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Experimental Study on Feasibility of Non Potable Water with Lime on Properties of Ppc

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Abstract: This research aimed to investigate feasibility of outlet water of water treatment plant and limewater on properties of Portland pozzolana cement (PPC) .Twenty water treatment plants were found out in the Bhimavaram municipality region in West Godavari district, Andhra Pradesh, India. Approximately, each plant supplying potable water about 4000 to 5000 L/day. All plants are extracting ground water and treating through Reverse Osmosis (RO) process. At outlet, huge quantity of wasted water is being discharged into side drains in Bhimavaram municipality. One typical treatment plant was selected, and water at outlet was collected and Physical and chemical analysis was carried out as per producer described in APHA. The effect of plant outlet water(POW), lime water(LM), and plant outlet water with lime (POWL) on physical properties i.e., setting times, compressive strength, and flexural strength of Portland pozzolana Cement (PPC) were studied in laboratory and compared same with reference specimens i.e., made with Distilled Water (DW) as mixing water. No significant change was observed in initial and finial setting time in POW, LW, and (POWL) as compared with reference specimens made with distilled water (DW). Compressive strength was significantly increased with LW and (POWL) specimens compared to that of reference specimens. XRD technique was employed to study the mineralogical analysis.

Keywords: Plant outlet water, limewater, setting time, compressive strength, flexural strength

1. INTRODUCTION

Ever since concrete began to be used as a construction material, potable water has been using as the mixing water in concrete due to the chemical composition is well known. The literature search indicates that, not much research work has carried out on the quality of mixing water in

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concrete and there are no detailed guide lines [1 - 3] for the use of water in concrete. The building code requirements of different countries generally contain broad guidelines on mixing and curing water. Most of the codes consider potable water to be satisfactory for both mixing and curing of concrete and stipulate permissible limits for solids and aggressive chemicals. .However, In recent years, attention has been focused on the potential for various aspects of wastewater reuse, although previous research has been performed on the use of wastewater that are producing from the water treatment plants and industries for making concrete and reported that no adverse effects on concrete properties in fresh and hardened state [6-16]. Also [1,17] stated that the compressive strength of the cubes made of water with unknown chemical composition not to be less than 90% of cubes made with potable water. There is a note in BS 3148 – 1980which states that non potable water that results in a strength reduction of up to 20% can be acceptable compared to that of cubes made with potable water, with appropriately mix proportions. However, limit of a chemical in mixing water of concrete given by various codes is tabulated in table .1

Therefore, throughout Andhra Pradesh 71 municipalities and 13 municipal corporations were existed. From these municipalities, small to large scale water treatment plants might have been setup. As a result of water treatment plants, huge volume of ground water is wasted as wastewater. Hence, present work is taken up on the effect of plant outlet water with lime on properties of PPC.

2. MATERIALS AND METHODS

2.1. Cement

Portland Pozzolana cement was used. The physical properties of cement are given in Table: 2.

2.2 Sand

The ennor sand was used. Table 3 gives its physical properties. The cement to fine aggregate ratio was maintained at 1:3 by weight in the mortar mixes.

2.3 Water

Distilled water was used in reference specimens and plant outlet water, Limewater (300mg/L), plant outlet water with lime(300 mg/L) were used in test specimens. The physical and chemical properties of DW, POW, POWL, and LW are given in Table: 4.

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Table:1 Tolerable limits of impurities in mixing water of concrete (all values in mg/L, except pH)

Constituent	Tolerable Limit	Reference
pH	3	[18,19]
	>5	[20,21]
	6	[1]
	6-8	[22]
	7-9	[2]
Total solids	50000	[3]
	5000-10000	[23]
	4000	[19]
Suspended solids	2000	[23,24,1]
Dissolved solids	50000	[26]
	2000	[24,1,2]
	<6000	[27]
Organic solids	200	[1]
Inorganic solids	3000	[1]
Sodium Carbonates and Bicarbonates	2000	[20,21,23]
Carbonate	1000	[25]
Bicarbonate	400	[25]
Chlorides for plain concrete	360	[32]
	500	[20,21,24]
	2000	[1]
	4500	[33]
Chlorides for Reinforced concrete	500	[8,1,34]
	1000	[35, 33]

Table 2: Properties of Cement

Property	Result
Specific gravity	3.20
Fineness, m^2/kg	34.3
Initial setting time, minutes	140
Final setting time, minutes	235
Compressive strength ,N/mm^2	
3 days	34.
7 days	48
28 days	58
90 days	60
Flexural strength ,N/mm^2	
3 days	3.7
7 days	4.9

28 days	6.2
90 days	6.5

Table 3: Properties of Sand

Property	**Result**
Specific gravity	2.65
Bulk density, kN/m^3	15.75
Fineness modulus	2.75
Grading	Percentage
Passing in 2mm sieve	100%
Retained on 2mm sieve	100%
Particles size 2mm to 1 mm	33.33%
Particle size lee than 1 mm to 500µ	33.33%
Particle size lee than 500 µ mm to 90µ	33.33%
Absorption in 24 hours	0.8%
Shape of grains	Sub angular

Table 4: Physical and chemical properties of mixing waters in PPC (Except pH all are in mg/L)

Property	As per IS:456-2000	DW	POW	POWL	LW
pH	Not less than 6	7.0	7.3	9.5	12.00
Suspended matter	2000	0	10	5	0
Organic solids	200	0	15	10	0
Inorganic solids	3000	0	250	150	0
Chlorides	500 for RCC 2000 for PCC	0	10	7.5	0
Sulphates	400	0	5	3.5	0

2.4 Methods

Distilled water, plant outlet water, limewater and plant outlet water with lime were analyzed as per procedure laid down in [36]. The quantity of cement, sand, and mixing water for each specimen were 200 g, 600g, and (P/4 + 3), where P denotes the percentage of water required to produce a paste of standard consistency. Twelve samples were prepared and tested for initial and final setting time using Vicat's apparatus. Sixty mortar cubes with 50 cm2cross sectional area and same number of square prisms of 160X40X40 mm were cast for compressive and flexural strengths. Tests were performed at 3 days, 7 days, 28 days and 90 days for compressive and flexural strengths. The compacted specimens in moulds were maintained at a controlled temperature of 270±20 and at 90 percent relative humidity for 24 hours by keeping the moulds under gunny bags wetted by the same mixing waters of the specimens. After 24 hours, all specimens were subjected to immerse curing for rest of 27 days.

2.5 Powdered X-Ray Diffraction (XRD)

Powdered XRD analyses were conducted to investigate the mineralogical composition of cement paste on 28 days of hydration [37]. The reference and test specimen (POWL) were grinded to a fine powder and a flat specimen was prepared on a glass surface using an adhesive for XRD measurement. The diffracted intensities were recorded using monochromatic Copper Kα radiation.

3. RESULTS AND DISCUISSION

3.1 Setting time

3.1.1 Initial setting time

Performance of DW, POW, POWL and LW on initial and final setting times of PPC is depicted in Fig. 3.1

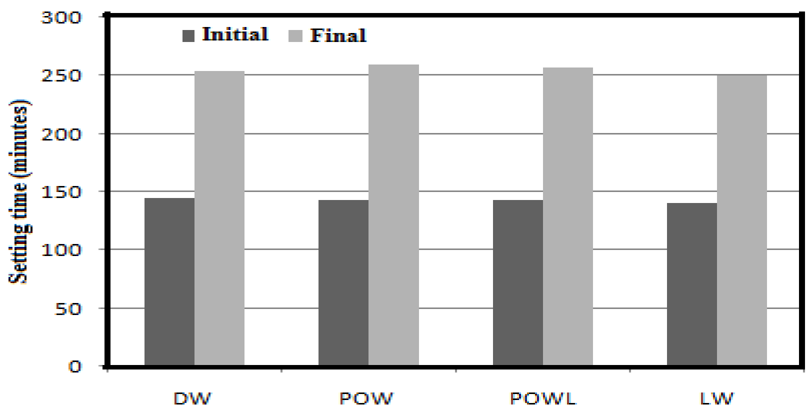

Fig 3.1 Effect of mixing waters on setting time

The performance of POW, POWL and LW in initial setting time of PPC is almost same as that of DW. Initial setting time of DW, POW, POWL and LW are 145, 143,144, 141 minutes respectively.

3.1.2 Final setting time

The performance of POW, POWL and LW on final setting time of PPC is shown in Fig 1. The final setting times of POW, POWL and LW are with marginal variations wirth same as that of DW. Final setting time of DW, POW, POWL and LW are 254, 260, 257, and 250 minutes respectively.

3.2 Compressive strength of PPC

Influence of DW, POW, POWL and LW on compressive strength of PPC is shown in Fig.2. It discloses that

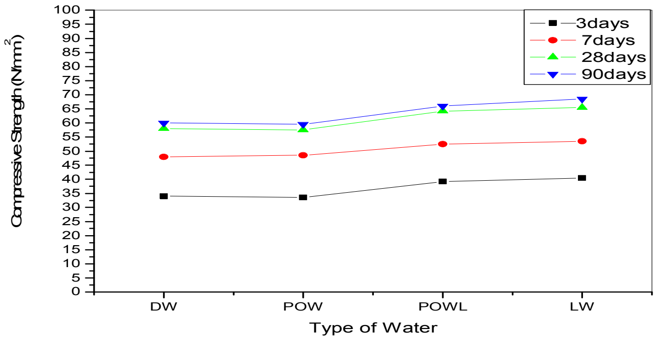

Fig. 3.2 Effect of different waters on compressive strength

3 days compressive strength of DW, POW, POWL and LW are 34, 33.5, 39.2, 40.5 N/mm2, Compressive strength of POWL and LW is 15.29%, 19.11% more than that of DW. For 7 days compressive strength of DW, POW, POWL and LW are 48, 48.5, 52.5 and 53.5 N/mm2, compressive strength of POWL and LW is 9.37%, 11.45% higher than that of DW. For 28 days compressive strength of DW, POW, POWL and LW are 58, 57.5, 64.2 and 65.5 N/mm2, increase in compressive strength of POWL and LW is 10.68%, 12.93% higher than that of DW. For 90 days compressive strength of DW, POW, POWL and LW are 60, 59.5, 66.0 and 68.5 N/mm2 respectively, increase in compressive strength of POWL and LW is 10.68%, 14.16% higher than that of DW. However, compressive strength of POW at 3, 7, 28, and 90 days is with a little variation same as that of reference specimens made with DW.

3.3 Flexural Strength

Influence of DW, POW, POWL and LW on flexural strength of PPC is shown in Fig.3.

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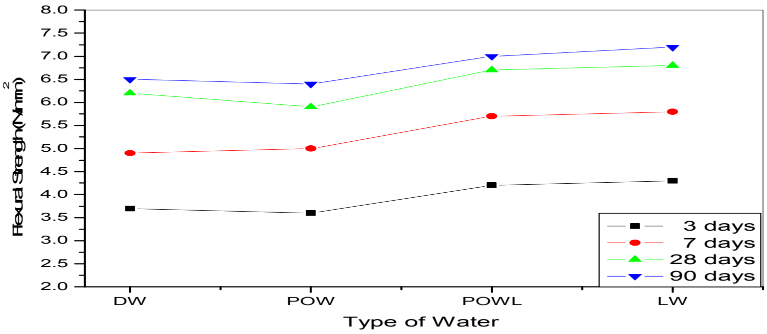

Fig 3.3 Effect different waters on flexural strength

3 days flexural strength of DW, POW, POWL and LW are 3.7, 3.6, 4.2 and 4.3 N/mm2, flexural strength of POWL and LW is 13.51%, 16.21% more than the DW. For 7 days flexural strength of DW, POW, POWL and LW are 4.9, 5.0, 5.7 and 5.8 N/mm^2, flexural strength of POWL and LW is 16.32%, 18.36% higher than that of DW. For 28 days flexural strength of DW, POW, POWL and LW are 6.2, 5.9, 6.7 and 6.8N/mm^2, increase in flexural strength of POWL and LW is 8.06%, 9.67% higher than that of DW. For 90 days flexural strength of DW, POW, POWL and LW are 6.5, 6.4, 6.8 and 7.0 N/mm2 respectively, increase in compressive strength of POWL and LW is 7.14%, 10.76% higher than that of DW. However, flexural strength of POW at 3, 7, 28, and 90 days is with a little variation same as that of DW.

3.4 XRD Analysis

XRD of DW and test sample POLW cured for 28 days is shown in Fig. 4. It can be seen that both reference and test samples XRD patterns are almost same. The compounds identified in reference sample (DW) and test sample (POLW) are C3S, C2S, CSH, and CH. No new compounds are formed, due to lime water, extra C-S-H gel produced, hence, strength is increased.

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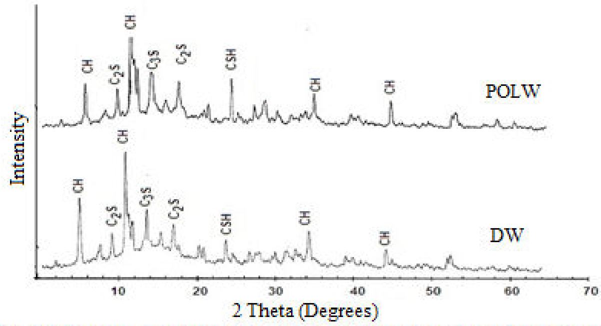

Fig 3.4 XRD Pattrens of the hydrate PPC powder DW and POLW at age of 28 days

CONCLUSION

The following conclusions are drawn on the basis of the results obtained in this paper

- Setting times of POW, POWL and LW is almost same as that of DW.
- Compressive and flexural strengths of POL and DW is almost same
- Compressive and flexural strengths of POWL and LW are significantly higher than that of DW,
- In the XRD analysis, regular compounds C3S, C2S, CSH, and CH are appeared.
- Water treatment plants outlet waters may be recommended to use in cement mortar.

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