

An Experimental Study on Using of Waste Marble Water & Waste Paper Pulp Water as Partial Replacement of Potable Water in Concrete

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ABSTRACT: Water is a key requirement for construction. It is either extracted from underground through pumping or directly from the govt. bodies. The waste water are usually not treated properly & are directly allowed to mix with water resources like river. The waste water is from marble industries, pulp & paper mills. Waste marble water samples were collected from marble cutting & polished factory in Bardoli region & Pulp & paper mills waste water samples were collected from J.K. paper, Songadh. Concrete mixtures were prepared using different proportions of waste water & water-to-cement ratio of 0.45. This research work is concerned with experimental investigation on strength of concrete & optimum percentage of the partial replacement by replacing normal water via 25%, 50%, 75% & 100% of Sludge. For each concrete mixture, four cubes of 150 mm × 150 mm × 150 mm & three cylinders of 300 mm × 150 mm dia. were casted. The characteristics strength of the concrete will be studied with partial replacement of water & with 100% potable water mix. We found out that as we increase the percentage of wastewater of pulp & paper industries the strength reduces & it is less than that of normal water. But in marble water strength increases up to 50% then it reduces in 75 % & again it increases in 100 % which is more than that of normal water.

KEY WORDS: Waste Marble Water, Eco-friendly Concrete, Green Concrete, Paper Pulp Waste Water

ABBREVIATIONS:

CA = Coarse Aggregate

FA = Fine Aggregate

WMW = Waste Marble Water

WW = Waste Water

CTM = Compression Testing Machine

PW = Potable Water

WPPW = Waste Paper Pulp Water

I. INTRODUCTION

Green concrete has nothing to do with colour. It is a concept of using eco-friendly materials in concrete, to make it more sustainable. Green concrete can be defined as the concrete with material as a partial or complete replacement for cement or fine or coarse aggregates or water. The substitution material can be the waste or residual product in the manufacturing process. Green concrete is very cheap to produce because it uses waste products for partial replacement of materials. The size of construction industry all over the world is growing at brisk. This faster rate of construction growth boosts demand for the construction materials as well as there is also increase in the demand of water to be used for mixing the concrete. As there is scarcity of water in many cities we can reuse the waste water produce from the marble industry and sugar industry. As water helps in binding the concrete it possess a major role. To overcome this problem, there is need to find replacement to some extent. Nowadays, there is a solution to some extent which is called as "Green Concrete". It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mix design to structural design, construction, and service life.

The main reason behind selecting this topic was to find out the effect of waste water on concrete. There are many papers related to use of waste water in concrete but not on using of WMW & WPPW.

II. LITERATURE REVIEW

E.W. Gadzama et. al.,⁽¹⁾ "Effects of Sugar Factory Wastewater as Mixing Water on the Properties of Normal Strength Concrete". The concrete grade of M-25 was made with proportion 1 : 2 : 4 having w/c ratio of 0.56. They have replaced PW with sugar waste water in 0%, 75%, 100%. They have replaced the PW as partial to total replacement in production of concrete and for curing as well. And they have concluded that conclude that target strength at 28 days was in the range of 83% to 91%. They have stated that if the curing period is increased upto 90 days there are chances of getting higher strength.



P. V. Shah et. al.⁽⁸⁾ “An Experimental Study on Using of Waste Marble Water as Partial Replacement of Portable Water in Concrete”. In this paper they have study about the effect of using WMW on concrete. They have studied the compressive strength and spilt tensile strength on concrete for 7 days and 28 days. And the study has shown that they can use the WMW as partial replacement of PW.

III. METHODOLOGY

PRELIMINARY INVESTIGATIONS:

Cement: It is the most basic material used for binding in the construction work. In this study we have used Portland Pozzalana Cement of 53 grade.

Coarse Aggregate: Coarse aggregate passing through sieve of size 12.5-20mm and normal continuous grading was used. The specific gravity is 2.83 and water absorption 2.47%

Fine Aggregate: Fine aggregate confirming from zone III was used. The specific gravity is 2.68 and water absorption 2.21 %.

Portable Water: PW were collected directly from the college tap water for drinking purpose. The table - 1 shows the chemical property of PW used in construction.

Waste Marble Water: WMW samples were collected from marble cutting and polished factory in Bardoli region. The table - 1 shows the chemical property of WMW with the permissible of IS : 456 -2000.

Waste Pulp Paper Water: WPPW was collected from the J. K. Paper, Songardh. The table - 1 shows the chemical property of WPPW.

Table – 1 : Chemical Properties of Waters

Test	PW	WMW	WPPW	Permissible Limit As Per IS : 456-2000
pH	6.6	8.6	6.86	> 6
Chloride (mg/l)	100	119	427.4	2000
Sulphate (mg/l)	250	70.34	126	400
SuspendedMatter (mg/l)	10	932	60	2000

EXPERIMENTAL INVESTIGATION:

Mix Design of concrete: In this research, concrete mix design was according to the IS : 10262 – 2019, and concrete specimen was designed to have a target mean strength of 31.6 MPa. Table 1 shows the mix proportion of concrete. There is partial replacement of water with the waste water of Marble and Paper industry. The proportions are made in 25 % that is 0 % of PW is replaced with WMW & WPPW. Than 25 %, 50 %, 75%, 100% of PW is replaced with WMW & WPPW.

Table – 2 : Mix Proportions of Concrete

Mix (%)	Cement (kg/m ³)	WW (kg/m ³)	PW (kg/m ³)	FA (kg/m ³)	CA (kg/m ³)
0	438	0	197	580	1156
25	438	49	148	580	1156
50	438	99	99	580	1156
75	438	148	49	580	1156
100	438	197	0	580	1156

Preparation of Specimen: Cubes and cylinder were prepared as per above mentioned mix proportions. Totally 72 cubes and 54 cylinders were casted for these project work. Following table shows partial replacement of water and numbers of cube and cylinders.

Table – 3 : Number of Cube & Cylinder for curing

Partial Replacement of PW	Curing Period (Days)			
	Cube		Cylinder	
	7	28	7	28
0 %	4	4	3	3
25 % WMW	4	4	3	3
50 % WMW	4	4	3	3
75 % WMW	4	4	3	3
100 % WMW	4	4	3	3
25 % WPPW	4	4	3	3
50 % WPPW	4	4	3	3
75 % WPPW	4	4	3	3
100 % WPPW	4	4	3	3

Curing: The mixing was done with the machine and guidelines provided by the IS : 516 were followed. The cube and cylinder were filled and vibrations were provided with the help of vibrating machine for 2 min. and cube and cylinder left for 1 day to dry and after 1 day they were cured for 7 days and 28 days from the date of casting.

IV. TESTS & RESULTS

Compressive Strength Test: These test was performed according to IS : 516. And the CTM was servo controlled with 3000 kN capacity. The cube were casted of standard size of 150 mm * 150 mm* 150 mm. The pace rate was 5.15 kN/sec. Result are shown in fig.

Split Tensile Test: These test was performed according to IS : 516. It performed to check the tensile property of the concrete it is another alternative of flexure test. As we all know concrete is weak in tension and generally cracks are developed due to tension in concrete. Results are show in fig.

Slump Cone Test: These test was performed according to IS : 1199. Mostly these test is performed to check whether the assumption in mix design is proper or not and to check the workability of concrete. Results are show in table.

Ultra Pulse Velocity Test: These test was performed according to IS : 13311 (Part – 1). These test was done to find the quality of concrete. After performing the test we have found out that the quality of concrete has come good and UPV was ranging from 3.77 to 4.36 km/sec.

Table – 4: Values of Slump cone

Design Mix	Slump Value
0%	100
25% WMW	100
50% WMW	100
100% WMW	95
25% WPPW	90
50% WPPW	100
75% WPPW	130
100% WPPW	170

V. COST ANALYSIS

Cost of water required for construction: The water is required for many things on site whether it is for curing, mixing , for flooring etc. The water can be used firm government bodies or by calling a tanker. Suppose a construction site is started in Bardoli, which requires 4 water tankers of 5000 liters capacity each to fulfill its demand at the rate of Rs. 3000 per tanker, Then the cost of water for one day = 4*3000=Rs. 12000 And if the site runs for average of 90 days then he cost spent only on water will be approximately 10.8 lacs.

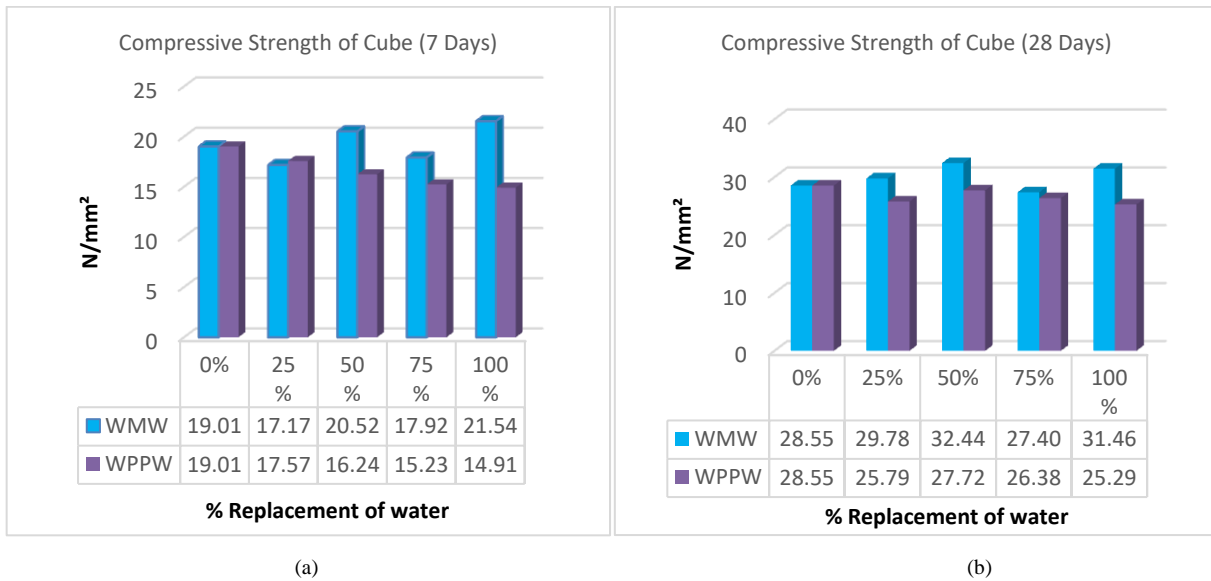


Fig. 1 Compressive strength of cubes at (a) 7 days (b) 28 days

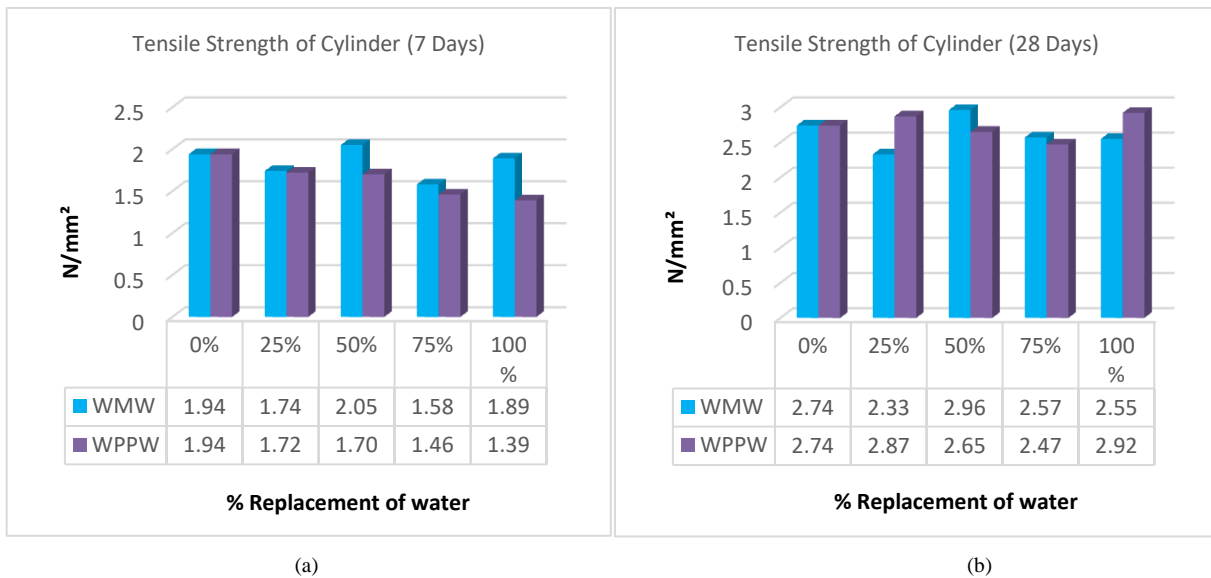


Fig. 2 Split Tensile strength of cylinders at (a) 7 days (b) 28 days

Cost of WW (like WMW & WPPW) used in any construction work: The cost of water affects any big construction project or site. In cost of water it includes its transportation cost along with the cost of PW. As both the WW are available for free and both are full filling the chemical properties of PW as per IS : 456-2000.

First we consider the cost of WMW: Let the cost of transportation for water tanker is Rs. 25/km. And the site for marble cutting is situated at 12 km from the construction site. The cost of per tanker of 5000 liter may be Rs. 300.

When we are using WPPW: In the same if the paper industry is situated at 40 km from the construction site. The cost of per tanker of 5000 liter may be Rs. 1000.

VI. DISCUSSIONS & CONCLUSIONS

On the basis of chemical analysis we can say that WMW and WPPW both can be used for partial replacement of PW as it is within the permissible limit of IS : 456 - 2000. We can use WMW & WPPW for curing purpose also. The partial replacement shows that there is increase as well as decrease in compressive and tensile strength of concrete.

When we are replacing the PW with 25% & 75% of WMW there is decrease in compressive strength and when 50% & 100% of WMW there is increase in the compressive strength. But when PW is replaced by WPPW there is decrease in the compressive strength with any % of WPPW.

Following conclusions are made:

- The consistency, initial and final setting time was found to be within the permissible limit as per IS code.
- The effect on compressive strength when we are replacing PW with 25% there is increase by 4.31% in WMW and decrease by 9.67% in WPPW.
- The effect on compressive strength when we are replacing PW with 50% there is increase by 13.63% in WMW and decrease by 2.97% in WPPW.
- The effect on compressive strength when we are replacing PW with 75% there is decrease by 4.03% in WMW and decrease by 7.60% in WPPW.
- The effect on compressive strength when we are replacing PW with 100% there is increase by 10.19% in WMW and decrease by 11.42% in WPPW.
- While in tensile strength there is increase in 25% of WPPW, 50% of WMW and 100% of WPPW only.
- We can use both waste water as a partial replacement of PW.
- Workability of concrete was good.
- The quality of concrete with partial replacement of PW was also found good.
- Concrete cost can be reduced by using the WMW in construction.
- When we are replacing the PW with 50% and 100% of WMW/WPPW we can save around 99 liters and 197 liters of water per m³ production of concrete.

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