

Experimental studies on effect of Date Seed Ash (DSA) on strength properties of cement sand mortar

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Abstract. The need for alternative material for the cement is arising and being compromised by many engineering researchers. However, the growing demand and surging prices of raw materials challenges the constructional field. India, being one of the largest agricultural economy, produces a quantitative volume of agro-waste that is being dumped. In the conventional concrete production, coarse aggregate (CA) plays an important filler material. The initial study on date seed as a replacement for CA was not successful. This study primarily focuses on Date seed ash as a replacement material for ordinary Portland cement. OPC was replaced by Date Palm Seed Ash (DPSA) in the ratio up to 10% in terms of 2% interval. The main objective of this paper was to study the variation of strength properties of mortar by DPSA in specified ratio along with curing period of 3,7,14 and 28 days. The stress strain behavior has indicated a significant improvement. The overall results indicated the increase in replacing ratio, decreases the strength properties. However the physical, chemical and mechanical properties increased gradually in strength in minimal ratio.

Key words: Cement Mortar, Date Palm Seed Ash, Cement replacement and Strength properties.

1. Introduction

The world is leaping forward towards the modern living standards through building up a sustainable infrastructure. The huge need and demand for buildings has created a direct increase in the consumption as well the production of cement. Due to the need for supplementary material for the ordinary Portland cement many researches are been conducted. Fly ash, one of the hazardous air pollutants, is presently used as a major partial raw material for the Portland Pozzolonic Cement (PPC). Pioneers of civil engineering research and many engineering students have taken this in their concern and because of which many scholarly articles stating the usage of Rice husk ash, Sunflower seed ash, Palm kernel ash, Coconut shell ash, etc., are being used as a partial replacement material for Ordinary Portland Cement. For a sustained growth in the construction industry, the necessity for a alternative or a supportive material is needed for cement [1-7]. This has to be researched without compromising the strength as well as the environment which can be made possible only with recyclable natural waste with pozzolanic reactivity. [8-13] Recycling industrial or agricultural waste is vital for the sustainable development which plays a crucial role in pollution control. The current society has immense interest in the use of innovative materials, which reduces cost with enhanced quality, in place of domestic products, which also aimed at reducing the environmental impact. The high cost of construction materials like cement has led to increased cost of construction. Mortar is a material having tiny spaces



through which liquidness or air may pass. The durability of mortar depends largely on movement of mortar.

Date, *Phoenix dactylifera*, is an edible fruit in the palm family. This is widely grown in temperate and arid zones which has a high fibrous strength. The research was carried out on date seed if it would find an application in building construction. The use of date seed in concrete mixtures will not only reduce the pile up of the same in the dump yards but will greatly help in cost cutting in construction industry. Adding colour to the ongoing research in utilization of waste as solution to the senior high cost of construction materials, this research was initially planned to investigate its suitability as light weight aggregate material in concrete production since little or no work exist on it.

2. Materials and Methods

2.1 Cement

Ordinary Portland cement of 43 grade conforming to IS: 8122-1989 was used.

Table 1. Properties of Ordinary Portland cement (OPC)

Description	Composition
Specific gravity	3.05
Initial setting time	30 minutes
Final setting time	600 minutes

2.2 Date Palm Seed Ash (DPSA)

Dates seed were dried in open air for about two months and burnt in open air until the seed loses its internal moisture. Then these burnt seeds were grinded using conventional method and then sieved to less than 90 microns manually to meet the size of cement.

Table 2. Chemical Properties of DPSA

S. No.	Element Name	Symbol	Normal DPSA	Calcinated DPSA
			(in %)	(in %)
1	Potassium	K	43.02	37.06
2	Oxygen	O	28.85	31.21
3	Phosphorous	P	7.40	8.55
4	Chlorine	Cl	5.54	4.74
5	Calcium	Ca	5.52	3.82
6	Magnesium	Mg	3.50	3.67
7	Sulphur	S	2.77	2.61
8	Silicon	Si	0.89	1.90
9	Iron(Ferrous)	Fe	0.70	3.61

2.3 Aggregates

Coarse aggregate (Granite) of maximum size 20 mm were used. River sand was used as fine aggregate.

Table 3. Properties of coarse and fine aggregates

Properties	Coarse aggregate	Fine aggregate
Specific gravity	2.68	2.39
water absorption	1.56	0.80

3. Experimental investigation

Specimens were casted for a replacement of DPSA by 0%, 2%, 4%, 6%, 8% and 10% with cement. The cube specimens of size $150 \times 150 \times 150$ mm were cast for compressive strength, and cylindrical specimens of diameter 150 mm and height of 100 mm for sorptivity test. The broken specimen powder from compressive strength was taken in a beaker dissolved in pH neutral water to test for alkalinity.

4. Results and Discussion

4.1 Effect of Compression

The compression test was carried using a compression testing machine and the results in MPa for three samples are given below. Each sample was arranged to face the load in X, Y and Z axis and tabulated below in the same order.



Figure 1. Arrangement of Sorptivity test in lab

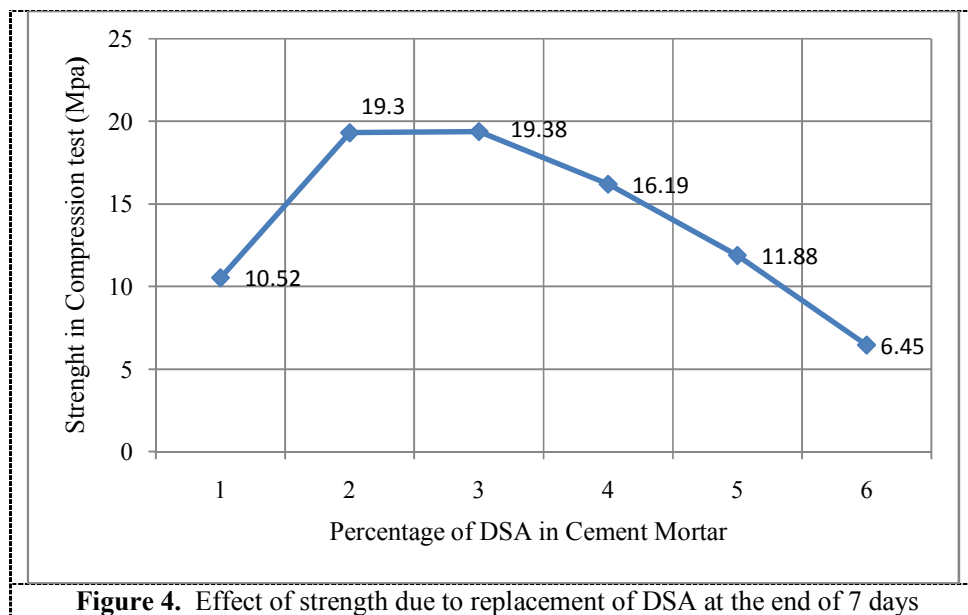
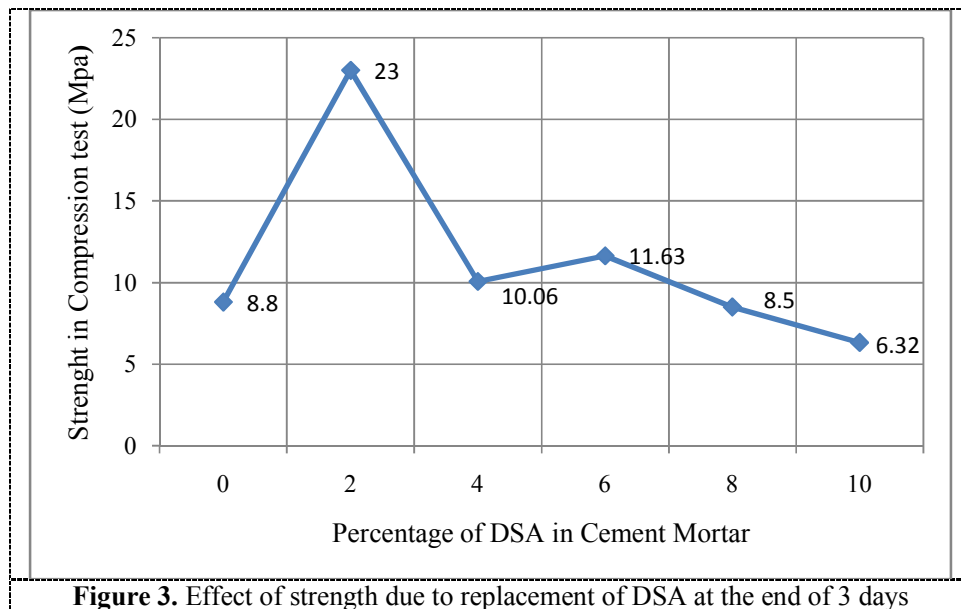


Figure 2. Arrangement for Compression Test

Table 4. Effect of DSA replacement in strength at the end of 3,7,14 and 28 days.

Mix ratio / Days	3 days	7 days	14 days	28 days
	Strength in MPa			
0	9.85	10.02	12.18	8.59
	8.81	10.52	12.11	8.33
	7.76	11.02	12.04	8.07
2	22.36	20.30	21.84	22.02
	23.00	19.31	21.57	21.38
	23.64	18.31	21.30	20.73
4	10.66	20.65	25.27	23.36
	10.07	19.39	23.43	21.80
	9.47	18.12	21.58	20.23
6	13.00	18.61	16.03	15.89
	11.63	16.20	16.16	17.19
	10.26	13.78	16.28	14.50
8	9.73	12.70	22.10	16.22
	8.50	11.88	17.04	15.56
	7.27	11.06	11.98	16.68
10	5.18	6.01	5.89	6.96
	6.33	6.45	5.94	6.72
	7.47	6.89	5.99	6.66

The average of each replacing ratio against the strength is plotted in the graph below



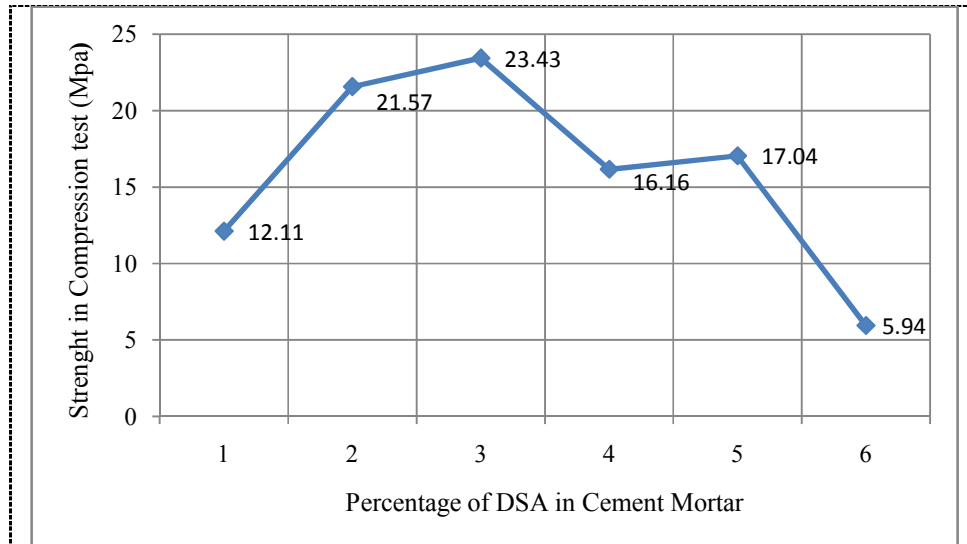


Figure 5. Effect of strength due to replacement of DSA at the end of 14 days

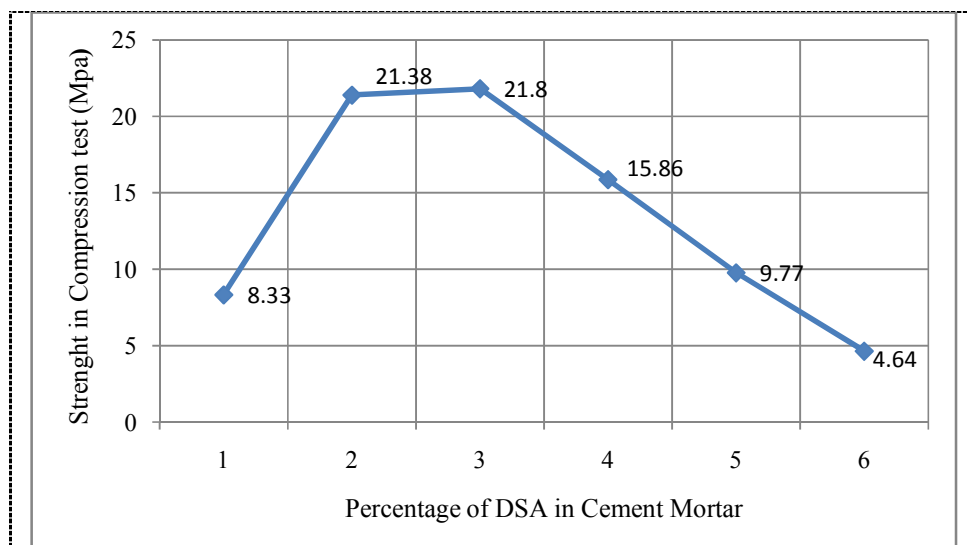


Figure 6. Effect of strength due to replacement of DSA at the end of 28 days

From the above observations, we could see that the initial compressive strength was poor for 4% ratio for 3 days curing, but it increased during the period of curing. However, 4% DSA ratio had a sustained performance towards the end.

4.2 Water Absorption Test

The mortar cube after casting was immersed in water for 28 days curing. These specimens were then over dried for 24 hours at the temperature 85°C until the mass became constant and again weighed. The weight was noted as the dry weight of the specimen. After that the specimen was kept in water at 85°C for 24 hours. Then this weight was noted as the dry weight of the specimen.

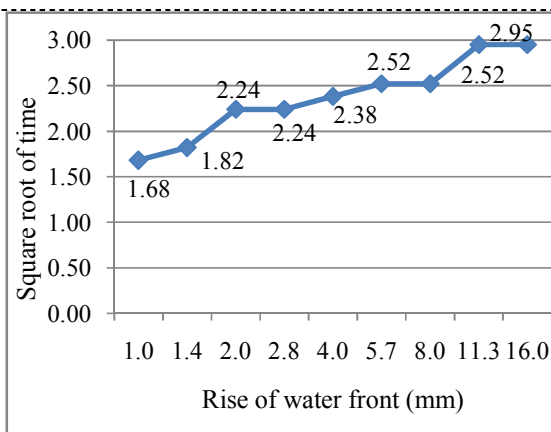
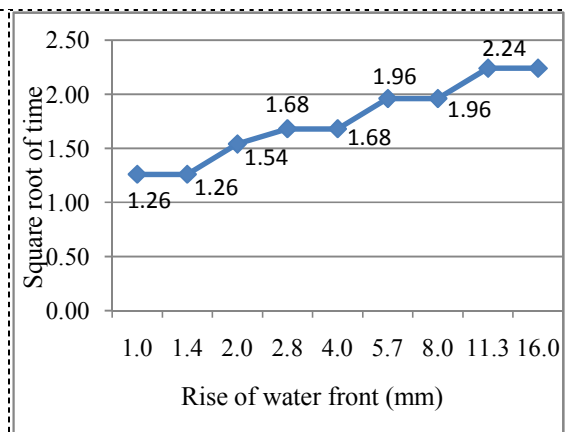
Table 5. Water absorption test result for mortar cubes

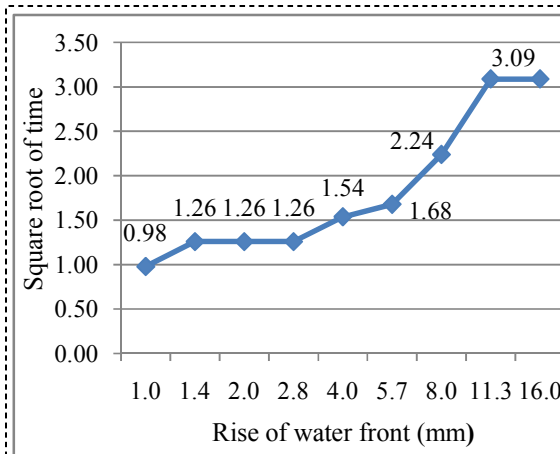
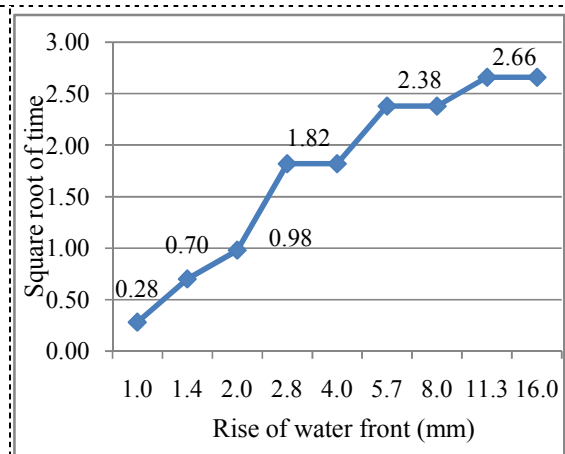
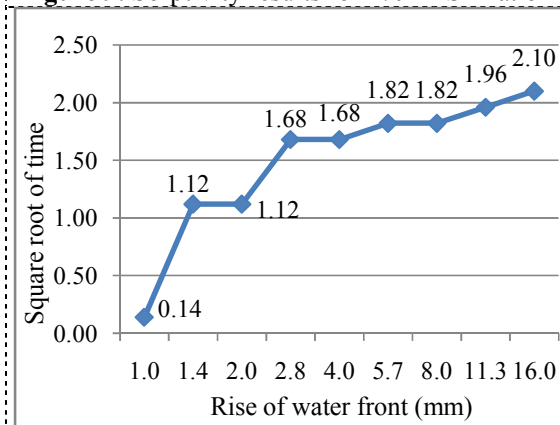
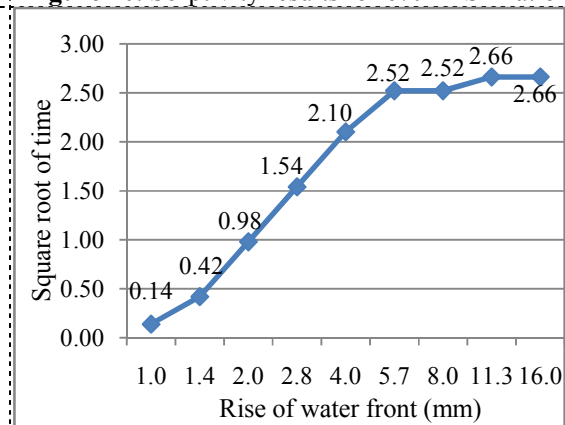
Ratio in %	W1 in grams	W2 in grams	Water absorption in %
0	700	736	5.14
2	700	732	4.57
4	700	719	2.7
6	700	724	3.42
8	700	742	6.00
10	700	746	6.57

Here 4% DPSA ratio was giving a better water absorption index; however the other ratio were comparatively higher.

4.3 Sorptivity Test

The samples were placed in a recipient in contact with level of water capable to submerge them about 5 mm as shown in the Fig.1 The weight increased with time intervals was plotted the graph between cumulative volumes of water per unit surface area to the square root of time. This determines the rate of capillary rise absorption by a concrete cube which rest on a small support in a manner such that only lowest 2 to 5 mm of the cube is submerge. The specimen in contact with water was kept around 5 hours. In the test, several measurements are taken over a period of up to five hours and a straight line is fitted to the plot of the increase in mass or rise of water front, versus the square root of time as given below.

**Figure 7.** Sorptivity results for 0% DPSA ratio**Figure 8.** Sorptivity results for 2% DPSA ratio

**Figure 9.** Sorptivity results for 4% DPSA ratio**Figure 10.** Sorptivity results for 6% DPSA ratio**Figure 11.** Sorptivity results for 8% DPSA ratio**Figure 12.** Sorptivity results for 10% DPSA ratio

From the sorptivity test, we can arrive that 4% ratio of DPSA gives a better sorptivity coefficient about comparing to other ratio of DPSA

4.4 Alkalinity Test

The powder from approximately middle of the broken cube was weighed for 200 grams and then was dissolved in the distilled water. This setup was left undisturbed for 72 hours, so that the powder completely dissolved in the water and the same was then taken in a beaker. The pH electrodes were immersed to it to understand the alkaline effect of the concrete. The results that were obtained are tabulated below.

Table 6. Change in pH concentration due to replacement of DSA

S. No.	Percentage of Replacement	pH
1	2	10.18
2	4	10.19
3	6	10.22
4	8	10.23

From the table, As the DPSA ratio was increased, the pH kept increasing however we limited to 8% so as to compromise along with the compressive strength.

5. Conclusion

From the above experiments and studies that were made, the below conclusions were suggested against the usage of date seed ash as a replacement for OPC in the ratio.

- 4% DPSA ratio would be an optimum amount of replacement of OPC with DPSA
- 8% replacement shows an enhanced alkaline property. Thus it can be adopted in places where acid resistance plastering is done
- 2% replacement can be adopted in places where higher bond strength is needed. Since this gives twice the compressive strength comparative to OPC
- Calcinated DPSA do not show a good bonding strength because the calcites are being oxidized during the calcination process.

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