International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 03 | Mar -2020 ISSN: 2582-3930

EFFICEINT USE OF WATER DURING CURING OF CONCRETE OF BUILDING CONSTRUCTION PHASE,USE OF DRIP IRRIGATION SYSTEM FOR CURING OF CONCRETE IN LATUR CITY,IN INDIA

PRITI V.PATWARI

Abstract: Water is an important and essential element for construction. It is involved at every stage of construction right from the commencement to the finishing stage. Water scarcity is a perilous issue throughout the globe. Cities have arrived to a combat like stage to conserve water in every possible aspect. There an attempt to save, reduced, recycle water by the alarmed countries including India towards a sustainable environment. Latur is a city facing water scarcity since 2012.Every year there is reduction in rainfall and a changed climate. It is the region having rainfall pre monsoon and post monsoon. This research provided an alternate to the traditional method of curing concrete. Drip irrigation is a system used to provide water to the crops in the field. This is a well know system in Latur as 72 % of the profession is farming and agro businesses in the region.

Key words: Concrete, Curing, Drip Irrigation.

INTRODUCTION

Water is needed in construction industry for various purposes; it is needed for in construction, to mix concrete, mortar, wash sand, wet bricks etc. and other raw ingredients that are needed in the construction work.

For making plaster and construction strong and solid, water is sprayed on the built surface in abundance it tougher and durable. In this process lot of water is wasted.

Though there are many new types of concrete like self compacting, self setting concrete, self curing concrete but not yet used for construction of buildings in Latur city.

Need of Study

In year 2015 to 2017 building permissions were denied by Latur Municipal Corporation and construction work was banned due to water scarcity

Water scarcity leads to stress, water shortage or deficit, and water crisis. This is caused due to both nature and human beings.

This issue is caused due to poor management of resources, lack of government awareness, and man-made waste.

Building construction industry and the stakeholders had a great impact of water scarcity.

Scarcity of water has hampers all industries in India in some or the other including the construction industry as well.

Aim: To study water consumption and improving use of water during curing process in construction.

Limitations: The study is limited to building construction sites in Latur (region with low water table and less rainfall)

Scope: Reducing water consumption and improving water efficiency in building construction is a major step towards sustainable water management. For the same depending on the volume of the construction project

Objective

- Impact on the construction industry due to water crisis
- To identify wastage of water in construction methods of curing
- To find efficient curing method for the particular region in Latur
- To analyze use of drip irrigation system for curing process.

Research Question

I. Where is water wasted during construction?
Ii what are different ways to save water?
Iii .How to reduce water consumption while construction?
IV .What is the effect on the cost and time constrains due to water issues

RESEARCH **APPROACH.**

- Drip irrigation is familiar to the people in Latur
- It saves water
- System can be customize
- Pipes are reusable.
- The construction activities in Indian construction projects use concrete which requires huge amount of water for curing.
- An innovative method should be adopted to reduce the water consumption during the construction phase.

CURING

Curing is essential for the structure has to perform and the proposed functions for the life of the structure.
Setting & curing of cement is exothermic reaction, it emits heat at the time of setting which is necessary for hydration process of cement.
The escalation of the construction cost may be due to excessive use of water for curing.

LITERATURE REVIEW

Curing is a method in which the concrete is protected against loss of moisture which required for hydration and as per the temperature range. The strength of concrete is increased and decreased by the permeability of concrete. Curing helps to mitigate thermal and plastic cracks, which can severely impact durability of structures. Uniform temperature needs to be maintained throughout the concrete-section depth to avoid thermal shrinkage cracks

The concrete can dry out prematurely due to solar radiation and wind curing can prevent this.

Concrete Curing Time

The curing of concrete depends on the rate of evaporation moisture from the concrete which is affected by wind, climate, relative humidity, radiant energy from sun glare and concrete temperature.
The evaporation of moisture is driven by the difference in vapor pressure on concrete surface and the in surrounding air; if it is high the rate of evaporation is high.
The right time of curing of concrete depends on:
1. Initial Curing – Bleeding of Concrete:
In initial curing of concrete fogging, evaporation reducers are used, by providing the sunshades and windscreens
2. Intermediate curing:
Before the final setting of concrete intermediate curing is done when the concrete surface finishing operations are carried.
3. Final Curing:
The final curing of concrete is done when the concrete is finished after the final setting of concrete. This helps to prevent surface drying of concrete which is due to the loss of moisture from the concrete surface that occurs immediately.
The curing duration of concrete depends on:

1. The size of concrete structural member
2. The type of concrete grade and rate of hardening of concrete
3. The temperature and moisture conditions of surroundings
4. The exposure conditions of the concrete surface during and after curing
5. The requirement of curing duration as per specification of concrete

The Indian Standard IS 456 – 2000 recommends that curing duration of concrete must be at least 7 days in case of ordinary Portland cement, at least 10 days for concrete with mineral admixtures or blended cements are used. It also recommends that the curing duration should not be less than 10 days for concrete exposed to dry and hot weather conditions and 14 days for concrete with

mineral admixtures or blended cement in hot and dry weather.

Methods in Practice for Curing

Water Curing

Water curing the most appropriate for some types of work, e.g. floors, and include ponding, sprinkling, and wet coverings.

Membrane Curing

Wet-cured concrete will be more impermeable and better able to withstand freezing and thawing, wetting and drying. Polythene sheeting is used, but a spray-on curing compound is usually more convenient, although its use may be subject to approval for special visual requirements for color and uniformity.

Drip Irrigation System

Drip irrigation is a technique to deliver water slowly and at low pressure, at or near the roots of the landscape plant material. Drip irrigation to be provided in the precise area that is to be irrigated. Drip irrigation is effectively applied to any non-turf area, large or small, including shrub beds, flower gardens and hard-to-water areas.

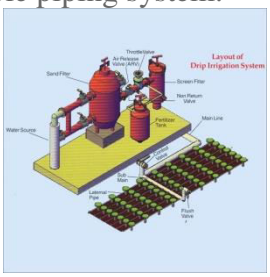
It is designed for the draught conditions and water restrictions throughout the country. It has been adopted by the farmers due to its efficient and cost-effective way to meet their agricultural demands.

Drip irrigation controls the water distribution and allowing using the exact amount of water needed for each plant.

As water is delivered slowly and directly to the root zone, water or soil runoff is significantly reduced.

Salient features of Drip Irrigation system

- Huge water savings: no evaporation, no run off, no waste
- 100% and utilization - drip irrigates uniformly in any topography
- Energy savings: drip irrigation works on low pressure
- Efficient use of water.
- Less dependency on weather, greater stability and lower risks.
- Reduce impact of drought and climate change.
- Avoid contamination of water.
- Flexible design.
- Cost effective.
- Reusable piping system.



Et al. (Kanchan Ambekar) practically drip curing is the most effective method of curing. It produced the highest level of compressive strength practically at site.

Et al (Md. Siddikur Rahman) Proper curing decreases, among other things, permeability, surface dusting, thermal shock effects, and scaling tendency. Proper curing increases strength development, abrasion resistance, durability property.

et al (Brijesh Patel) curing cost, water requirement, and water wastage, evaporation of water from concrete, electricity consumption, sustainability factor (Green Building material),

Supervision required, and number of workers required for evaluating emerging curing methods.

It will help the construction professionals in value engineering by providing the cost effective solutions for curing and contributing towards sustainable development.

METHODOLOGY

Methodology includes an experiment on M25 grade concrete cured with drip irrigation system

to achieve desired compressive strength of concrete and a comparative analysis for consumption of water with the traditional curing method and drip system curing. To analyze the effect on cost of the project.

DATA COLLECTION

Experiment

5.1.1 Testing of compressive strength of concrete
The mix proportioning for a concrete of M25 grade is given below
A-1 Stipulations for Proportioning

a) Grade designation: M25
b) Type of cement: 0pc 53 grade conforming to IS 12269
c) Maximum nominal size of aggregate: 20mm
d) Minimum cement content: 320kg/mm^2
e) Maximum water-cement ratio: 0.5
f) Workability: 50-75mm (slump)
g) Exposure condition: Mild
h) Method of concrete placing: pumping concrete
i) Degree of supervision good: good
j) Type of aggregate: crushed angular aggregate
k) Maximum cement aggregate: 450kg/mm^3
l) Chemical admixture type: super plasticizer

A-2 Test Data for Materials

a) Cement used: OPC 53 grade confirming toIS:12269-1987
b) Specific gravity of cement: 3.15
c) Chemical admixture: superplasticizer conforming to IS 9103
d) Specific gravity of:
   1) Coarse aggregate: 2.64
   2) Fine aggregate: 2.84
e) Water absorption:
   1) Coarse aggregate: 0.5 percent
   2) Fine aggregate: 1.0 percent
f) Free (surface) moisture:
   1) Coarse aggregate: Nil (absorbed moisture also nil)
   2) Fine aggregate: Nil
g) Sieve analysis:
   1) Coarse aggregate: 20mm size
   2) Fine aggregate: conforming to zone II of IS-383

A-3 Target Strength for mix proportioning

$$f'_{ck} = f_{ck} + 1.65s$$

Where

f'_{ck} = target average compressive strength at 28 days,

f_{ck} = characteristics compressive strength at 28 days, and

s = standard deviation

From table 1 standard deviation s=5 N/mm^2
therefore, target strength = 25+1.65*4 =35.6 N/mm^2
A-4 Selection of water- cement ratio
For table 5 of IS 456
Maximum water cement ratio for mild exposure condition = 0.55
Based on experience, adopt w/c ratio as 0.5
0.5< 055, hence ok
A-5 Selection of Water Content
From table 2 of IS 10262-2009
Maximum water content = 186 kg
(for nominal maximum size of aggregate=20mm)

Parameter	Values as per standard reference condition	Values as per present problems	departure	Correction in water content
slump	25-50mm	50-75mm	25	(+3/25) *25 =+3
Shape of aggregate	Angular	Angular	Nil	-
			Total	+3

Table 1:Table for correction in water content

Estimated water content for 50-75mm slump= 186+ (3/100) *186
= 191.6kg/m^3
By Trail with super plasticizer & by maintaining constant slump we obtained water reduction of 25% has been achieved.
Water content = 191.6- (191.6*0.25)
=143.7 kg/m^3 (with super plasticizer dosage)
A-6 Selection of cement content
Water cement ratio = 0.5
Cement content = 191.6/0.5= 383.2 kg/m^3
From table 5 of IS 456,
Minimum cement content for mild exposure condition=300kg/m^3
383.2kg/m^3> 300kg/m^3 hence ok
As per clause 8.2.4.2 of IS: 456 2000
Maximum cement content = 450kg/m^3
A-7 Proportion of volume of coarse aggregate and fine aggregate content
From table 3 of IS 10262-2009
For nominal maximum size of aggregate=20mm
Zone of fine aggregate = Zone II
And w/c = 0.5
Volume of coarse aggregate per unit volume of total aggregate = 0.62

Parameter	Values as per standard reference condition	Values as per present problems	Departure	Correction in coarse aggregate proportion
w/c	0.5	0.5	Nil	-
Workability	-	Pumpable concrete	-	-10%
			Total	-10%

Table 2: Table for correction in estimation of coarse aggregate proportion

Note: 1 for every ±0.05 change in w/c, the coarse aggregate proportion is to be changed by 0.01
If the w/c is less than 0.5(standard value), volume of coarse aggregate is required to be increased to reduce the fine aggregate content.
If the w/c is more than 0.5, volume of coarse aggregate is to be reduced to increase the fine aggregate content.
If coarse aggregate is not angular, volume of coarse aggregate may be required to be increased suitability based on experience.
Note2: For pump able concrete or congested reinforcement the coarse aggregate proportion may be reduced up to 10%.
Hence
Volume of coarse aggregate per unit
Volume of total aggregate=0.52*90%
= 0.558
Volume of fine aggregate = 1-0.558
= 0.442
A-8 Mix Calculation
The mix calculation per unit volume of concrete shall as follows:
a) Volume of concrete = 1m^3
b) Volume of cement = (mass of cement/specific gravity of cement)
= (383.2/3.15) *(1/1000)
= 0.122m^3

c) Volume of water = (mass of water/specific gravity of water) *(1/1000)
= (191.6/1) *(1/1000)
= 0.1916m^3

d) Volume of Total Aggregate = a-(b+c)
= 1-(0.122+0.1916)
= 0.6864m^3

e) Mass of coarse aggregate = 0.6864*0.558*2.84*1000
= 1087.75kg/m^3

f) Mass of Fine aggregate = 0.6864*0.442* 2.64x1000 = 800.94kg/m^3

Concrete Mix Proportion

1. Cement = 383.2kg/m^3
2. Water = 191.6 kg/m^3
3. Fine aggregate = 800.94 kg/m^3
4. Coarse aggregate = 1087.75 kg/m^3
5. w/c = 0.5

Trial 1: Mix 1

1. Volume of concrete

For each mix 9 cubes were casted (considering 25% wastage)

2. Volume of nine cubes(15cmx15cmx15cm) = 9x (0.15^3 x1.25)
   = 0.038

Quantity of materials for 9 cubes as follows

Mix 1

I. Cement = 14.55kg
II. Water = 7.28kg
III. Fine aggregate= 30.43kg
IV. Coarse aggregate = 41.33kg

Trial 2: MIX 2 (with SP doses.)

I. 143.7 kg/m^3 (with super plasticizer dosage) Volume of water 143.7X 0.038=5.46 KG
II. Cement = 14.55kg
III. Water = 5.46kg
IV. Fine aggregate= 30.43kg
V. Coarse aggregate = 41.33kg

CUBE TEST

Sampling

M25 Regular Mix

Mix 1(Regular M25 Concrete)

Days	Immersed Method	Drip System
7	19.71	21.93
14	20.75	22.08
28	24.38	23.56

Table 3; Compressive Test Result of M1 Mix

- Compressive strength achieved by immersed method on 28 day is 24.38kg/m3
- Compressive strength achieved by drip irrigation system method on 28 day is 23.56kg/m3

MIX 2: M2 (M25 WITH SP DOSES 40 ML)

Days	Immersed Method	Drip System
7	14.38	14.82
14	17.49	17.19
28	19.56	19.04

Table 4: Compressive Test Result of M2 Mix

- Compressive strength achieved by immersed method on 28 day is 19.56kg/m3
- Compressive strength achieved by drip irrigation system method on 28 day is 19.04 kg/m3

MIX 3: M3 (M25 WITH SP DOSES 79 ML)

Days	Immersed Method	Drip System
7	18.38	15.49
14	22.67	20.45
28	23.86	22.38

Table 5: Compressive Test Result of M3 Mix

- Compressive strength achieved by immersed method on 28 day is 23.86kg/m3
- Compressive strength achieved by drip irrigation system method on 28 day is 22.38 kg/m3

MIX 4: M4 (M25 WITH SP DOSES 118 ML)

Days	Immersed Method	Drip System

7	19.56	17.19
14	23.49	22.53
28	24.01	23.93

Table 6: Compressive Test Result of M4 Mix

- Compressive strength achieved by immersed method on 28 day is 23.86kg/m3
- Compressive strength achieved by drip irrigation system method on 28 day is 22.38 kg/m3

	CURING BY IMMERSED METHOD				CURING BY DRIP IRRIGATION METHOD			
	M1	M2	M3	M4	M1	M2	M3	M4
7days	19.71	14.38	18.38	19.56	21.93	14.82	15.49	17.19
14days	20.75	17.49	22.67	23.49	22.08	17.19	20.45	22.53
28days	24.38	19.56	23.86	24.01	23.56	19.04	22.38	23.93

Table 7; Compressive Test Result of All Mixes

Concrete cube of 15cmx15cm of m25 grade (regular) casted for immersed and drip irrigation system curing method

IMMERSED BLOCKS

CURING BY DRIPI.SYSTEM

Concrete cube of 15cmx15cm of m25 grade with sp doses casted for immersed and drip irrigation system curing method

Sp doses mixed in 30% water for mix

COMPARATIVE ANALYSIS

Analysis comparision for quantity of water required for curing
Sample taken for a bungalow of139.50 sqm (1500 sqft) with
No of columns=16
Size of founding =1.2mx1.5mx0.6 m
Size of column= 0.45x0.60
Area of bungalow 43x34.8=1496.4 sqft

*Traditional Method
0.5 hp water pmp is used for spraying for curing
Average 1000 liters water discharged is from pump in 30mins by 1" dia rubber pipe.

*Drip Irrigation Method
Average 8 liters of water id discharged from 6 droplets in one hour by gravity method.
No of drip holes @ 0.45 ft considered for slab=690 droplets
6 droplets discharge 8 liters of water per hour
690 droplets discharge 920ltrs/hr.

WATER REQUIREMENT CALCULATION

TRADITIONAL METHOD (0.5 HP PUMP FOR SPRAYING)

ITEM	TRADITIONAL METHOD	NO OF TIMES	TIME OF CURING	TOTAL WATER REQUIRED PER DAY	NO OF DAYS	TOTAL WATER UTILIZED FOR PROCESS
PCC	500	2	30 MIN	1000	3	3000
FOUNDATION	1000	2	30 MIN	2000	6	12000
COLUMNS	1500	3	45 MIN	4500	12	54000
SLAB	2500	2	10 HRS	5000	21	105000
RCC STRUCTURE	1700	2	1HR	3400	15	51000
RCC & BRK WALLS	4000	2	2 HRS	8000	8	64000
STRUCTURE WITH PLASTER	5000	2	1.5 HRS	10000	8	80000
						369000

Table 8: Water Consumption by Traditional Method of Curing

DRIP SYSTEM CURING

ITEM	DRIP CURING	NO OF TIMES	TOTAL WATER REQUIRED PER DAY	NO OF DAYS	TOTAL WATER UTILIZED FOR PROCESS
PCC	200	2	400	3	1200
FOUNDATION	200	2	400	6	2400
COLUMNS	700	3	2100	12	25200
SLAB	1000	2	2000	21	42000
RCC STRUCTURE	1500	2	3000	15	45000
RCC & BRK WALLS	2000	2	4000	8	32000
STRUCTURE WITH PLASTER	3000	2	6000	8	48000
					195800

Table 9 : Consumption of Water by Drip Irrigation System for Curing

Traditional method = 3,69,000 lts

Drip irrigation system=1,95,800,ltrs

% water saved=195800/369000=53

Hence,

53% of water is saved during construction phase for curing of a bungalow of 140 sqm by drip irrigation system.

Cost analysis for same bungalow

Average construction cost of a bungalow (ground floor only)

(Latur city) plinth area rate=Rs 12000/sqm

Estimate cost of bungalow=16.80,000.

2% considered for water=rs.33,600.00

Rate a tanker of capacity of 6000 liters=Rs 500

Water required for curing by traditional method (table) = 369000 liters

Cost of purchase of water=Rs 30750

Water required for curing by drip system (table) = 195800liters

Cost of purchase of water=Rs 16316 say Rs 16300

Cost of water reduces up to 50% of estimated cost.

DATA ANALYSIS

1. Experiment :

Compressive strength is achieved by drip irrigation system for regular M25

Grade concrete for MIX 1 and MIX 4

Water saved by adding SP doses while preparing concrete

MIX 1: Water required= 7.28kg

MIX 4: Water required = 5.46kg

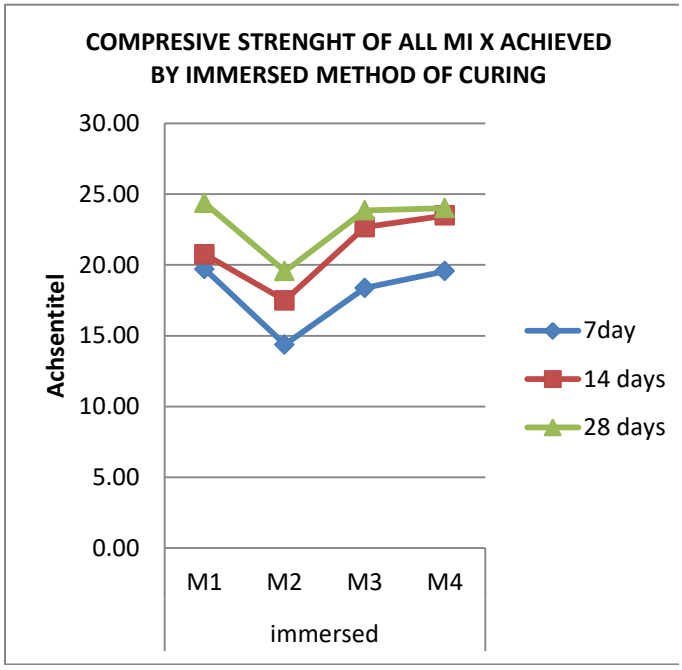


Chart 1 Compressive Strength Achieved By Immersed Technique for Curing

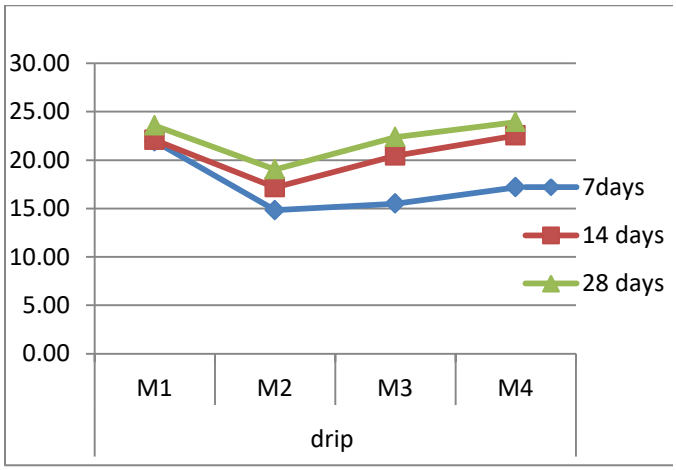


Chart 2: Compressive Strength Achieved By Drip System for Curing

2. Survey

- Cost time and quality is affected by water crises.
- 90% of respondents face water crises almost every year
- 70 % respondents agree that water is wasted during curing process
- Only 2% of responded agreed that water cost s considered while estimating

- 56% people accept to adopt new method for curing.

3. Comparative Analysis

(Traditional curing method and drip irrigation system)

53% of water is saved during construction phase for curing of a bungalow of 140 sqm by drip irrigation system.

53% of cost of water (for curing) can be saved by drip system

FINDINGS

A. Compressive strength achieved by immersed method on 28 day is 24.38kg/m3

Compressive strength achieved by drip irrigation system method on 28 day is 23.56kg/m3

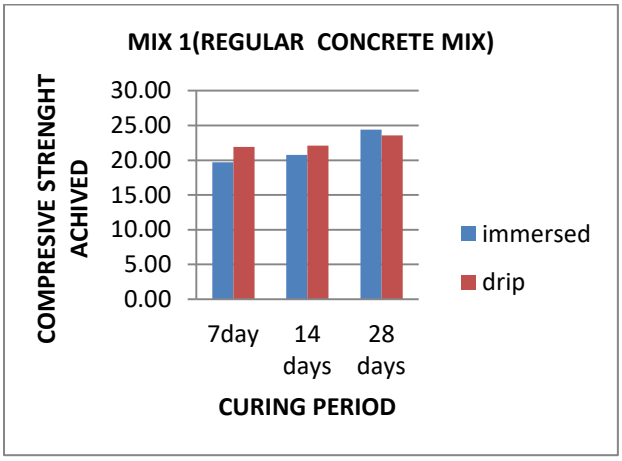


Chart 3: Compressive Strength of Mix 1

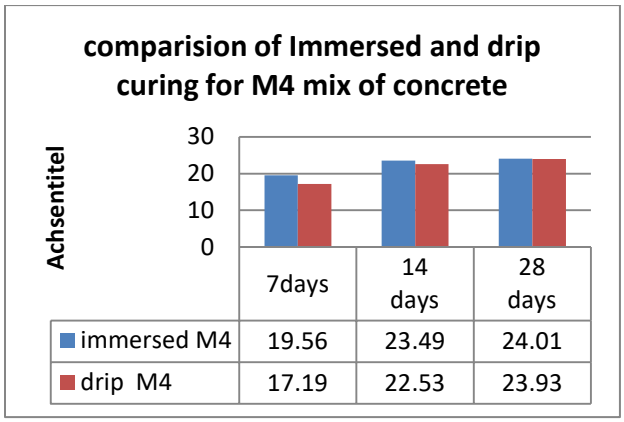


Chart 4: Comparison Of Immersed and Drip System for Mix 4

Compressive strength achieved by immersed method on 28 day is 23.86kg/m3
Compressive strength achieved by drip irrigation system method on 28 day is 22.38 kg/m3

B. 56% of respondents agree to accept alternate method of curing

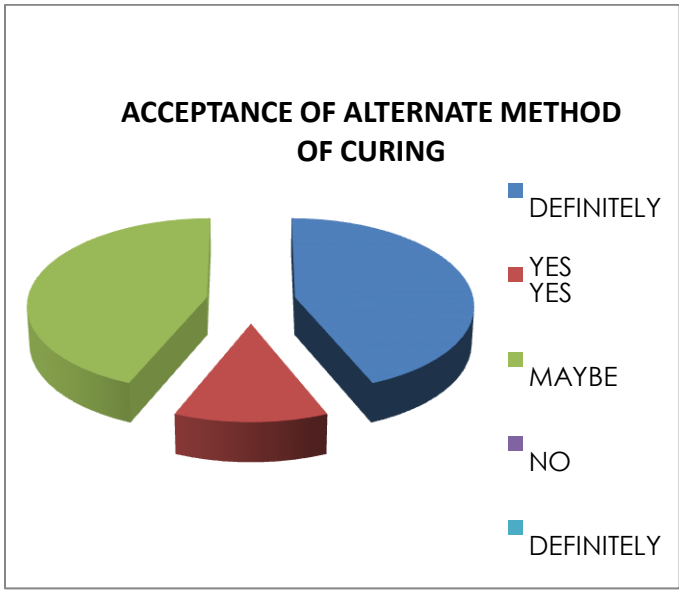


Chart 5: Responses for Alternate Method for Curing

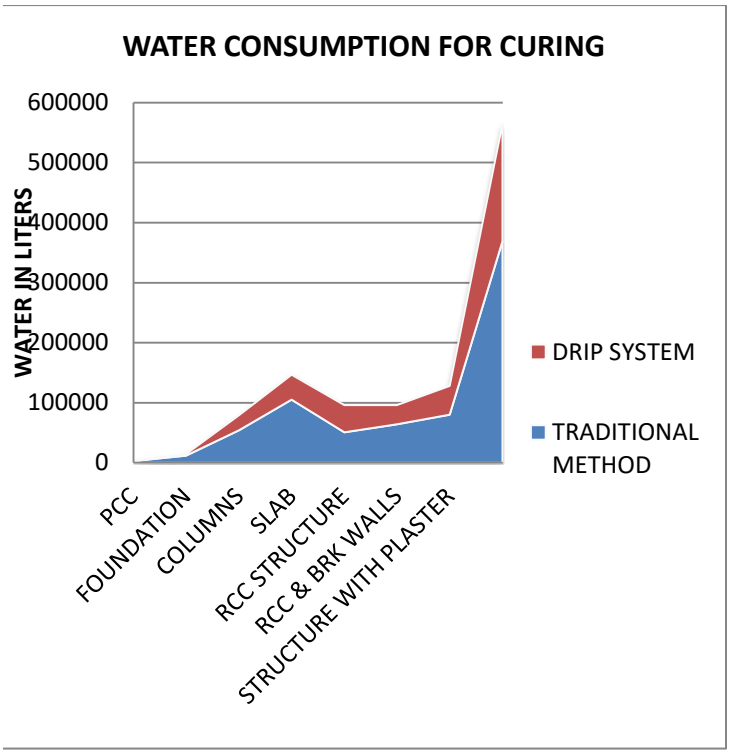


Chart 6: Comparison of water consumption by traditional method and drip system

C. 53% of water is saved during construction phase for curing of a bungalow of 140 sqm by drip irrigation system.
53% of cost of water (for curing) can be saved by drip system

CONCLUSION

Water is wasted during the curing process of concrete by the traditional methods such as spraying; ponding etc. drip irrigation system is an effective method in which water is used for curing of concrete .It can be adopted in construction as familiar to the people of Latur city. It reduces the cost and time of the construction.
Drip irrigation system can improve use of water during curing process of concrete in construction.

RECOMMENDATION

Drip system is can be used for curing of concrete. Use of super plasticizers can also be an effective method to reduce water consumption while making of concrete.

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