UTILIZATION OF WASTE WATER IN CONCRETE: A REPLACEMENT OF POTABLE WATER

Submitted in partial Fulfillment of the requirements

of the degree of

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by

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LOVELY PROFESSIONAL UNIVERSITY, PHAGWARA

2017

DECLARATION

I, Gagandeep Singh (41400030), hereby declare that this thesis report entitled **"UTILIZATION OF WASTE WATER IN CONCRETE: A REPLACEMENT OF POTABLE WATER "** submitted in the partial fulfillment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

Date: 27/05/2017 **Gagandeep singh**

Place: Lovely Professional University

CERTIFICATE

Certified that this project report entitled **"UTILIZATION OF WASTE WATER IN CONCRETE: A REPLACEMENT OF POTABLE WATER"** submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara , carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

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ABSTRACT

In construction industry, the cement concrete is most important and widely used material .The concrete is mainly the mixture of cement, sand, coarse aggregates and water in a mix proportion. The strength of concrete is more in the hardened state. Concrete is preferred more in the construction industry due to its mould ability property and also it is easy in manufacturing. For manufacture and curing of concrete, water plays the part of essential constituent. The main sources of water are river, lake, pond and well water etc. Due to rapid growth of industrialization and construction , water is depleting day by day. Hence, we must take one step forward towards conservation or reuse of water in the construction industry. By reusing or recycling the water or waste water in construction industry we can minimize water scarcity problem and wastewater disposal problem. The major sources of waste water is from domestic, industrial and commercial area .In the construction industry water is required in a huge amount as a curing waters for cement concrete structures. so an attempt has been made to study the effect of untreated algae, kitchen and garage wastewater on the strength characteristics of cement concrete as curing water's. For the present study the dissertation work is carried out on M20 grade of concrete, the curing of these specimens was carried out by using primary and secondary treated Wastewater for a period of 28 and 60 days. An attempt is made to study the strength characteristics of M20 grade of concrete. This study will motivate and help for utilization of wastewater in the construction industry. Hence we can reduce the water scarcity problems and also reduce the usage of Potable water in the construction industry.

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LIST OF ABBREVIATIONS

%	Percentage
MSW	Municipal solid waste
TDS	Total dissolve solid
TSS	Total suspended solid
TS	Total solid
mg/l	Milligram per liter
EDTA	Ethylene dia-amine tetra acetate
EBT	Eri-chrome black T
BIS	Bureau of Indian Standard
MLD	Million Litres Per day

Chapter 1
Introduction

1.1 General

1.2 Water and its Crisis:-

India has the second largest population in the world. One concern is that India may lack the quantity of water in long term. While India's aquifers are currently associated with replenishing sources, the country is also a major grain producer with a great need for water to support the commodity. As with all countries with large agricultural output, excess water consumption for food production depletes the overall water table.

1.3 Waste Water Generation:-

Sewage is a part of city sewage which means waste water that is discarded from households. It may also be referred as sanitary sewage; this water contains a wide variety of dissolved and suspended impurities and may cause many disorders. One of the primary causes of environmental degradation in a country could be attributed to rapid growth of population, which adversely affects the natural resources and environment. It is a fact that if water is used there will be waste. So the waste water generation will never stop. 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. Therefore, increasing the awareness of use of wastewater in the Reinforced Cement Concrete is necessary which will ultimately prevent the scarcely available potable water.

1.3.1 Waste Water Generation in Jalandhar City:-

Jalandhar Municipal corporation has 500 Tubewells installed in the city serving 1,90,000 house holds and commercial places. All tubewells are deep bore working for 10 Hrs each day. Total sewage generated in Jalandhar city is calculated in table below:-

Table – 1:- Total sewage generated in Jalandhar City.

Total Sewage Generated under MC limit of Jalandhar City			
SR No.			
1	Total Discharge of Tubewells run by MCJ		
1(a)	Total No. of Tubewells	500 No.	
1(b)	Average Discharge per Tubewell	1000 LPM	
1(c)	Total working hours per Day	10 Hrs	
	Discharge= 500X1000X60X10/1000000=300 MLD		
		Discharge	**300 MLD**
2	Avg. Discharge of Tubewells run by Private Org.=15% of 300 MLD	(approx.)	**45 MLD**
		Total Water Supply Discharge	**345 MLD**
3	**Total Sewage Generated = 85% of 345 MLD**		**293 MLD**

1.3.2 Present condition of Waste Water Treatment in Jalandhar city-

According to Municipal Corporation Jalandhar they have 500 Tube wells in municipal limit and the waste water generated in city is about 293 MLD that is 293 million litres per day.

Table -2:- Details of sewage Treatment plant in Jalandhar is listed above with their Capacities

Jalandhar STP Data				
Sr No.	**Zone No.**	**Location**	**Capacity**	**Technology**
1	1	Pholriwal	100 MLD	UASB
2	1	Pholriwal	25 MLD	SBR
3	1	Pholriwal	25 MLD	SBR
4	2	Basti Peer Dad	50 MLD	SBR
5	3	Jaitewali	25 MLD	SBR
6	4	Bambianwali	10 MLD	SBR
	Total 6 No. STP		**235 MLD**	

In this :-
MLD = Million Litres Per Day.
UASB = Up flow Anaerobic Sludge Blanket Technology.
SBR = Sequential Batch Reactor Technology

1.3.3 Source of Waste Water for Project Report:-

The waste water is the mixture of both domestic as well as pre-treated industrial waste water.

Table -3 showing the percentage of type of sewage in city

Sr No.	Type of Waste Water	Percentage of Compostion
1	Domestic	80%
2	Industrial	20%

1.4 Characteristics of Waste Water- In order to identify the exact characteristics of Municipal Waste Water, it is necessary that we analyze those using physical and chemical parameters. The Physical Properties that are essential to analyze wastes disposed in sewer are Colour , Odour , Temperature. Knowledge of the classification of chemical compounds and their characteristics is essential for the proper understanding of the behavior of Waste Water, as it moves through the Sewage Treatment Plant.

Chemical Characteristics of Waste Water are listed Below:-

Table – 4 showing average results of chemical characteristics of waste water

SrNo.	Parameters	Average
1	pH	7
2	TSS	750 mg/l
3	Total Phosphate	1.95 mg/l
4	Total Kjeldhal Nitrogen	35 mg/l
5	Ammonical Nitrogen	30 mg/l
6	Sulphate	14 mg/l
7	Chemical oxygen Demand	600 mg/l
8	Biochemical Oxygen Demand	250 mg/l

1.4.1 Physical characterization of Waste Water:-

Turbidity- Waste Water is generally turbid. It consist of many suspended impurities like fecal matter, grease, soap etc. The degree of turbidity can be measure with nephelometer.

Colour- the colour of the waste water can be directly detected by naked eye. Generally waste water is a very dark coloured. The decomposition of organic matter may change the colour of waste water to brown and yellow depends upon humic acid production.

Odour- waste water is having very pungent smell because of anaerobic decomposition. Generally top layer of waste water is in contact with air so it is having aerobic decomposition and bottom layers under anaerobic decomposition which gives foul smell.

Temperature- Temperature has an effect on biological decomposition of waste water and it also affects the solubility of gases. Basically seasonal variation changes the characteristics of waste water and time to time it varies. Temperature is the major factor which affects the characteristics of waste water.

1.4.2 Chemical characteristics of Waste Water - The chemical composition of waste water tell us about the composition of waste water which consist of total solid, total dissolve solids and volatile solids etc. the following parameters are chemical characteristics of Waste Water are given below-

1. Total solid, suspended and dissolve solids
2. pH value
3. Hardness
4. Conductivity
5. Sulphate ion concentration
6. chloride content
7. Nitrogen content
8. Dissolve oxygen
9. Chemical oxygen demand (COD)
10. Biochemical oxygen demand (BOD).

1) **Total solid, suspended solids and dissolve solids-** Generally waste water consists of high amount of Solids. Typically it is found in many forms. These are total suspended solids, total dissolved solids and colloidal solids. Suspended solids are those solids which remain floating in the waste water. Dissolve solids are those which remain dissolved in waste water. Colloidal solids are fine particles which remain in solution either suspended.
2) **pH value**- pH value generally indicate the acidic and basic nature of waste water. pH value indicates the negative log of hydrogen ion concentration present in the waste water. Thus it is indicator of alkalinity. If the pH value is less than 7 then it is acidic in nature if it is greater than 7 then it is basic in nature.

3) **Hardness-** hardness is due to presence of calcium and magnesium ions. Measurements of hardness will give the concentration of magnesium and calcium ions in the sample. Generally hardness is measured with the help of volumetric method. EDTA method is used for determination of hardness. Generally it is expressed in mg/l.

4) **Conductivity**- the ability of the material to conduct the electricity due to presence of cations and anions is known as conductivity. Conductivity is calculated as the ratio of the current density in the material to the electric field applied which cause for electric flow. Conductivity is measured in μς (micro mhos). Generally waste water is having high value of conductivity due to presence of minerals.

5) **Sulphate ion concentration**- Waste water is consisting of organic matter which includes the sulpher. During decomposition it starts oxidizing and converted into sluphide and sulphate and hydrogen sulphide gas. It gives bad odour and smell. Its concentration in waste water can be measured with colorimeter in mg/l.

6) **Chloride content**- generally chloride is present in waste water and it is driven from kitchen waste and from bathroom waste. It starts oxidised and found in different form in waste water.

7) **Nitrogen content-** nitrogen is present in organic matter and it comes from residential waste water. During decomposition it founds in four different forms ie. free ammonia, organic ammonia, nitrites and nitrates.

8) **Dissolve oxygen**- the amount of oxygen which is present in dissolve state in waste water is known as dissolve oxygen. Generally DO is in very less amount in waste water because its maximum amount is utilized for waste decomposition.

9) **Chemical oxygen demand-** it is a measurement of the oxygen required to oxidize soluble and particulate organic matter present in solid waste. This is the total oxygen required for biologically active and inactive material. Generally waste water is having high value of COD.

10) **Biochemical oxygen demand-** it is the measurement of oxygen required for biologically active matter. Generally BOD is calculated for 5 days at 200C and taken as a standard demand and it is about 68% of the total demand.

1.5 Basti Peer Dad sewage treatment plant:--

Municipal Sewage Treatment plant is divided into several processes. These are Pumping of Sewage , primary treatment , secondary treatment , chlorination and diposing of treated water in drain.

1.5.1 Waste generation source-

Generally waste water is generated form city households and from industries . On the basis of source waste water are of following types-

1) Industrial waste water = 20%
2) Domestic waste water = 80%

These are the main sources from where waste water is generated and disposed into sewer and collection ponds. An average of 50 Million Litre waste water is generated on the daily basis.

1.5.2 Collection by MPS (Main Pumping station)-

Main Pumping station comprises of 4 horizontal slow speed motors of 75HP each .

1.5.3 Primary Treatment- primary treatment is done by two screen chambers one is of 20mm opening size and another is of 6mm opening size and then grit chambers are used to remove grit from waste water.

1.5.4 Secondary Treatment – secondary treatment is done in a technology based names as Sequential Batch Reactor in which artificial oxidation is done to reduce biological oxygen demand as it is a aerobic process.

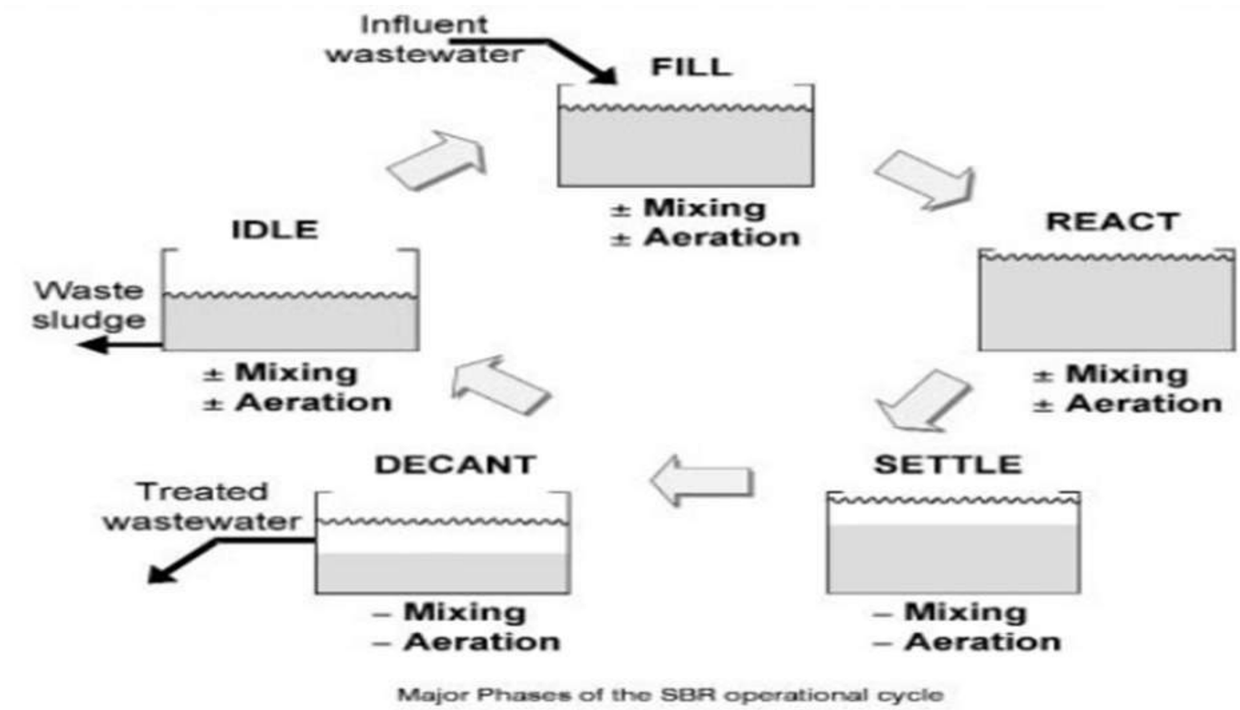

Fig-1- :- showing the process of STP based on SBR Technology.

1.5.5 Results:-

Table – 5 :- Showing Results of the samples taken after Primary and Secondary treatment of waste water are listed below:-

Primary Treated waste water :-

SrNo.	Parameters	Results
1	Ph	7.01
2	Temperature	25.1 degree Celsius
3	Dissolved Oxygen	0.5 mg/l
4	Total Suspension Solids	666 mg/l
5	COD	660 mg/l
6	BOD	250 mg/l
7	Total Kjeldhal Nitrogen	45 mg/l

Secondary Treated Waste Water :-

SrNo.	Parameters	Results
1	pH	7.30
2	Temperature	24.9 degree Celsius
3	Dissolved Oxygen	5.4 mg/l
4	Total Suspension Solids	12 mg/l
5	COD	44 mg/l
6	BOD	6 mg/l
7	Total Kjeldhal Nitrogen	10 mg/l

1.5.6 Samples taken from Basti Peer Dad STP were tested from Thapar laboratory named as Sophisticated Analytical Instruments Laboratories Society in October month of 2016 .

Sophisticated Analytical Instruments Laboratories Society *(Registered as Society with Registrar of Firms & Societies, Punjab, Chandigarh)*

Thapar Technology Campus, Bhadson Road, Patiala-147 004 (India)

TEST REPORT

Test Report No.:	NN/16-17/187	Date:	28.10.2016
Service No.	NN/16-17/187 (01-02)	Customer's Ref.	Sample Submitted by M/s Gondwana Engg. Ltd. dtd 25.10.2016

Customer's name and address:

M/s Sub Divisional Engineer
Pb. W/S & Sew Sub Div. No. 1
Jalandhar.

Sample Description	Effluent
Condition of the sample received	O.K.
Customer's sample identification No. (if any)	50 MLD STP at Basti Pir dad Jalandhar 01- Inlet 02- Outlet
Quantity/number of samples	Two
Sampling Procedure (if any)	--
Test parameters	01 & 02- pH, COD, BOD, TSS, Total Phosphate, TKN, Ammonical Nitrogen, Sulphate, Faecal Coliform
Standard/Specification/Method followed	APHA 22nd Edn., IS: 3025
Deviations (if any)	--
Documents constituting this report (if any)	--

Date of Receipt of Job	Date of Completion of Job	Total Number of Pages
25.10.2016	28.10.2016	1

TEST RESULTS

S. No.	Parameters	Test Method	Unit	Results	
				01	02
1	pH	APHA 22nd. Edn.4500-H+B	---	7.0	7.8
2	Chemical Oxygen Demand (COD)	APHA 22 Edn. 5220B	mg/l	492	33
3	Biochemical Oxygen Demand for 3 days at 27°C (BOD)	IS: 3025 (Part 44)-1993, Reaffirmed May, 2009	mg/l	191	<5.0
4	Total Suspended Solid (TSS)	APHA 22nd. Edn.2540-D	mg/l	22	<10
5	Total Phosphate as P	APHA 22nd. Edn. 4500-PC	mg/l	1.97	0.23
6	Total Kjeldahl Nitrogen as TKN	APHA 22nd. Edn. 4500 N_{org} B	mg/l	34.8	6.41
7.	Ammonical Nitrogen as N	APHA 22nd. Edn. 4500 NH_3N	mg/l	29.3	1.57
8.	Sulphate as SO_4	APHA 22nd. Edn.4500SO_4^{-2}C	mg/l	12	<10
9.	Faecal Coliform	APHA 22nd. Edn.9221 E	Faecal Coliform/100ml	>1600	<1.8

.....end of the report...

Dr. A. Rajor
Verified by:
(I/C, Microbiological Lab)

S. Chandra
Head, SAI Labs
(Authorized Signatory)

Note:
1. The results listed refer only to the tested samples and applicable parameters. Endorsement of products is neither inferred nor implied.
2. Samples will be destroyed after one month from the date of issue of the test report unless otherwise specified
3. This report is not to be reproduced wholly or in part and cannot be used as an evidence in the products is neither inferred nor implied. court of law and should not be used in any advertising media without special permission in writing.
4. In case any reconfirmation of contents of the test report is required, please contact the authorized signatory of the test report within 15 days of the issue of test report

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URL: www.sailabs.org

1.5.7 Pictures of Treatment Plant Basti Peer Dad 50 MLD capacity:-

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Fig-2 :- STP basin in which aeration and filling is going on

Fig-3 :- STP basin in which settling is taking place.

Fig-4 :- showing beakers of samples
1st beaker = primary treated water sample
2nd beaker = secondary treated waste water

1.6 The Parameters limit recquired for cement concrete cube test as per IS 456:2000 is shown below:-

For cubes which are mixed with potable water as per Indian specification:-

Grade of concrete selected for design mix is M20:-

1) Compressive strength of M20 concrete 150mm cube after 28 days = 20N/mm sq.
2) Type of cement = OPC 53 grade
3) Maximum nominal aggregate size = 20mm
4) Water cement ratio = 0.5
5) Workability by Slump test = 25mm
6) Chemical admixture = Super plasticizer conforming to IS-9103

Definitions:-

- Compressive Strength = is the capacity of a cube or structure to withstand loads tending to reduce its size.
- OPC = Ordinary Portland cement
- Water cement ratio = water cement ratio is the ratio of the weight of water to the weight of cement. A lower water cement ratio means high strength and durability.
- Workability = the concrete can be said workable if it can be handled without segregation. Workability can be calculated by slump test.
- Chemical admixture = chemical admixtures are used mainly as air-entraining admixtures or water reducers

Fig-5 :- showing preparation of concrete cubes for testing.

Fig-6:- Showing apparatus for Slump test.

Fig-7 :- showing apparatus for testing compressive strength of concrete cubes.

1.7 Back ground of the project-

Jalandhar is a district of the Punjab state of India the oldest city and it has seen rapid urbanization and developed into a highly industrialised centre of commercial activity in recent years. According to the latest census of India held in 2011-12, population of Jalandhar city is 8.74 lakhs. The map showing the location of plant and sewage network in Jalandhar is shown below:-

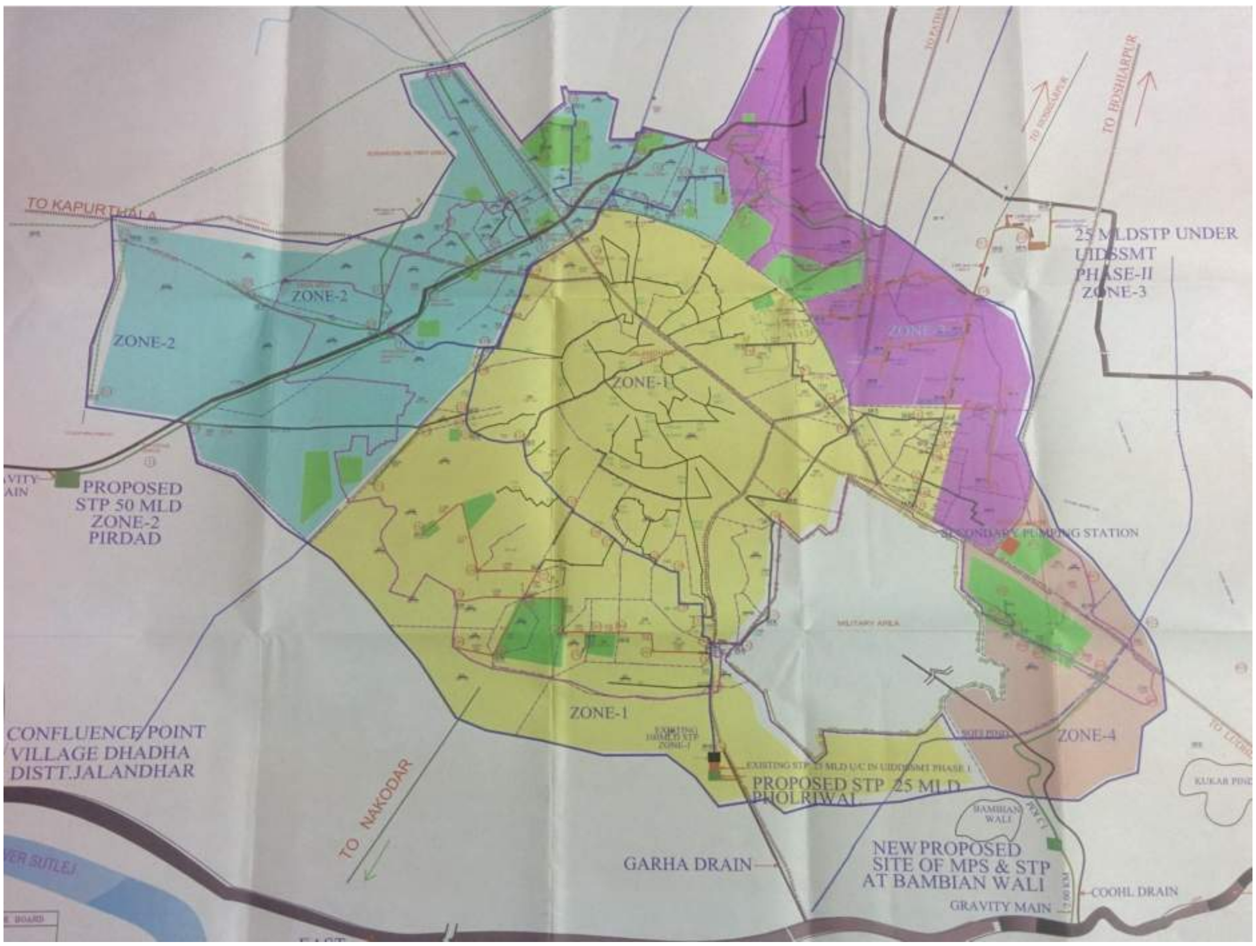


Fig-8:- Jalandhar map showing STP site.

1.8 Need of the project

The need of a sustainably developed and environmental friendly concrete is aggravated by population growth and scarcity of water. And it is expected that the water demand will have an increasing trend to leading the water recycling and conservation as a necessity. Shortage of water is perhaps the most critical environmental problem in several countries. Freshwater accounts for only 2.5% of the Earth's water, and most of it is frozen in glaciers and ice caps. The remaining unfrozen fresh water is mainly found as groundwater, with only a small fraction present above ground or in the air. The quality of the mixing water plays a significant role in the concrete. The concrete industry alone uses over one trillion gallons of water each year worldwide, not including wash water and curing water. In addition, the use of water for industrial purposes increases in proportion to a country's GDP (gross domestic product). From 10% in the low-income and medium-lower income countries, it increases to 59% in high-income countries. Therefore it is essential to conduct research of substitution of potable water by reclaimed water partially or totally to produce concrete.

1.9 Objective of the project- According to the need of the project there are some objectives/ aim of the project. These are mentioned below –

1) USE OF PRIMARY AND SECONDARY TREATED WASTE WATER IN CONSTRUCTION.

2) TO CHECK VARIOUS PARAMETERS OF PLAIN CONCRETE AND REINFORCED CONCRETE MIXED WITH PRIMARY AND SECONDARY TREATED WASTE WATER.

   VARIOUS PARAMETERS ARE :-

   A) COMPRESSIVE STRENGTH
   B) WORKABILITY
   C) SETTING TIME

3) TO CHECK THE RATE OF COROSSION OF STEEL IN REINFORCED CONCRETE WITH INCREASING AGE.

1.10 Scope of the project -

The present scope of the project is to minimize the use of potable water used for making concrete and to use waste water treated after different processes in ready mix concrete with different proportions and the to check different characteristics and parameters of cement concrete cubes.

Literature review

Management of waste water for various cities and towns has been widely studied throughout the world. As the huge quantities of waste water is generated in urban areas. Majority of researchers concentrated on this issue. Numbers of researchers have tried to find out new techniques for the use waste water in concrete and its check on strength. This report represents a review of the available literature on utilization of waste water, characteristics of waste water and characteristics of concrete after utilization in India and in other countries.

Asif Rashid Shaikh et al. (2016) had a research on the topic "Study of Utilization of waste water in concrete" and concluded that With the comparison of potable water cement concrete and treated waste water cement concrete both gives nearly the similar results. Now a days as we know that there is scarcity of water, Therefore we need to arrange other source of water for concrete in construction of buildings . This treated waste water which is draining in canals or rivers can be used in concrete.

Vivek Thakur et al.(2016) had a research on the topic "Effect of treated wastewater on compressive strength and permeability of M25 grade of concrete" and have concluded that For M25 grade of concrete the permeability values are lowest for 100% treated waste water. The compressive strength results for M25 grade with 100% treated waste water are higher with respect to its target mean strength as per design mix. According to the test results, the use of treated waste water can be recommended for the use in Plain cement concrete also.

Vidhya lakshmi.A et al. (2016) had done a review on the topic "Secondary treated wastewater in construction" and have concluded that tests performed in this study suggest that secondary treated wastewater is an interesting sample for use in concretes for applications in the mixture. There is an increase in the load carrying capacity, the compressive strength of the secondary treated wastewater concrete when compared with the potable water concrete. The compressive strength is 9.62% more in case of concrete cubes confined with secondary treated wastewater. Concrete prepared by using secondary treated wastewater gives aesthetic appearance. It is found that the compressive strength and tensile strength in secondary treated wastewater concrete increases when compared with the potable water concrete.

Abdul Razak.B.H et al.(2015) had a review on the topic "Experimental investigation on usage of gray water in concrete production" and concluded that there is a decrease in the workability of concrete using primary treated water whereas secondary treated water gave better workability to concrete. There is no significant difference in the compressive strength value of concrete made using primary treated water, secondary treated water and potable water.The tensile strength of concrete made using sewage treated water was found to be lesser compared to that of potable water. Considerable construction cost can be reduced by utilizing the treated water for plain cement concrete.

Chetan S Chavan et al. (2015) had a review on the topic "Feasibility of use of wastewater in reinforced cement concrete – A sustainable approach" and then concluded that study aims at increasing the awareness of use of wastewater in the Reinforced Cement Concrete which ultimately prevent the scarcely available potable water. At the end of this study we will find the accelerated rate of corrosion which will increase due to use of wastewater in Reinforced Cement Concrete. Further extension of study will be to find remedial measure to decrease the rate of corrosion to acceptable limits.

Rajesh T Peche et al. (2015) had a research on the topic "Influence of gray water as mixing water on properties and strength of cement" and have concluded that Considering huge and perennial availability of grey water has a potential to fight against scarcity of water. The types of grey water used, met the standards of mixing water as mentioned in various codes. Grey water should be disinfected before use to avoid health risks to people at work. Compared with tap water lesser amount of grey water is required to attain consistency of cement. Soundness of Grey water mixed cement paste is almost same to that of tap water cement paste. Grey water reduces the initial and final setting time but that reduction is marginal and still within the prescribed limits. Cement mixed with Grey water has more compressive strength than the cement mixed with tap water.Increase in compressive strength may be due to the presence of higher soaps, detergents and surfactants in grey water.

Pritam Patil et al. (2015) had a detailed research on the topic “Study of the effect of untreated algae,kichen and garage waste water on strength characteristics of concrete as curing water” and have concluded that from test results we came to know that kitchen wastewater used for curing of concrete structures shown considerable increase in a compressive strength compared to algae, garage and potable curing water’s for a period of 28 and 60 days. Also kitchen wastewater used for curing of concrete structures shown considerable increase in a tensile strength test compared to algae, garage and potable curing water’s for a period of 28 and 60 days. Algae wastewater used for curing concrete structures has shown considerable increase in a flexural strength compared to kitchen, garage and potable curing water’s for a period of 28 and 60 days.

EW Gandzama et al. (2015) had a research on “Effects of sugar factory waste water as mixing water on the properties of normal strength concrete” and concluded that there is a delay in the setting time of the cement mix using wastewater, the delay increase with an increase in the percentage of mixing wastewater. Concentrations of metallic elements as measured from the wastewater and compared with that of portable water revealed that Zinc, Lead and Sodium were within the range of WHO standard and the wastewater had a pH that is acidic, outside the quoted standard. Positive volume change as much as 3.03% was observed and measured using a digital meter. Target strength at 28 days was not met, but it ranged from 83% - 91%, however, when
the curing duration was extended to 90 days, the concrete cubes produced strength that
surpassed the target strength.

G.Murali et al.(2012) in their paper named as "Influence of various industrial effluents on concrete structure "and has concluded that due to increase in population with urbanization results in the scarcity of water and due to industrialization the waste water is being generated in a large amount. So, for the utilization of this waste water measures should be taken . An attempt has been done in utilization of this industrial waste in construction industry. The Concrete blocks of M25 grade has been molded and used for strength analysis, so indicating that these effluents can be used in the curing sector of construction industry.

Marcia Silva et al.(2010) Studied the effect of usage of sewage treated water in preparing mortar.The study revealed that significant difference do not exixt between mortar cube made of potable water versus sewage treatment plant water.

Giaou Leong et al. (2008) had written a research paper named as *"*Use of RMC waste water as curing water*"* and has concluded that they used a waste water product from the RMC plant for the purpose of curing of concrete for the period of 14 and 28 days after this curing period they did the test on the strength of concrete and they got an desirable values on the compressive, split tensile and flexural strength of concrete compared to the curing with portable water for the same period.

Semsi Yazici et al. (2008) studied the "Effect of elevated temperature and time, on the mechanical behavior of concrete "and process was that the concrete mixtures are produced using two different water/cement ratios; 0.4 and 0.6 with standard 28 days curing. After standard curing period, specimens are dried in a furnace at 105 degree Celsius for 4hrs. Then the specimens are kept in laboratory for 1 day with different exposure temperatures 300oC, 600oC and 900oC for 1 to 3 and 5hrs. Then compressive strength and split tensile strength are determined. It was concluded that, compressive strength and split tensile strength of specimens are reduced after the high temperature and time exposure. Compressive strength increases with lesser water to cement ratio.

G. L. Low et al. (2007) studied the behavior and usage limit of recycled cement based slurry water for concrete making. The study concluded that concrete produced with slurry water was able to meet the performance criteria in terms of compressive strength, setting time and drying shrinkage when specific gravity of the slurry water used was less than 1.03

Pavita. G et al. (2002), in her paper entitled "Effect of copper slag waste water on the mechanical properties of concrete" studied the effect of copper slag waste water used for curing of concrete by 40% replacement with waste water. She reported that there is a increase in the compressive and flexural strength but there is decrease in the tensile strength and also the setting time was beyond the limit. The workability and durability of the concrete gives the better result.

Suresh G Patil et al. (2001) in their paper "Use of Domestic waste water as curing waters" has concluded that they used a Domestic waste water as curing water's for M20 grade concrete for a period of 7, 14 and 28 days. After curing for 14 and 28 days, they got a minimum increase in the Compressive strength, Split tensile strength and Flexural strength. But for 7 days of curing period they got an 1.12% decrease in the Compressive strength, 5.32% decrease in Split tensile strength and 6.52% decrease in Flexural strength.

Leigh M. Mcharthy et al. (2001) submitted a thesis titled "Analysis of alternative water sources for the manufacture of concrete". The report concluded that even a simplest purifying process provides water suitable for manufacture of concrete from wash out water. These results were compared to a series of alternative water sources. The water sources included treated effluent, sea water and dam water and were subjected to same testing parameters as the reference. Analysis of these results found that despite having higher levels of organic and inorganic properties, the water from these sources was found suitable for manufacture of plain concrete.

Cebeci et al. (1989) reported on the "Use of both treated and raw wastewater in concrete mixing" Treated wastewater was not shown to have an adverse effect on concrete. However, raw sewage reduced the 3 and 28 day compressive strength by 9%. Thus, the average raw domestic sewage was shown to increase the initial setting time, entrain air and reduce the strength of mortar and concrete

Tay et al. (1987) had written a review paper on "Use of Waste Water in Concrete Mix". They made an attempt to use waste water in concrete mix instead of portable water and they mixed the waste water in various proportions such as 0%, 25%, 50% and 100% to cast the cubes of mix proportion 1:2:4 and after this they studied on long and short term effect of concrete. But after 28 days they got an compressive strength of 1.5% increase then by using with portable water.

Chapter 3
Material and Methodology

3.1 Material

This project is based on characterization of waste water and assessment of concrete after mixing waste water in concrete instead of potable water. It includes two main materials waste water and concrete for which analysis will be made in the laboratory. The project will follow these methodologies. The following processes are discussed in the flowing pattern.

1) Collection of primary and secondary treated waste water.
2) Laboratory analysis of treated waste water.
3) Mixing treated waste water in ready mix concrete of design M20.
4) Analysis of concrete cube – its strength, workability, water cement ratio.
5) Result for using the waste water in concrete.

3.2 Waste Water sampling and its preservation- To determine the quality of waste water, sample has been collected from Sewage Treatment Plant. The study area for this project work was Jalandhar city and sample has been collected from Basti Peer Dad plant. This plant was started from 2008 and still it is continue. The capacity of the plant is 50 MLD. Waste Water sample has been collected from the outlet of grit chamber and outlet of biological reacting basin. Sample was collected in beaker and it will be properly rinsed with distilled water. After filling the sample into the beaker it is immediately transfer to the laboratory, so that its bacteriological activities will not take place.. Sample will be immediately analyzed for DO, BOD and COD so that results will not change the current properties of the waste water.

3.3 Analysis Method- The Analysis is done according to the standard method for examination of water and wastewater. Table shows the methods of analysis of different parameter as explained in chapter 1.

Table-6:- Methods of analysis of different physiochemical characteristics of Waste Water and water.

Sr No.	Parameters	Instruments used for parameters
1	pH	pH meter
2	Conductivity	Conductivity meter
3	TDS	TDS meter
4	COD	Open reflux method
5	BOD	Winklers method
6	Sulphate , chloride	Titration
7	Sodium	Flame photometer method
8	Nitrate	Spectophotometer Method

3.3.1 pH- The pH value of waste water sample will be measured with pH meter. It gives the idea about the acidic and alkaline nature of sample. If the pH value of sample will be 7 then it is neutral in nature but if it is less than 7 then it will be acidic in nature and alkaline if greater than 7. pH can also be measure with new instrument LCD Digital Pen hydroponic pH meter**.** It is very easy to use. There is no calibration required for this instrument. Directly power is supplied with the help of battery and its knob is dip inside the sample which will give the concentration of ions in waste water sample.

3.3.2 Conductivity- it is the property of the material by which we can measure the degree to which a specified material conducts electricity. This parameter is influenced by the total amount of dissolved solids in the solution. It also represents the strength of all pollutants in Waste Water . Conductivity is measured with the help of conductivity meter. Generally this EC meter is based on potentiometric method. Conductivity could in principle be determined using the distance between the electrodes and their surface area using the Ohm's law. Initially EC meter should be switch on 30 minute before conducting the lab test for Waste Water . Prepare a solution of KCL of known conductivity 14.23. Calibrate the instrument after dipping the probe inside the KCL solution, set the knob at 14.23. Remove the probe and put inside the Waste Water sample. It will show the reading on screen in μς (micro mhos).

3.3.3 Hardness- Hardness is due to presence of minerals that is in dissolved form. Generally hardness gives the detail of concentration of ions in mg/l present in the sample. According to Indian standard methods of sampling and test, hardness is measured by EDTA titration method. It gives the idea about presence of Ca^{2+} and Mg^{2+} ions. For this titration we required chemicals like EDTA, EBT (indicator), and buffer solution.

Procedure for finding the total hardness-

1) Add 20 ml of water sample in titration flask and add 2-3 drop of buffer solution followed by EBT (Eri chrome Black T).
2) A wine red colour will appear and titrate it against EDTA until blue colour will appear. This is the end point of reaction.
3) For average reading three reading will be taken.

Total Hardness= (Vol. of EDTA consumed x N x 50 x 1000)/ Vol. of sample taken

3.3.4 TDS, TS & TSS- A total dissolved solids refer to the salts and minerals that is in dissolved form in sample. TDS comprises of inorganic and inorganic salts. Its concentration in sample is measured in mg/l. Total solids in the sample According to standard method of water test is measure with evaporation method. For the measurements of total dissolve solid, total solid and total suspended solid we required silica crucible, muffle furnace for temperature 550^0C, drying oven, analytical balance, graduated cylinder, beaker, filter paper and funnel.

3.3.4.1 Procedure for finding the TS-

1) Take preconditioned beaker and weight it.

2) Add 100 ml of water sample into it and dry it in oven at 103 ^{0}C for I hour.

3) After drying weight the beaker again.

Calculation-

Total solid (mg/l) = (weight of dry residue with beaker-weight of beaker)*10^6/volume of sample taken.

3.3.4.2 Procedure for finding TDS and TSS-

1) Take a filter paper and weight it after placing inside the oven for 5 minute.
2) Take 100 ml of water sample in preconditioned beaker.
3) Filter the sample through filter paper.
4) Collect the filtrate from the beaker and place it inside the oven for drying process at temperature of 103^{0}C.
5) Also place the filter paper on petri plate and dry it in oven for 1 hour.

Calculation-

TDS (mg/l) = (Weight of dry residue with beaker –weight of beaker)*10^6/ volume of sample taken

TSS (mg/l) = (Weight of residue with filter paper after ignition -weight of filter paper)*10^6/ volume of sample.

3.3.5 COD (Chemical oxygen demand) - the amount of oxygen required for degradation of biologically active and biologically inactive matter is known as chemical oxygen demand. The determination of COD is done in mg/l.

Procedure for COD measurement-

1) To avoid contamination wash the culture tubes with sulphuric acid properly.
2) Take 2.5 ml of water sample in culture tube and add 1.5 ml of potassium dichromate (oxidant).

3) Add 3.5 ml of suphuric acid and close the tubes properly and invert them for proper mixing.

4) Place the culture tubes in the digester for 2 hours at temperature of 150^0C.

5) Cool the culture tube in the stand at room temperature.

6) Add few drops of Ferroin indicator and mix it well and titrate it with standardized 0.10 M Ferrous aluminum sulphate.

7) The end point will come when colour will change from blue-green to reddish brown.

8) Similar procedure for blank sample is to be done.

Calculation-

COD in (mg O2 /L) = [(a-b) × m ×8000) / (V sample)

There for a = volume of Ferrous aluminum sulphate used for blank (ml)

b = volume of Ferrous aluminum sulphate used for sample (ml)

m = molarity of FAS 8000 = milli equivalent weight of oxygen (8) ×1000 ml/L.

3.3.6 D.O (Dissolve oxygen) - it is the amount of oxygen present in the sample in dissolve form. Generally it is measured in mg/l. Winkler method is used for determination of D.O. The requirements of chemicals for measurements are Manganese Sulfate, Alkali iodide azide, sulphuric acid and starch. Apparatus required BOD bottles, conical flask, measuring cylinder or pipette.

Calculation-

1 ml of sodium thiosulfate of 0.025N = 1 mg of dissolve oxygen/L

Dissolved oxygen (D.O) (mg/L) = ml of sodium thiosulfate (0.025N) consumed.

3.3.7 BOD (Biochemical oxygen demand) – the amount of oxygen requirement for oxidation of organic matter present in the sample is known as biochemical oxygen demand. Generally standard BOD is measured for 5 days in mg/l. it depend upon the amount of D.O present in the sample. BOD_5 is measured with Winkler method.

Procedure for measurement of BOD_5-

1) First repeat the procedure similar to D.O to find out the initial D.O level of the sample.

2) Now with the same dilution which was used for D.O sample is prepared in BOD bottle and kept inside the BOD incubator at temperature of 25 ^{0}C for 5 days.

3) Prepare the sample of blank and place inside the incubator for correction factors.

4) After incubation of 5 days sample will be titrated with sodium thiosulphate until pale yellow colour appear.

5) Add the 2-3 drops of starch it will turn into blue.

6) Now further titrate until color change from blue to colourless, the end point of the reaction.

7) Note down the amount of sodium thiosulphate consumed and calculate the final value of D.D

Calculation of BOD= (Initial DO- Final DO)* Dilution factor.

3.3.8 Sulphate ion- sulphate ions are present in water sample which cause for permanent hardness of the water. Generally sulphate ions are measured with turbidimetric method and measured in mg/l. The main source of sulphate in sample is the agriculture waste and industrial waste.

Procedure for sulphate ion determination-

1) Take two different measuring cylinders and add 1ml of barium chloride solution in both cylinders. Name them sample and standard cylinders.
2) Add 1.5 ml of ethanolic sulphate standard solution of 10PPM concentration in both cylinders. Mixed it well and stand it for 3 minute.
3) Add 15 ml of filtered water sample in cylinder named as sample cylinder.

4) Add 15 ml of standard sulphate solution of 10 PPM concentration in cylinder named as standard cylinder.
5) Add 0.15 ml acetic acid in both cylinder and mix it well.
6) Add distilled water in both cylinder and make the volume 50 ml.
7) Place the cylinder at rest for 10 minute in dark area.
8) Switch on turbidity meter and calibrate the instrument with distilled and standard solution of 400 NTU.
9) Place the standard solution in nessler cylinder and note the reading.
10) Again put the sample in nessler cylinder and note down the reading on screen.
11) Take three readings for average result.

Calculation= Sulphate ions in water sample (PPM) = (NTU Water sample / NTU of standard) * concentration of standard solution.

3.3.9 Chloride ion – chloride ions are the salts which present in water sample and excess amount of it can cause for objectionable bitter taste in water. It is measured with Mohr method in which titration is done with silver nitrate. Potassium chromate is used an indicator for finding the end point of the reaction.

Procedure for finding chloride ions-

1) Add 20 ml of water sample in flask and 1ml of potassium chromate in flask.
2) The colour will change into yellow.
3) Fill the burette with silver nitrate of N/35.5 and titrate the sample with it.
4) Colour will change from yellow to brick red, the end point of the reaction.
5) Take three reading for average result.

Calculation

Chloride ion concentration (mg/l) = (consumed volume of silver nitrate*normality*35.45*1000)/ volume of sample.

3.4 Concrete cube sampling and its curing

As the cement concrete is mixed with primary and secondary treated water sample then this concrete is placed in moulds.

3.4.1 Steps for making cubes of concrete is listed below:-

Step 1 • Check the moulds they should be clean and lightly oiled with all bolts tightened to ensure no leakage .

• Remix the sample properly.

Step 2 • Fill the mould with concrete in 50mm layers using tamping bar, compact the concrete with no fewer than 25 tamps for each of the two layers in a 100mm mould and no fewer than 35 tamps for each of the three layers in a 150mm mould

• For very high workability concrete you may not need the minimum number of tamps

Step 3 • After tamping of each layer, tap the sides of the mould with the hide hammer until large bubbles of air cease to appear on the surface and the holes left by the tamping bar are closed.

Step 4 • Remove surplus concrete and smooth over with a float

• Wipe clean the mould edges

• Number the moulds for identification and record details is to be recorded.

Step 5 • Cover each mould with a damp cloth and plastic sheet • Store inside at room temperature (15-25oC) e.g. on top of the curing tank

• Protect the cube moulds at all times from high and low temperature (especially sub-zero temperatures) and drying winds.

After the moulds are filled with cement concrete they are to be cured as they will be placed in water for 7 days,14 days and 28 days and then it will be sent for testing for different parameters.

3.5 Analysis of Concrete Cubes

There are different tests performed for the analysis of cement concrete. Some of the tests with their procedures are listed below.

Table-7 showing different parameters and their test for concrete

Sr No.	Parameter	Test Performed
1	Workability	Slump Test
2	Compressive Strength	Load Test

3.5.1 Slump Test - is performed to test the workability of fresh cement concrete , which steps are written below:-

Step 1 • Empty the sampling bucket onto the mixing tray

Step 2 • Thoroughly remix the sample

Step 3 • Flatten the final heap by repeatedly digging-in the shovel vertically

• Lift the shovel clear each time

Step 4 • Ensure the slump cone and base plate are clean and damp

• Place the metal plate on solid level base away from vibration or other disturbance

• Place the cone on the plate and stand on the foot-pieces

Step 5 • Fill the cone in three equal depth layers

• Use the standard slump rod

•Stirr the rod in each layer 25 times

• Spread the blows evenly

• Heap the concrete above the top of the cone before rodding the third layer over the area

• Make sure the rod just penetrates the layer below

Step 6 • Top up if necessary

• Use the rod with a sawing and rolling motion to strike the concrete level with the top of the cone.

Step 7 • Carefully clean off spillage from sides and base plate whilst maintaining foot pressure.

Step 8 • Carefully lift the cone straight up and clear, to a count of between 2 and 5 seconds

Step 9 • Lay the rod across the upturned slump cone

• Measure the distance between the underside of the rod and the highest point of the concrete – the true slump

• Record the distance to the nearest 10mm

• Check and record the kind of slump

• If the slump isn't true, take a new sample and repeat the test

• If the second slump isn't true, get advice

• Complete the sampling and testing certificates

3.5.2 Load test:-

Procedure for load testing or testing of compressive strength is given below:-

(I) Remove the specimen from water after specified curing time and wipe out excess water from the surface.

(II) Take the dimension of the specimen to the nearest 0.2m

(III) Clean the bearing surface of the testing machine

(IV) Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.

(V) Align the specimen centrally on the base plate of the machine.

(VI) Rotate the movable portion gently by hand so that it touches the top surface of the specimen.

(VII) Apply the load gradually without shock and continuously at the rate of 140kg/cm2/minute till the specimen fails

(VIII) Record the maximum load and note any unusual features in the type of failure

4.1 Strength Test :-

As per Clause 15.2 of IS 456:2000 3 cubes can be casted for 16-30 m^3 of work. Cubes were Casted by mixing Cement, sand, Aggregate in the Ratio of 1:1:2 (These are the Hand Mix Concrete Cubes) and can also be named as M25 Concrete (if it is a design mix).

Water for Mixing:- Water samples of Treated Waste Water was taken from Basti Peer Dad 50 MLD Sewerage Treatment Plant and then was mixed with Potable Water in Concrete With the different Ratio's stated below.

Cubes were casted by taking various water samples in various ratios listed below:-

1) Potable water
2) Primary Treated Domestic Waste Water : Potable Water (Ratio -1 = 60:40)
3) Primary Treated Domestic Waste Water : Potable Water (Ratio -2 = 70:30)
4) Primary Treated Domestic Waste Water : Potable Water (Ratio -3 = 80:20)
5) Secondary Treated Domestic Waste Water : Potable Water (Ratio -1 = 60:40)
6) Secondary Treated Domestic Waste Water : Potable Water (Ratio -2 = 70:30)
7) Secondary Treated Domestic Waste Water : Potable Water (Ratio -3 = 80:20)

4.1.1 Results of Various Samples Tested of Different Water Samples mixed with Concrete :-

Table-8 Showing Characteristic Strength of Concrete of different Water-Waste Water Concrete mixes

Treated Water : Potable water Mix Concrete Cubes Table								
Characteristic strength of concrete (N/mm^2)	After 7 Days				After 28 Days			
	1	2	3	Aveg.	1	2	3	Aveg.
Potable Water Concrete Mix	13.11	13.91	13.77	13.59	23.75	24.28	23.85	23.96
Primary Treated Waste Water : Potable Water								
Ratio-1 (60:40)	13.77	13.77	13.44	13.66	17	17.22	17.66	17.29
Ratio-2 (70:30)	13.33	13.11	13.55	13.33	17.33	17.11	17.33	17.25
Ratio-3 (80:20)	13.33	13.33	13.33	13.33	17.11	17.22	17.11	17.14
Secondary Treated Waste Water : Potable Water								
Ratio-1 (60:40)	13.77	13.66	13.22	13.55	21.99	22	22.11	22
Ratio-2 (70:30)	13.55	13.33	13.66	13.51	21.44	21.66	21.99	21.69
Ratio-3 (80:20)	13.11	13.33	13.99	13.47	21.33	21.99	21.88	21.73

4.1.2 Concrete mixed with Potable Water 100% :-

Concrete cubes were casted with 100% Potable Water mixed with cement , sand and aggregate in 150mm cube mould and then load test was conducted on cubes so as to get baseline data for further tests as this is the hand mix.

Table-9 Showing Strength of Concrete mixed with Potable Water 100%

Potable Water Mix Concrete Cubes		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.11	23.75
cube no.2	13.91	24.28
cube no.3	13.77	23.85

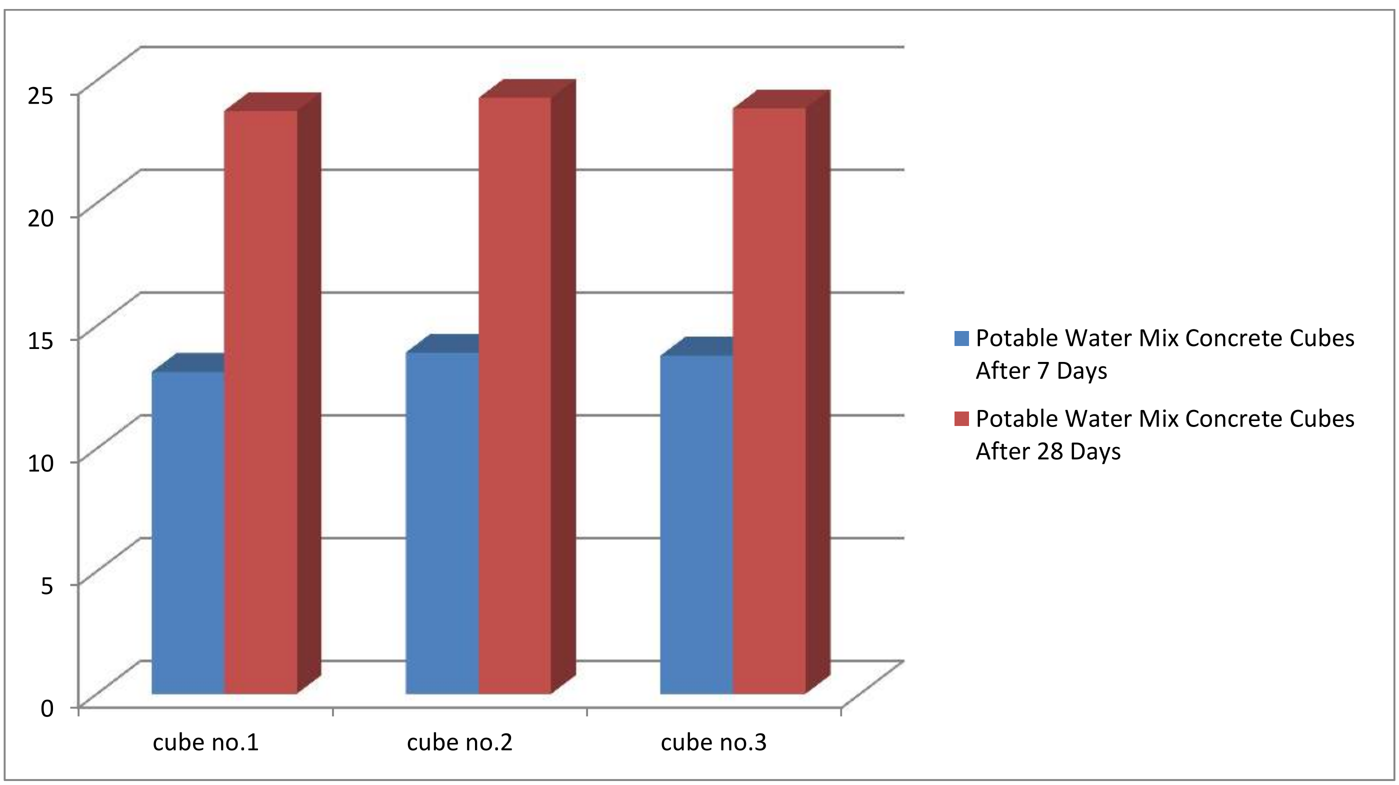


Figure-9:- Bar chart showing characteristic strength of Concrete mixed with 100% Potable Water

4.1.3 Concrete mixed with Ratio of Primary Treated Waste Water and Potable Water in a Ratio of (60 : 40) :-

Concrete cubes were casted with a ratio of Primary Treated Waste Water and Potable Water in a Ratio of (60:40) mixed with cement , sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-10 Showing Strength of Concrete mixed with Primary Treated Waste Water : Potable Water in ratio 60:40

Primary Treated Water : Potable water Mix Concrete Cubes (60:40)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.77	17
cube no.2	13.77	17.22
cube no.3	13.44	17.66

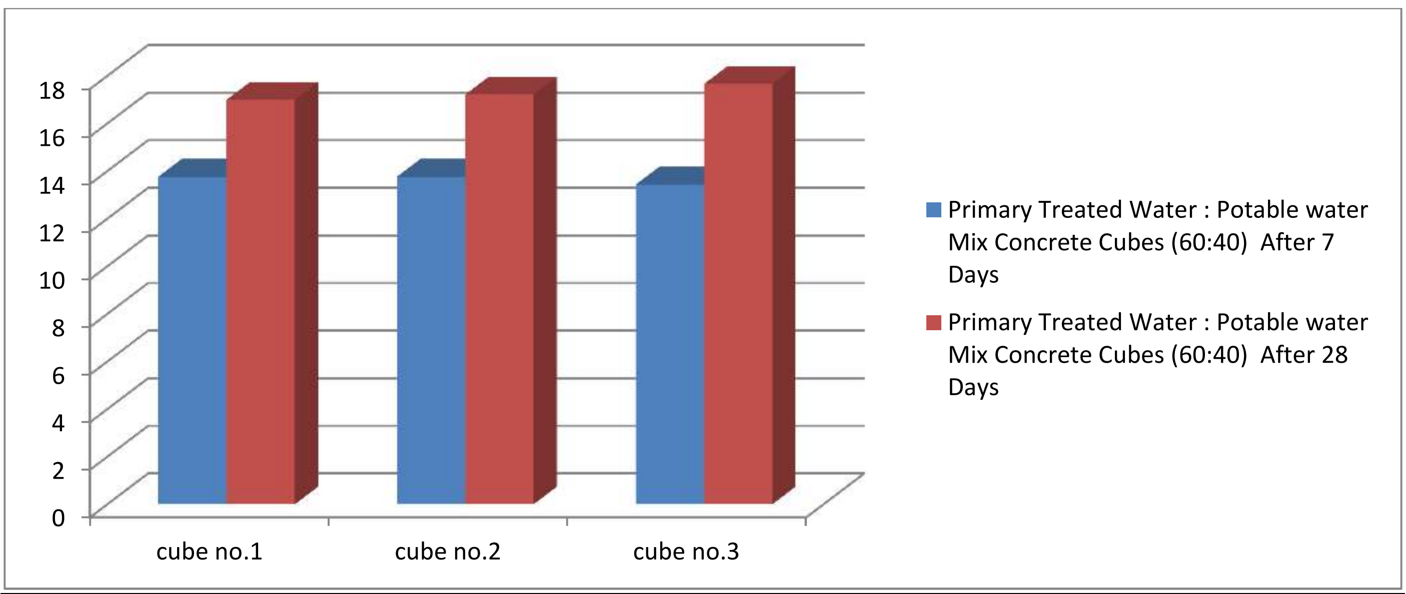


Figure-10:- Bar chart showing characteristic strength of Concrete mixed with Primary Treated waste Water : Potable Water in a Ratio of 60:40

4.1.4 Concrete mixed with Ratio of Primary Treated Waste Water and Potable Water in a Ratio of (70 : 30) :-

Concrete cubes were casted with a ratio of Primary Treated Waste Water and Potable Water in a Ratio of (70:30) mixed with cement , sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-11 Showing Strength of Concrete mixed with Primary Treated Waste Water : Potable Water in ratio 70:30

Primary Treated Water : Potable water Mix Concrete Cubes (70:30)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.33	17.33
cube no.2	13.11	17.11
cube no.3	13.55	17.33

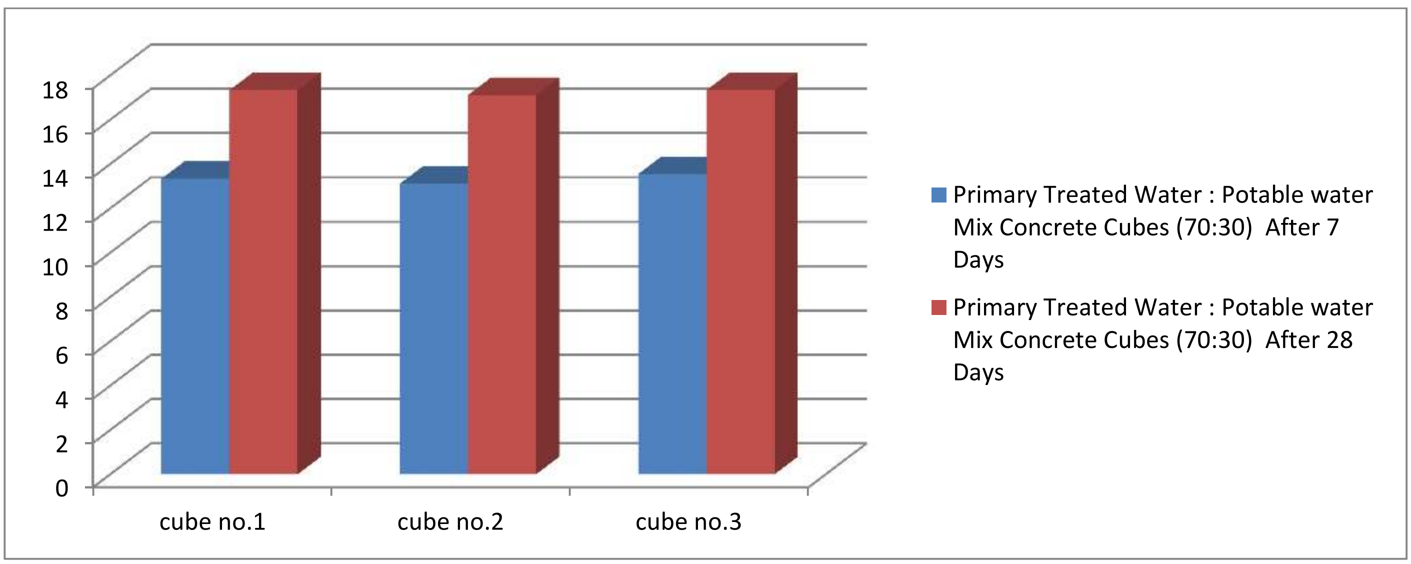


Figure-11:- Bar chart showing characteristic strength of Concrete mixed with Primary Treated waste Water : Potable Water in a Ratio of 70:30

4.1.5 Concrete mixed with Ratio of Primary Treated Waste Water and Potable Water in a Ratio of (80 : 20) :-

Concrete cubes were casted with a ratio of Primary Treated Waste Water and Potable Water in a Ratio of (80:20) mixed with cement, sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-12 Showing Strength of Concrete mixed with Primary Treated Waste Water : Potable Water in ratio 80:20

Primary Treated Water : Potable water Mix Concrete Cubes (80:20)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.33	17.11
cube no.2	13.33	17.22
cube no.3	13.33	17.11

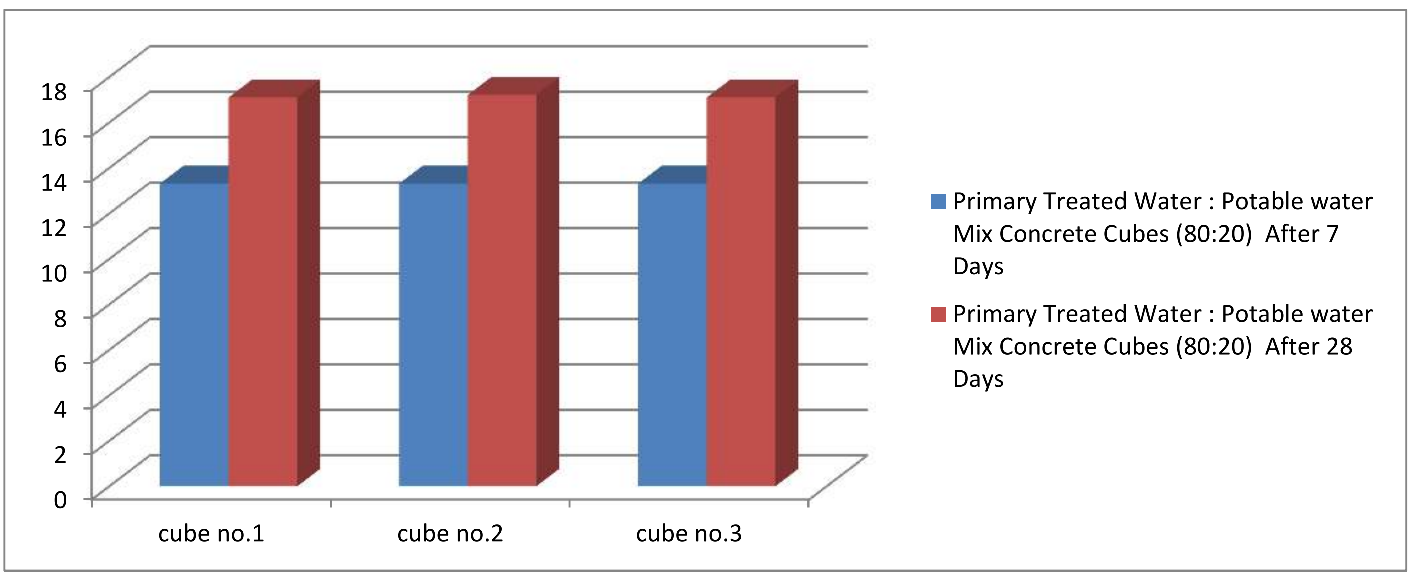


Figure-12:- Bar chart showing characteristic strength of Concrete mixed with Primary Treated waste Water : Potable Water in a Ratio of 80:20

4.1.6 Concrete mixed with Ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (60 : 40) :-

Concrete cubes were casted with a ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (60:40) mixed with cement, sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-13 Showing Strength of Concrete mixed with Secondary Treated Waste Water : Potable Water in ratio 60:40

Secondary Treated Water : Potable water Mix Concrete Cubes (60:40)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.77	21.99
cube no.2	13.66	22
cube no.3	13.22	22.11

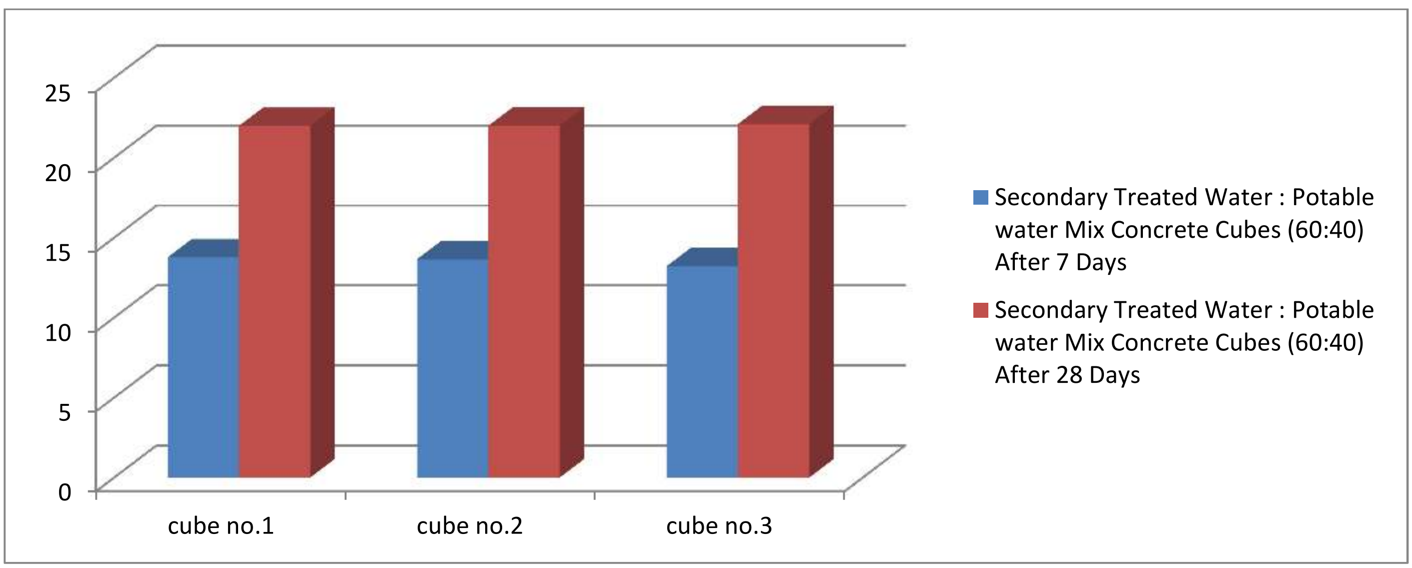


Figure-13:- Bar chart showing characteristic strength of Concrete mixed with Secondary Treated waste Water : Potable Water in a Ratio of 60:40

4.1.7 Concrete mixed with Ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (70 : 30) :-

Concrete cubes were casted with a ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (70:30) mixed with cement, sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-14 Showing Strength of Concrete mixed with Secondary Treated Waste Water : Potable Water in ratio 70:30

Secondary Treated Water : Potable water Mix Concrete Cubes (70:30)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.55	21.44
cube no.2	13.33	21.66
cube no.3	13.66	21.99

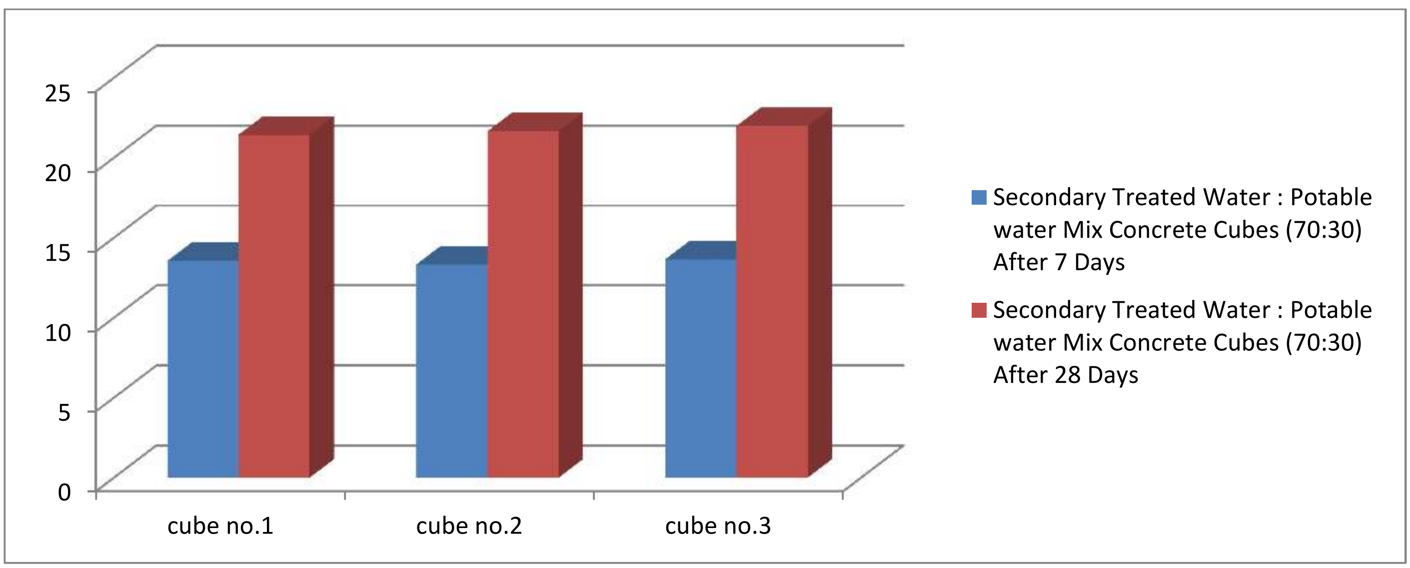


Figure-14:- Bar chart showing characteristic strength of Concrete mixed with Secondary Treated waste Water : Potable Water in a Ratio of 70:30

4.1.8 Concrete mixed with Ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (80 : 20) :-

Concrete cubes were casted with a ratio of Secondary Treated Waste Water and Potable Water in a Ratio of (80:20) mixed with cement, sand and aggregate in 150mm cube mould and then load test is conducted on cubes and bar chart is drawn for the better understanding of results.

Table-15 Showing Strength of Concrete mixed with Secondary Treated Waste Water: Potable Water in ratio 80:20

Secondary Treated Water : Potable water Mix Concrete Cubes (80:20)		
Characteristic strength of concrete (N/mm^2)	After 7 Days	After 28 Days
cube no.1	13.11	21.33
cube no.2	13.33	21.99
cube no.3	13.99	21.88

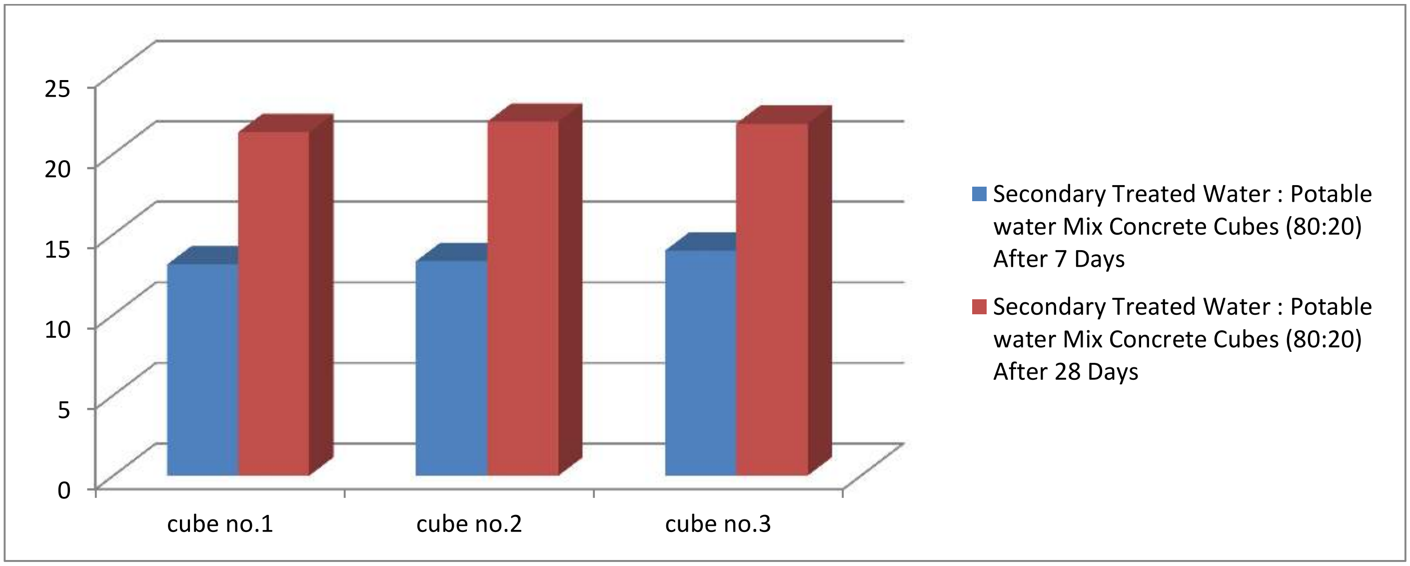


Figure-15:- Bar chart showing characteristic strength of Concrete mixed with Secondary Treated waste Water: Potable Water in a Ratio of 80:20

4.1.9 Concrete mixed with Ratio's of Treated Waste Water and Potable Water were tested after 7 days with Average Results :-

Load test was conducted on cubes after 7days and bar chart is drawn of their Average Results for the better understanding of Results.

Table-16 Showing Average Strength of Concrete mixed with Treated Waste Water: Potable Water which are Tested after 7 days

Treated Water : Potable water Mix Concrete Cubes Average Table	
Characteristic strength of concrete (N/mm^2)	**After 7 Days**
Potable Water Concrete Mix	**13.59**
P.T. (60:40)	**13.66**
P.T. (70:30)	**13.33**
P.T. (80:20)	**13.33**
S.T. (60:40)	**13.55**
S.T. (70:30)	**13.51**
S.T. (80:20)	**13.47**
Where P.T. = Primary Treated Waste Water : Potable Water Mix	
and S.T. = Secondary Treated waste Water : Potable Water Mix	

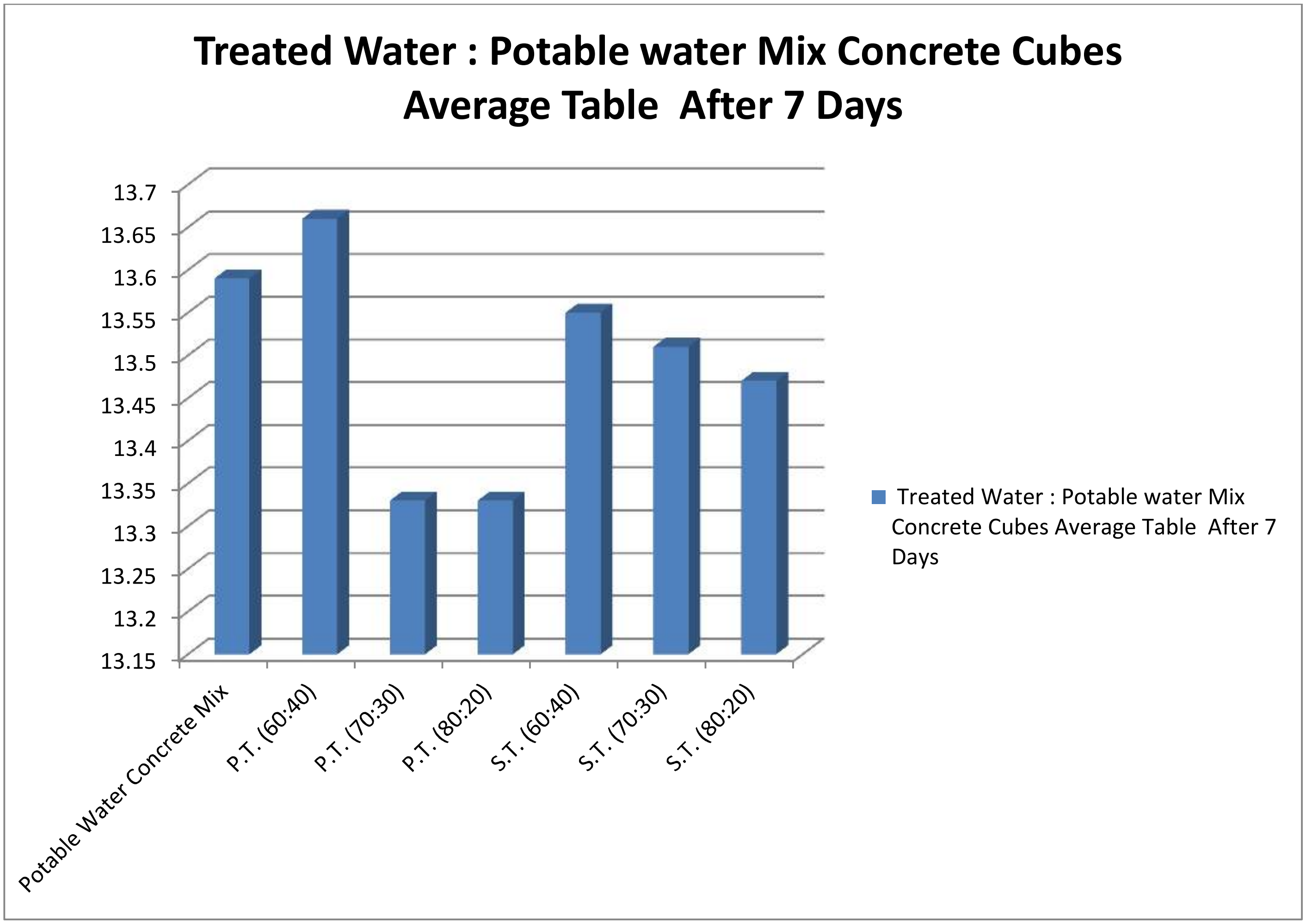


Figure-16:- Bar chart showing Average characteristic strength of Concrete after 7 Days

4.1.10 Concrete mixed with Ratio's of Treated Waste Water and Potable Water were tested after 28 days with Average Results :-

Load test was conducted on cubes after 28 days and bar chart is drawn of their Average Results for the better understanding of Results.

Table-17 Showing Average Strength of Concrete mixed with Treated Waste Water: Potable Water which are Tested after 28 days

Treated Water : Potable water Mix Concrete Cubes Average Table	
Characteristic strength of concrete (N/mm^2)	After 28 Days
Potable Water Concrete Mix	23.96
P.T. (60:40)	17.29
P.T. (70:30)	17.25
P.T. (80:20)	17.14
S.T. (60:40)	22
S.T. (70:30)	21.69
S.T. (80:20)	21.73
Where P.T. = Primary Treated Waste Water : Potable Water Mix	
and S.T. = Secondary Treated waste Water : Potable Water Mix	

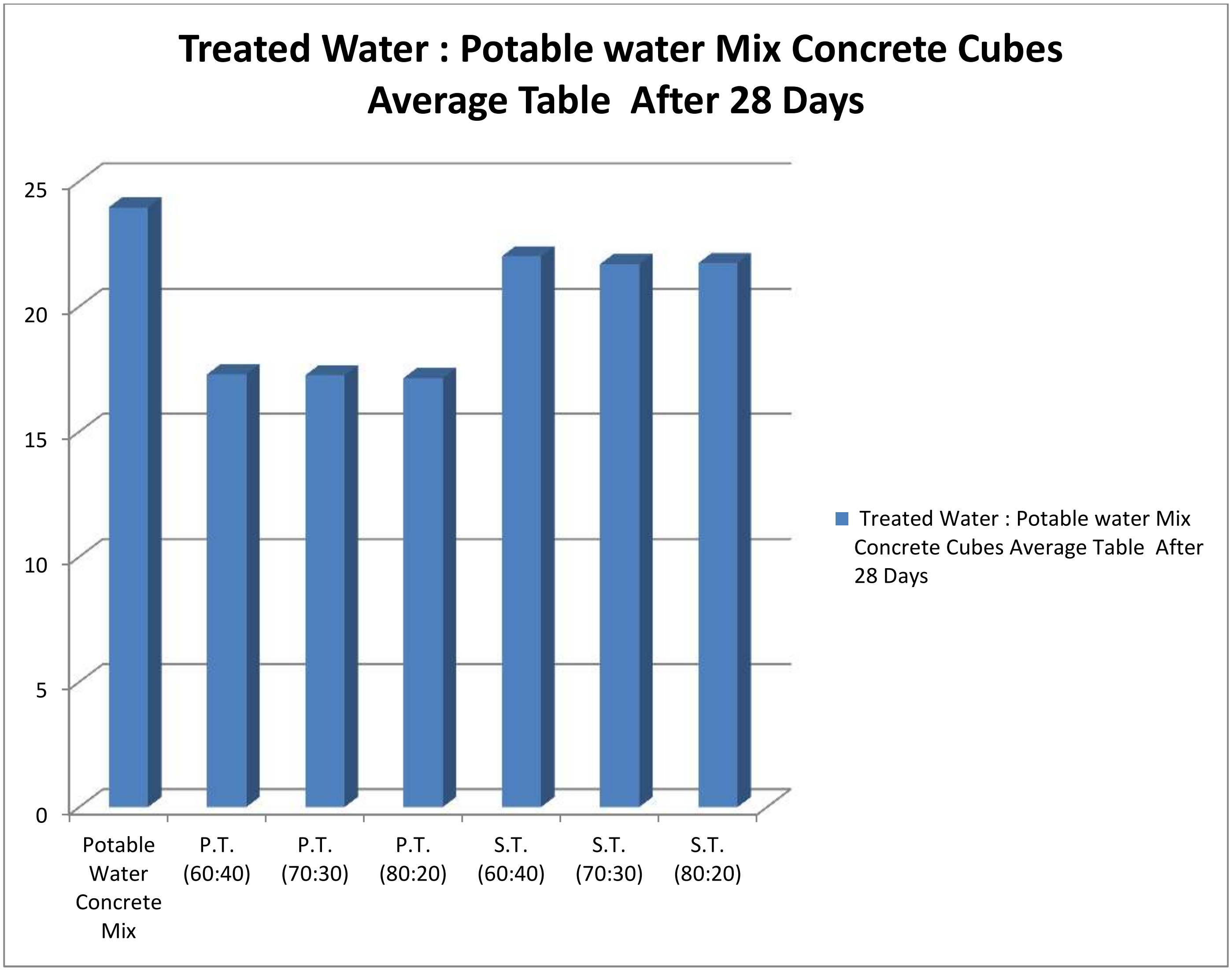


Figure-17:- Bar chart showing Average characteristic strength of Concrete after 28 Days

4.1.11 Concrete mixed with Ratio's of Treated Waste Water and Potable Water were tested after 7 days and 28 days with Average Results (Final Bar Chart showing all Results) :-

Load test was conducted on cubes after 7 Days and 28 days and bar chart is drawn of their Average Results for the better understanding of Results.

Table-18 Showing Average Strength of Concrete mixed with Treated Waste Water: Potable Water which are Tested after 7 Days and 28 Days

Treated Water : Potable water Mix Concrete Cubes Average Table		
Characteristic strength of concrete (N/mmsq.)	**After 7 Days**	**After 28 days**
Potable Water Concrete Mix	**13.59**	**23.96**
P.T. (60:40)	**13.66**	**17.29**
P.T. (70:30)	**13.33**	**17.25**
P.T. (80:20)	**13.33**	**17.14**
S.T. (60:40)	**13.55**	**22**
S.T. (70:30)	**13.51**	**21.69**
S.T. (80:20)	**13.47**	**21.73**
Where P.T. = Primary Treated Waste Water:Potable Water Mix		
and S.T. = Secondary Treated waste Water:Potable Water Mix		

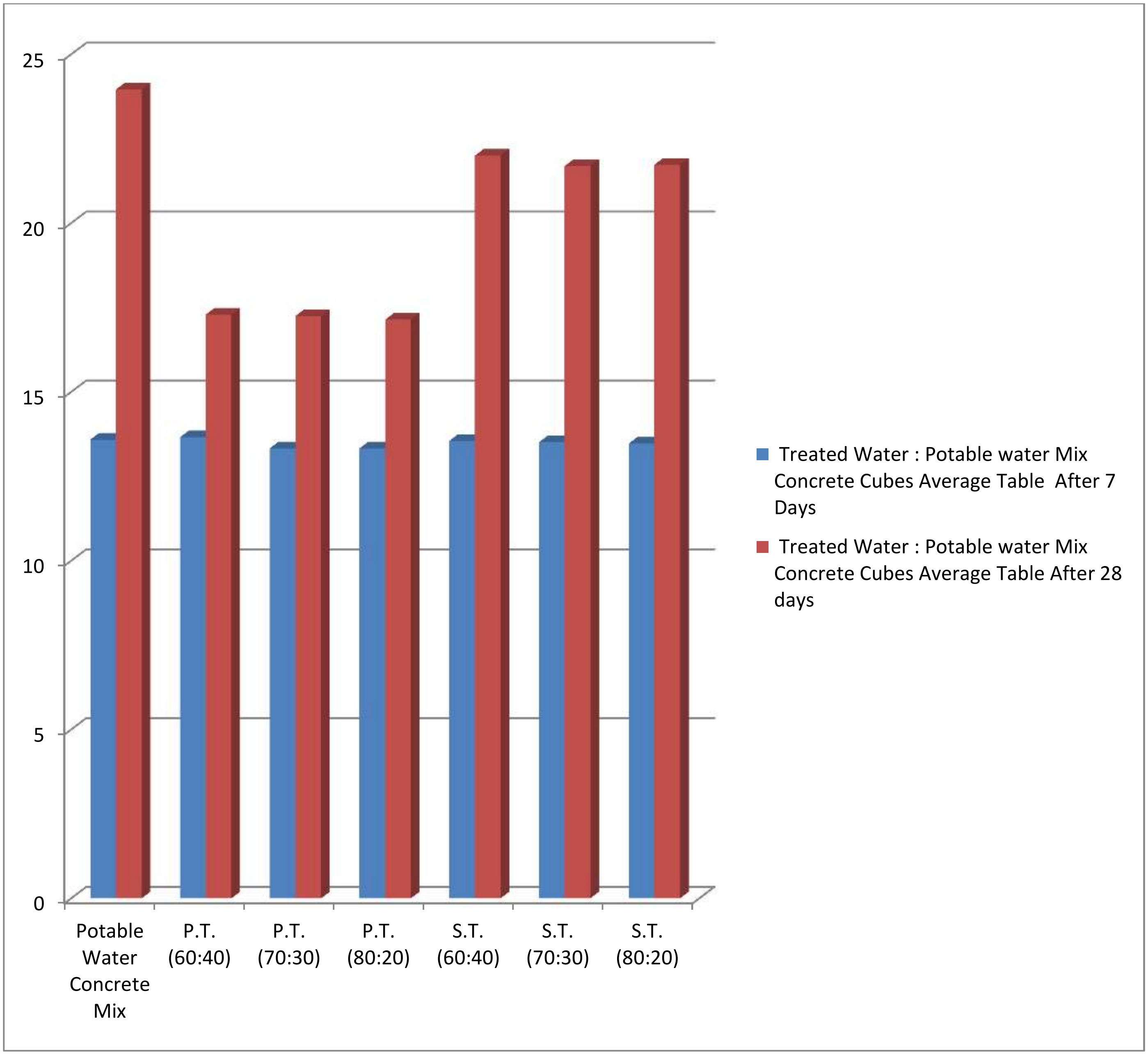


Figure-18:- Bar chart showing Average characteristic strength of Concrete after 7 Days and 28 Days

As per the Results of the strength tests being performed on 150 mm cubes of M25 concrete i.e. (1:1:2 Ratio) the trend has been seen that the Strength of Cubes with increasing volume of Primary Treated Waste Water Decreases and the Strength of concrete cubes mixed with secondary treated waste water is close to the strength of the concrete cube made by mixing 100% Potable water which is as per IS 456:2000.

Table-19 Showing Characteristic Strength of Concrete of different Water-Waste Water Concrete mixes

Treated Water : Potable water Mix Concrete Cubes Table								
Characteristic strength of concrete (N/mm^2)	After 7 Days				After 28 Days			
	1	2	3	Aveg.	1	2	3	Aveg.
Potable Water Concrete Mix	13.11	13.91	13.77	13.59	23.75	24.28	23.85	23.96
Primary Treated Waste Water : Potable Water								
Ratio-1 (60:40)	13.77	13.77	13.44	13.66	17	17.22	17.66	17.29
Ratio-2 (70:30)	13.33	13.11	13.55	13.33	17.33	17.11	17.33	17.25
Ratio-3 (80:20)	13.33	13.33	13.33	13.33	17.11	17.22	17.11	17.14
Secondary Treated Waste Water : Potable Water								
Ratio-1 (60:40)	13.77	13.66	13.22	13.55	21.99	22	22.11	22
Ratio-2 (70:30)	13.55	13.33	13.66	13.51	21.44	21.66	21.99	21.69
Ratio-3 (80:20)	13.11	13.33	13.99	13.47	21.33	21.99	21.88	21.73

Chapter 6
Conclusion

From the Study and Experiments it is concluded that the Concrete mixed with the ratio of Secondary Treated Waste Water and Potable Water can be used with an average characteristic strength of 22 N/mm sq. and the use of Potable Water can be reduced in the mixing of concreting and can be sustained for the Future Generation. The concrete mixed with primary treated waste water and potable water in different ratio's can be used in plain cement concretes as they does not require much strength and can be used for plastering of walls and ceiling, the better use of primary treated waste water in concrete can also be used in plain cement concrete of ratio 1:8:16 in which strength is not required and the main purpose is to separate soil from reinforced cement concrete.

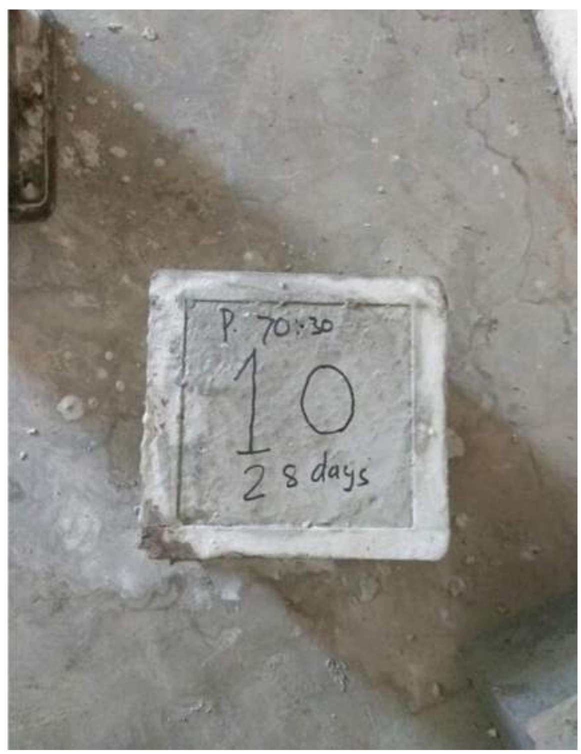
Hence I conclude that Secondary Treated Waste Water can be used in all types of concrete as it gives better strength and Primary treated waste Water can be used in plastering and other concrete mixtures where strength is not the only subject of matter.

Chapter 7

Pictures of the Tests Performed

<u>Figure 19:-Pictures taken at the time of Casting Concrete cubes with different Ratios of Treated Waste Water with Potable Water are shown below:-</u>


P=70:30
11
ACID


P. 70:30
10
28 days

<u>Figure 20:- Pictures Taken at time of Testing Characteristic Strength Of Cubes using Load Test are shown below:-</u>


RCP) "Provid
Laying Cutting Joi
S.W. Pipe Sewe
Thrusting of M.S. P
0mm Dia & all
ther
works at Pragpur &
wali, Jalandhar.
The Survey


AGENCY : Gupta
Name of Work : Extension &
Scheme Jalandhar (Under N
Laying Cutting Jointing of S
Thrusting of M.S. Pipe of 90
works at Pragpur & Dhanow
LOAD IN KILO NEWTON


Scheme Ja
RCP) "Providing
Laying Cutting
of S.W. Pipe Sewer,
Thrusting of M.S
f 900mm Dia & all othe
works at Pragpu
nowali, Jalandhar.
The Survey

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