater than 4.75 mm sieves are called coarse aggregate. The followingtests are conducted on coarse aggregate.

- Specific gravity
- Impact test

4.3.1 Specific gravity of coarse aggregate:

Procedure:

- A clean and dry pycnometer is taken and note down the weight (W1 g)
- Add coarse aggregate about one third of bottle and note down the weight (W2 g)

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- Add the water to the pycnometer up to its tip, remove the air bubble and note down the weight of bottle (W3 g)
- Clean the bottle and fill it completely with water up to its tip and note down the weight as (W4 g).
- The specific gravity of coarse aggregate is determined.

Sl No	Observations	Readings (g) 1	Readings(g) 2	Readings(g) 3
1	Weight of the pycnometer, W1	608	608	608
2	Empty weight of pycnometer + 1/3rd of coarse aggregate, W2	1021	1019	1021
3	Empty weight of pycnometer + 1/3rd of coarse aggregate + water, W3	1760	1758	1756
4	Empty weight of pycnometer + full of water, W4	1497	1498	1495

Table 4.7: Specific gravity test on coarse aggregates

Calculations:

1. Specific gravity of coarse aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

   = [1021-608]/ [(1021-608) -(1760-1497)]

   = 2.71

2. Specific gravity of coarse aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

   = [1019-608]/ [(1019-608) -(1758-1498)]

   = 2.72

3. Specific gravity of coarse aggregates = [W2-W1]/[(W2-W1) -(W3-W4)]

   = [1021-608]/ [(1021-608) -(1756-1495)]

   = 2.69

Result: The specific gravity of coarse aggregate is = 2.70

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4.3.2 Impact test

Procedure:

- Specified amount of the aggregate (about 350 g) which retained on 10 mm and passed through
- 12.5 mm IS sieve are taken.
- The aggregate is washed thoroughly and dried and placed in measuring cylinder in 3 layers and each layer is being given 25 blows and uniformly distributed, after third layer the excessamount is trimmed and note down the weight (W1 g).
- The whole sample is transferred to steel cup and compacted by tamping rod with 25 blows and it is placed below the machine, the hammer is raised to the height of 38 cm and allows to the face on the aggregate.
- After subjecting the sample to 15 blows the crushed aggregates are sieved through 2.36 mm IS sieve, the weight of the material passed through 2.36 mm IS sieve is noted down (W2 g).

Sl.No	Observations	Readings(g) 1	Readings(g) 2	Readings(g) 3
1	Weight of empty cylinder	996	996	996
2	Quantity of aggregate passes through 12.5mm IS sieve and retained in 10mm IS sieve (W1)	288	290	296
3	Quantity of sample passes through 2.36 mm IS sieve(W2)	84	86	82

Table 4.8: Impact test on coarse aggregates **Calculation:**

1. Impact value = (W2 / W1) × 100

   = (84/288) ×100

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= 29.16%

2. Impact value = (W2 / W1) × 100

   = (86/290) ×100

   = 29.65%

3. Impact value = (W2 / W1) × 100

   = (82/296) ×100

   = 28.27%

Result: The impact value of coarse aggregate value is = 29.02%

4.4 Potable Water (PW): Casting and curing of specimens were done with potable water.Tests conducted on PW are as follows:

- pH
- Alkalinity
- Turbidity
- Acidity
- Chloride Test
- BOD
- Calcium, Magnesium
- Total Hardness test

4.4.1 pH test:

Procedure:

- Prepare the buffer solution of known pH to calibrate the instrument. Prepare the standard buffer solutions in acidic range (4.0) and alkaline range (9.2) or pH 7 neutral ranges.
- Set the room temperature. Switch on the pH meter and warm up for about 15 min.

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- Take out the electrodes from the distilled water, rinse and clean with a tissue paper and immerse them in standard buffer solution of say pH 4.
- Press the knob to pH position and using the calibrating knob adjust it to read pH of 4.
- If the meter shows the correct reading directly, the instrument is calibrated.
- Place the electrode in the given sample and record the pH directly.

Results:

The pH of Potable water = 7

4.4.2 Alkalinity test Reagents used:

- 0.02N SulphaaaZazuric acid solution
- Methyl orange indicator
- Phenolphthalein indicator

Procedure:

- Fill the burette with 0.02N Sulphuric acid solution.
- Take 50 ml of a given sample in a conical flask using pipette.
- Add few drops of Phenolphthalein indicator in the conical flask.
- Now titrate, until the color changes from colorless to faint pink color. Note down the value is used to calculating the phenolphthalein alkalinity.
- Take another sample of 50 ml in a conical flask to this. Add 2 to 3 drops of methyl orange indicator and solution turns to yellow.
- Titrate till color changes from yellow to orange. Note down the value and is used to calculate the total alkalinity.

Results:

- The alkalinity of Potable water = 172 mg/L

4.4.3 Turbidity test

Procedure:

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- Switch on the nephelometer wait for 10 to 15 minutes for the instrument to warm up.
- Fill up the sample holder with distilled water place it in the instrument adjusts the reading to show zero.
- Take out the distilled water sample and fill up the holder with the standard solution of 20 NTU, 100 NTU, 800 NTU from the already prepared standard stock solution place it in the instrument one by one for calibrating the turbidity meter for the above values respectively.
- To know the turbidity of the given unknown sample, keep in the instrument and record the turbidity reading directly in NTU.

Results: The turbidity of Potable water = 9.15 NTU

4.4.4 Acidity test

Reagent used:

- 0.02N Sodium hydroxide (NaOH) Solution
- Phenolphthalein indicator

Procedure:

- Fill the burette with 0.02N Sodium hydroxide and adjust the burette.
- Take 50 ml of a given sample in a conical flask using pipette.
- Add few drops of Phenolphthalein indicator in the conical flask • Now titrate, until the color changes from colorless to faint pink color.
- Note down the value is used to calculating the total acidity.

Results:

The acidity of Potable water = 12.6 mg/L

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4.4.5 Chloride test

Reagent used

- 0.0141N Silver nitrate ($AgNO_3$) Solution
- Potassium chromate (K_2CrO_3)

Procedure:

- Take 50 ml of a given sample in a conical flask using pipette.
- Add 2 to 3 drops of potassium chromate indicator to get light yellow colour.
- Titrate the sample against silver nitrate solution until colour changes from yellow to brickred colour.
- Note down the value to calculate the chloride content.

Results:

The chloride value of Potable water= 64 mg/L

4.4.6 Calcium and Magnesium

Reagent used

- 0.02N EDTA (Ethylene diamine tetra acetic acid) solution
- 2N Sodium hydroxide (NaOH) Solution
- Murexide indicator

Procedure:

- Fill the burette with 0.02 N EDTA solutions.
- Take 50 ml of a given sample in a conical flask using pipette.
- Measure 2 ml of 2N sodium hydroxide solution. Add it to the water sample in conical flask so that the pH will be maintained between 12 and 13.

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- Add few amounts of murexide indicator to the sample. Now it turns into pink colour.
- Titrate until blue colour appears. Note down the reading to calculate the calcium and magnesium content.

Results:

- The calcium value of Potable water = 35mg/L
- The magnesium value of Potable water =18.2 mg/l

4.4.7 Total hardness Reagents:

- EDTA (ethylene diamine tetra acetic acid) solution
- Ammonia buffer solution
- Eriochrome black T indicator

Procedure:

- Fill the burette with 0.02 N EDTA solutions.
- Take 50 ml of a given sample in a conical flask using pipette.
- Add 2 to 3 ml of Ammonia buffer solution to the water solution.
- Add few drops of EBT indicator to the conical flask and sample turns to wine red in color.
- Titrate until blue color appears. Note down the reading and calculate the total hardness.

Results:

- The total hardness of Potable water =53.2 mg/L

SL.No.	Tests Conducted	Results	IS Limits
1	pH	7	>6
2	Acidity	12.6	<50 mg/L
3	Alkalinity	172	<250 mg/L
4	Chlorides	64	< 250 mg/L
5	Turbidity	9.15	<5 NTU
6	Calcium hardness	35	<200 mg/L

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7	Magnesium hardness	18.2	<100 mg/L
8	Total hardness	53.2	<200 mg/L

Table 4.9: Properties of portable water

4.5 Concrete Mix: The concrete mix of M20 grade was prepared and the fresh properties of concrete were tested by using Slump cone test and compaction factor test.

Slump test is most commonly used method of measuring workability of concrete. And Compaction factor test works on the principle of determining the degree compaction achieved by amount of work done by allowing the concrete to fall through a standard height.

4.5.1 Mix design: The concrete mix design for M20 is designed as per IS 10262 – 2019 and the proportion is fixed after all the workability tests are done.

1. **Grade = M20**
2. **Type of cement = OPC 43**
3. **Size of aggregate = 20 mm**
4. **Workability = 100mm**
5. **Exposure condition = mild**
6. **Specific gravity of cement =2.96**
7. **Specific gravity of coarse aggregate = 2.63**
8. **Specific gravity of fine aggregate =2.58**
9. **Chemical admixture = Superplasticizer**
10. **Specific gravity of superplasticizer =1.145**
11. **W/C ratio =0.55**
12. **Zone = II**

Target strength, $f'ck = fck + 1.65\,S$

$= 20 + 1.65 \times 4$

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= 26.6 N/mm^2 (from table 2 clause 4.2.1.3, S=4)

Were, f'ck = target mean compressive strength at 28days, in N/mm^2

fck = characteristic compressive strength at 28days, in N/mm^2

S= standard deviation, in N/mm^2 (see 4.2.1)

X= factor based on the grade of concrete, as per Table 1.

Or

f'ck = fck + x

(From table 1 clause 4.2 from M20, x=5.5)

= 20 + 5.5

= 25.5 N/mm^2

- Selection of w/c ratio

  (From table 5, IS 456-2000)

  For M-20 concrete, max w/c ratio = 0.55

- Calculation of water content

  (from table 4, IS 10262:2019)

  For 50mm slump, water content = 186 kg for 20mm aggregatesfor 100mm slump = 186 + (6/100) ×186 = 197.16 kg

  As super plasticizer is used, the water content may be reduced. Based on the trial data the water content reduction of 23% is considered while using s.p at the rate of 1% by weight of cement. Since we use 0.2% of S P, hence 4.6% water content reduction should be considered.

  Water content = 197.16× 0.77 = 152 kg.

Calculation of cement content w/c ratio = 0.55, cement content = 152/0.55

= 276.36 $kg/m^3 \approx$ 300kg

(From table 5 IS 456.2000)

Minimum cement content for mild condition is 300 kg/m^3, hence ok

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- Volume of coarse aggregate (from table 5, IS 10262:2019) For 20mm aggregates, volume of C.A =0.62-0.01=0.61
- Volume of fine aggregate = 1-0.61=0.39

- Mix calculations

a) Total volume = 1m^3

b) Volume of entrapped air in wet concrete= 0.01 m^3

c) Volume of cement = (mass of cement/Sp. g of cement) × (1/1000)

= (300/2.96) × (1/1000)

=0.101m^3

d) Volume of water = (mass of cement/Sp. g of cement) × (1/1000)

= (152/1) × (1/1000)

= 0.152m^3

e) Volume of chemical admixture (Sp. g) @ 1% by mass of cementitious material

= mass of chemical admixture

= (3/1.145) × (1/1000)

= 0.0026m^3

f) Volume of all in aggregate = (a-b)-(c+d+e)

= (1-0.01) – (0.101+0.152+0.0026)

= 0.734 m^3

g) Mass of coarse aggregate = volume of all aggregates× vol of C A ×sg of C A ×1000

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= 0.734 × 0.61 ×2.70×1000

= 1208.89 kg≈ 1209 kg

h) Mass of fine aggregate = volume of all aggregates× vol of F A × sg of F A ×1000

= 0.734×0.39×2.58×1000

= 738.55 kg ≈ 739 kg

Proportion = (300:739: 1209)/ 300

= 1:2.32:3.9

Trail No.	W/C Ratio	IR (cm)	FR (cm)	Slump (mm)
1	0.5	0	30	30
2	0.55	0	120	120

Table 4.10: Slump cone test on concrete

Sl No	W/C ratio	Mass with partially compacted concrete (w_2) kg	Mass of fully compacted concrete (w_3) kg	C F = $(W_2-W_1)/(W_3-W_2)$
01	0.55	16.72	17.40	0.83

Table 4.1: Compaction factor test n concrete

Result:

Consistency of given concrete for given mix proportion at 0.55 w/c ratio by compaction factor test is = 0.830

CHAPTER 5

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METHODS OF CURING

Methods of Curing: There are various methods of curing namely: Covering Concrete Surfaces with Hessian or gunny bags, sprinkling of water, Ponding method, Membrane curing, Steam curing, Pack curing, Calcium chloride $CaCl_2$, Immersion curing, Oven curing. Sheet curing, impervious paper curing. The adoption of a particular method will depend upon the nature of work and the climatic conditions. In this work the following methods of curing of concrete are adopted.

5.1 Immersion curing (C1)

This is the best water curing method.in immersion method finished concrete is immersed in the curing tank or curing pond. This method of total immersion is practically not possible unless the concrete is a laboratory test specimen or small precast units. The precast concrete items are usually immersed in curing tanks for a specific duration.

Fig.5.1 Immersion curing method

5.2 Sprinkling of water (C3)

In this method of curing continuous sprinkling with water is also an excellent method of curing. If sprinkling is done at intervals, care must be taken to prevent the concrete from drying between applications of water. A fine spray of water applied continuously through a system of nozzles provides a constant supply of moisture. It is mostly used for curing floor slabs. The concrete should be allowed to set sufficiently before sprinkling is started. The spray can be obtained from a

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perforated plastic box. On small jobs sprinkling of water may be done by hand. Vertical and sloping surfaces can be kept continuously wet by sprinkling water on top surfaces and allowing it to run down between the forms and the concrete. For this method of curing the water requirement is higher.

Fig.5.2 Sprinkling of water method

5.3 Sheet curing (C3)

In this method of curing both the type of the sheet is sued to cure the flat surfaces usually. Polythene sheets are sued to cover the concrete cubes. The sheet can be placed on the concrete cubes just after it gets hardened. Shelter areas are also created by using the polythenes in addition to applying them to the concrete.

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Fig.5.3 Sheet curing method

5.4 Impervious paper curing (C4)

Impervious paper for curing concrete consists of two sheets of Kraft paper cemented together by a bituminous adhesive with fiber reinforcement. Such paper, conforming to, is an efficient means of curing horizontal surface and structural concrete of relatively simple shapes. A crucial advantage of this method is that periodic additions of water are not required. Curing with impervious paper enhances the hydration of cement by preventing loss of moisture from the concrete as soon as the concrete has hardened sufficiently to prevent surface damage, is should be thoroughly wetted and the widest paper available applied.

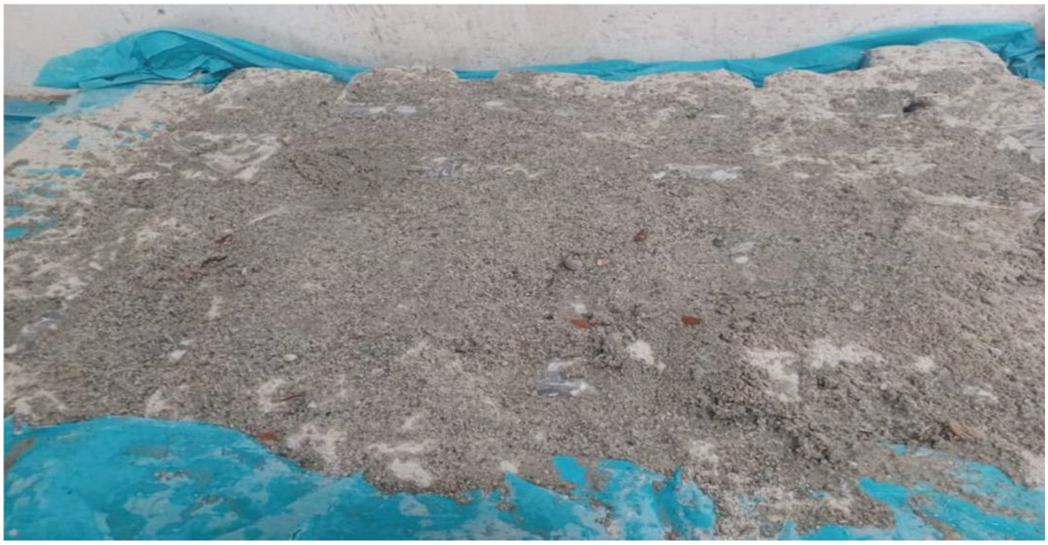

Fig.5.4 Impervious paper method

5.5 Casting the specimens and testing of hardened concrete:

Casting the specimens: Concrete cubes of size 150 mm are cast for testing the compressive strength of concrete and concrete cylinders of 150 mm diameter and 300 mm length are cast to test the splitting tensile strength of concrete.

5.5.1 Compressive strength test (as per IS: 516 – 1959)

Cube size: 150 ×150×150 mm

Procedure

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- Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition.
- Surface water and grit shall be wiped off the specimens and any protecting fins removed.
- Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimension of the specimens to the nearest 0.2 mm and their weight shall be noted before testing.

Placing the specimen in the testing machine:

- The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression platens.
- In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast.
- The specimen shall be carefully aligned so that it should place on Centre of loading area.
- The movable portion shall be rotate gently by hand so that uniform seated may be obtained.
- The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/sq., cm/mm until the resistance of the specimen to the increasing load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted. **Formula**: The compressive strength is calculated by C = P/A ...N/mm^2

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm^2)
				Load (KN)	Strength (N/mm ^{2})	
C1	7 days	14/02/23	21/02/23	400	17.77	18.81
				450	20.00	
				420	18.67	
C1	14days	14/02/23	28/02/23	460	20.44	23.26
				520	23.11	

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				590	26.22	
C1	28 days	14/02/23	14/03/23	540	24.00	27.10
				730	32.44	
				560	24.88	

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm^2)
				Load (KN)	Strength (N/mm^2)	
C2	7 days	16/02/23	23/02/23	320	14.22	16.29
				380	16.88	
				400	17.77	
C2	14days	16/02/23	02/03/23	590	26.22	24.40
				640	24.00	
				520	23.00	
C2	28 days	16/02/23	16/03/23	670	29.77	26.36
				600	26.66	
				510	22.66	

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm^2)
				Load (KN)	Strength (N/mm ^{2})	
C3	7 days	20/02/23	27/02/23	440	19.55	19.25
				480	21.33	
				380	16.88	
C3	14days	20/02/23	06/03/23	590	26.22	23.85
				540	24.00	
				480	21.33	

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C3	28 days	20/02/23	20/03/23	810	36.00	33.13
				750	33.33	
				690	30.06	

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm^2)
				Load (KN)	Strength (N/mm^2)	
C4	7 days	23/02/23	02/03/23	600	26.67	20.74
				300	13.33	
				500	22.22	
C4	14days	23/02/23	09/03/23	530	23.55	25.48
				600	26.67	
				590	26.22	
C4	28 days	23/02/23	23/03/23	530	23.55	28.44
				690	30.66	
				700	31.11	

Table 5.1: Compressive strength of concrete

5.5.2 Splitting tensile strength test (as per IS: 516 – 1959)

Cylinder specimen size: 150 mm diameter and 300 mm height **Procedure:**

- It shall be made of steel, and 3mm thick.
- The mould shall be capable of being opened longitudinally to facilitate the removal of the specimen and is provided with a means of keeping it closed while in use.
- The mean internal diameter of the mould is 15cm $\pm$ 0.2mm and the height are 30+/0.1cm.
- The moulds are provided with a metal base plate mould.

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- Mould needs to be coated with a thin film of mould oil before use, in order to prevent adhesion of concrete.

Placing the specimen in the testing machine:

- Initially, take the wet specimen from water after 7,14 and 28 of curing or any desired age at which tensile strength to be estimated.
- Then, wipe out water from the surface of specimen.
- After that, draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
- Next, record the weight and dimension of the specimen.
- Place plywood strip on the lower plate and place the specimen.
- Align the specimen so that the lines marked on the ends are vertical and centered over thebottom plate.
- Place the other plywood strip above the specimen.
- Bring down the upper plate so that it just touches the plywood strip.
- Apply the load the continuously without shock at a rate within the range 0.7 to1.4 MPa/min(1.2 to 2.4 MPa/min based on IS 5816 1999).
- Finally, note down the breaking load (P).

Formula: The splitting tensile strength is calculated by$S = 2P/\pi DL$…N/mm^2

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm^2)
				Load (KN)	Strength (N/mm^2)	
C1	7 days	14/02/23	21/02/23	130	1.84	1.88
				120	1.69	
				150	2.12	
C1		14/02/23	28/02/23	170	2.4	2.44
				190	2.68	

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	14days			160	2.26	
C1	28 days	14/02/23	14/02/23	180	2.54	2.77
				180	2.54	
				230	3.25	

Curing Method	**Age**	**Date of casting**	**Date of testing**	**Compression test**		**Average(N/mm²)**
				Load (KN)	**Strength (N/mm²)**	
C2	7 days	16/02/23	23/02/23	110	1.55	1.67
				140	1.98	
				105	1.48	
C2	14days	16/02/23	02/03/23	170	2.40	2.30
				150	2.12	
				150	2.12	
C2	28 days	16/02/23	16/03/23	130	1.89	2.30
				180	2.54	
				175	2.47	

Curing Method	**Age**	**Date of casting**	**Date of testing**	**Compression test**		**Average(N/mm²)**
				Load (KN)	**Strength (N/mm ²)**	
C3	7 days	20/02/23	27/02/23	120	1.69	1.97
				160	2.26	
				140	1.98	
				160	2.26	2.35

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C3	14days	20/02/23	06/02/23	180	2.55	
				160	2.26	
C3	28 days	20/02/23	20/02/23	140	1.98	
				230	3.25	
				150	2.12	2.45

Curing Method	Age	Date of casting	Date of testing	Compression test		Average(N/mm²)
				Load (KN)	Strength (N/mm ²)	
C4	7 days	23/02/23	02/03/23	120	1.69	1.97
				140	1.98	
				160	2.69	
C4	14days	23/02/23	09/03/23	180	2.55	2.60
				200	2.80	
				180	2.55	
C4	28 days	23/02/23	23/03/23	190	2.68	3.00
				200	2.82	
				260	3.67	

Table 5.2 Splitting tensile strength of concrete

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CHAPTER 6

RESULTS AND DISCUSSIONS

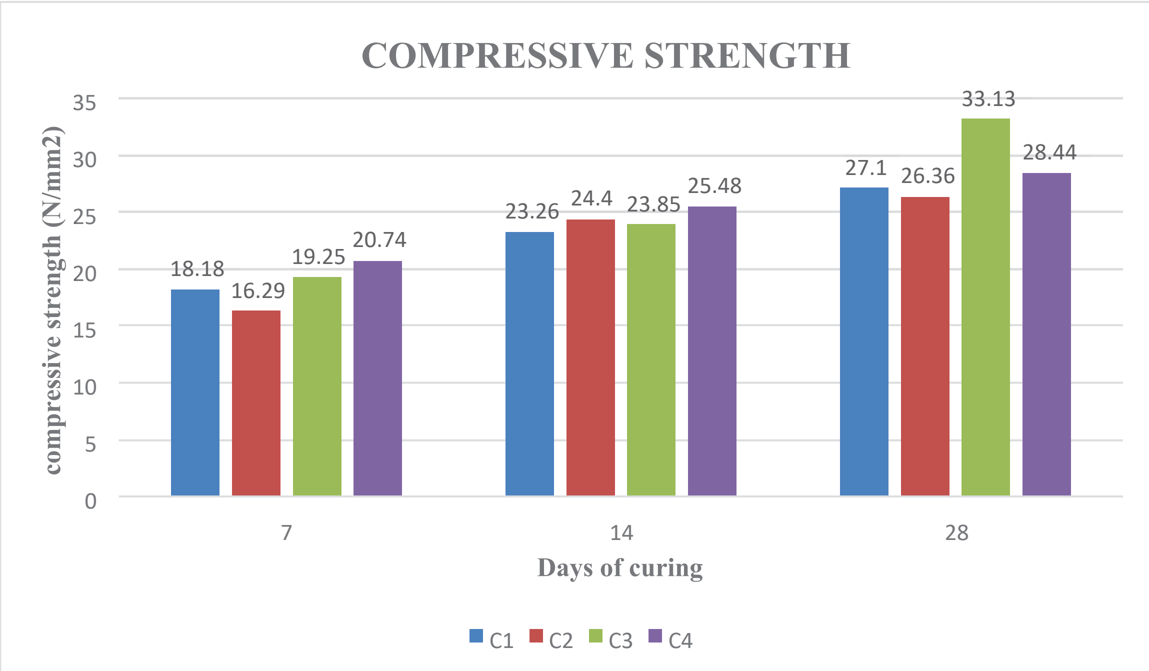

Fig 6.1 compressive strengths of concrete

It is clear from the above chart that the compressive strength of concrete cured by Sheet curing for 28 days is more than the compressive strength of concrete cured by other curing methods.

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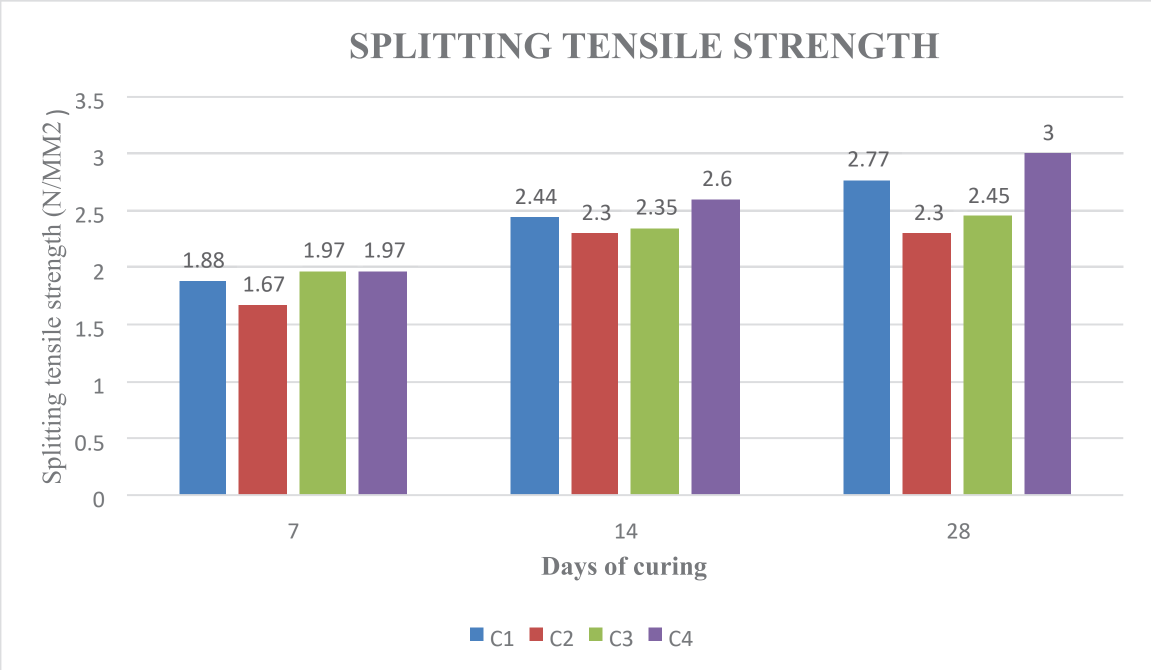

Fig 6.2 Splitting tensile strength of concrete

It is clear from the above chart that the splitting tensile strength of concrete cured by Sheet curing for 28 days is more than the strength of the concrete cured by other curing methods.

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CHAPTER 7 CONCLUSIONS

Based on the above observations, results and discussions the following conclusions are drawn:

1. Considering 28 days compressive strength results, all the curing methods achieve the target mean strength of 20 N/mm^2.
2. Sheet curing proved to be the most effective method giving the highest compressive strength of 33.13N/mm^2 and Impervious paper curing is highest splitting tensile strength of 3 N/mm^2 while using least amountof water compared to other methods of curing.
3. Sheet curing cannot be used for all types of concrete elements, therefore depending on the site location, site condition, type of structure, different curing methods can be adopted to achieve desired strength and durability.
4. Impervious paper curing can be used for columns, beams and precast elements, etc.,

REFERENCES

[1] T. James, A. Malachi, E.W. Gadzama, their work on "**Effect of curing methods on the compressive strength of concrete**" vol. 30, No. 3, October 2011.

[2] Akeem Ayinde Raheem, "**Effect of curing methods on density and Compressive strength of concrete**" vol.3, No.4, April 2013.

[3] Nuruddeen Usman and Muhammad Nura Isa worked on "**Curing methods and their effects on the strength of concrete.**" IRE journals

[4] O. James, P.N. Ndoke and S.S. Kolotheir work on "**Effect of different curing methods on the compressive strength of concrete**" vol. 38, 18 Decemberr 2011.

[5] Daniel yaw Osei, Zakari Mustapha, Mohammed D.H. Zebililla. Study on "**Compressive strength of concrete using different curing methods**" vol.10, No.3, September 2019.

[6] Dr. Elson John and Princy K.P their "**Study on the Effectiveness of various curing methods on the properties of concrete** " vol. 04, No 11, November 2015.

[7] D.Hari Prakesh and K. Prasanthi, their "**Study on concrete strength parameters under different curing conditions** " vol. 09, No. 6, June 2018.

[8] P Balamurugan, Assistant professor their work on "**Experimental study on curing methods of concrete**" vol. 5, Issue 1, 2017.

[9] Dr Sanjeev, in his work "**To study effect of different curing methods on compressive strength of concrete**" vol. 8, Issue 10, October-2017.

[10] P.L. Jadhav, Paraji Kale, Shubham Gawade, Shivraj Tanpure, Professors, Zeal Polytechnic Pune, their work on "**Experimental strength analysis of concrete by using different curing methods** " vol. 04, No. 05, May 2022.

Textbooks:

01. **Concrete Technology**: M.S. SHETTY.

02.. **Concrete Technology**: Narayan V. Nayak, K.G. Guptha, Purnanand P. Savoikar.

International Journal of Engineering Research & Technology (IJERT)
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Codebooks:

1. IS 4031 part-1 1996
2. IS 383 - 2016
3. IS 10262 – 2019
4. IS 456 (2000)