Salinity Concrete of Palm Ash

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Abstract

This project studies the partial replacement of cement content in the concrete by the palm ash in the presence of seawater as a full replacement of pure water in mixing of the concrete. Certain percentages of replacement of the cement content with palm leaves ash are considered to investigate the behavior of both the strength and workability of the concrete. The slump test is carried out for the fresh concrete and the concrete strength is tested after 7 and 28 days. 5% of the cement replacement with palm leaves ash in conjunction with full replacement of pure water with sea water achieves 84.188% increase in the ultimate compressive strength after 28 days more than that gained by the normal concrete with the mixing sea water, also a reasonable workability is obtained.

Introduction

In the last decades, many researchers sought to use seawater in the mixing and curing of the concrete, in order to reduce the consumption of pure water to face the shortage in the pure water that the world is facing nowadays . The results of the researches didn't agree, where some researches showed improvement in the compressive strength, but the majority showed a reduction in the compressive strength.

S. K. Kaushik and S. Islam (1995) concluded that seawater was not convenient to be used in mixing and curing of plain concrete, reinforced concrete and pre-stressed concrete. They recommended of using retarding admixtures during mixing concrete with seawater, where sea water reduces the setting time of cement by 30-75% as the salt concentration of the mixing water increases. Sunil Kumar (2000) investigated the compressive strength of the concrete, which is exposed to seawater attack, considering the quality of mixing water. Gracemodupeolaamusan and Festusadeyemiolutoge (2014) investigated the effects of using seawater on the shrinkage properties of concrete, they showed that when mixing or curing the concrete with seawater the shrinkage value increased more than the normal concrete. Haseeb Khan et al (2016) mixed and cured the concrete with saline water with different salt (NaCl) concentrations (1g/l – 8g/l) and they showed that the compressive strength of the concrete that mixed with saline water increased at the early age (7 days of curing) but there was a reduction of range of (1–6)% of the compressive strength at 28 days of curing in salty water when comparing with normal concrete. Miren Etxeberria et al (2016) studied using the recycled aggregates of the mixed composition, which were mixed using two different types of cement and seawater in order to produce recycled aggregate concretes. It was found that using seawater enhancing the mechanical properties, reducing the setting time and increasing the drying shrinkage. Adiwijaya et al (2017) studied the influence of seawater mixing of the concrete with GGBS on the strength and porosity, the effect of pure water and seawater on curing was studied. No significant influence of seawater mixing on the compressive strength of GGBS concrete up to 365 days in curing with pure water and seawater. Jianzhuang Xiao et al (2017) reviewed the studies on the effects of using seawater and sea-sand in mixing of concrete on the workability and strength of the resulting concrete. They showed that the durability problem associated with the abundance of chloride ions in sea-sand seawater concrete (SSC) can be solved by making a combination of mineral admixtures for the concrete and reinforcement with fiber reinforced polymer (FRP). Tanaz Dhondy et al (2019) comprehensively reviewed the benefits of using sea-sand and seawater in the mixing of concrete, they ensured that main befits are to save natural resources, permitting sustainable and efficient construction way and controlling the additional costs of the repairs of concrete spalling. F. A. Shaikh and J. Dobson (2019) studied the compressive strength and chloride binding ability of fly ash matrix when using seawater in mixing, with increasing the fly ash content the mortar compressive strength increased at all ages. T. Dhondy et al. (2020) compared the mechanical properties of sea–sand seawater concrete with conventional concrete, the results showed sand–seawater concrete had a high rate of increase in the strength at an early age but this rate decreased with the age progression.

Materials and Methods

Seawater

in this study the seawater from Oman sea (near to the north Oman coast) is used to replace pure water in mixing the concrete with salinity ranged from 36.9 to 37.3 PPT (S. P. Pous and X. Carton (2004), Zhankun Wang et al. (2013), S. A. Piontkovski and T. Chiffings (2014).

Mix Design

In this study a concrete of grade C30 is considered, this concrete grade is designed using British standard. The considered design parameters are presented in **Table (1).** The obtained components weights of the considered mix are shown in **Table (2).**

Table (1) Design Parameters of the concrete Mix

Water cement ratio	0.5
Cement category	42.5
Type of coarse aggregate	crushed
Range of the slump	6–18cm
Maximum size of the aggregate	20 mm

Table (2) Mix's Components

Component	Mass (Kg/m^3)
Tap-Water/ Seawater	225
Cement content	432.7
Sand	498.69
Coarse Aggregate	1163.61
Specific weight	2320

Palm Leaves Ash

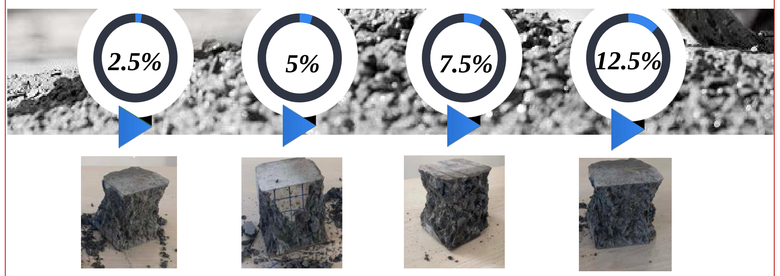
The palm leaves are collected from Buraimi – Oman, the palm leaves are dried and burned in the oven with the presence of air. The palm leaves ash is collected to partially replace cement in the concrete mixes.

Experimental Specimens

All specimens are mixed with seawater except one of the verification samples is mixed with pure water. The following Table (3) shows specimens codes, the percentages of cement replacement and the type of mixing water.

Table (3) Design Parameters of the concrete Mix

Specimen Code	Percentage of Replacement With Palm Leaves Fly Ash (%)	Type of Mixing Water
PCTW000	0	Tap-water
PCSW000	0	Seawater
PASW025	2.5	Seawater
PASW050	5	Seawater
PASW075	7.5	Seawater
PASW125	12.5	Seawater



Results

Workability

The workability of the fresh concrete mixes is examined through slump test to check the effect of mixing concrete with seawater as a full replacement of pure water in conjunction with the partial replacement of the cement with palm leaves ash.

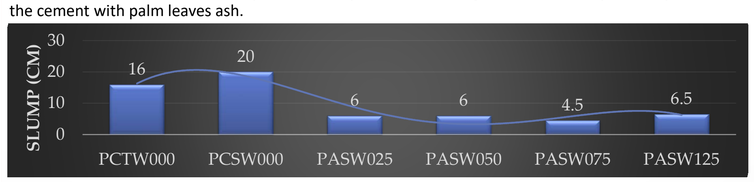


Figure (1) Slump Test Results for Different Mixes

Figure 1 shows that all mixes give reasonable slump values within the design range.

Compressive strength

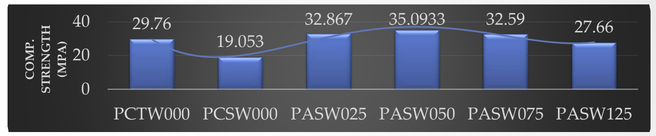


Figure (2) Compressive Strength Results After 7 Days of Curing

Figure 2 shows the gained compressive strength after 7 days of curing and its trend. It could be noted that the using of the seawater as a full replacement of pure water in the mixing, reduced the compressive strength gained after 7 days of curing, where it reduced the strength by 27.778%. The replacement of the cement with 2.5% of palm leaves ash improved the gained strength regarding to the normal concrete mix with the seawater instead of the pure water by 82.502%, and it improved the strength regarding to normal concrete mix with the pure water, where it increased strength by 31.806%. Replacing the cement with 5% of the palm leaves ash increased the compressive strength by 81.255% with respect to the normal concrete mix with seawater and increased the strength by 30.906% with respect to the normal concrete mix with the pure water.

By increasing the replacement of the cement by 7.5% with the palm leaves ash, the compressive strength gained after 7 days of curing increases by 78.632% over the strength gained for the normal mix with the mixing seawater and it increases by 29% over the strength gained for the normal mix with the mixing pure water. By reaching to 12.5% of the replacement of the cement content with the palm leaves ash, the gained strength after 7 days of curing increases by 34.845% over the strength gained for the normal concrete mix with the mixing seawater, but the gained strength decreases by 2.612% under the strength gained of the normal concrete mix with the mixing pure water.

Also, it could be noted that for the mixes of cement replacements by 2.5%, 5% and 7.5% with palm leaves ash achieve around 84% of the target strength after 7 days of curing, which meant that using of the palm leaves ash within the mentioned percentages in the presence of the seawater as a full replacement of the mixing pure water increased the rate of early gained strength of the concrete mix.

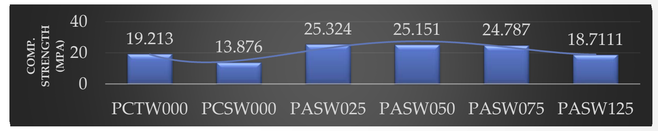


Figure (3) Compressive Strength Results After 28 Days of Curing

Figure 3 shows the compressive strength results and its trend after 28 days of curing, the normal concrete mix with the mixing pure water achieves 99.2% of the target strength. The normal concrete mix with the mixing seawater gained strength less than that gained by the normal concrete mix with the mixing pure water by 35.977%. The partial replacement of the cement by 2.5% of the palm leaves ash increased the compressive strength by 72.503% over the gained strength by the normal concrete mix with the mixing seawater, on the other hand it increased strength by 10.44% over the gained strength by the normal concrete mix with the mixing pure water. For the concrete mix of 5% of the cement replacement with palm leaves ash, the compressive strength increased by 84.188% more than the gained strength by the normal concrete mix with the mixing seawater, and it increased the strength by 17.921% over the strength gained by the normal concrete mix with the mixing pure water. 7.5% replacement of the cement content with palm leaves ash made 71.049% increase in the compressive strength obtained by the normal concrete mix with the mixing seawater and it increased strength by 9.509% more than that got in the normal concrete mix with the mixing pure water. Reaching the cement replacement of 12.5% with palm leaves ash increases the compressive strength by 45.174% over the gained strength of the normal concrete mix with the mixing seawater, but it reduced the compressive strength by 7.056% of the obtained strength of the normal concrete mix with the mixing pure water.

Conclusion

This study concludes that using the palm leaves ash as a partial replacement of the cement content in the concrete mix with the mixing seawater of the salinity of 37.1 PPT improves the concrete strength with acceptable workability, as stated in the followings:

- 2.5% of the cement replacement with the palm leaves ash increases the early compressive strength after 7 days by 82.502% and increases the ultimate compressive strength after 28 days by 72.503% more than the gained strengths of the normal concrete mix with mixing seawater.
- 5% of the cement replacement with the palm leaves ash increases the early compressive strength after 7 days by 81.255% and increases the ultimate compressive strength after 28 days by 84.188% more than the gained strengths of the normal concrete mix with mixing seawater.
- 7.5% of the cement replacement with the palm leaves ash increases the early compressive strength after 7 days by 78.632% and increases the ultimate compressive strength after 28 days by 71.049% more than the gained strengths of the normal concrete mix with mixing seawater.
- 12.5% of the cement replacement with the palm leaves ash increases the early compressive strength after 7 days by 34.845% and increases the ultimate compressive strength after 28 days by 45.174% more than the gained strengths of the normal concrete mix with mixing seawater.