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Study on Behavior of Paper Industry Treated Effluent as Mixing Water in Concrete for Pollution Control and Sustainable Development.

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Abstract:- In this paper, the feasibility of using treated paper industry effluent as mixing water for concrete was studied. Treated effluent from paper industry is currently being wasted through direct discharge into waterways. With proper water quality control, this treated effluent can also be considered as a potential water resource for specific applications. Tests were carried to determine the mechanical properties and feasibility of using treated effluent as mixing water for concrete. The results were compared against the tests conducted on control specimens which is prepared with potable water. Test results shown that concrete samples made with 40% treated paper industry effluent water blended with potable water exhibit better mechanical strength than control concrete. Therefore, it is suggested that 40% treated paper industry effluent water with potable water can be considered as mixing water for concrete. Reusing of such wastewater results in reduction of fresh water consumption, disposal cost, environmental pollution and hazard.

Key words: Paper industry waste, Treated effluent, Mixing water, Mechanical properties.

1. INTRODUCTION

The pulp and paper industry is one of India's core sector industries. The socio-economic importance of paper has its own value to the country's development as it is directly related to the industrial and economic growth of the country. In India, around 906 million m3 of water is consumed and around 696 million m3 of wastewater is discharged annually by this sector. Looking into the serious nature of pollution, the pulp and paper industry in India has been brought under the 17 categories of highly polluting industries. In this study an attempt has been made to utilize the treated effluent from paper industry as mixing water in concrete. Concrete is the single most widely used manmade material in the world. Annually around 12 billion tons of concrete is produced worldwide. Normally concrete industry uses significant amount of natural resources especially an enormous amount of portable water. Around 150-200 liters of water is required to produce $1m^3$ of concrete. We know that portable water sources are not inexhaustible. So reusing the pulp and paper industry wastewater in concrete have a great benefit in disposal cost as well as protection of environment. Thus this investigation aims to reuse the pulp and paper industry wastewater in concrete and study the effects of this waste water on mechanical properties of concrete.

2. Material and Experimental program

2.1 Materials

2.1.1 Cement slurry mixed and Cement slurry removed washout water.

In this study pulp and paper industry wastewater is collected from SPB paper mill near Tiruchengode, India. Pulp and paper industry wastewater is blended with potable water at 0%, 40%, 50%, 60%, 80 and 100% and used as mixing water for production of concrete. The properties of both pulp and paper industry wastewater and potable water used in this study were shown in table.1.

Table.1 Chemical composition of paper industry wastewater and potable water for significant parameters

Parameter	Potable Water	40% mixed wastewater with Portable water	50% mixed wastewater with Portable water	60% mixed wastewater with Portable water	80% mixed wastewater with Portable water	100% wastewater
pH	7.76	7.81	7.83	7.83	7.86	7.89
TDS(mg/l)	1472	2124	2934	3155	3395	3548
	148	153	161	165	170	179
Chloride(mg/l)	135	139	146	152	158	163
Sulphate(mg/l)						

2.1.2 Cement

Ordinary Portland cement of grade 53 was used in this study and the basic properties of the cement were tested and the cement meets the requirements of IS 12269-1987.

2.1.3 Aggregate

Crushed angular aggregates of 20 mm size were used as coarse aggregate and natural river sand was used as fine aggregate for production of concrete both fine and coarse aggregate meets the requirements of IS 383-1970.

2.2 Experimental Program

2.2.1 Mix proportions

In this study water cement ratio was kept as 0.51. The pulp and paper industry wastewater was blended with fresh water in various ratios and used as replacement for potable water. Table 2. Shows the details of mix proportion for $1m^3$ of concrete.

Where, Mix SW1, SW2, SW3, SW4 and SW5 denotes concrete mixed with 40%, 50%, 60%, 80% and 100% pulp and paper industry wastewater. M1 denotes control mix concrete made with portable water.

Table. 2 Mix proportions of concrete

Mix	Cement (Kg)	Water (liters)	paper industry wastewater (liters)	Fine aggregate (kg)	Coarse aggregate (kg)
M1	375.64	191.6	0	653.72	1168.43
SW1	375.64	114.96	76.64	653.72	1168.43
SW2	375.64	95.8	95.8	653.72	1168.43
SW3	375.64	76.64	114.96	653.72	1168.43
SW4	375.64	38.32	153.28	653.72	1168.43
SW5	375.64	0	191.6	653.72	1168.43

2.2.2 Testing procedure

In order to investigate the effects of paper industry wastewater on mechanical properties of concrete, concrete cubes of size (100x100x100 mm), prisms of size (500x100x100 mm), cylindrical concrete specimens of size (150x300 mm) were casted. After 3, 7, 28 and 56 days of curing concrete cubes were tested for compressive strength. Similarly prism and cylindrical concrete specimens were tested for flexural and split tensile strength after7 days and 28 days of curing.

2. RESULTS AND DISCUSSIONS

3.1 Mechanical properties of concrete

3.1.1 Compressive strength

The compressive strength of control concrete and concrete made with cement slurry mixed washout water for 3 days, 7 days, 28 days and 56 days are shown in figure1. It is noted that increase in paper industry wastewater content tends to reduce compressive strength except for mix SW1. The main reason for reduction in compressive strength is excess total dissolved solids in waste water reacts with hydrated Portland cement. This excess dissolved solids may form a thick layer in transition zone and reduce the bonding between cement paste and aggregate which results in lower compressive strength. The compressive strength increase in mix SW1 is due to the fine ligin particles present in 40% waste water is densely packed in the pores of concrete and propagation of cracks is restricted.

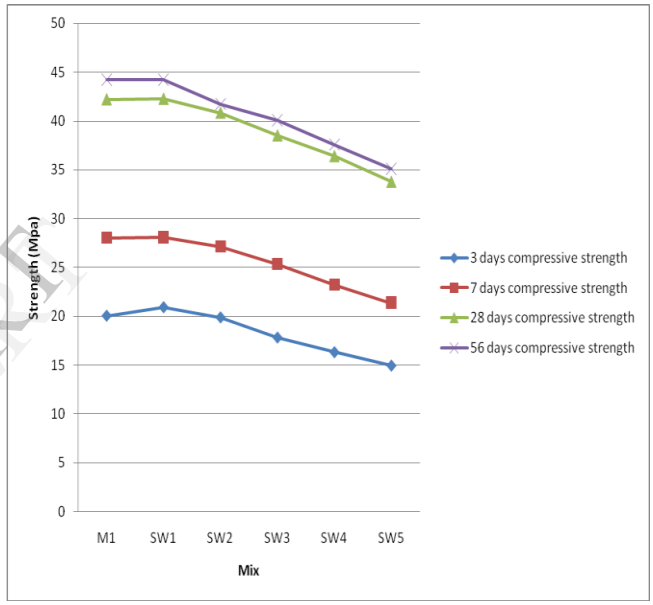

Figure.1 Compressive strength of concrete after 3, 7, 28 and 56 days of curing for various mixes

3.1.2 Flexural strength

7 days and 28 days flexural strength of paper industry waste water is shown in figure.2. Similar to compressive strength, flexural strength of concrete also reduced when increase in paper industry waste water content. It was noted that flexural strength of concrete increased for the mix SW1.

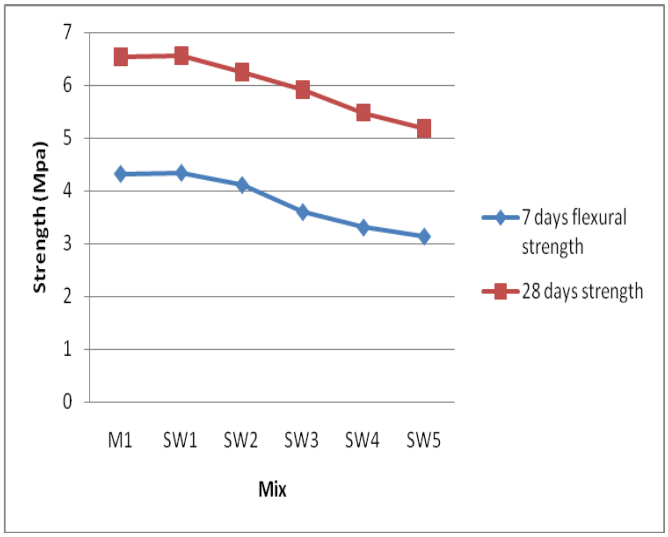

Figure.2 Flexural strength of prisms after 7and 28 days of curing for various mixes.

3.1.3 Split Tensile strength

Compared to control concrete it was found that split tensile strength of concrete was increased for the mix SW1. Figure.3 shows the 7 and 28 days split tensile strength of various mixes. The reason for increase in split tensile strength of concrete is same as the increase in compressive strength of concrete for the mix SW1. Generally increase in waste water content tends to reduce split tensile strength this is due to excess solids present in waste water. Mix SW1 which contain total dissolved solids content of 2124 mg/l has no adverse effect on strength.

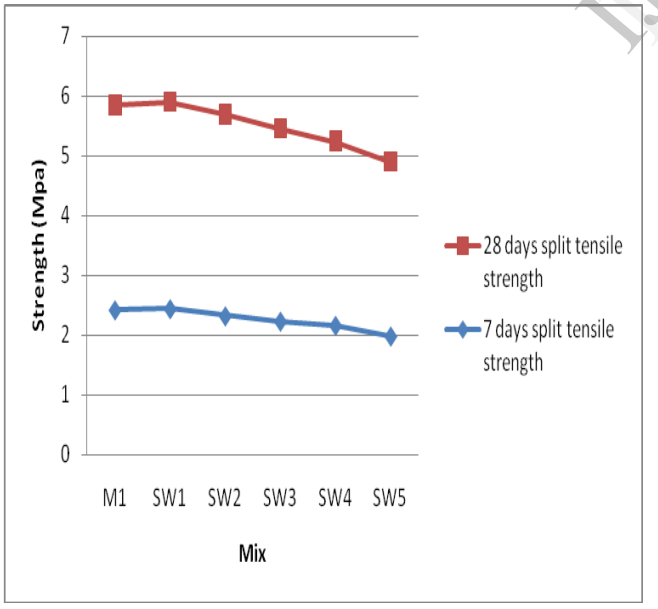

Figure.3 Split tensile strength of cylinders after 7 and 28 days of curing for various mixes

3. CONCLUSION

- 40% paper industry treated waste water blended with portable water has total dissolved solids content of 2124 mg/l was used as mixing water for mix SW1. It was noted that the compressive, flexural and split tensile strength of washout water concrete was higher than that the concrete mixed with potable water.
- After curing of 3, 7, 28 and 56 days, the compressive strength of concrete mixed with 40% paper industry waste water is in the range of 100.8-101.6% of control concrete.
- The flexural strength and split tensile strength of concrete after 7 and 28 days are in range of 101.15-101.86% and 101.3-102.1% of control concrete, both strengths were higher than that the control concrete.
- Based on the test results obtained it seems that 40% paper industry waste water blended with potable water could be used as mixing water in concrete without any adverse effects on mechanical properties of concrete. On the whole the use of paper industry waste water as mixing water in concrete is advantageous in both economical and environmental aspects.

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