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Experimental Investigation of Mortar by Partial Replacement of P-Sand with Red Soil

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Abstract: *An experimental investigation is carried out to study the behaviour of cement mortar using red soil partially replaced with p-sand (plastering sand). In this study, cement mortar of mix proportion 1:4 using red soil is partially replaced with p-sand as 5%, 10%, 15%, 20%, 25%. Compressive strength test, water absorption test, sorptivity test and acid immersion test are conducted to determine the properties of the cement mortar. The results show that the partial replacement of red soil with p-sand improves the compressive strength and reduces water absorption and sorptivity. Additionally, the acid immersion test revealed that the cement mortar with partial replacement of red soil with p-sand is more resistant to acidic conditions. This study provides insights into the potential use of p-sand as a partial replacement of red soil in cement mortar production, particularly for plastering purposes.*

Keywords: Red soil, p-sand, compression strength, water absorption, sorptivity, acid immersion

I. INTRODUCTION

Currently there is a scarcity of sand and obtaining sand in an economical way has become increasingly difficult. Therefore, finding alternative materials is crucial to overcome this issue. In order to fulfil the demand for fine aggregates, it is essential to explore and utilize alternative materials. This project aims to carry out an experimental investigation by preparing cement mortar with replacing fine aggregate with readily available natural red soil particularly for the purpose of plastering. Sand is a crucial material used in the preparation of mortar and concrete, and its consumption is high due to the widespread construction practices. In developing countries, such as India, the demand for natural sand is rapidly increasing to meet the demands of infrastructure growth. In this study, red soil is utilized as an alternative to river sand for constructing buildings.

Additionally, p-sand is used to partially replace red soil in the cement mortar. Plastering manufactured sand, commonly referred to as crushed sand or manufactured fine aggregate is produced by crushing stones and grading them to create a construction material with fine grain size distribution.

II. MATERIALS USED

2.1 Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together.

2.2 Red soil

Red soil is an important soil resource, which bears substantial implication for sustainable development of agriculture and healthy growth of economy.

2.3 P-Sand

P-sand is used for wall plastering and brick work purposes. The Granular thickness 150 microns to2.38mm is ideal for block masonry and plastering purposes.

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III. TESTING OF MATERIALS

3.1 Cement

3.1.1 Fineness Test

The fineness value of the cement is 7%

3.1.2 Consistency Test

The consistency of cement is 30%

3.2 Red Soil

3.2.1 Specific Gravity

The value of specific gravity of red soil is 2.25.

3.2.2 Fineness test

The fineness value of red soil is 2.24.

3.2.3 Liquid Limit Test

The value of liquid limit of red soil is 33.8%

3.3 P-Sand

3.3.1 Specific Gravity

The value of specific gravity of p-sand is 2.56.

3.2.2 Fineness test

The fineness value of p-sand is 1.25.

IV. METHODOLOGY DETAILS

1. Collection of materials.
2. Basic tests on materials.
3. The cement, Red soil and water should be mixed as per standard and P.Sand should be mixed at different ratios.
4. Casting of specimens.
5. The specimens should be cured on normal water for 7 and 28 days for experimental purpose.
6. Testing of specimens.

V. TEST RESULTS

5.1 Compressive Strength Test

Compressive strength of the cement mortar is determined by casting and testing cubes of size 70.6 mm x 70.6 mm x 70.6 mm after the curing period of 7 days and 28 days. The obtained results are tabulated below.

% replacement of red soil with p-sand	Compressive Strength Mpa	
	7-Days	28-Days
0%	3.40	3.74
5%	3.74	6.34
10%	3.81	4.34
15%	5.27	6.34
20%	4.67	7.01
25%	3.67	7.01

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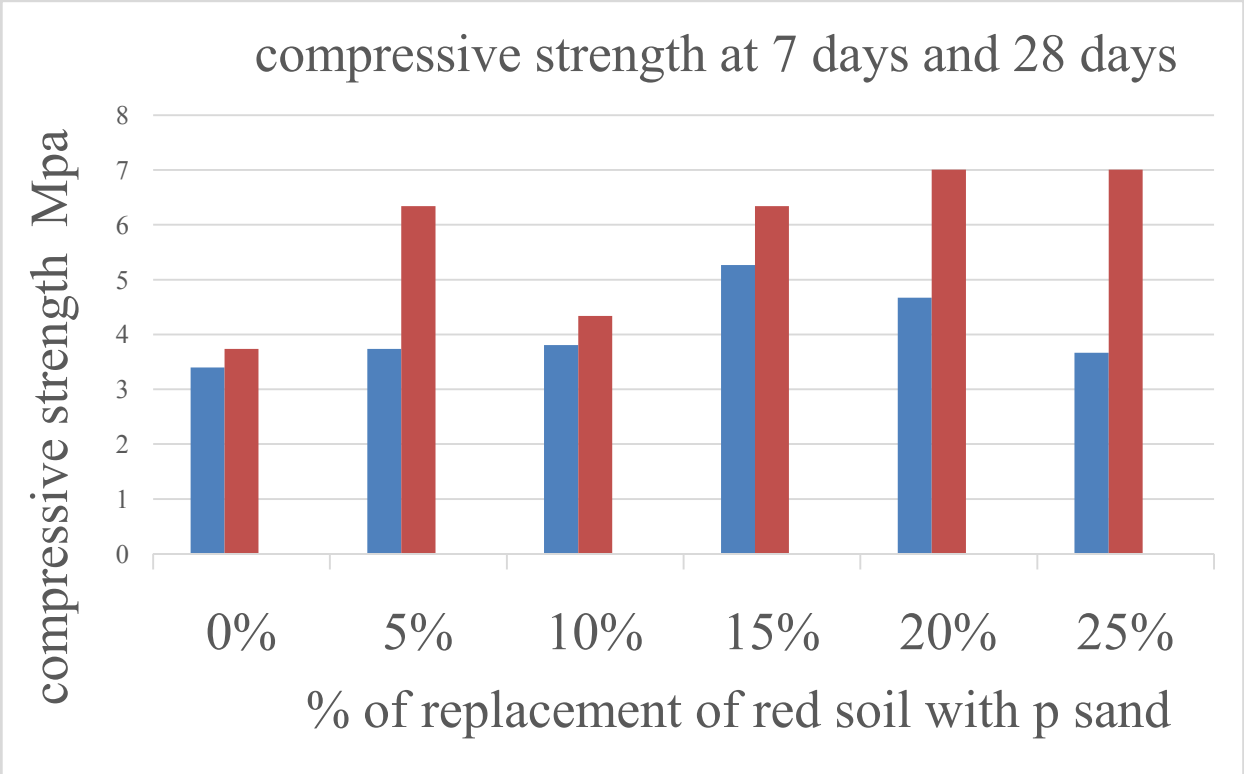

Compressive strength test

5.2 SORPTIVITY TEST

The Sorptivity can be determined by the measurement of the capillary suction of water by the bottom surface of the specimen. After casting the cube immersed in water for 28 days curing. The specimen size 70.6 mm x 70.6 mm x 70.6 mm after drying in oven at temperature of 85 °C were drowned in water. The water level should not be more than 5 mm above the bottom of specimen and the flow from the peripheral surface is prevented by sealing it properly with non-absorbent coating. The quantity of water absorbed in time period of 30 minutes was noted by weighting machine.Surface water on the specimen was wiped off with a cloth or tissue and each weighting of specimens was completed within half minute.

Sorptivity (S) is a material property which characterizes the tendency of a porous material to absorb water by capillary suction. The total water retention (per unit region of the inflow surface) increments as the square foundation of clapsed time (T) $I=S.T^{1/2}$, therefore, $S=I/ T^{1/2}$

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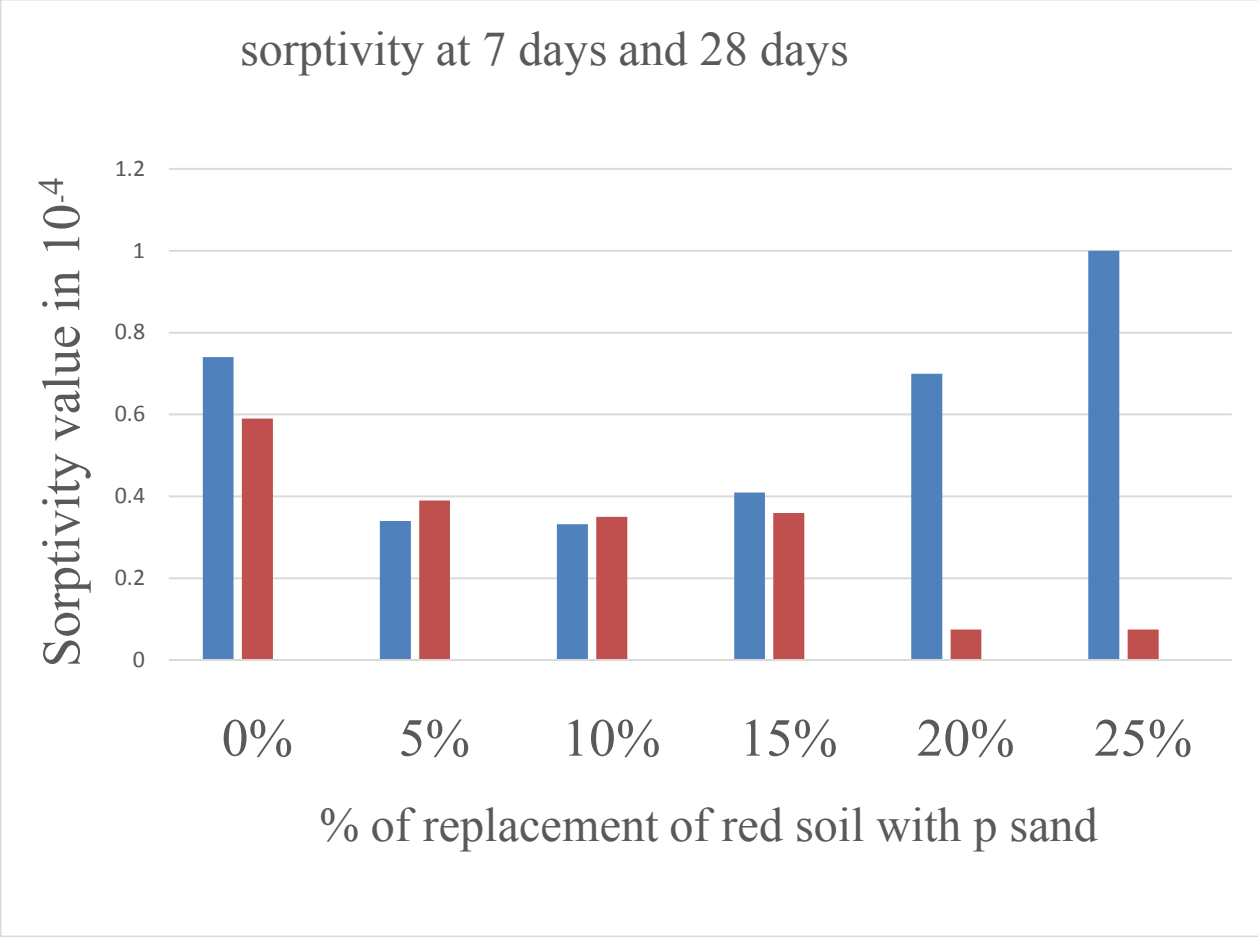
Where,
S= sorptivity in mm.
T=elapsed time in mint.
I=Δw/ Ad
Δw=change in weight of cube = W2-WI
WI=Oven dry weight of cube in grams
W2 =Weight of cube after 30 minutes capillary rise of water in grams.
A= surface area of the cube through which water penetrated.
d= density of water.

% replacement of red soil with p-sand	Sorptivity value in 10^{-4}	
	7-Days	28-Days
0%	0.74	0.59
5%	0.34	0.39
10%	0.332	0.35
15%	0.41	0.36
20%	0.7	0.075
25%	1	0.075



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Sorptivity test

5.3 WATER ABSORPTION TEST

The 70.6 mm x 70.6 mm x 70.6 mm size cube after casting were immersed in water for 28 days curing. These specimens were dried in the oven for 24 hours at the temperature 85°C until the mass became constant and again weighed. This weight was noted as the dry weight (W1) of the cube. After that the specimen was kept in waterfor 24 hours. Then this weight was noted as the wet weight (W2) of the cube.

% water absorption = [(W2-W1)/ WI] x 100

Where,

WI-Oven dry weight of cubes in grams

W2= after 24 hours wet weight of cubes in grams.

% replacement of red soil with p-sand	% Water Absorption	
	7-Days	28-Days
0%	26.44	18.14
5%	23.23	19.63
10%	23.56	21.45
15%	20.28	21.27
20%	21	9.09
25%	22.05	12.26

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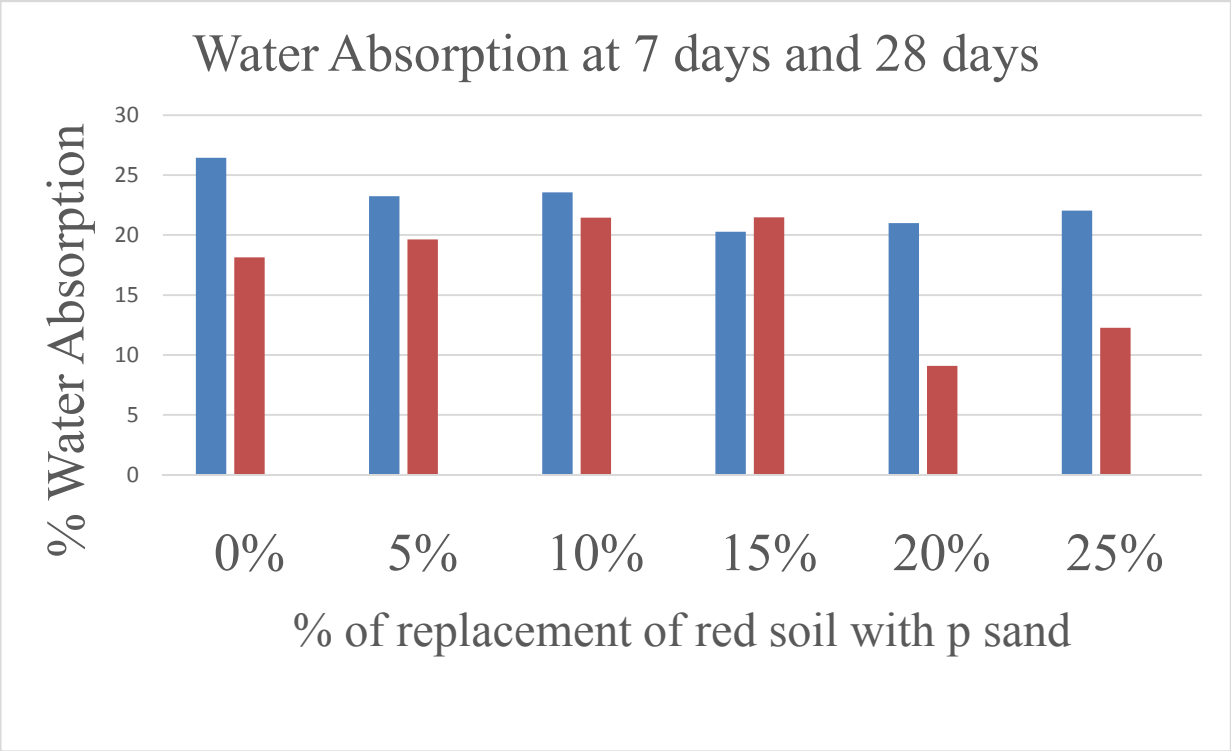

Water absorption test

5.4 ACID IMMERSION TEST

The 70.6 mm x 70.6 mm x 70.6 mm size cement mortar cubes are immersed in H_2SO_4(Sulfuric acid) of 5% concentration for 7 days. Weight loss of the specimen is calculated by taking weight of the specimen before and after immersing in the acid. Compressive strength of the specimen after immersed in acid is determined.

% replacement of red soil with p-sand	Weight loss %	Compressive Strength Mpa
0%	15.43	5.01
5%	8.78	6.21
10%	10.61	4.01
15%	8.58	3.74
20%	9.26	3.94
25%	9.90	6.01

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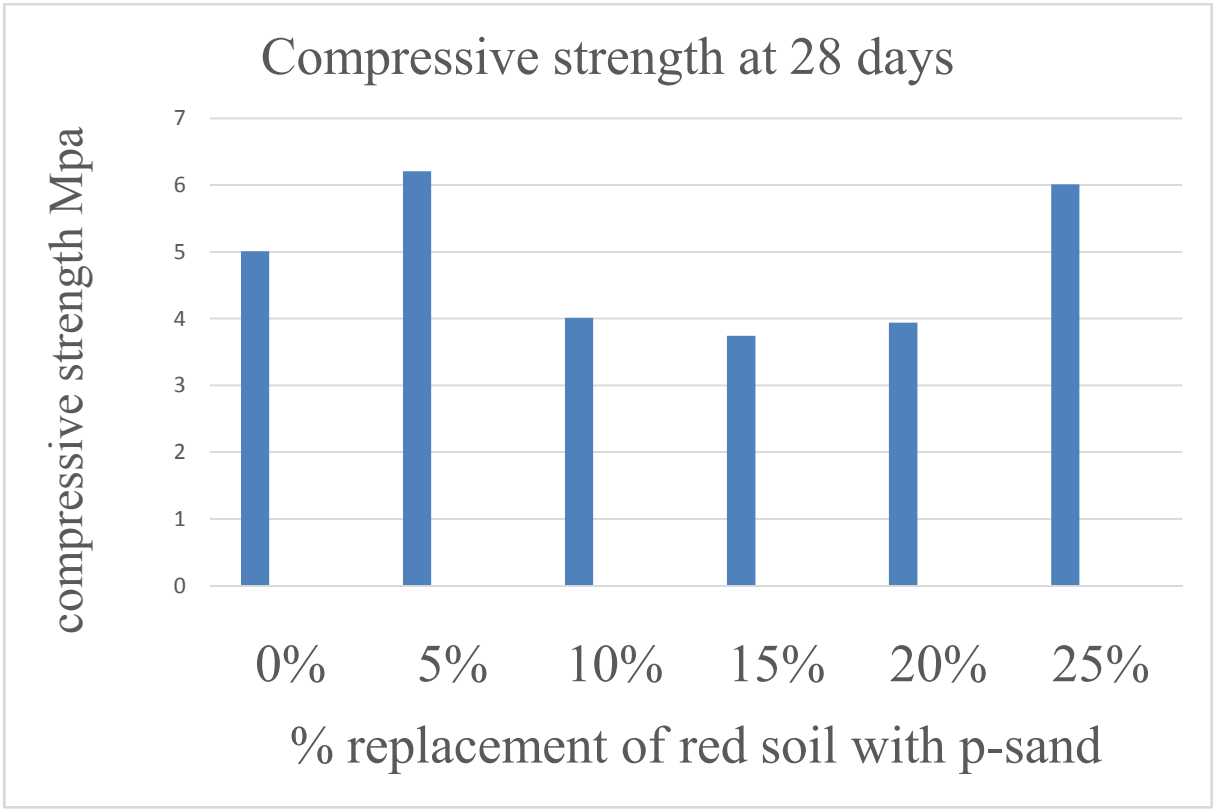

Acid immersion test

VI. CONCLUSION

The following conclusions are drawn

1. The compressive strength of the cement mortar increases as the percentage of partial replacement of red soil with p-sand increases.
2. Sorptivity is determined to reduce as the partial replacement percentage increases.
3. Water absorption test shows that percentage of water absorption also decreases with increase in percentage of partial replacement.

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4. As the percentage of partial replacement of red soil with p-sand increases, the specimens exhibit improvement in acid resistance.

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