Use of Treated Domestic Waste Water in Concreting

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Introduction

Water in India is primarily a state subject. Water is the main part of our life. It is a fact that if water is used there will be waste. So the waste water generation will never stop. In construction industry concrete being the most widely construction material used, uses most of the water. In construction industry water is used for mixing, aggregate washing, curing of concrete and for washing concrete related mechanical machines. Also water is used for domestic purposes. So as said above when we use water, waste water is produced. And due to this waste water there is a great environmental impact.

"By 2030, water demand in India will grow to almost 1.5 trillion m^3 with supply at approximately 740 billion m^3. His gap will need to be bridged by several initiatives ranging from national river linking projects, infrastructure rehabilitation, reducing transport losses to wastewater reuse." Says Vivek Vikram Singh, Director, Business Advisory services, Grant Thornton India.

"World population to increase to 9.7 billion by 2050; India will overtake China as most populous Nation: New study. India's population will rise to 1.6 billion by 2050 which is currently
1.2 billion and China's being 1.3 will be unchanged. " International Business

Times, Thursday, March 6, 2014 OF 11.00 pm EST

"An approximate estimate of global waste water production is about 1500 km^3 per day."

United Nations World Water Development Report, 2003.

Hence, the ultimate and last option will be treating the waste water and using it. But the humans have not accepted or will never accept the treated waste water for drinking purpose. So we can use this treated waste water in the construction industry where the large amount of share of water is used and save the freshwater. This paper explains how treated waste water can be used in construction industry and reduces the load on nature. The impurities present in the waste water can affect the properties of the concrete when used for mixing in concrete. Also the impurities may not affect all properties of concrete but some. The water samples PTWW and STWW were collected from Mundhwa treatment plant, Pune, India. And the was collected from Simply City, Hadapsar, Pune, India. The waste water was tested in the laboratory of Sewage Treatment Plant Chinchwad, India which was found to be as per the IS standards.

So if we can use the treated waste water for above purposes in construction industry, we can save a lot of freshwater and try to spread awareness and importance of water.

1.1 Availability WATER on Earth

The basic building block for all life on Earth, water is the most plentiful natural resource on the planet; in fact, over two-thirds of the Earth is covered by water. However, 97 percent is held in the oceans, while only 3 percent is fresh water. Of the freshwater, only 1 percent is easily accessible as ground or surface water, the remains are stored in glaciers and icecaps. Moreover, freshwater is not evenly distributed across land surfaces, and there are a number of heavily populated countries located in arid lands where fresh water is scarce.

"Water, water, everywhere, nor any drop to drink."

"Rime of the Ancient Mariner,"

Samuel Coleridge

1.2 Water required for Construction site

About 5 billion cubic yards of concrete are used each year; annual production is about two tons per person on the planet. As per provision of IS10262-2009 186 liters of water is required for 1m^3 of concrete. On an average 150 liters of water is required for 1m^3 of concrete. The construction of a 100,000 sq. ft. multi-storey structure can require about 10 million liters of water for production, curing and site development activity. A double lane flyover can consume 70 million liters of water on the same scale.

1.3 Waste water generation in India

It is estimated that about 38,254 million liters per day (MLD) of wastewater is generated in urban centers comprising Class I cities and Class II towns having population of more than 50,000 (accounting for more than 70 per cent of the total urban population). The municipal wastewater treatment capacity developed so far is about 11,787 MLD that is about 31 per cent of wastewater generation in these two classes of urban centers. In view of the population increase, demand of freshwater for all uses will become unmanageable. It is estimated that the projected wastewater from urban centers may cross 120,000 MLD by 2051 and that rural India will also generate not less than 50,000 MLD in view of water supply designs for community supplies in rural areas. However, wastewater management plans do not address this increasing pace of wastewater generation

Central Pollution Control Board (CPCB) studies depict that there are 269 sewage treatment plants (STP's) in India, of which only 231 are operational, thus, the existing treatment capacity is just 21 per cent of the present sewage generation.

1.4 Present Practices of Wastewater Reuse

The volume of wastewater generated by domestic, industrial, and commercial sources has increased with population, urbanization, improved living conditions, and economic development. The productive use of wastewater has also increased, as millions of small-scale farmers in urban and pre-urban areas of developing countries depend on wastewater or wastewater polluted water sources to irrigate high-value edible crops for urban markets, often because they have no alternative sources of irrigation water. Conventionally, sewage is collected through a vast network of sewerage systems and transported to a centralized treatment plant, which is resource intensive. Instead of transporting it long distance for centralized treatment, the Central Pollution Control Board is promoting decentralized treatment at the local level using technology based on natural processes. After proper treatment, sewage can be used in pisiculture, irrigation, forestry, and horticulture. Its conventional treatment generates sludge, which acts as manure. The sludge can also be used for energy recovery. Some STPs in the country are recovering this energy and utilizing it.

1.5 Case study: - "Pune City"

Pune is the 8th largest metropolitan city of India and one of the fast growing cities in India. Population of Pune city is approximately 3.4million in the year 2007, and the two neighboring cities Pune and Pimpri-Chinchwad form an urban agglomeration with almost 5.0 million inhabitants. The annual population growth has been 3.5-4.0 per cent since 1981 and the driver of migration is the economy and especially the Information Technology (IT) Sector.

1.5.1 Management Scenario In Pune City

Pune city has total population of about 35 lakh and the total water supply is 1050 MLD. Required per capita water supply as per standard Indian norms for A class cities is 135 lpcd whereas PMC provides 229 lpcd of water. (Considering about 20% losses, which comprise of 16% losses in distribution and 4% losses during treatment).About 80 % water supplied to consumers get converted in sewage in Indian metropolitan cities. According to estimate Pune generates more than567 million liter sewage per day. This is less than a normal figure of 80% due to non-consumptive use of water which does not get reflected in sewage as well as due to non-metered water supply, making the actual water supply as well as wastewater generation a suspect. (Journal of Environmental Research and Development Vol. 7 No. 1A, July-September 2012)

1.5.2 Sewage treatment plants in "Pune City"

Pune Municipal Co-operation (PMC) has constructed 7 sewage treatment plants (STPs) along with the STP at Naidu Hospital at Koregaon Park (Bhairoba Nala), Erandwane, Tanajiwadi, Vithalwadi, Mundhawa and Bopodi. The total 567 MLD of sewage is generated in PMC limit, out of that 437 MLD (i.e. @ 77%) is treated by 8 STPs and the treated effluent is discharged into Mula Mutha Rivers.

Table:- 1.1 :- Sewage treatment plants in "Pune City"

Sr,No.	Description	Capacity Of The Plant
1.	Bopodi	18 MLD
2.	Tanajiwadi	17 MLD
3.	Erandwane	50 MLD
4.	Vithalwadi	32 MLD
5.	Dr. Naidu Hospital	115 MLD
6.	Bhairoba	130 MLD
7.	Mundhawa	45MLD
8.	Kharadi	30 MLD
9.	Akurdi	30 MLD
Total		467 MLD

In this chapter, the literature review is mentioned till date 2012. As members of studies regarding the subject were carried out and papers were published. Here some of the papers published in the same research are described with their Abstracts which show the current development and interest in the Subject.

2.1 Research paper by IBRAHIM AL - GHUSAIN(6) on "Use of treated wastewater for concrete mixing in Kuwait"

The suitability of using treated wastewater for mixing concrete was experimentally evaluated. Concrete cube specimens were cast using tap water (TW), preliminary treated waste water (PTWW), secondary treated wastewater (STWW), and tertiary treated wastewater (TTWW) obtained from the local Reqqa wastewater treatment plant.

The type of water used for mixing did not affect concrete slump and density. However, setting times were found to increase with deteriorating water quality. PTWW and STWW were found to have the most effect on retarding setting time. Concrete made with PTWW and STWW showed lower strengths (i.e., slower strength development) for ages upto 1yr. At early concrete ages of 3 and 7 days, the strength of concrete made with TTWW was higher than that of concrete made with TW. The possibility of steel corrosion increased with the use of STWW and PTWW, especially when a thinner cover to the reinforcing steel was used. In summary, tertiary treated wastewater, of the type produced from wastewater plants in Kuwait, is found to be suitable for mixing concrete with no adverse effects.

2.2 Research paper by K. S. AL-JABRI(7), on "Effect of using Wastewater on the Properties of High Strength Concrete"

This paper investigates the effect of using wastewater on the properties of high strength concrete. Wastewater samples were collected from three car washing station in Muscat area. The collected wastewater samples were mixed together and chemical analysis was carried out. Four water samples, including controlled potable (tap) water were analyzed for pH, total dissolved solids (TDS), chloride, hardness, alkalinity, and sulfates. Chemical analysis results showed that although the chemical compositions of wastewater were much higher than those parameters found in tap water, the water composition was within the ASTM standard limits for all substance indicating that the wastewater produced can be used satisfactorily in concrete mixtures. High strength concrete mixtures were prepared using different proportions of wastewater and water-to-cement ratio of 0.35. The percentage of wastewater replaced ranged between 25-100% of tap water used in concrete. For each concrete mixture, six 150mmx150mmx150mm cubes, three 300mmx150mm dia. cylinders and three 100mmx100mmx500mm prisms were cast. Slump, compressive, tensile and flexural strengths were determined at 28-day of curing. Cube compressive strength was also determined at 7-day of curing. Also, initial surface absorption test was conducted at 28-day of curing in order to assess the durability of concrete. Results indicated that the strength of concrete of the mixtures prepared using wastewater was comparable with the strength of the control mixture. Also, the water absorption of concrete is not affected when wastewater was used.

2.3 Research paper by Marcia Silva[8] on "Sustainable Use of Resources – Recycling of Sewage Treatment Plant Water in Concrete"

Concrete is the most widely used construction material in the world. Production of Portland cement used in concrete produces over 2.5 billion tons of carbon dioxide and other greenhouse gases worldwide. In addition, concrete is one of the largest water consuming industries. Approximately 150 liters of water is required per cu. m. of concrete mixture, without considering other applications of water at the concrete industry. Water is a critical environmental issue and water supplies and water quality are becoming more limited worldwide. This paper presents an overview of the current state of knowledge about the use of reclaimed water, especially partially processed sewage treatment plant water in concrete. On the basis of identified knowledge, an initial laboratory investigation was conducted. A detailed research agenda has also been developed for additional knowledge on this topic in order to understand and to reduce the environmental impacts of the concrete industry. This preliminary research finding suggested that significant difference do not exist between mortar cubes made of potable water Vs sewage treatment plant water.

2.4 Research paper by MOHAMMAD SHEKARCHI[9] on "Use of biologically treated domestic waste water in concrete"

The concrete industry is consuming annually one billion tones of mixing water with large quantities of fresh water which are also used for washing aggregate and curing concrete by ready mixed concrete industry. A variety of by-product materials have been successfully incorporated as raw material substitutes, additives, and admixtures in cement and concrete technology. The same scenario might be considered for domestic waste water.

In this study three types of water obtained from a local plant of treatment of domestic waste water were characterized and used as mixing and curing water. Physical and mechanical tests were performed on cement paste, mortar and concrete specimens. Some durability characteristics of concrete have been also investigated.

3.1 Aim

<u>**"Use and effect of effluent waste water on concrete"**</u>

3.2 Objectives

1. To determine the chemical parameter of Normal Water, Grey water, primary treated waste water and secondary treated waste water for Chloride, Alkalinity and pH.

2. To determine the consistency of cement paste, initial setting time, final setting time of cement and compressive strength of cement by using Normal water, Primary Treated Waste Water, Secondary Treated Waste Water, and Grey Water.
3. To determine the variation in strength, workability and setting time with Normal Water, Grey water, primary treated waste water and secondary treated waste water in concrete.

3.3 Methodology

An experimental investigation was carried out to evaluate the feasibility of treated waste water in concrete. To achieve above mentioned objectives we performed various experiments on cement and concrete with the help of PTWW, STWW, and and compared the results with TW.

1. Chemical parameters like ph, Alkalinity, Hardness and TSS were tested for PTWW, STWW, and TW and compared the results with IS standards.
2. The test like consistency of cement, initial setting time of cement, final setting time of cement, compressive strength of cement were carried out on cement.
3. Tests on concrete were workability, compressive strength of concrete, tensile strength of concrete.
4. To get compressive strength of cement we casted the mortar cube specimens for 7 days and 28 days by mixing PTWW, STWW, and TW.
5. For compressive strength of concrete, concrete cubes were casted for 3 days, 7 days, 28 days by mixing PTWW, STWW, and TW.

3.3.1 Method of batching

1) Material are batched by Weighing Machines

3.3.2 Method of Mixing

The concrete is mixing by weighing method.

1) Mixing are done by manually.
2) The coarse aggregates, fine aggregates and cement were placed into the span and dry mixing was carried out by fawada.
3) The water was added in 2 intervals and the concrete was prepared within 5 min.

3.3.3 Method of curing

Curing of concrete done by immersed method, in which all concrete cube place for different period of curing, like 7days, 14days, and 28 days.

4. Material Used And Testing

In this chapter we are dealing with properties and significance of all materials which we used in our project. All the test on materials like cement, coarse aggregate , fine aggregate , water , were carried out in Y. B. Patil Polytechnic Akurdi, Pune.

1) Cement
2) Fine Aggregate
3) Coarse Aggregate
4) Normal Water
5) Primary Treated Waste Water
6) Secondary Treated Waste Water

4.2 Cement

The cement used were Ambuja Cement (OPC -43 grade), Because of its fine nature, good particle size distribution, optimal phase composition, impart the properties higher strength to the structure and the physical and chemical lab properties of OPC -43 grade as defined in IS 12269-1987. We collected the Ambuja cement from local agency Rajmudra Hardware, Chakan to carry out the experimental Result.

4.1.1 Tests on Cement

Test results are presented in Table (3.1).

Table 4.1:- Physical Properties of Cement.

Sr.No.	Description of Test	Results
1	Fineness of cement (residue on IS sieve No. 9)	3 %
2	Specific gravity	3.15
3	Standard consistency of cement	28 %
4	Setting Time Of Cement: (a) Initial Setting Time (b) Final Setting Time	102 Min 295 Min
5	Compressive Strength Of Cement (a) 7 Days (b) 28 Days	25.39 N/mm^2 54.75 N/mm^2

4.2 Fine Aggregate

Fine Aggregate used for experiment investigation is crushed sand which is obtained from locally available agency. Physical property of crushed sand is test acc. to IS 383-1970

Table 4.3.- Testing of fine aggregate

Sr no.	Test on aggregate	Result
1	Max. Size of aggregate	4.75
2	Specific Gravity	2.86
3	Water Absorption	0.34%
4	Water Content	0.00%
5	Sieve Analysis	Conforming to Gradient Zone: 2 IS 383 table-4

Table 4.3 :- Sieve analysis of fine aggregate

IS Sieve	WT. retained (gm)	Cumulative WT retained (gm)	Cumulative % WT retained (gm)	% Passing
4.75 mm	12.1	12.1	1.21	98.79
2.36mm	355.2	367.3	36.73	63.27
1.18mm	435.8	803.1	80.31	19.69
600µ	177	980.1	98.01	1.99
300 µ	15.5	995.6	99.56	0.44
150 µ	1.6	997.2	99.72	0.28
Pan	2.8	1000	100	00
Wt. of Sample	1000	1000		

4.3 Coarse Aggregate

The coarse aggregate used were locally available. The maximum nominal size of aggregate was 20 mm. Aggregate are the major ingredient of concrete. They contribute about 70-75 % of the total volume, provide a rigid skeleton structure for concrete & act as economical space fillers.

Table 4.4:- Testing of coarse aggregate

Sr. No.	Test Of Aggregate	Result
1	Max. Size Of Aggregate	20 mm
2	Specific Gravity	2.92
3	Water Absorption	0.65%
4	Water Content	0.00%
5	Sieve Analysis	Conforming to IS 383-1970 Table 2

Table 4.6:- Sieve analysis of coarse aggregates

IS Sieve	Wt. Retained (Gm)	Cumulative Wt, Retained (Gm)	Cumulative % Wt Retained (Gm)	% Passing
80mm	0.00	0.00	0.00	100
63mm	0.00	0.00	0.00	100
40mm	0.00	0.00	0.00	100
20mm	0.00	0.00	0.00	100
16mm	438	438	17.52	82.48

12.5mm	852	1290	51.6	48.4
10mm	1190	2480	99.2	0.8
6.3mm	0.00	2480	99.2	0.8
4.75mm	20	2500	100	0.00
Pan	0.00	0.00	100	0.00
Wt, Retained Sample	2500	2500		

4.4 Water

It is important ingredient of concrete. Combining water with a cementious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely.

4.5.1 Normal Water

Any natural water which is fit for drinking and has no undesirable taste or colour is generally acceptable for concrete. The tap water is used for preparation of concrete.

4.5.2 Primary Treated Waste Water

Primary treated water is the sewage water from which removal of constituents like as racks, sticks, floatable grit and grease. Primary treated waste water is collected from

SEWAGE TREATMENT PLANT CHINCHWAD, PUNE" for experimental investigation.

4.5.3 Secondary Treated Waste Water

Secondary treated waste water is the primary treated waste water from which removal of suspended solid , organic matter and biodegradable organic waste. Secondary treated waste water is collected from , PUNE for experimental investigation. SEWAGE TREATMENT
PLANT CHINCHWAD, PUNE

4.5.4 Sullage

This refers to the wastewater generated from bathrooms, kitchens, washing place and wash basins, etc. Composition of this waste does not involve higher concentration of organic matter and it is less polluted water as compared to sewage.

Table 4.7 :-Characteristics of PTWW, STWW, NW

Sr. No	Parameters	Units	IS Guidelines	PTWW	STWW	NW
1	pH		Not Less Than 6	7.4	6.9	7.3
2	TSS	Ppm	2000	350	<10	-
3	Hardness	Mgl	300 Mg/L	75	125	60
4	BOD	Ppm	-	50	<10	-
5	COD	Ppm	-	150	<100	-
6	Turbidity	Ppm	5 NTU Max	20.5	19.5	2.78

5.1 Concrete Mix Design

The concrete mix design is a process of selecting suitable ingredients for concrete and determining their proportions which would produce, as economically as possible, a concrete that satisfies the job requirements, i.e. concrete having a certain minimum compressive strength, workability and durability. The proportioning of the ingredients of concrete is an important phase of concrete technology as it ensures quality and economy.

STIPULATION OF DESIGN

A) Grade Designation M25

B) Type of cement OPC 43 grade conforming to IS 8112

C) Maximum nominal size of aggregate 20 mm

D) Minimum cement content 320 kg/m³

E) Maximum water cement ratio 0.45

F) Workability 100

G) Degree of supervision good

H) Type of aggregate Crushed angular aggregate

I) Maximum cement content 450 kg/m³

Test Data For Materials

A) Cement used OPC 43 grade conforming to IS 8112

B) Specific gravity of cement 3.15

C) Specific gravity of

A) Coarse Aggregate 2.92

B) Fine Aggregate 2.86

D) Sieve analysis

A) Coarse aggregate conforming to table 2 of IS 383

B) Fine aggregate conforming to grading zone

Selection Of Water Cement Ratio

From table 5 of IS 456 maximum water cement ratio: 0.45

Adopt water cement ratio: 0.45

Selection Of Water Content

From table 2 maximum water content for 20mm aggregate = 186liters Estimated water content for 100mm slump= 197 liters

Calcuation Of Cement

Water cement ratio= 0.45

Cementious material content = 197/0.45

= 437.78 kg/m³

Proportion Of Volume Of Coarse Aggregate And Fine

Aggreate Content Volume of coarse aggregate corresponding to 20mm size of aggregate and fine

aggregate for water cement ratio 0.50=0.60

Therefore, Volume of coarse aggregate for water cement ratio 0.45=0.61 therefore volume of fine aggregates 1 – 0.61=0.39

5.2 Mix Calculation

A) Volume of concrete = 1m³

B) Volume of cement = mass of cement / specific gravity of cement *1//1000

= 437.78/ 3.15*1/1000

= 0.138 m³

C) Volume of water = mass of water / specific gravity of water *1//1000

= 197/1*1/1000

=0.197

E) Volume of all in aggregate =1-0.197-0.138

= 0.665

F) Mass of Coarse aggregate = F * Volume coarse aggregate * specific gravity of coarse aggregate *1000

= 0.665*0.61*2.92*1000

= 1184.49 kg

G) Mass of fine aggregate= F * Volume Fine aggregate * specific gravity of fine aggregate *1000

= 0.665*0.39*2.86*1000

= 741.74 kg

5.3 Mix Calculation For Trail Number 1

A) Cement	=437.78kg/m^3
B) Water	=197 kg/m^3
C) Coarse aggregate	=1184.49 kg/m^3
E) fine aggregate	=741.74 kg/m^3
F) Water Cement Ratio	=0.45

6.1 Experimental Work

In this Chapter we are dealing with the test carried out on water, cement and concrete. The test carried out on water are determine the pH , determine the total suspended solid, determine alkalinity, determine the hardness, determine the BOD & COD for NW, PTWW, STWW, GW. The test carried out on the cement are Standard consistency of cement, Initial and Final setting time of cement, Compressive Strength of cement. Test carried out on concrete are workability i.e. Slump cone test, Compressive strength of concrete.

6.1 Test on water parameters

6.1.1 pH

pH is measured by using pH meter

6.1.2 Total Suspended Solid

TSS determines suitability of waste water effluents for disposal into inland surface water.

6.1.3 Alkalinity

Concentration of alkalinity determines the extent to which an acid can be neutralized.

6.1.4 Hardness

Hardness is a property of water which represents total concentration of Ca and Mg ions in $CaCO_3$.

6.1.5 BOD

BOD tests are used for determining the pollution strength of organic wastewaters, domestic or industrial.

6.1.6 COD

COD value indicates practically the overall pollution strength of a raw waste, domestic or industrial. It is also used for determining the suitability of a treated waste for disposal.

6.2 Test On Cement

6.2.1 Standard Consistency

Introduction

Consistency test is used to find the amount of water to be mixed with cement. It is necessary to find the consistency because amount of water present in the cement paste may affect the setting time. Standard consistency is indicated by the vi-cat plunger reading (5 to 7) from the bottom of mould. The test results are considerable affected by the quantity of water used in a given quantity of cement. To control this quantity of water to be used in each test is decided on the basis of percentage of water required to produce a paste of standard consistency.

Reference:- IS 4031 (part 4)1988

Procedure:-

A standard consistency test performed by V- Cat apparatus and the procedure is followed

Figure No. 1 Standard consistency of cement paste

Observation Table

Table 6.1 Standard consistency of cement paste

Sr. no	Nos.	Water used to carry out the test	Weight of cement (gm)	Weight of water added (gm)	Penetration (mm)	Standard consistency in %
1.	1	NW	400	105	8	28%
	2	NW	400	110	6.5	
	3	NW	400	112	5	
2.	1	PTWW	400	110	8	30.5%
	2	PTWW	400	122	1	
	3	PTWW	400	125	10	
3.	1	STWW	400	110	4	28.75%
	2	STWW	400	118	5	
	3	STWW	400	110	9	

6.2.2 Initial Setting Time And Final Setting Time

Introduction

The setting time of cement is divided into initial setting time & final setting time. Initial set is a term, which is applied to that stage at which any cracks that appear do not reunite. Time interval from the time the water is added to the time elapsed up to this stage is called as initial setting time & total time elapsed till the cement paste forms a solid mass is called as final setting time. The initial setting time or rate of setting is governing factor for mixing, transportation, placing & compaction of concrete.

Reference

I.S.269-1967

I.S.4031-1968(part -5)

Definition

1) Initial setting time:- Initial setting time is that time period between the time water is added to cement and time at which 1 mm square section needle fails to penetrate the cement paste, placed in the Vi-cat's mould 5 mm to 7 mm from the bottom of the mould.
2) Final Setting time:- Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does not make any impression.

Procedure

The initial and final setting time is performed by vicat apparatus. Test procedure is followed by IS 4031-1968(part -5) standard.

Observation Table

Table 6.2:-Initial and final setting time of cement

Sr. No	Water Used To Carry out The Test	Weight Of Cement Taken (Gm)	Weight Of Water Added (Gm0	Initial Setting Time (Min)	Final Setting Time (Min)
1	NW	400	0.85*112	102	330
2	PTWW	400	0.85*122	118	347
3	STWW	400	0.85*115	108	335

6.2.3 Compressive Strength Of Cement

Introduction

In this test, compressive strength of cement is determined. Formation of Cement paste and its cubes for compressive testing are not useful. Cement mortar is made using standard sand helps to make the test result applicable everywhere. Cubes of size 70.7 mm are cast and cured. These are tested in compression at the end of 7days, and 28 days till failure occurs.

References: - IS: 4031-1988

IS: 12269-1987

Procedure

The compressive strength of cement test is followed by IS 4031-1988.

Mix Proportion:-Cement : Sand = 1 : 3

W/C ratio = 0.4

Figure No.2 Mortar cubes

Observation Tables

Table 6.3 :- Mortar cube prepared by NW

Sr. no	Cube	Age of cube days	c/s of cube section (mm^2)	Maximum load (n)	Compressive strength (N/mm^2)	Avg. compressive strength (N/mm^2)
1.	1	7	4998.49	123.86	24.78	25.36
	2	7	4998.49	127.76	25.56	
	3	7	4998.49	128.71	25.75	
2.	1	28	4998.49	178.69	35.71	33.49
	2	28	4998.49	164.85	32.98	
	3	28	4998.49	158.95	31.80	

Table 6.4 :- Mortar cube prepared by PTWW

Sr. No	Cube	Age Of Cube Days	C/S Of Cube Section (Mm^2)	Maximum Load (KN)	Compressive Strength (N/Mm^2)	Avg. Compressive Strength (N/Mm^2)
1.	1	7	4998.49	109.81	21.97	22.44
	2	7	4998.49	115.16	23.04	
	3	7	4998.49	111.51	22.31	
2.	1	28	4998.49	158.60	31.73	30.63
	2	28	4998.49	148.40	29.69	
	3	28	4998.49	152.30	30.47	

Table 6.5 :- Mortar cube prepared by STWW

Sr. No	Cube	Age Of Cube Days	C/S Of Cube Section (Mm^2)	Maximum Load (KN)	Compressive Strength (N/Mm^2)	Avg. Compressive Strength (N/Mm^2)
1.	1	7	4998.49	125.21	25.05	25.40
	2	7	4998.49	126.36	25.28	
	3	7	4998.49	129.31	25.87	
2.	1	28	4998.49	189.69	37.95	36.09
	2	28	4998.49	174.39	34.89	
	3	28	4998.49	177.39	35.49	

6.3 Test Carried Out On Concrete

6.3.1 Workability

Introduction

In general terms workability of a freshly mixed concrete means the ease with which it can be compacted. It represents the amount of work to be put in to overcome the internal friction & achieve full compaction of concrete. Workability cement is affected by chemical composition of cement, amount of cement, size & shape of aggregates, quantity of water used etc. The major factor is the quantity if water used. Excess use of water will facilitate easy placement & adversely affects the strength of concrete. The degree of workability depends on several factors like method of mixing, method of compacting, size & shape of structure, amount of reinforcement in R.C.C etc.

Reference

IS 1199-1959 - methods of sampling & analysis of concrete.

IS 7320-1974 m - Specification for concrete slump test apparatus.

6.3.2 Compressive strength of concrete

Introduction

Cement concrete is widely used in a variety of structures. Compressive strength is the most important property of concrete. It varies with properties & grading of aggregate, water cement ratio, method of mixing, transportation & compaction, method & period of curing etc.

Reference:- **IS 516 -1959.**

Procedure

The test procedure is followed by IS 516 - 1959.

Observation Table

Table 6.7:- Cubes prepared by mixing NW

Sr. No	Cube	Age Of Cube Days	C/S Of Cube Section (Mm^2)	Maximum Load (KN)	Compressive Strength (N/Mm^2)	Avg. Compressive Strength (N/Mm^2)
1.	1	7	22500	425	18.88	18.58
	2	7	22500	420	18.66	
	3	7	22500	410	18.22	
2.	1	14	22500	480	21.33	21.48
	2	14	22500	495	22	
	3	14	22500	475	21.11	
3.	1	28	22500	610	27.11	27.33
	2	28	22500	615	27.33	

	3	28	22500	620	27.55	

Observation Table

Table 6.8 Cubes Prepared By PTWW

Sr. No	Cube	Age Of Cube Days	C/S Of Cube Section (Mm^2)	Maximum Load (KN)	Compressive Strength (N/Mm^2)	Avg. Compressive Strength (N/Mm^2)
1.	1	7	22500	300	13.33	14.44
	2	7	22500	350	15.55	
	3	7	22500	325	14.44	
2.	1	14	22500	400	17.77	18.96
	2	14	22500	450	20	
	3	14	22500	430	19.11	
3.	1	28	22500	550	24.44	24.81
	2	28	22500	525	23.33	
	3	28	22500	600	26.66	

Observation Table

Table 6.9 Cubes Prepared By STWW

Sr. No	Cube	Age Of Cube Days	C/S Of Cube Section (Mm^2)	Maximum Load (KN)	Compressive Strength (N/Mm^2)	Avg. Compressive Strength (N/Mm^2)
1.	1	7	22500	450	20	22.22
	2	7	22500	550	24.44	
	3	7	22500	500	22.22	
2.	1	14	22500	600	26.66	27.4
	2	14	22500	580	25.77	
	3	14	22500	670	29.77	
3.	1	28	22500	700	31.11	33.55
	2	28	22500	750	33.33	
	3	28	22500	815	36.22	

7.1 Result And Disscusion

The experimental investigation shows the following results

1) Treated waste water

The results for water analysis are provided in table no. 4.7. An experimental investigation shows that there are significant difference in analyzed parameters

i.e. pH, Alkalinity, Hardness, TSS etc. The pH of PTWW, STWW, GW and TW is above 6. So it is as per guidelines provided in IS 456: 2000. The TSS of PTWW, STWW, GW and TW is less than 2000 mg/l which is within given limits in IS 456: 2000. BOD and COD of PTWW, STWW, GW and TW is within the desirable limit.

2) Consistency of cement paste

Figure no. 10 shows the result for consistency of cement. As the quality of mixing water deteriorates it affects the consistency of cement. The consistency of cement paste using STWW increases by 1.785% as compared to TW. The consistency of cement paste using PTWW and GW is more than STWW. As per IS guidelines consistency of cement is 24 – 30 % of cement. So the results obtained are within the permissible limits.

Standard consistancy of cement

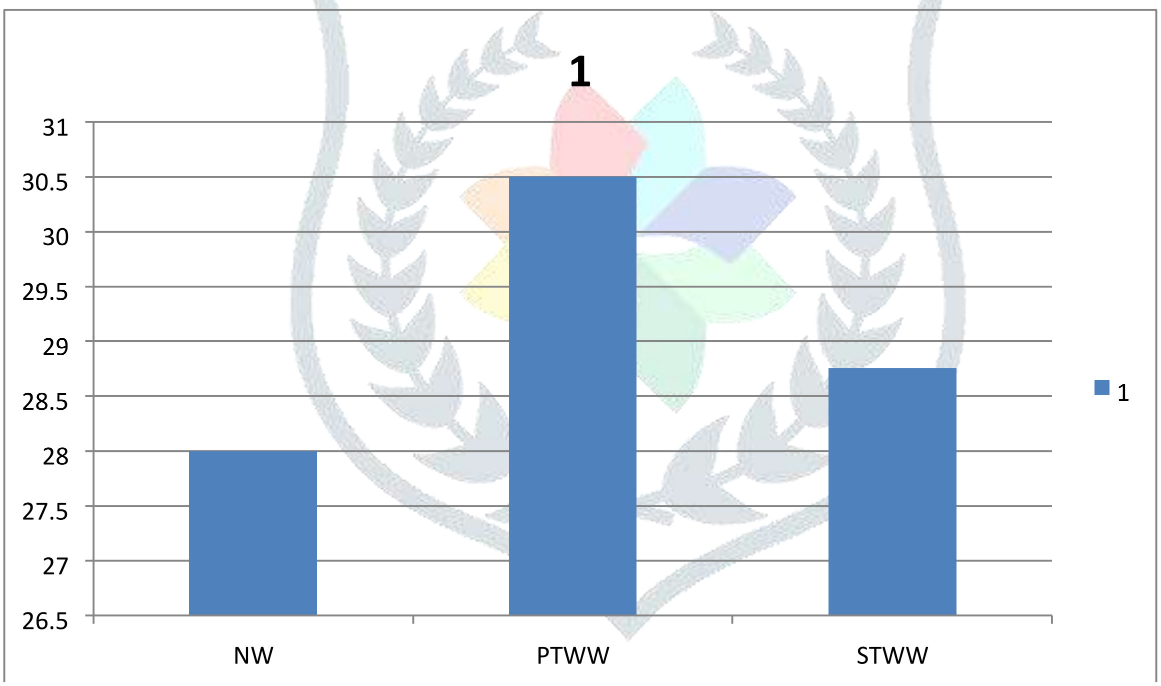

Figure No. 05 Standard consistency of cement

3) **Initial and Final setting time of cement**

The effect of type of mixing water on setting time is shown in figure nos. 11 and 12. As the salt present in water it affects the time of setting and the dissolved organic matter retards the time of setting. The initial setting time of cement paste is increased by 5.88% for STWW as compared to TW. The initial setting time of cement paste for PTWW and GW is more than STWW. As per recommendation of IS standard the initial setting time should not be less than ±30 min and final setting time should be less than 600 min given in IS 456 : 2000. The initial and final setting time of cement paste is as per guidelines recommended by IS 456: 2000.

Final setting time of cement

Figure No. 06 Final setting time of cement

4) Compressive strength of mortar cubes compressive strength of mortar cube by mixing STWW for 7 days is near about same as TW. Compressive strength of mortar cube prepared with STWW shows improvement in the strength by 7.76% as compared to TW for 28 days. The mortar cubes prepared with PTWW and GW shows decreasing results as compared with TW. The result suggested that the organic content present in STWW may be acting as a dispersing agent, improving the dispersion of particles

5) Compressive strength of concrete

The figure no. 11 shows the effect of mixing waste water in concrete on compressive strength of concrete for 3 days, 7 days, 28 days and 60 days(Assumed).The compressive strength of concrete is increased by 2.37% for STWW at end of 60 days(Assumed) as compared to TW. The strength gained is slower but at the end of 60 days(Assumed) it is more than TW. PTWW contains more algae content and thus reduce the strength of concrete.

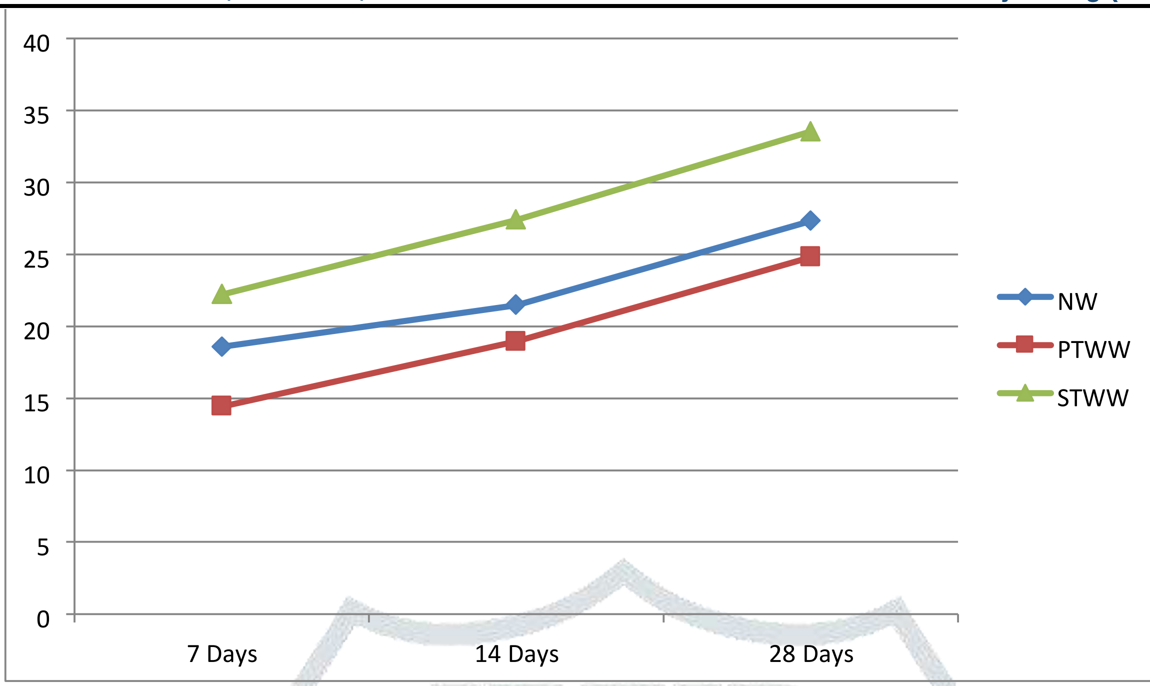

Fig. No.07 Compressive Strength Of Concrete

8.1 Conclusion

From this experimental investigation we conclude that

1) STWW is most suitable water sample as use of ingredients of concrete. STWW contain less impurities and fits in norms of Indian Standard.

2) Reaction of Bogue's component and STWW is normal as taking place while use of portable water.

3) Use of STWW doesn't carry any changes on properties of concrete i.e. Consistency, Initial Setting Time, Final Setting Time and Workability. All above properties are within limit. The impurities which are disposable may reduce the strength but the STWW also contains some impurities which are not disposable and can be used as strength gainer.

4) Compressive strength of mortar cube prepared with STWW shows improvement in the strength by 7.76% as compared to TW for 28 days.

5) The rate of compressive strength of concrete gaining is initially slow while it gains more strength at 28 days and 60 days(Assumed) than normal water used. Due to some suspended solids which are present in the water which may help for gaining the strength at the later stage as initially they are wet they may not help for gaining strength but as it dries it comes into account for gaining the strength.

6) STWW is Techno Economical ingredient because STWW is resulting 2.37% more strength than normal water used at 60 days and STWW is economical than normal water. So as the result shows not only it can be replaced for the strength gain as potable water but also it increases the strength than the potable water so it is an alternative for normal water.

From this possible outcome and contributions of this research are : to minimize the need for the use of potable water, eliminate the need to expand potable water, supply for use in concrete industry, minimize the need to construct more water treatment possibility, save the potable water for drinking purpose, make sewage treatment plant become more economically attractive by reusing water before its final treatment and other similar goals towards Sustainable development.

8.2 Future Scope

Future work to be performed will include the intensive laboratory experiments.

1)The reinforcement should be provided with different cover of concrete.

2) The preparation of concrete for different grades concrete like M40, M45, M50 etc. for more accurate results.

3) The concrete preparation by adding different admixtures so that effect of admixtures on the properties of concrete can be determined.

4) Different samples of STWW from different water treatment plants can be used for acquiring more accurate results.

5) Preparation of more cubes for durability purpose by preparing cubes for
90 days, 6 months

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3. IS: 9399-1979:-Specification for flexure testing of concrete.

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