EFFECT OF DIFFERENT SOURCES WATER SAMPLES ON CONSISTENCY AND SETTING TIMES OF CEMENT MORTARS MADE WITH OPC AND PPC

R Rajesh Kumar[1], M Tejoprakash[2]
[1]Assistant Professor of Civil Engineering Department, Siddharth Institute of Engineering & Technology, Puttur A.P, India
[2]Post Graduate Student, Civil Engineering Department, Siddharth Institute of Engineering & Technology, Puttur A.P, India

ABSTRACT

Ground water pollution is showing a heavy impact on strength and durability of Civil Engineering Constructions. In this investigation is mainly focused on the impact of quality of ground water on consistency and setting times of cement mortars made with Ordinary Portland Cement and Portland Pozzolana Cement. The ground water was collected from six different sources namely Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi and RTC Area (Places nearer to Tirupati) for preparation of mortar. The ground waters were analysed for their Physical and Chemical Characteristics in a laboratory.

The final setting times of OPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram and Karakambadi shows lower values when compared with OPC with deionized water. The final setting times of OPC with various sources of water collected from Airport and RTC area shows higher values when compared with OPC with deionized water.

The final setting times of PPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram, Karakambadi and RTC area shows lower values when compared with PPC with deionized water. The final setting times of PPC with water collected from Airport shows higher values when compared with PPC with deionized water.

KEYWORDS: Deionized water, Ordinary Portland Cement, Port Pozzolana Cement, Consistency and setting times of cement

1. INTRODUCTION

The availability of potable water is getting diminished every year all over the world and particularly in the developing countries. As against the problem of increased demand for water. The construction industry has to use the available water in the vicinity of construction. The parameters considered setting times, compressive strength of cement mortar cubes at different ageing periods.

Mortar consists of aggregate, which is normal sand and the binding material, which is cement mixed thoroughly with water. Mortar is used to bed blocks as well as for plastering. A good mortar should be easy to use and should harden fast enough that it does not cause delays in the construction. It must be strong enough, long lasting and weather proof.

1.1 **Types of Mortar:**

In mortar, Binding material play key role. The quality, durability and strength of the mortar will mainly depend on the quantity and quality of binding material used. Classification based on the binding material used is as follows.

- Cement mortar
- Lime mortar
- Gypsum mortar
- Gauged mortar
- Surkhi mortar
- Aerated cement mortar

2. LITERATURE REVIEW

Cement is the principal constituent of traditional binding materials that are used in construction. The energy requirements for the production of cement are very high and consequently there is a significant cost premium and environmental impact associated with the use of this material.

According to ASTM C150, Portland cement is defined as hydraulic cement produced by pulverizing clinker primarily consisting of hydraulic calcium silicates, and containing one or more types of calcium sulphate as an inter ground addition. "Blended Cement" refers other materials which may the term for a hydraulic cement consisting of portland cement and other appropriate inorganic materials.

Normally, 3-5% of gypsum is added to cement to regulate the time to set. When cement is mixed with water, it forms a gel called calcium silicate hydrate (CSH), which binds the coarse and fine aggregate. The reaction of water with calcium hydroxide ($Ca(OH)_2$) is produced as a by-product of cement hydration. The quantum of ($Ca(OH)_2$) liberated is dependent on C_3S/C_2S ratio. However the quantum of $Ca(OH)_2$ produced due to hydration reaction is more than 30% by weight of cement. The $Ca(OH)_2$ produced by the hydration reaction significantly influences the durability performance of portland cement concrete. On one hand it increases the alkalinity of the pore solution which is helpful in providing electrochemical production to steel, while on the other hand it forms as essential component for deterioration of portland cement due to sulphate attack. The other compound of cement which controls its durability performance is tricalcium aluminate (C_3A). The susceptibility of portland cement concrete to sulphate attack increases with increasing quantum of C_3A.

According to Neville (1993), the strength of mortar depends on the cohesion of the cement paste and on its adhesion to the fine aggregate (quartz sand in our case). In the compressive strength mortar test a 1:3 cement – sand mortar is used. The cement, which is used in construction works, must have certain qualities in order for it to play its part actively: otherwise it will create a number of problems. When these properties lie within a certain specified range of standards, the engineer is confident that the cement performance will be quite satisfactory. Moreover, based on these properties, it is possible to compare the quality of cement.

In the past, natural pozzolanas (materials that when finely ground and used in combinations with calcium hydroxide and water exhibit cementitious properties) such as metakaolinite (MK) have also been shown to increase the strength of OPC. For example, showed that the use of 10% of a natural pozzolana increased the overall strength of OPC Paste. Another study showed that when MK was added to OPC, it promoted a decrease in the porosity, and the formation of a finer pore size distribution of the cement paste.

3. EXPERIMENTAL PROGRAMME

3.1 Materials

Two different kinds of cements namely Ordinary Portland Cement (OPC) and Portland Pozzolana Cement (PPC) were used in the present investigation. These materials were procured from local market. Water samples were collected from the different places like Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi and RTC area (the places nearer to Tirupati). River sand is used as Fine Aggregate to prepare mortar. Deionised water is used as a reference solution.

3.1.1 Ordinary Portland Cement

Ordinary Portland Cement 53 grade was used corresponding to IS 12269 (1987). The chemical and physical properties of the cement as obtained by the manufacturer are presented in the Table 3.1 and 3.2 respectively.

Table: 3.1 Chemical Composition of Ordinary Portland Cement

Oxide	Common Name	Approx. Amount (%)
CaO	Lime	60 – 67
SiO_2	Silica	17-25
Al_2O_3	Alumina	3 – 8
Fe_2O_3	Iron Oxide	0.5 - 6
MgO	Magnesia	0.1 - 4
Na_2O	Soda	0.2 – 1.3
K_2O	Potassa	
SO_3	Sulphuric Anhydride	1 – 3

Table 3.2 Physical Properties of Ordinary Portland Cement

Physical properties	Test result
Specific gravity	3.06
Fineness (m^2/Kg)	311.5
Normal consistency	30%
Initial setting time (min)	90
Final setting time (min)	220
Soundness Lechatelier Expansion (mm) Autoclave Expansion (%)	0.8 0.01

3.1.2 Portland Pozzolana Cement

The Portland Pozzolana Cement is a kind of Blended Cement which is produced by either intergrading of OPC clinker along with gypsum and Pozzolanic materials in certain proportions or grinding the OPC clinker, gypsum and Pozzolanic materials separately and thoroughly blending them in certain proportions.

Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementitious properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. It is essential that pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland cement) in the presence of water to form stable calcium silicates which have cementitious properties.

3.1.3 Fine aggregate

The sand used for the experimental programmed was locally procured (Indian Standard Specifications IS: 383-1970). The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. The aggregates were sieved through a set of sieves of 4.75 mm, 2.36 mm, l.l8 mm, 0.6 mm, 0.3 mm, 0.150 mm, 0.75 mm and pan to obtain sieve analysis.

Natural river sand was used as fine aggregate. The bulk specific gravity in oven dry condition and water absorption of the sand as per IS 2386 (Part III) 1963 were 2.62 and 1% respectively. The gradation of the sand was determined by sieve analysis as per IS: 383-1970. Fineness modulus of sand was 2.69.

Table: 3.3 Sieve Analysis of Fine Aggregate

Sieve No.	Cumulative Percent Passing	
	Fine Aggregate	Requirements as per IS 383 – 1970 (ZONE II)
10 mm	100	100
4.75 mm	98.8	90 – 100
2.36 mm	96.8	75 – 100
1.18 mm	70.8	55 – 90
0.600 mm	48.2	35 – 59
0.300 mm	14.4	8 – 30
0.150 mm	2.0	0 - 10

3.1.4 Water

Though addition of water decreases both the yield stress and the plastic viscosity, it reads to segregation. Moisture content and water absorption of aggregates should be considered to avoid segregation. As water content affects the stability of the mix, self-compacting mortar (SCM) tests should be carried out to optimize the dosages.

The oldest method for production of pure water is the thermal method or distillation. Water evaporation from the surface and condensation. The basis of the process is the transfer of water in the vapour phase with its subsequent condensation. The main drawback of this method is the very high maintenance costs of the electricity needed to convert the water into the steam. In addition, in the process of steam formation along with water molecules other solutes can enter the steam according to their volatility. Evaporation is achieved in various ways: the vacuum above the water, heating, etc. Deionized water or DI water

3.2 Test Methods

This section describes the test methods that are used for testing the cement and cement mortars.

3.2.1 Determination of Fineness of Cement by Dry Sieving (IS: 4031 (Part 1) 1996)

Procedure

- Take representative sample of 10grams (R_1) of cement from the specified lot
- Agitate the sample of cement to be tested by shaking for 2 minutes in a stoppered jar to disperse agglomerates wait 2 minutes and stir the resulting powder gently using a clean dry rod in order to distribute the fines throughout the cement.
- Fit the tray under the sieve and place the sample on the sieve.
- Fit the lid over the sieve, agitate the sieve by swirling, planetary and linear movement until no more fine material passes through it.
- Remove and weigh the residue (R2).
- Express its mass as a percentage of the total quantity.
- Gently brush all the fine material of the base of sieve in to the tray.
- Make at least two determinations for each test.

3.2.2 Determination of Consistency of Standard Cement Paste (IS: 4031 (Part 4) 1988)

Procedure

- Unless otherwise specified this test shall be conducted at a temperature 27 + 20C and the relative humidity of laboratory should be 65 + 5%.
- Prepare a paste of weighed quantity of cement (300gms) with weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3minutes nor more than 5minutes and the gauging is completed before any sign of setting occurs.
- The gauging is counted from the time of adding water to the dry cement until commencing to fill the mould.
- Fill the vicat mould with this paste resting upon a non-porous plate.
- Smoothen the surface of the paste, making it level with the top of the mould.
- Slightly shake the mould to expel the air.
- In filling the mould operator's hands and the blade of the gauging trowel shall only be used.
- Immediately place the test block with the non-porous resting plate, under the rod bearing the plunger.
- Lower the plunger gently to touch the surface of the test block and quickly release, allowing it sink into the paste.
- Record the depth of penetration
- Prepare trial pastes with varying percentages of water and test as described above until the plunger is 5mm to 7mm from the bottom of the vicat mould.

3.2.3 Determination of Initial & Final Setting Time

Procedure

- Unless otherwise specified this test shall be conducted at a temperature of 27 $\pm$ 2^{0}C and 65 $\pm$ 5% of relative humidity of the Laboratory.
- Prepare a paste of 300 grams of cement with 0.85 times the water required to a give a paste of standard consistency IS: 4031 (Part 4) 1988.
- The time of gauging in any case shall not be less than 3 minutes not more than 5 minutes and the gauging shall be completed before any sign of setting occurs.
- Count the time of gauging from the time of adding water to the dry cement until commencing to fill the mould
- Fill the vicat mould with this paste making it level with the top of the mould.
- Slightly shake the mould to expel the air.
- In filling the mould the operator hands and the blade the gauging trowel shall only be used.
- Initial Setting Time
- Immediately place the test block with the non-porous resting plate, under the rod bearing the initial setting needle.
- Lower the needle and quickly release allowing it to penetrate in to the mould.
- In the beginning the needle will completely pierce the mould
- Repeat this procedure until the needle fails to pierce the mould for 5 + 0.5mm.
- Record the period elapsed between the times of adding water to the cement to the time when needle fails to pierce the mould by 5 + 0.5mm as the initial setting time.
- Final Setting Time
- Replace the needle of the vicat apparatus by the needle with an annular ring
- Lower the needle and quickly release.
- Repeat the process until the annular ring makes an impression on the mould.
- Record the period elapsed between the times of adding water to the cement to the time when the annular ring fails to make the impression on the mould as the final setting time.

4. RESULTS AND DISCUSSION

In the present investigation the impact of quality of ground water at different location was tested and the consistency of two kinds of cement namely Ordinary Portland Cement (OPC) and Portland Pozzolana Cement (PPC) and ground water were collected from six different sources namely Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi, RTC Area (Places nearer to Tirupati) for preparation of mortar. The ground waters were analysed for their Physical and Chemical Characteristics in a laboratory.

4.1 Properties of Water:

From the table 4.1, it is clearly shows that different physical and chemical properties of water samples collected from different sources like Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi and RTC Area.

Chandragiri water has low alkalinity when compared to remaining water samples.

4.2 Fineness Tests:

Table: 4.2 Fineness of Cement

Type of Cement	Ordinary Portland Cement	Portland Pozzolana Cement
Fineness of Cement (%)	7	8.3

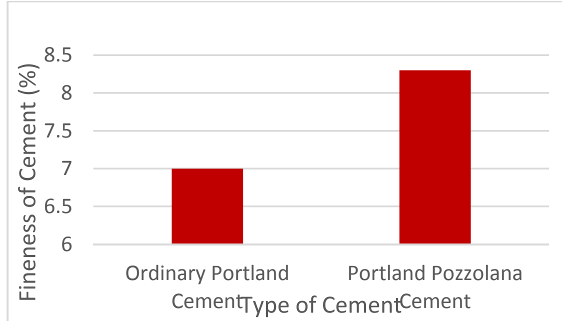

Fig: 4.1 Fineness of Cement

Table: 4.1 Properties of Water

Name of Test	Deionized Water	Avilala	Airport	Chandragiri	Padmavathi puram	Karakambadi	RTC Area
P^H	7.3	8	8	7.4	8.4	7.4	7.4
Total Hardness, mg/l	NIL	660	320	600	327	460	666
Electrical Conductivity, mg/l	40	3698	3210	1762	1585	1770	3003
Chlorides, mg/l	90	390	449	205	153	189	272
Acidity, mg/l	15	100	200	120	NIL	100	120
Alkalinity, mg/l	20	800	536	380	400	466	533
Total Solids, mg/l	20	1767	1492	900	736	1055	1277
Dissolved Solids, mg/l	3	1758	1485	887	729	1042	1265
Suspended Solids, mg/l	NIL	220	186	113	92	132	160
Calcium, mg/l	NIL	330	160	300	164	230	333
Turbidity, NTU	2	4	1.6	3.5	4.1	3.8	1.8
Sulphate, NTU	NIL	160	195	130	165	175	106

Table: 4.3 Normal Consistency of Cements with Various Sources Water

Type of Cement	Consistency Test Reading Percentage of water (%)						
	Deionized Water	Avilala	Airport	Chandragiri	Padmavathi puram	Karakambadi	RTC Area
OPC	29	32	31	30	31	32	31
PPC	31	31	31	30	30	31	31

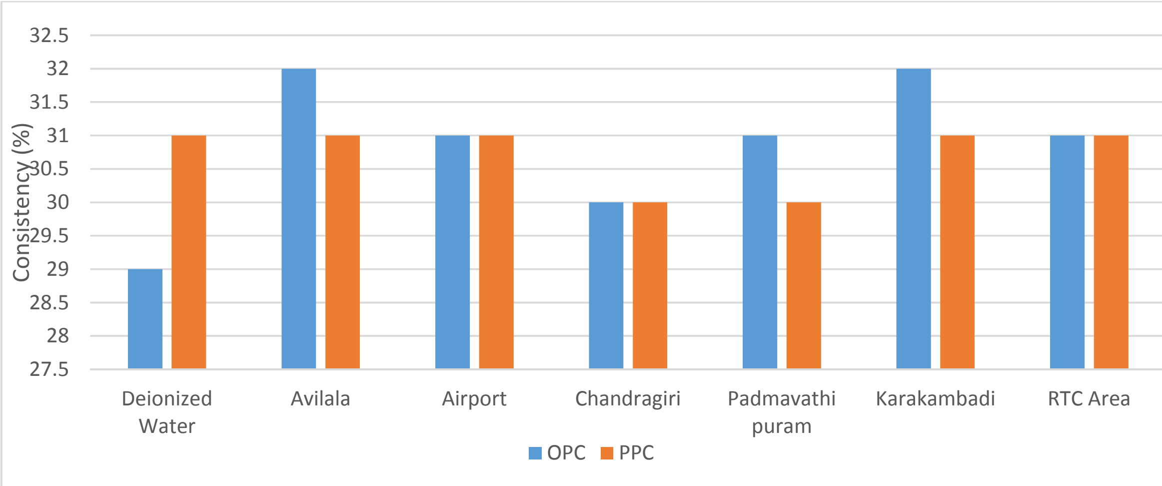

Fig: 4.2 Normal Consistency of Cements with Various Sources Water

Table: 4.4 Initial Setting Time of Cements with Various Sources Water

Type of Cement	Initial Setting Time (min)						
	Deionized Water	Avilala	Airport	Chandragiri	Padmavathipuram	Karakambadi	RTC Area
OPC	117	117	91	83	107	115	115
PPC	131	70	105	75	110	105	65

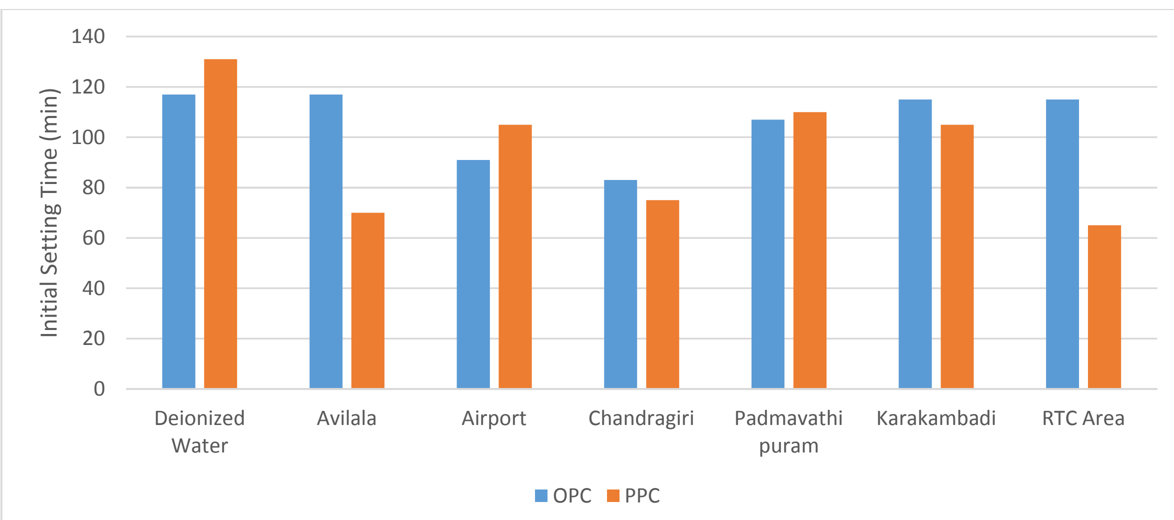

Fig: 4.3 Initial Setting Time of Cements with Various Sources Water

Table: 4.5 Final Setting Time of Cements with Various Sources Water

Type of Cement	Final Setting Time (min)						
	Deionized Water	Avilala	Airport	Chandragiri	Padmavathipuram	Karakambadi	RTC Area
OPC	397	389	401	385	391	393	410
PPC	419	360	455	370	365	370	345

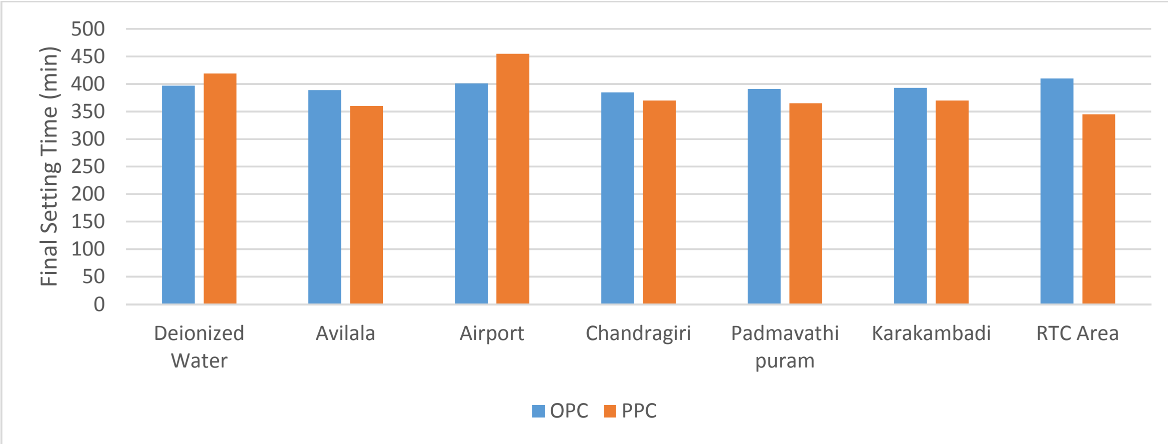

Fig: 4.4 Final Setting Time of Cements with Various Sources Water

From the table 4.2, Fineness of cement is compared with various types of cements like Ordinary Portland cement and Portland Pozzolana Cement it is clearly shown that Ordinary Portland Cement exhibits higher fineness when compared to Portland Pozzolana Cement.

4.3 Normal Consistency Tests:

From the table 4.3, Consistency of OPC with deionized water shows lower value when compared to consistency of OPC with different sources of water collected from Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi, and RTC area. Consistency of OPC with Avilala and Karakambadi water shows higher value.

Consistency of PPC with deionized water shows equal value when compared to consistency of PPC with different sources of water collected from Avilala, Airport, Karakambadi and RTC area. Consistency of PPC with deionized water shows higher value when compared to consistency of PPC with Chandragiri and Padmavathipuram water.

4.4 Initial Setting Times of Cement:

From the table 4.4, the initial setting times of OPC with various sources of water shows lower values when compared to OPC with deionized water.

The initial setting times of PPC with various sources of water shows lower values when compared with PPC with deionized water.

4.5 Final Setting Times of Cement:

From the table 4.5, the final setting times of OPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram and Karakambadi shows lower values when compared with OPC with deionized water. The final setting times of OPC with various sources of water collected from Airport and RTC area shows higher values when compared with OPC with deionized water.

The final setting times of PPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram, Karakambadi and RTC area shows lower values when compared with PPC with deionized water. The final setting times of PPC with water collected from Airport shows higher values when compared with PPC with deionized water.

5. CONCLUSION

This chapter summarizes the overall conclusions drawn from the present investigation.

1. Chandragiri water has low alkalinity when compared to remaining water samples.
2. Ordinary Portland Cement exhibits higher fineness when compared to Portland Pozzolana Cement.
3. Consistency of OPC with deionized water shows lower value when compared to consistency of OPC with different sources of water collected from Avilala, Airport, Chandragiri, Padmavathipuram, Karakambadi, and RTC area.
4. Consistency of OPC with Avilala and Karakambadi water shows higher value.
5. Consistency of PPC with deionized water shows equal value when compared to consistency of PPC with different sources of water collected from Avilala, Airport, Karakambadi and RTC area.
6. Consistency of PPC with deionized water shows higher value when compared to consistency of PPC with Chandragiri and Padmavathipuram water.
7. The initial setting times of OPC with various sources of water shows lower values when compared to OPC with deionized water.

8. The initial setting times of PPC with various sources of water shows lower values when compared with PPC with deionized water
9. The final setting times of OPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram and Karakambadi shows lower values when compared with OPC with deionized water. The final setting times of OPC with various sources of water collected from Airport and RTC area shows higher values when compared with OPC with deionized water.
10. The final setting times of PPC with various sources of water collected from Avilala, Chandragiri, Padmavathipuram, Karakambadi and RTC area shows lower values when compared with PPC with deionized water. The final setting times of PPC with water collected from Airport shows higher values when compared with PPC with deionized water.

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