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Use of Municipal and Industrial Wastewater in and around Nangal for Construction purposes

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Abstract*: Water is one of the vital needs of all living beings for daily activities like drinking, washing, bathing etc. It is the most important factor in shaping the land and regulating the climate. The quality of water for drinking and other activities if does not satisfy the standard conditions of physical, chemical and biological characteristics as prescribed it then becomes ineffective. The quality of water is usually described according to its. Hence it becomes necessary to find the suitability of water for various purposes like drinking, irrigation and Industrial purposes. Rapid industrialization and use of chemical fertilizers and pesticides in agricultural lands, discharge of voluminous municipal and industrial waste waters are causing deterioration of water quality vis-à-vis depleting of aquatic biota. This ultimately causes massive pollution not only to the rivers, ponds and wells but also drastically degrade the quality of groundwater. Research have been undertaken to use such type of waste water in different construction purposes. It is absolutely true that demand of fresh water by the construction sector is expected to increase due to high increase in the growth of construction activities in India (Dhanraj, 2017). Highly polluted Sutlej river in Punjab has been a constant encouragement to the environmentalists about reusing the contaminated water of the river. A total of 14 water samples from different point sources of pollution were collected and tested for physico-chemical parameters (pH, temperature, DO, BOD, COD, TSS, TDS), metals (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) and microbiological parameter using World Health Organization (WHO) and the Bureau of Indian Standards (BIS) standards to justify how the strength of concrete goes on varying with respect to using the river water directly. An attempt was made to justify the use of wastewater directly in preparing concrete for construction purposes by testing concrete cubes prepared by the untreated water and comparing them with the strength of standard cubes.

***Index Terms*: BOD, COD, Waste water, Compression Test.**

I. INTRODUCTION

Re-use of treated wastewater is an important issue in many civil works policies where water is needed as a component in concrete mixtures. Shortage of water is perhaps the most critical environmental problem in several countries (Okun, 1994, EPA, 2004, Silva and Naik 2010]. It is needed for the hydration process of cementations materials and for curing (Ghannam, 2016),. Nangal area besides which Sutlej river flows has been undertaken as the area of study (Figure 1 to Figure 3) which cites the best place all along the course due to maximum pollution incurred in the area. The locations from where water samples were collected for further study belong to National Fertilizer Limited (NFL) established in the year 1947. The municipal waste water of the entire colony and its nearby township discharge large volume of treated, semi-treated and untreated water directly to the river (Figure 1,2& 3).

Figure 1 Wastage of Nangal town directly deposited in Satlej

Figure 2 Domestic water is directly released into Satlej near Ropar thermal plant

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Figure 3 Polluted water near Rishab Paper mill

Use of waste water in construction after treatment saving million liters of water is a common phenomenon but if waste water that is discharged from municipal as well as industrial source by any means without treatment used directly in construction purpose is definitely a challenge to the construction industry. In the construction sites, potable water is usually used since it is recommended by most specifications and its chemical composition is known and well regulated (Zabri et al., 2011). Approximately 150 liters of water is required per cu. m. of concrete mixture without considering other applications of water at the concrete industry (Shrilatha et al., 2017). The only problem with waste water is the presence of bacteria which can be eradicated by the heat generated due to hydration, hence can be easily used in concrete for construction purpose. The benefit of this project is to save million liters of water which is disposed in the river. As it is evident that wastewater contains some impurities and solid particles, which may affect some of concrete properties like setting time, hardening, density, workability and strength (Kanwal et al., 2018). On the other hand untreated water contains high level of organic materials, numerous pathogenic, microorganism as well as nutrients and toxic compounds that can be harmful to human health as well. OPC of grade 53 was used in this study which was bought from a local dealer (Mahajan and Husain, 2016).

II. PROPOSED METHODOLOGY

Due to huge scarcity of water there is need to arrange other source of water for concrete or construction of building units (Asif Rashid Shaikh and Inamdar, 2016). Preliminary survey was conducted for detecting the suitable place from where wastewater has to be collected. A set of questionnaires were randomly distributed to the common people residing near Satlej. Attempts were made to cover up the maximum possible wards of Satlej area to get optimum samples and their feedback from the survey was recorded. An effort was also made to move from door to door to find out the difficulties in accessing the waste water as well as polluted water discharged from nearby industries. Various tests of the local water bodies were conducted in the government laboratory under PHE at HMT. To determine turbidity of the samples, Nephelometric Turbidity meter was used, to establish the result for total dissolved solids and conductivity electrical based conductivity meter was used. To find out alkalinity and hardness, titration process was adopted whereas pH was calculated through digital pH meter, DO by DO detector, BOD by BOD incubator and other cations and anions according to the normal procedures. In addition to finding different elements, usual tests of cement were also conducted to acknowledge the standard quality that the cement maintains. Concrete characteristic strength was specified according to established modern theories in concrete mix preparation (Ghrair and Al-Mashaqbeh, 2016). Sutlej's water, which enters Punjab at Bhakhra Nangal are rated as A class (pure) at Nangal headwork at Nangal but due to effluents discharged from NFL, PNFC and Punjab Alkalies, its toxity level constantly goes on increasing. At Kiratpur sahib the addition of human ashes further increases the impurity. Subsequently at Ropar (due to effluent discharge from the Ropar thermal plant, DCM, Swaraj Mazda and United Pulp and Paper Mills) the impurity drastically increases.
The entire process of the methodology adopted has been presented in Figure 4 through a flow chart.

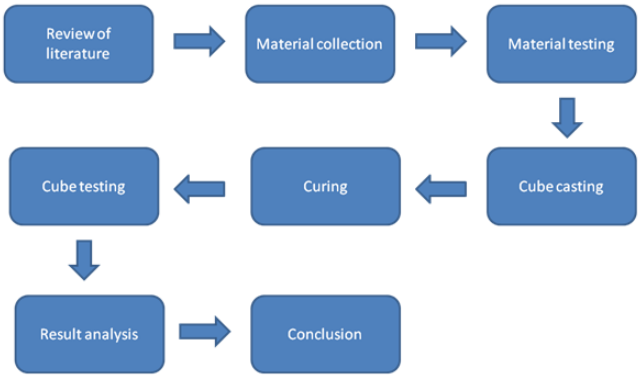

Figure 4 Flow chart for the methodologies adopted in use of wastewater

Samples were collected from different points all along Sutlej river to get a clear picture of the quality of water that is to be used in concrete industries.

III. RESULTS AND DISCUSSIONS

Average results of the 14 water samples collected from different points have been presented in Table 1. Though the pH does not show a rhythmic result but looking at the F-Coli and Turbidity of the samples it can well been represented that the values are quite erratic. The graphical presentation of the results for a better comparison has been presented in two different graphs with four parameters in Figure 5 and two in Figure 6.

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Table 1 Average result of Physico Chemical Analyses of waste water samples.

S.N.	Name of Station	pH	C.O.D mg/l	B.O.D mg/l	F.Coli MPN/100ml	Turbidity MPN/100ml
1	Industrial area Nangal	7.8	4	0.8	50	400
2	NFL Nangal	7.1	9	2.6	400	900
3	Brari	7.4	8	1.8	50	500
4	Lodhipur	7.2	12	2.8	300	700
5	Kotla (power House)	7.5	15	3.5	540	1200
6	Kiratpur Sahib	7.8	20	4.2	800	1700
7	Thermal plant	7.3	5	1.0	50	500
8	Rishab paper mill	7.9	85	25	7000	11000

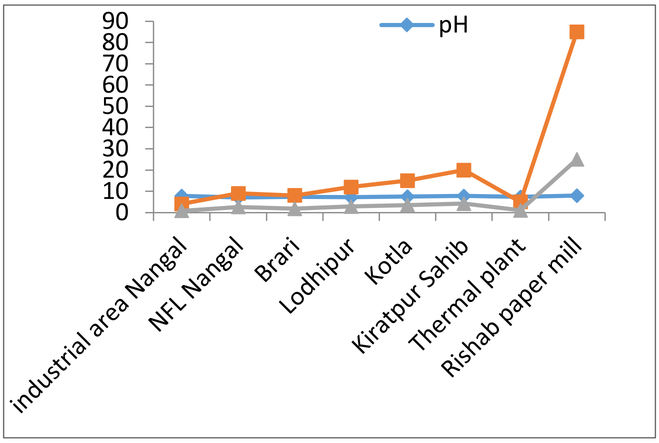

Figure 5 Graphical presentations of pH, COD and BOD of waste water samples.

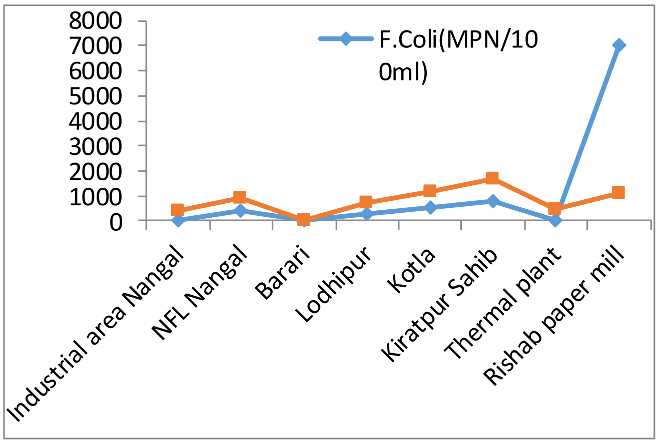

Figure 6 Graphical presentations of F- Coli and Turbidity of waste water samples.

The water samples were directly used to prepare concrete cubes and their compressive strength were measured for 7 days, 14 days and 28 days. The mix proportion for 1cubic meter of concrete to prepare mix design of M25 grade concrete has been presented in Table 2.

Table 2 Mix design proportion for preparing M25 grade concrete.

Cement	Fine aggregate	Coarse aggregate	water
383kg	546kg	1187kg	191.6
1	1.42	3.09	0.5

As per IS 456:2000 the compressive strength of M25 grade concrete may be approximately equal to 25kN/mm^2 but as per the readings (Table 3) it is clearly understood that compressive strength goes on reducing by percentage when one moves to record the strength from 7 days to 28 days. Instead of attaining strength of 25kN/mm^2 after 28 days curing it has come down to 23.77, a marginal reduction of 1.23kN/mm^2 and 0.93kN/mm^2 from the actual strength derived by using portable water in testing.

Table 3 Compressive strength of cubes after 7, 14 and 28 days of curing.

Days	Percentage with pure water	Percentage with waste water	Compressive Strength with pure water	Compressive Strength with waste water
7	65	62	16.25kN/mm^2	15.5kN/mm^2
14	90	87	22.5kN/mm^2	21.75kN/mm^2
28	99.8	95.1	24.7 kN/mm^2	23.77 kN/mm^2

IV. CONCLUSION

Though a concrete conclusion has been done that the bacteriological hazards predominantly hampering the strength of concrete may not exist due to ample heat generated in the process of hydration but as far the reduction in strength of concrete is definitely a matter of concern. It can also be assured that for non-structural use simply filtering the wastewater and using in concrete may be that much harmful as it is expected for huge construction with reinforcements it is better to avoid using wastewater directly. Rather after treating wastewater by the procedures recommended may be definitely followed up.

ACKNOWLEDGMENT

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