Impact of Conventionally and Non-Conventionally Treated Waste Water on Characteristic Strength of Concrete

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Abstract - *Concrete may be cast into bricks, blocks, and other relatively small building units, which are used in concrete construction. Concrete has a great variety of applications because it meets structural demands and lends itself to architectural treatment. The consumption of water is more for the concrete for its mixing and curing. Because of the scarcity of water now a days the alternate use of water for the concrete is made by considering two types of secondary treated water that is conventional and non-conventional treatment. Comparing the compressive strength of normal grade of concrete made by portable water with the secondary treated conventional and non-conventional type for different mix proportions of 0.35, 0.4 and 0.45 water cement ratios for 7,14 and 28 days the optimum type of secondary treated water is used for the concrete for its mix and also for its curing.*

Key Words: **Concrete, Compressive Strength, Conventional water, Non-Conventional water, Mix design, etc**

1. INTRODUCTION

Concrete is the most commonly used building material. It has the advantage of being formed into any desired shape most conveniently. It is an artificial stone obtained by mixing aggregates, cement and water allowing these product to cure for hardening. The fine and coarse aggregates in a concrete mix are the inert, or inactive, ingredients. Cement and water are the active ingredients. Its essential ingredients are cement and water which react with each other chemically; to form another material having the useful strength .The strength of concrete depends upon the quality of its ingredients, their relative quantities and the manner in which they are mixed, compacted and cured. Concrete is the premier construction material across the world and the most widely used in all types of Civil Engineering works. Concrete, its total consumption is around twenty billions tones, which is equivalent to two tones for every living human being.

2. NEED AND OBJECTIVE OF THE STUDY

The first requirement for good concrete is to use a cement type suitable for the work at hand and have a satisfactory supply of sand, coarse aggregate, and water. Everything else being equal, the mix with the best graded, strongest, best shaped, and cleanest aggregate makes the strongest and most durable concrete.

2.1 Need for the Study

The need of a sustainably developed and environmental friendly concrete is aggravated by population growth and scarcity of water. The world population doubled from 1959 to 1999, increasing from 3 billion to 6 billion .According to the US Census Bureau, the world population is projected to reach nine billion by 2043. Thus it is expected that water recycling and conservation as a necessity.

2.2 Objectives

- To investigate the impact of conventionally and non-conventionally treated waste water for mixing and curing of concrete cube.
- To compare the compressive strength of the casted cubes for tap water, conventionally and non-conventionally treated waste water.
- To replace the usage of fresh water by treated water in the concrete mix.
- To get comparative analysis of test results.

3. MATERIALS AND ITS PROPERTIES

i. Portland cement is the most common type of cement in general usage.
Normal consistency of cement=31%
Fineness = (Mass of residue in gms/100) =1.8%
Initial setting time of cement sample is found to be 45 min
Final setting time of cement sample is found to be 325 min
Specific gravity of cement = 3.24

ii. Coarse Aggregate
Specific Gravity of coarse aggregate is 2.63
Water Absorption =0.67%

iii. Fine aggregate
Specific Gravity of coarse aggregate is 2.6
The fine aggregate confines to zone I

iv. Water

In this study both conventionally and non-conventionally treated waste water is used and its properties are given in the table.

Table 3.1 Basic tests results on treated waste water

Sl no	Parameters	Tap Water	NC treated waste water	Tolerable Limits
01	pH	8.1	7.25	6.8
02	Alkalinity	545mg/lt	210 mg/lt	250 mg/lt
03	Acidity	28mg/lt	10 mg/lt	50 mg/lt
04	Total Hardness	600mg/lt	330 mg/lt	------
05	Total Suspended Solids	300mg/lt	5 mg/lt	2000mg/lt
06	BOD	59mg/lt	7 mg/lt	-------
07	COD	------	26 mg/lt	-------
08	DO	15.82mg/lt	5.8 mg/lt	-------
09	Chloride content	282.99 mg/lt	168mg/lt	2000–3000 mg/lt

Table 3.2 Basic tests results on conventional treated waste water

Sl no	Parameters	Conventionally Treated waste water	Tolerable Limits
01	pH	7.2	6.8
02	Alkalinity	210 mg/lt	250 mg/lt
03	Acidity	10 mg/lt	50 mg/lt
04	Total Hardness	330 mg/lt	------
05	Total Suspended Solids	5 mg/lt	2000mg/lt
06	BOD	7 mg/lt	-------
07	COD	26 mg/lt	-------
08	DO	5.8 mg/lt	-------
09	Chloride content	168mg/lt	2000– 3000 mg/lt

Fig 3.1 Cement

Fig 3.2 Coarse aggregate

Fig 3.3 Fine aggregate

Fig 3.4 Conventional and Non-conventional water

4. BRIEF DESCRIPTIONS OF THE PLANTS INCLUDED IN THE SCOPE OF WORK:

i. Conventional type

The V-Valley sewage treatment plant has been constructed to treat sewage generated in the western part of the city. Capacity of the treatment plant is 180MLD. This treatment plant is situated near Nayandahalli Bangalore-Mysore road. The treatment process involved in this plant is "Conventional two stage trickling filter process".

ii. Non Conventional type

The 75 MLD secondary sewage treatment plant was constructed to treat the wastewater. The plant is designed to treat the sewage of the above said qualities for the flow/capacities as mentioned below are expected up to the year 2011. The plant bagged the "ICI-(KBC)-Birla Plus Endowment Award" for outstanding concrete structure of Karnataka for the year 2004.

Table 4.1 Characteristics of waste water in treatment plant (conventional type)

PARAMETERS	INFLOW (mg/l)	OUTFLOW (mg/l)
Total Suspended Solids (TSS)	615	<5
BOD	412	<5
COD	820	<20
DO	Nill	4
pH (unit less)	6.9	7 to 8

Table 4.2 Characteristics of waste water in treatment plant (non conventional type)

PARAMETERS	INFLOW (mg/l)	OUTFLOW (mg/l)
Total Solids	1050	520
Total Suspended Solids (TSS)	230	7
BOD	350	7.25
COD	608	42
Chlorides (as Cl)	137	128
Sulphates (as SO_4)	42	16
pH (unit less)	7.18	7.40

5. CONVENTIONALLY AND NON-CONVENTIONALLY TREATED WATER PROCESS

The major aim of waste water treatment is to remove as much of the suspended solids as possible before the remaining water, called effluents is discharged back to the environment. As solid materials decays, it uses up oxygen which is needed by the plants and animals leaving in the water. Primary treatment removes above 60% of suspended solids from waste water. This treatment also involves aerating the waste water, to put oxygen back in. Secondary treatment removes more than 90% of suspended solids.

5.1 Conventionally treated water process

Pre Treatment Units:

- Screening
- Gritting
- Primary clarifiers
- Primary bio-filters
- Recirculation pump house
- Sludge pumping

Secondary Treatment Units:

- Secondary bio-filters
- Secondary clarifiers
- Sludge digesters
- Sludge pumping
- Sludge drying bed

5.2 Non-Conventionally treated water process

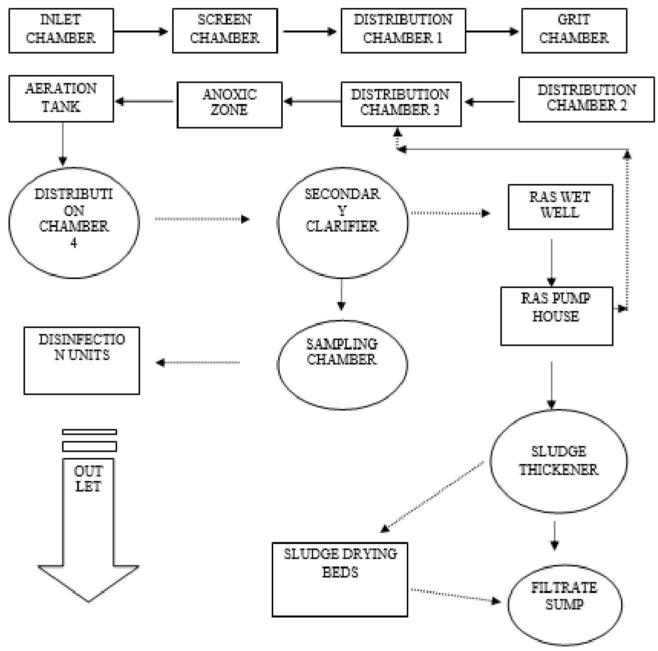

Fig 5.1 Flow chart showing Operational Units at Mailasandra 75 MLD STP

6. MIX DESIGN

Mix design is carried out as per IS: 10262-2009 for M20 concrete by varying water cement ratio (0.4&0.45). The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design.

Design stipulations for proportioning

- Grade designation : M20
- Type of cement : OPC 53 grade confirming to IS 8112
- Maximum nominal size of aggregates 20 mm
- Minimum cément content : 300 kg/m3
- Maximum water cement ratio : 0.5
- Workability : (25-50)mm (slump)

- Exposure condition : Moderate
- Degree of supervision : Good
- Type of aggregate : Crushed angular aggregate
- Maximum cement content : 450 kg/m3

Table 6.1 Mix proportions of different w/c

WATER CEMENT RATIO	0.35	0.4	0.45
CEMENT (kg/m3)	450	450	413.33
WATER (liters)	186	186	186
FINE AGGREGATE (kg/m3)	649.35	666.9	696.618
COARSE AGGREGATE (kg/m3)	1118.407	1100.655	1102.15
MIX RATIO	1 : 1.44 : 2.48	1 : 1.48 : 2.44	1: 1.68 : 2.66

7. MIXING, CASTING AND CURING

All the ingredients required for the preparation of concrete were effectively mixed manually (hand mixing) on a large steel tray. First, all the dry ingredients such as cement, fine aggregates, coarse aggregates and polyester fibers and steel fibers were mixed for 3 minutes, after which water was added based on the quantity determined from the mix design and then all the ingredients were mixed thoroughly for about 4 minutes.

15 concrete cubes will be casted according to the mix proportions and by varying water cement ratio (0.35,0.4&0.45). For M20 concrete different combination of concrete mixing will be carried out as given below
5 Specimens are casted using 100% tap water.
5 Specimens are casted using 100% conventionally treated waste water.
5 Specimens are casted using 100% non-conventionally treated waste water.

Curing will be done by immersing the specimens in curing ponds of tap water and treated water separately. Three curing ages are selected i,e 7,14,28 days. Three concrete blocks are tested for compressive strength at single ag

Fig 7.1 Mixing

Fig 7.2 Casting

Fig 7.3 Curing

Table 7.1 Details of number of cubes

fck	W/C	Portable Water			Convention water			Non Convention water			No of Cube
M 20		7	14	28	7	14	28	7	14	28	
	0.35	5	5	5	5	5	5	5	5	5	45
	0.4	5	5	5	5	5	5	5	5	5	45
	0.45	5	5	5	5	5	5	5	5	5	45
	Total Number Of Cubes										135

8. TEST RESULTS

Table 8.1 Average Compressive strength of concrete (Tap water as mixing and curing water)

Water cement ratio	Curing age (days)	Sl no	Weight of cube (kg)	fck (N/mm^2)	Avg comp strength (N/mm^2)
0.35	7	1	8.18	18.44	18.538
		2	8.04	18.8	
		3	7.94	17.86	
		4	8.2	19.02	
		5	8.02	18.57	
	14	1	8.14	23.64	22.806
		2	7.96	23.02	
		3	8.0	23.24	
		4	8.14	22	

		5	8.18	22.13	
	28	1	8.1	28.17	29.47
		2	7.48	31.06	
		3	8.1	28.97	
		4	8	30.35	
		5	8.25	28.8	

Table 8.2 Compressive strength of CTW and NCTW concrete

W/C	Curing	Weight Of Cube	Fck Of CTW	Fck Of NCTW
0.35	7	7.8	13.18	14.16
	14	7.8	17.74	17.78
	28	7.7	27.52	27.85

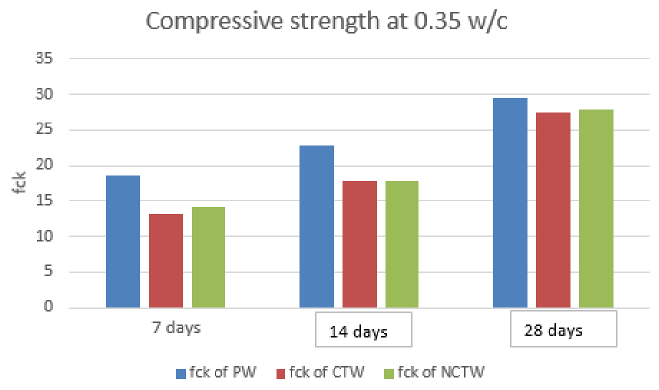

Chart 8.1 Compressive strength at 0.35w/c

Table 8.3 Average Compressive strength of concrete (Tap water as mixing and curing water)

Water cement ratio	Curing age (days)	Sl no	Weight of cube (kg)	Fck (N/mm²)	Avg comp strength (N/mm²)
0.4	7	1	8.04	17.91	17.196
		2	7.84	17.15	
		3	7.88	17.55	
		4	7.72	16.57	
		5	7.94	16.8	
	14	1	7.84	20.35	19.87
		2	7.74	19.33	
		3	7.9	19.64	
		4	7.78	20.57	
		5	7.88	19.466	
	28	1	7.82	29.68	28.464
		2	7.88	27.06	
		3	7.74	29.02	
		4	7.76	28.08	
		5	8.1	28.48	

Table 8.4 Compressive strength of CTW and NCTW concrete

W/C	Curing	Weight Of Cube	Fck Of CTW	Fck Of NCTW
0.4	7	7.8	16	16.19
	14	7.8	19.24	20.33
	28	7.9	25.58	25.98

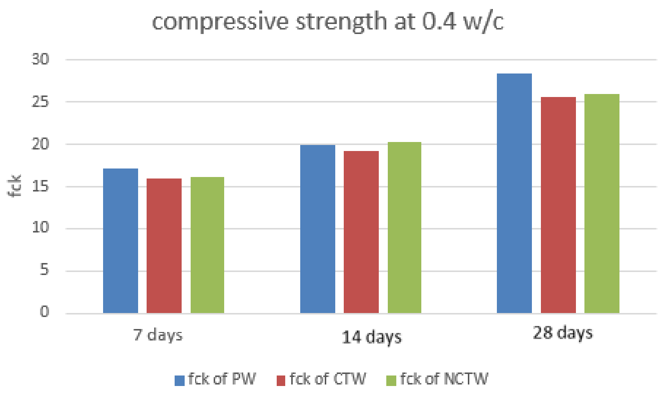

Chart 8.2 Compressive strength at 0.4w/c

Table 8.5 Average Compressive strength of concrete (Tap water as mixing and curing water)

Water cement ratio	Curing age (days)	Sl no	Weight of cube (kg)	Fck (N/mm²)	Avg comp strength (N/mm²)
0.45	7	1	8.04	15.37	14.928
		2	8.2	15.91	
		3	8.32	14.75	
		4	7.82	14.17	
		5	7.58	14.44	
	14	1	7.76	18.755	18.28
		2	7.68	18.488	
		3	8.04	18.62	
		4	7.78	17.86	
		5	8.1	17.68	
	28	1	7.7	26.57	26.972
		2	8.32	27.2	
		3	7.78	28.35	
		4	8.08	26.97	
		5	7.88	26.77	

Table 8.6 Compressive strength of CTW and NCTW concrete

W/C	Curing	Weight Of Cube	Fck Of CTW	Fck Of NCTW
0.45	7	7.8	17.67	16.95
	14	7.8	20.46	21.17
	28	7.7	25.02	25.8

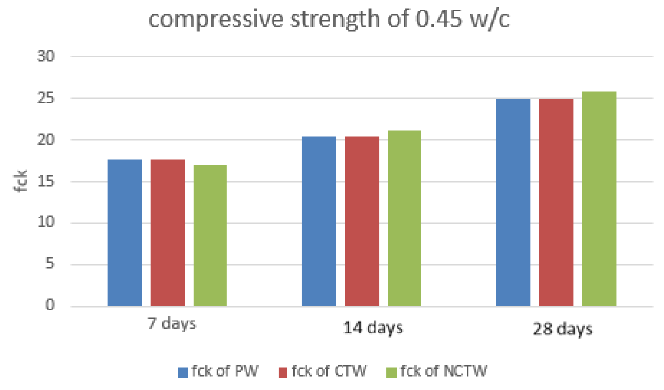

Chart 8.2 Compressive strength at 0.4w/c

Fig 8.1 Compressive testing machine

9. CONCLUSIONS

- The normal consistency, initial and final setting time of cement paste by mixing Secondary treated waste water Within the IS limit.
- The compressive strength of portable treated water and secondary treated water is compared in all the water cement ratios.
- Tests performed in this study suggest that Non conventionally treated waste water is an interesting candidate for using concrete for applications in the mixture and curing.
- The compressive strength of non conventionally treated water concrete of 0.35,0.40 and 0.45 water cement ratio is more compared to the conventionally treated water in all the ratios.
- For 0.45 water cement ratio the compressive strength of non conventionally treated waste water is almost same as the portable treated water for 14 and 28 days.
- When compared to three water cement ratios (0.35,0.4 and 0.45) 0.45 water cement ratio is found to be efficient in using it in concrete mix and curing for treated water.

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