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Studies on the Suitability of Rice Mill Processed Water in Construction Industry based on Durability Properties

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ABSTRACT:

The water is a precious material and its requirements are linked with the density of population and the growth of industrial activity. Due to the increase in the population and the industrial activities, it is susceptible to have more possibilities of water scarcity. The construction activity requires more amount of water for mixing and curing. Hence an alternate for potable water has to be identified. In this research work the potable water is replaced with processed water from rice mills. Many experiments were conducted and results were presented in this paper. Based on the experimental results, it is concluded that the processed water from rice mills can be used for construction purposes by adding suitable admixture.

Keywords: water, sulphate, chloride, flyash

1.0 INTRODUCTION:

The water requirements are linked with the density of population and the growth of industrial activity. As the population and the industrial activity increase, it is susceptible to have more possibilities of water scarcity. Even though water is surplus on the earth, approximately 97% of the water contains salt and it is not suitable for domestic (cooking, drinking, etc.), construction and various industrial purposes. The remaining two percent of water is in the form of ice and one percent of the total water is only usable water, of which ground water accounts for 98% and the surface water accounts for 2%. Therefore such a limited resource is very precious and it needs to be utilized economically.

Kaushik and Islam (1995) prepared and cured the concrete samples using sea water. They examined the concrete properties such as setting time, compressive strength of the concrete, corrosion of reinforcement bar embedded in the concrete and chloride ion penetration of the concrete over a period of 18 months. They reported that the compressive

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strength of the concrete samples prepared using the sea water was less than that of the concrete samples prepared using the potable water. The setting time was prolonged for the concrete sample prepared by using the sea water. The corrosion of reinforcement bar embedded in the concrete and chloride ion penetration were more in the concrete specimen cast using the sea water.

Saricimen et al (2004) studied the effects of using treated effluent for preparing the concrete as a replacement to potable water. They prepared the concrete samples using both the potable water and the treated industrial effluent and allowed the concrete samples for curing in the respective water. The compressive strength of the concrete was determined after 7, 14, 28 and 90 days of casting. They reported that the compressive strength of the concrete prepared using treated effluent was higher than that of the concrete samples prepared using the potable water. The strength of the concrete samples prepared using treated water was 112% higher than that of the concrete samples prepared using potable water. The strength of the concrete samples blended with 8% silica fume using treated effluent was 115% higher than that of the concrete samples prepared using potable water. There was 8% to 9% decrease in the setting time of the concrete prepared using treated effluent than that of the concrete prepared using potable water where as the setting time of the concrete blended with 8% silica fume prepared using treated effluent was 10% higher than that of the conventional concrete.

Al-Harthy et al (2005) replaced the potable water with the waste water obtained from oil production fields and other brackish ground water for making the concrete samples. They determined the compressive strength of the concrete samples after 7, 14, 21, 28, 35, 42, 49, 56 and 63 days of casting. They reported that the compressive strength of the concrete prepared using waste water was less than that of the concrete prepared using potable water but the required target mean compressive strength was obtained by the concrete sample prepared using the water obtained from oil production fields and other brackish ground water.

Based on various studies and experiments conducted by us, we had choosen the processed water from rice mills as a replacement for the potable water in construction. Many experiments were conducted by replacing the potable water with processed water from rice mills and results are presented. By trial and error method, suitable admixture is choosen and added with the concrete to counteract few adverse effects on the durability properties of the concrete.

2.0 EXPERIMENTAL PROCEDURE:

2.1 Determination of Sulphate Attack on the Concrete

Sulphate attack test was carried out on the concrete cubes of size 150 mm x 150mm x 150 mm. The concrete cubes were dried in normal room temperature after 28 days of curing and the weight (W_1) of the cubes were noted. A sodium sulphate solution was prepared by adding 5 % sodium

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sulphate (by volume of water) to 50 litres of distilled water. In this experimental study the concrete cubes were immersed in 5 % sodium sulphate (Na_2So_4) solution for a period of three months. The observations were then made after the required duration. A characteristic whitish appearance was the indication of sulphate attack. The cubes were dried in normal room temperature for a period of 24 hours and then the weight (W_2) of concrete cubes was noted. The compressive strength and loss of weight were calculated using the following equations (2.1) and (2.2),

$$\text{Compressive strength} = \left(\frac{P}{A}\right) \qquad (2.1)$$

where

P is ultimate load (load of failure) in Newton
A is area of cube in mm^2.

$$\text{Loss of weight} = \left(\frac{W_1 - W_2}{W_1}\right) \text{ X } 100\ (\%) \qquad (2.2)$$

where

W_1 is initial weight of the concrete specimen
W_2 is final weight of the concrete specimen

2.2 Determination of Chloride Attack on the Concrete

Chloride attack test was carried out on the concrete cubes of size 150 mm x 150mm x 150 mm. The concrete cubes were dried in normal room temperature after 28 days of curing and the weight (W_1) of the cubes were noted. The sodium chloride solution was prepared by adding 3.5 % sodium chloride salt (by volume of water) to 50 litres of distilled water. In this experimental study the concrete cubes were immersed in 3.5 % sodium chloride (NaCl) solution for a period of three months. The observations were then made after the required duration. After drying the cubes in normal room temperature for a period of 24 hours, the weight (W_2) of concrete cubes were noted. The compressive strength and loss of weight were calculated using the equations (2.3) and 2.4),

$$\text{Compressive strength} = \left(\frac{P}{A}\right) \qquad (2.3)$$

where

P is ultimate load (load of failure) in Newton
A is area of cube in mm^2.

$$\text{Loss of weight} = \left(\frac{W_1 - W_2}{W_1}\right) \text{ X } 100\ (\%) \qquad (2.4)$$

where

W_1 is initial weight of the concrete specimen
W_2 is final weight of the concrete specimen

3.0 RESULTS AND DISCUSSION:
3.1 Sulphate Attack on the Concrete

The sulphate attack on the concrete is mainly due to chemical reaction between calcium aluminate hydrate and sulphate ions. The result of the chemical reaction is calcium sulphoaluminate hydrate, commonly referred to as ettringite ($3CaO.A1_2O_3.3CaSO_4.32H_2O$) which results in the

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reduction of bond strength and internal disintegration of the concrete (Hime and Bryant Mather 1999, Bing Tian and Cohen 2000, Vijayarangan 2006, Frank et al 2006). These solids (ettringite) have a very much higher volume up to 225% of the concrete specimen. As a consequence, stresses are produced in the concrete which may result in the breakdown of the cement paste and it ultimately results in the breakdown of the concrete (Lee et al 2005a).

The loss of weight of the concrete prepared by using the potable water and processed water from rice mills after 28 days are 2.20% and 3.42% respectively which is portrayed in the figure 3.1. It is observed that the loss of weight of the concrete prepared using the processed water from rice mills is higher than that of the concrete prepared using the potable water and this is due to the presence of more amount of sulphate content in the processed water from rice mills. The same trend is observed for result after 365 days. When 4.2% silica fume along with 7.8 % fly ash are added, the loss of weight got reduced which is apparently shown in the figure 3.1.

Figure 3.1: Loss of Weight due to Sulphate Attack

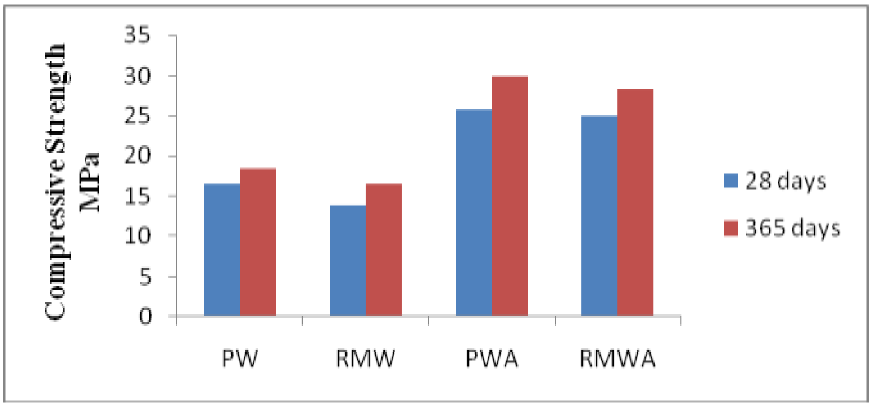

Figure 3.2: Compressive Strength due to Sulphate Attack

It is evident from the figure 3.2, the compressive strength of the concrete prepared by using the potable water is 16.50MPa after 28 days and 18.42MPa after 365 days. It was also observed that the compressive strength of the concrete prepared by using processed water from rice mills was 13.82MPa after 28 days and 16.52MPa after 365 days. The great loss in compressive strength is due to the sulphate attack. When the admixture is

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added, the compressive strength prepared by using potable water and processed water from rice mills were almost same.

3.2 Chloride Attack on the Concrete

The chloride attack on the concrete is particularly important because it primarily induces the corrosion of reinforcement bar embedded in the concrete (Glass and Buenfeld 1998, Luping Tang 1999). It is observed that more number of failure and collapse of structures are due to corrosion of reinforcement bar embedded in the concrete. The concrete subjected to chloride attack is characterized by efflorescence and persistent dampness in the concrete structure.

The loss of weight of the concrete prepared by using the potable water and processed water from rice mills after 28 days are 1.68% and 2.82% respectively which is portrayed in the figure 3. It is observed that the loss of weight of the concrete prepared using the processed water from rice mills is higher than that of the concrete prepared using the potable water and this is due to the presence of more amount of sulphate content in the processed water from rice mills. The same trend is observed for result after 365 days. When 4.2% silica fume along with 7.8 % fly ash are added, the loss of weight got reduced which is apparently shown in the figure 3.3.

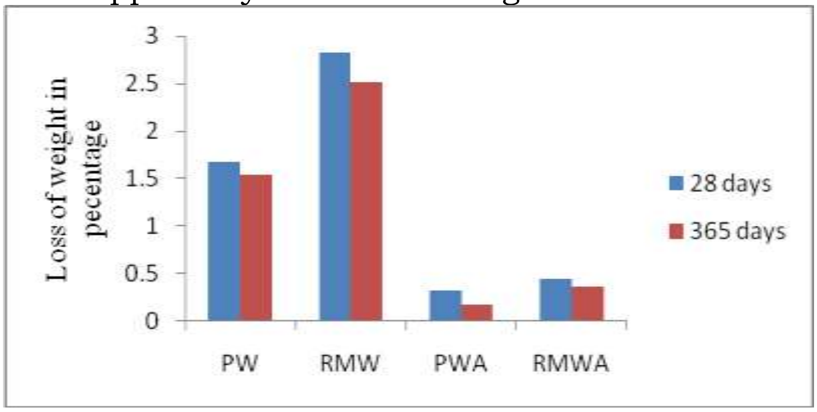

Figure 3.3: Loss of Weight due to Chloride Attack

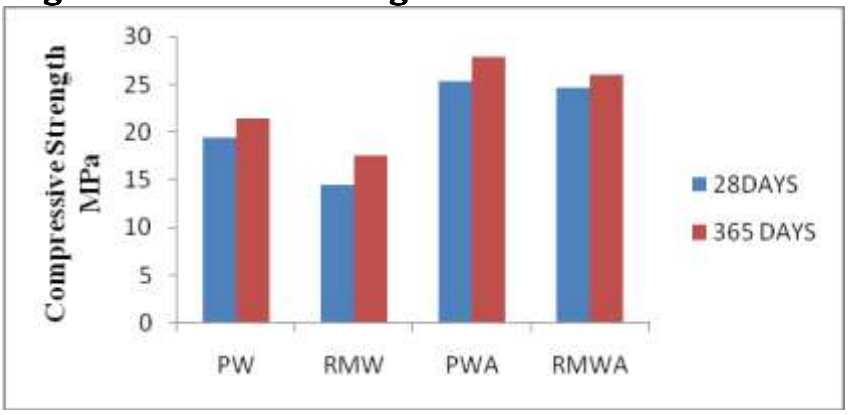

Figure 3.4: Compressive Strength due to Chloride Attack

It is evident from the figure 3.4, the compressive strength of the concrete prepared by using the potable water is 19.37MPa after 28 days and 21.46MPa after 365 days. It was also observed that the compressive strength of the concrete prepared by using processed water from rice mills

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are 14.42MPa after 28 days and 17.52MPa after 365 days. The great loss in compressive strength is due to the sulphate attack. When the admixtures are added, the compressive strength prepared by using potable water and and 17.52MPa were almost same which is clear from the figure 3.4.

CONCLUSIONS:

Due to sulphate attack and chloride attack, there is loss of weight and reduction in the compressive strength of the concrete samples prepared using the processed water from rice mills. When fly ash is added along with 4.2% of silica fume along with 7.8 % of fly ash while preparing the concrete, the loss of weight of the concrete samples is decreased when subjected to sulphate attack and chloride attack and the reduction in the compressive strength is almost minimized and the compressive strength of the concrete is equal to that of the concrete specimen prepared by using the conventional water (potable water). It is concluded that the sulphate attack and the chloride attack are counteracted by adding 4.2% of silica fume along with 7.8 % of fly ash along with the concrete prepared by using processed water from rice mills.

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NOTATIONS:

PW	Concrete prepared by using Potable Water
RMW	Concrete prepared by using processed water from rice mills
PW	Concrete prepared by using Potable Water & Admixture Added
RMW Admixture	Concrete prepared by using processed water from rice mills & Added

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