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SODIUM HYDROXIDE (NaOH) RESISTANCE OF CEMENT MORTAR MADE WITH TREATED DOMESTIC WASTE WATER

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ABSTRACT

This article provides the effectiveness of the cement mortar mixes prepared with Treated Domestic waste Water (TDW). At first phase, the experimental study has been taken place on effective replacement of portable water with treated domestic waste water. The treated water was used in the cement mortar mixes with various dosages of 0,25,50,75 and 100%. In the second phase for effective replacement mix, the resistance of Sodium hydroxide (NaOH) is studied and it is used with various concentrations of 0, 1,2,3,4 and 5%. From the results it is found that, 50% treated water is effective and for this mix as the NaOH concentrations increases the strengths are decreasing. A model is deduced to evaluate the strength results and the model estimated the experimental results more or less with good accuracy.

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INTRODUCTION

The cement mortar composed with cement, fine aggregate and water sometimes admixtures are also used to enhance the strength of matrix. In similar way the concrete is also made with same materials including coarse aggregate additionally. The concrete is most accepted material for construction purpose (Orie (2015)) and now days with advent technology high strength concrete is recommended for special structures. In the matrix of concrete, the water plays a major role to form CSH gel and bond between the materials. Water approved for drinking is also most of times utilized for concrete works. But sometimes the water used for concrete works which is not suitable for drinking because may exceeds the limits of chloride and bicarbonates which may contribute alkali reaction with silicate material (Neville (1995,1996)). In general the water used for concrete works may have the pH value between 6 to 8 (Gupta et al.(2012),Paulo et al. (1999) and Olubenga (2014)) and water cement ratio plays major role to achieve the strength (Lawrence (2016)). Steompir (1990) and Thomas and Lisk (1970) found the influence of waste water on setting times and reinforcement corrosion (Gupta et al. (2012), Orie (2015)) of the cement concrete.

Al Manaseer et.al. (1998) studied the strength of concrete when the used water containing the sodium, calcium and potassium. Ghosh et al (2001) have used the micro organism containing water to the concrete to evaluate the (compressive and flexural) strength and durability properties (Onesmus et.al.(2016)). Smith (1976) and Ulman (1973) used the different water sources to study the strength and durability of harden concrete matrix. In addition to the different source water Sandorolini and Franoni (2001) have used the sea water to study the mechanical properties of concrete. Chatveera et al.(2006) have used the recycled sludge water for concrete works and found the properties of concrete and noticed the decrement of strengths. Cordelia Nnennaya Mama et al. (2019) collected the river, rain and portable water and used for the concrete elements. In this concern the present experimental work has focused to use the Treated Domestic waste Water (TDW) for cement mortar and to evaluate resistance for NaOH chemical. In this concern the next section presents the experimental program.

Experimental Program: To evaluate the cube compressive strength of mortar the work has planned in two phases. In the first phase the Treated domestic waste water is added to

portable water as replacement in the proportion of 0,25,50,75 and 100%. From this the effective replacement is found to achieve of pre targeted strength of cement mortar (55MPa). In the second phase for effective replacement of treated water, the mix is to expose NaOH chemical with various concentrations of 1 to 5%, with an increment of 1% for 4,8,12 and 16 months. In addition to those, a mix is prepared with portable water to know the variation of results. In the first stage total 30 cubes (70.06x70.06x70.06mm) were cast for cement mortar mixes and from these strength results, a effective mix is picked up in order to use maximum domestic treated water to evaluate and for this NaOH resistance to be evaluate. All the mixes were cast with cement to artificial sand as 1:3 with water cement ratio of 0.40 and dosage of super plasticizer is 0.2% by weight of cement.

MATERIALS AND MATERIALS

PPC, Portable water, artificial sand (or manufacture sand) used for this experimental work and these properties were checked with IS code specifications and found that, those were satisfied the limits. The treated domestic waste water was collected from the treatment plant and the properties of treated water are presented in the Table 1, including the codes limits.

Table 1. Properties of TDW and Portable water (PW)

Description	TDWW	PW	Limits as per codes		
			IS456-2000	ASTM C1602	BS EN 1008
pH	6.9	7.2	≮ 6	----	> 4
TS	850	220	----	50000	
TDS	825	210		----	2000
TSS	25	10	2000	----	2000
Organic solids	350	60	200	----	----
Inorganic solids	500	160	3000	----	----
Alkalinity	45	150	250	----	1000
Acidity	25	5	50	----	----
Chlorides for RCC	300	200	500	1000	1000
Chlorides for PCC	300	200	2000		4500
Sulphates	202	85	400	3000	2000

Note: Except pH, all are in mg/L

DISCUSSION OF RESULTS

TDW effect on Cube compressive strength: The cube compressive strength of the results is presented in Table 2 and figure 1. From the results it is noticed that, for PPC mixes the strengths are increasing as the age of specimens increases. The mix with 0T was taken as reference mix for comparison of other results. For PPC mixes the 28 days compressive strength was decreased and it ranges from 2.18 to 22.52%, in the similar way for 90 days it ranges from 3.04 to 21.22%. From the results it is observed that, the 28 days PPC mixes shows lesser strengths than the 90 days mixes. Probably this may be due to presence of fly ash in the PPC; this may not react at early stage to attain the effective CSH gel. Hence the variation in strengths apparently noticed. The cement mortar mix was targeted to achieve 55MPa and from the Table 2 it is observed that, the design strength at 90 days it was noticed for 50%TDW and for other of more than 50% TDW the strengths are less. These observations may due to quality of water used for preparing the mixes. Hence in this case the effective replacement was declared as 50% and this considered to study the sulphate and acid resistance and the detailed discussion of this is presented in the next section.

Table 2. Compressive strength (MPa)

Sl.No.	Mix name	% TDW	PPC	
			28 days	90 days
1	0T	0	59.50	64.10
2	25T	25	58.20	62.15
3	50T	50	53.25	57.60
4	75T	75	50.20	54.15
5	100T	100	46.10	50.50

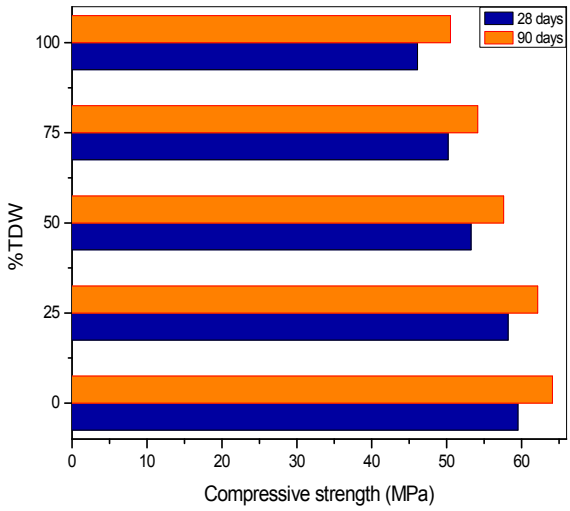

Fig. 1. Compressive strength vs %TDW

NaOH effect: To study the NaOH effect on cement mortar, cube specimens cast with treated domestic waste water of 50% and these were soaked with various dosages of NaOH. For this total 72 cube specimens (70.6x70.6x70.6mm) were prepared and exposed to 4,8,12 and 16 months. The specimens were immersed with various concentrations of NaOH 1,2,3, 4 and 5%. In addition to those mixes 0% NaOH mix also taken and exposed for same curing days and this mix was consider for evaluation of performance of others. All the cubes were tested under compression testing machine and the obtained results are presented in Table 3. From the results it is observed that, for a particular % NaOH as the curing age increases the %of compressive strength increases. In this aspect for 1%NaOH the strength increment ranges from 1.41 to 5.85% with various curing period of 120 to 480 days. Similarly for 2, 3,4 and 5%NaOH solutions the strength varies 1.35 to 5.50%, 1.30 to 5.00%, 1.25 to 3.70% and 0.69 to 2.78% respectively. The change of compressive strength is slow for 5%NaOH and it is followed by 4, 3, 2 and 1% of NaOH. By observing the results in view of curing age, for 120 days the compressive strengths are decreasing 1.53 to 0.69% when compared with 90 days strength of 50%TDW mix (57.6Mpa) for various concentrations of NaOH solutions. In the similar way for 240,360 and 480 days the compressive strength decreases in % from 5.16 to 1.04, 6.13 to 2.08 and 6.49 to 2.78% respectively for 0 to 5%NaOH solutions. The percentage changes of compressive strengths for all mixes are shown in the figure 2.

In general to evaluation of strength results, mathematic relations can be used with different variables which were affecting. In this view here it is decided to deduce a model by considering the variables of 90 days cube compressive strength (water curing), expose period in days and various concentrations of NaOH. By considering the regression analysis (principle of least squares), multiple regression

procedure has been adopted and obtain model depicted below. The model is verified and the results are presented in Table 3. The ratios between experimental and model results are shown in the same table. From the observations is came to know that, the model is varying with a maximum value of 2% and this indicates consistency of results. In the provided equation, f_{naoh} represents the cube compressive strength (MPa) and remaining terms in the equation are self explanatory.

$f_{naoh} = 2.08(f_{c90})+0.0035(Days)-0.168(\%NaOH)-61.06$ ---------- (Equation -1)

Table 3. Compressive Strength (CS) of NaOH

Sl.No	% NaOH	Experimental Compressive strength (MPa)			
		4 months	8 months	12 months	16months
1	0	58.48	60.57	61.13	61.34
2	1	58.41	60.31	60.77	60.97
3	2	58.38	60.08	60.42	60.77
4	3	58.35	59.79	60.25	60.48
5	4	58.32	59.50	59.96	59.73
6	5	58.00	58.20	58.80	59.20
Model Compressive strength (MPa)					
7	1	58.94	59.36	59.78	60.20
8	2	58.77	59.19	59.61	60.03
9	3	58.61	59.03	59.45	59.87
10	4	58.44	58.86	59.28	59.70
11	5	58.27	58.69	59.11	59.53
Ratio between experimental to model results					
12	1	0.99	1.02	1.02	1.01
13	2	0.99	1.01	1.01	1.01
14	3	1.00	1.01	1.01	1.01
15	4	1.00	1.01	1.01	1.00
16	5	1.00	0.99	0.99	0.99

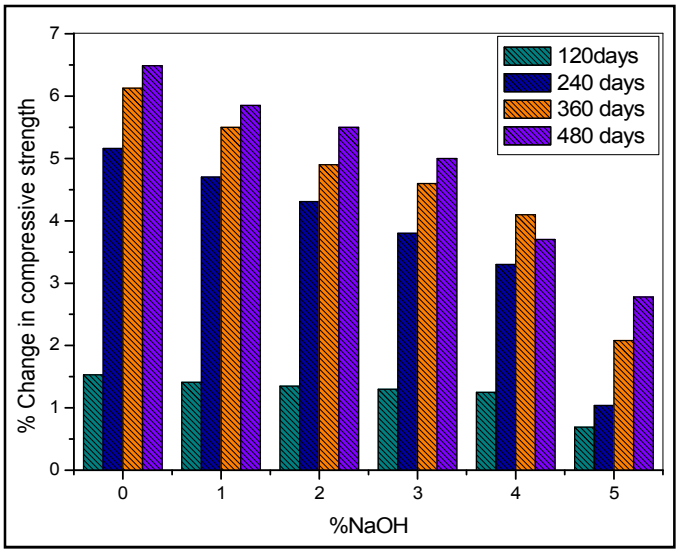

Fig. 2. Change in compressive strength

Conclusion

The effective replacement of TDW is 50% among various replacements of 0 to 100% to achieve pre targeted cube compressive strength (55MPa). When this mix exposed to NaOH concentrations of 0 to 5% for various curing periods of 120,240,360 and 480 days, the cube compressive strength increase as curing age increases for a particular % NaOH concentration and with respect particular curing period the strengths are decreasing for various % NaOH's. To estimate the results a model is developed and it exhibited good consistency of results.

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