

# Comparison of Physical Properties on Natural Cement Motor with Alkalinity

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**Abstract:** Water used for mixing and curing of concrete or motor should be free from deleterious chemical substances which are likely to exert appreciable influence on hardening and strength development of cement motor or concrete. Most of the ground water available in India possesses more alkalinity than that specified by standard codes. Alkalinity of water indicates the presence of substances like carbonates, bicarbonates of calcium, magnesium and sodium in water. Hence, the present work is undertaken to examine the influence of chemical substance as calcium chloride, magnesium chloride and magnesium sulphate on hardening and strength development of concrete structures by considering the various water quality parameters. In order to overcome the failure of structures due to alkalinity of water in natural pozzolona cement various tests has been conducted such as soundness test, initial and final setting time test, and compressive strength at various stages. These results should be compared with both deionized water and the various concentration levels of three acidic substances. If the concentration of  $\text{CaCl}_2$ ,  $\text{MgCl}_2$  and  $\text{MgSO}_4$  exceeds 1.5-2g/l then the strength at long duration can be decreases.

**Keywords:** PPC, cement alkalinity, deionized water, ph value

## 1. Introduction

The first known Pozzolan was pozzolona, a volcanic ash, for which the category of materials was named. The most commonly used pozzolona today is fly ash, though silica fume and other materials are also used as pozzolona.

During the past decade significant attention has been invested in another pozzolona, silica fume (SF). The advantages of concrete containing silica fume over a plain Portland cement concrete are mainly in its higher strength and lower permeability. Under practical conditions it can attain strengths of approximately 96 MPA about 2-3 times the strength of Portland cement concrete. This means a significant reduction in weight and size of a structure can be achieved. The lower permeability can also make it a very durable material.

The I.S. Code 456-2000 also specifies the minimum Ph-value as 6.0 and also permissible limits for solids in the water to fit for construction purpose. I.S Code 456(1978&2000) precise that in cases of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and setting time test. According to these standards, the best way to determine the suitability of water unknown performance for making concrete is to compare the setting time of cement and strength of mortar cubes made with the unknown water and a reference water that is clean. The Cubes Made with the questionable water should have compressive strength equal to or at least 90 percent of the strength of reference specimens made with a clean water, also the quality of mixing water should not effect the setting time of cement to an unacceptable degree and the setting time different should not be more than 30 minutes from the setting times of the control test block prepared with same cement and distilled water.

## 2. Materials and Method

### 2.1. Portland Pozzolona Cement (PPC)

The most common cement currently used in construction is type I/II Portland pozzolona cement, the grade of cement is similar to ordinary Portland cement. Initial experiments like initial setting time, final setting time, soundness and compressive strength test on mortar cubes were conducted on Portland Pozzolona cement and Portland pozzolona cement with the regard to various natural admixtures

### 2.2 Sand

The sand used throughout the experimental work has obtained from the river Swarnamukhi near Tirupathi. This type of sand was used by many of researchers as an ingredient in cement mortar. Sand shall be of quartz, light gray or whitish variety which is free from slit. The shape of grains shall approximate to spherical form, enlarged and flattened grains shall be present only in negligible quantities.

### 2.3 Silica Fume

Specific gravity of silica fume ranges between 2.2 to 2.3 bulk density of silica fume ranges from 130-600  $\text{kg/m}^3$ . Silica fume has extreme fines and high silica content. By adding silica fume with PPC there will be increase in compressive strength, bond strength and abrasion resistance. Also by adding silica fume permeability and corrosion of concrete should decrease

### 2.4. Water:

Water is used for mixing and curing the concrete. Water which is fit for drinking can also be used for construction purpose

METHODS:

### Consistency

About 400 g of cement was initially mixed with 30 percent mixing of water. The paste was filled in the mould of Vicat's apparatus and care was taken such that the cement paste was not pressed forcibly in the mould and the surface of the filled paste was smoothed and levelled. A square needle 1mm\*1mm of size is to be attached to the plunger and then lowered gently on to the surface of the cement paste and is released quickly. As plunger pierces the cement paste, reading on scale was recorded. The experiment was performed carefully away from vibrators and the other disturbances. The test procedure was repeated by increasing the percentage of mixing water at 0.5 % increment until the needle reaches 5 to 7 mm from the bottom of the mould. When this condition was fulfilled, the amount of water added was taken as the correct percentage of water for normal consistency. The entire test was completed within 3 to 5 minutes, if the time taken to complete the experiment exceeded 5 minutes, the sample was rejected and fresh sample was taken and the operation was repeated again. Fresh cement was taken for each repetition of the experiment. The plunger was cleaned each time the experiment was done.

### Initial and final setting times

Cement paste was prepared by mixing cement with 0.85 times approximate mixing water required to give a paste of standard consistency. The stop watch was started at the instant the mixing water was added to the cement. After half a minute, the paste was thoroughly mixed with fingers for one minute. The mould resting on a nonporous plate was filled completely with the cement paste and the surface of the filled paste was levelled smooth with the top of the mould. The test was conducted at room temperature of 27±2° C at a relatively humidity of 60 %.The mould with the cement paste was placed in the Vicat's apparatus and the needle lowered gently to make contact with the test block and was then quickly released. The needle thus penetrates the test block and the reading on the graduated scale of Vicat's apparatus was recorded. The procedure was repeated until the needle fails to pierce the block by about 5 to 7 mm measured from the bottom of the mould. The stop button of stop watch was pushed down and the time was recorded which give the initial setting time. The cement paste was considered finally set when upon applying the needle gently to the surface of the test block, the needle makes an immersion, but fails to penetrate and the time was noted which gives the final setting time. The needle was cleaned

after every repetition and also care was taken such that there could not be any vibrations.

### Soundness

Le-Chatelier apparatus is used for the determination of soundness of cement (IS 5514:1969).It consists of a small split cylinder of spring mass of 0.5 mm thickness, forming a mould with 30 mm internal diameter and 30 mm high. On either side of the split are attached two indicators with pointed ends AA, the distance from these ends to the centre of the cylinder being 165 mm. The mould was placed on a glass sheer and was filled with cement paste formed by gauging 100 g of cement with 0.78 times the mixing water required to give a paste of standard consistency. The mould was covered with a glass sheet and a small weight was placed on its top. The mould was then submerged in the water at a temperature of 27 ± 2° C. After 24 hours the mould was taken out and the distance separating the indicators points was measured. The mould was again submerged in water. Using the water heaters the water was brought to boiling point within 25 to 35 minutes and the specimen was kept for 3 hours at a boiling point. The mould was removed from water and was allowed to cool down at 27° C. The distance between the indicator points was measured again. The distance between the two measurements represents the unsoundness of cement. For each concentration of mixing water, three samples were tested and the mean value was taken as the unsoundness of cement sample.

## 3. Compressive Strength

The cubes were casted with natural admixture at different stages for 3 days,7 days, 21 days, 28 days, etc .with deionized water by different water cement ratio such as 0.5,0.6 and 0.65. After Casting the cubes with size 15x 15cm<sup>2</sup>, 10liters curing tank should be used for curing. Then the values at different stages are noted. Further, by adding different concentration of levels of CaCl<sub>2</sub>, MgCl<sub>2</sub> and MgSO<sub>4</sub> such as 0.5g/l, 1g/m, 1.5 g/l, 2 g/m. similarly compressive strength at different stages can be calculated .meanwhile the differences between natural admixtures and alkalinity of different concentrations can be compared and results are indicated.

## 4. Results and Discussion

**Table 5.1.1:** Initial and final setting times, soundness of cement and percentage variation of compressive strength of admixture cement mortar cubes of various concentration of slightly acidic substances at different stages.

Sno	Water samples	Initial setting	Final setting	Soundness in mm	Percentage change in compressive strength						
					3day	7day	21day	28day	60day	90day	
I	Deionised water	128	347	0.5	0	0	0	0	0	0	
II	Slightly acidic substances (i)CaCl <sub>2</sub> g/L										
	0.5	148	220	1.5	16	-2.7	-4.76	-0.85	-15.38	-11.11	
	1	126	207	1.6	26	0	-2.38	-4.25	-7.69	-5.56	
	2	97	198	1.7	24	-8.1	-2.38	-9.7	-9.6	-10.18	
	(ii)MgCl <sub>2</sub> g/L										
	0.5	148	323	1.9	14	-8.1	-3.57	-5.31	-13.46	-14.81	
	1	175	359	2	20	-6.7	-2.38	-10.64	11.53	-11.11	
	1.5	180	388	2.5	14	-16	-9.1	-8.33	-15.95	-18.51	

(iii)MgSO <sub>4</sub> g/L										
0.5	130	229	1	8	13.5	0	-6.38	-14.42	-16.66	
1	118	220	1.5	12	-8.8	-14.76	-4.25	-10.57	-11.11	
1.5	80	214	2.5	4	18.9	-7.14	-10.63	-19.23	-20.37	

Only deionised water and deionised water mixed with different constituents with varying concentrations are considered for clarity in presentation, comparison and analysis of results. For 3-day sample, increase in compressive strength is observed with an increase in the concentration and it is significant if the concentration is more than 0.5 g/L. When the concentrations is 0.1 g/L, the increase in compressive strength is observed in 7-day sample at the maximum concentration of 1.5 g/L. However, the decrease in compressive strength at the other ages, i.e., 14-day, 21-day and 28-day and 90-day is at significant level

## 5. Conclusions

- 1) Presence of CaCl<sub>2</sub> in concentrations more than 1 g/L in water accelerates both the initial and final setting significantly, Its presence in water does not significantly increase the strength at longer duration with an increase in concentration, the maximum being 2.0 g/L.
- 2) Presence of MgCl<sub>2</sub> in water retards significantly both the initial and final setting in concentrations more than 1 g/L. Further a concentration up to 2 g/L results in a significant decrease of compressive strength in all age samples.
- 3) Presence of MgSO<sub>4</sub> in water accelerates significantly the initial and final setting in concentrations more than 1 g/L. Its presence in water initially increases significantly the compressive strength up to 3-days but gradually decrease the compressive strength below the significant

## References

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