Partially Substituting Red Soil for Sand in an Experimental Investigation of Concrete

S. SAI KRISHNA[1], D. SRI LATHA[2], P. GOPI REDDY[3], D. ESWAR KUMAR[4], P. VENKATA PRAVEEN VARMA[5], G. EZRI BABU[6]

[1, 2, 3, 4, 5] *Student, PACE Institute of Technology & Sciences*

[6]*Asst. Professor, PACE Institute of Technology & Sciences*

Abstract*—This study aims to determine whether red soil can replace some of the sand in concrete, this study is going to investigate the possibility and how it will affect the mix's durability, mechanical properties, and environmental impact. One of the materials used in construction the most is concrete. Cement, fine aggregates, coarse aggregates, and water are the components used to make up concrete. Because of its high sand concentration, red soil can help strengthen and increase durability. In this research, an experimental program is carried out to investigate the compressive strengthening of 12 concrete cubes, to partially replace red soil at percentages of 0%,5%,10%, and 15%. As per IS 456 2000 and IS 10262 2019, M30 grade concrete with a design mix of 1:1.6:3.15 was used to perform the casting of cubes measuring 150 x 150 x 150 mm. In an experiment, red soil that is easily available in the area was used in place of fine aggregate to study the behavior of concrete. To achieve good strength in concrete, red soil was partially substituted for sand by the specified mix proportion. To distinguish between the strength of plain concrete and concrete mixed with red soil, the compressive strengths of each were measured. Red soil can substitute sand since its chemical properties are nearly identical to those of sand. In this case, red soil made up of 0% 5%, 10%, and 15% was used in place of some of the sand. When compared to a plain concrete specimen with all percentages of soil replacement, the compressive strength in 10% replacement cubes was found to be satisfactory.

***Indexed Terms*—Cement, Coarse Aggregate, Fine Aggregate, Red soil, Compressive Testing Machine.**

I. INTRODUCTION

The increasing demand for sand in construction, especially in developing nations like India, has led to severe shortages and financial difficulties in getting this necessary resource. To meet the demand for fine aggregates, it is necessary to investigate and use alternative resources. The proposed research depends on an experimental investigation to determine whether it is possible to prepare cement concrete by partially replacing sand with natural red soil instead of sand. Sand is an essential component in concrete mixes since the fine aggregate has the greatest impact on the mixture's characteristics.

However, the extensive mining of natural sand from the banks of rivers causes damage to the environment, making it scarcer and increasing the cost of this resource. Constructions near riverbanks might suffer damage from river sand mining, which also causes environmental disturbances. Red soil seems to be an acceptable replacement given these problems. It is a freely accessible resource from the earth that could be used in concrete mixtures in place of sand. The project plans to partially replace fine aggregate with red soil in a concrete mix proportion specified as M30, according to a 1:1.6:3.15 design mix ratio.

This method offers a cost-effective solution to the increased demands of the building sector, in addition to resolving the environmental issues related to sand extraction. A more environmentally friendly and sustainable construction process can be achieved by including red soil in the concrete mix, which may reduce the need for sand. Should this program be successful, it might result in widespread execution and a change in perspective for construction methods, which would ultimately help to protect the environment.

A. Objectives

The investigation has been carried out with the following objectives.

1.To determine the compressive strength of concrete at normal 0 percent.

2. To determine the compressive strength at 5, 10, 15 percent.
3. To compare compressive strength for 0, 5, 10, and 15 percent.

II. RESEARCH SIGNIFICANCE

The most common material used to prepare concrete is natural sand. Due to excessive river sand mining and large-scale resource depletion, there have been major issues with its availability, cost, and impact on the environment related to its continuous consumption over the past ten years. The concrete industry currently needs an alternative to river sand. The material's capacity to meet strength and durability standards demonstrates its suitability as a substitute for fine aggregates in concrete. One such substance that has been discovered to be suitable for use as a sand replacement in concrete is red soil. A percentage of red soil is used in an experiment to partially replace fine aggregate to investigate the qualities of concrete. In these mixed proportions, workability, and mechanical properties are further studied.

III. MATERIALS AND METHODOLOGY

A. Material required

1. Cement:

A binder, known as cement, is used to set, harden, and remain in other materials, binding them together. Cement, sand, and gravel combine to form concrete. OPC 53 grade cement was used throughout the project work.

2. Fine aggregate:

In this study, manufactured sand, which passes through a 4.75 mm sieve, is used as the fine aggregate. The samples are tested according to IS 2386.

3. Coarse aggregate:

The coarse aggregate, which has a maximum size of 12.5 mm and is retained on an IS 4.75 sieve, was chosen based on shape per IS 2386 (Part I) 1963. The aggregate's surface texture properties are classified using 383–1970. The nominal size of 20 mm coarse aggregate is used throughout the project work.

4. Red soil:

Red soil is an important soil component with significant consequences for agriculture's long-term development and economic health. Locally obtained soil samples are used as fine aggregates instead of sand.

5. Water:

Water plays a crucial role in both the mixing and curing processes of concrete, ensuring its strength and durability.

B. Tests on materials

S. No	Materials	Name of Tests	Results
1.	Cement	Fineness Test	8%
		Consistency Test	31%
2.	Red soil	Fineness test	2.20
		Specific Gravity	2.35
		Liquid Limit Test	33.6
3.	Fine aggregate	Fineness test	2.65
		Specific Gravity	2.61
4.	Coarse aggregate	Water absorption	1%
		Specific Gravity	2.74

TABLE 1.1 Test results on different materials.

C. Methodology

An experimental study is conducted to investigate the characteristics of concrete by partially replacing fine aggregate with a specified percentage of red soil in the mix design of M-30 grade (IS 10262, 2009). To achieve an optimum mix, the mixture is made with varying amounts of fine aggregate. Once a suitable mix has been determined, proportions of red soil (0%, 5%, 10%, and 15%) are added to the weight of fine particles in the mix design.

The experimental plan is executed in two phases.

- In the first phase, testing takes place on each mix to determine the fresh workability quality (slump flow) of the concrete.
- In the second phase, cubes are cast with fresh concrete. The specimens are then cured in water for durations of 7, 14, or 28 days, after which they are tested for mechanical properties.

IV. EXPERIMENTAL INVESTIGATION

In this experiment, red soil that is easily available from the construction site is utilized as a substitute for fine aggregate. The soil analysis was conducted using the soil as a partial replacement for fine aggregate. The design mix for M30 concrete was created using the IS

10262:2009 code, typical concrete elements of OPC 53-grade cement, fine aggregate, and 20 mm coarse aggregate. Red soil was substituted for fine aggregate in partial replacement. To determine the physical properties of concrete, sieve analysis, water absorption, specific gravity, and compressive strength tests were conducted

Figure(a): Locally available red soil

Figure(b): Fine Aggregate

A. Mix design

A concrete mix design was carried out to identify the correct amounts of cement, sand, and coarse particles required for casting concrete with a target compressive strength of 3000 psi. Table II displays the findings of the material proportions of cement (C), fine aggregate (FA), coarse aggregate (CA), and the water-cement ratio (W/C). The slump value was also considered satisfactory.

C: FA:CA	1:1.6:3.15
W/C	0.58

TABLE1.2 Mix design results.

B. Casting and curing

For the compressive strength test, 12 cubes were cast as shown in Fig. 3. Throughout the work, a suitable mix proportion was maintained. After 24 hours of casting, the cubes have been placed in water for the proper curing times (Fig. 4).

Figure(c): Casting the concrete cubes

Figure(d): Curing the cubes for 7, 14, & 28 days.

Figure(e): Cubes tested under compressive testing machine.

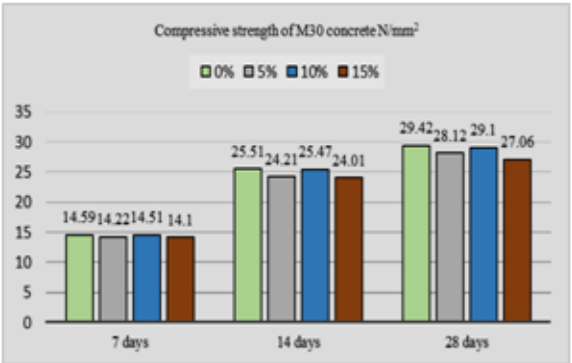
V. RESULTS AND DISCUSSION

A. Compressive strength of concrete cubes

A total of 150 mm-sized 12 specimens were cast. Aftera curing period of 7, 14, and 28 days tested respectively, by using a calibrated compression testing machine of 2000 KN capacity. The obtained results are tabulated below.

Grade of concrete	% of red mud used	7 days	14 days	28 days
M-30	0%	14.59	25.51	29.42
	5%	14.22	24.21	28.12
	10%	14.51	25.47	29.10
	15%	14.10	24.01	27.06

TABLE 1.3Compressive strength of concrete cubesfor 7, 14, & 28 days



1.1: Comparing compressive strength for plain concrete and concrete with 5%, 10%, and 15% red soil with respect to curing time.

The compressive strength of concrete is increased by 10% by replacement fine aggregate with red soil, after which it is reduced.

CONCLUSION

The result states that the compressive strength of concrete was strongly influenced by the replacement of sand with red soil. The strengths increased as the amount of red soil increased, but again decreased with the over adding of red soil. Because the addition of excessive red soil consumed more water than the sand, it reduced the strength of the concrete. So, red soil can be used as an alternate solution to sand, but in a limited way that does not affect the strength of concrete due to over-absorbing water.

- After testing 12 blended soil samples (0% to 15% replacement of sand by red soil) with an increment of 5%, it can be said that the optimum use of red soil is 10% as a partial replacement of sand by red soil will give satisfactory results.

REFERENCES

[1] Ashwin, S., Aishwarya, B., R., Praveen, H., R., Shwetha, N. and Uttarkar, A. (2017), 'An experimental study on concrete with partial replacement of fine aggregates by laterite sand' International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, No. 5, pp. 8732-8737.

[2] Experimental Investigation of Concrete Partial Replacement of Fine Aggregate with Red Soil and Lime Powder- Mr. G. Pradeep, R. Parameswaran, S. Prakash, S. Samynathan, R. Vijayarahavan- International journal of engineering research and technology (IJERT), June 2020.

[3] Alexander, J., Godwin, A. and Alexander, S. (2016), 'Study on the behavior of red soil cement concrete International Journal of Advances in Mechanical and Civil Engineering. Vol. 3, No. 3, pp. 158-162.

[4] Kusum Deelwal, Kishan Dharavath Mukul Kulshreshtha. "Evaluation of characteristics properties of Red Mud for possible use as a geotechnical material in Civil Construction." International Journal of Advances in Engineering & Technology, July, 2014.

[5] Fale, S., S., Pande, S., S., Gaud, V., R., Davre, S., V. and Thombre, P. (2017), 'Study of compressive strength of concrete by partial replacement of fine aggregate by natural sand with red soil International Journal of Research in Science & Engineering, Vol. 3, No. 2, pp. 98-105.

[6] Kiran Kumar MS and Raghavendra Naik. "Experimental Study on Utilization of Industrial By product (Red mud and Copper slag) in concrete block and Concrete International Journal of Civil and Structural Engineering Research.

[7] Experimental investigation of concrete by partial replacement sand with red soil- Rahman. S, Farnaz. T and Islam. T- International conference of engineering research, innovation and education ICERIE 2019,25-27 January, Sylhet, Bangladesh.

[8] T. Gupta, Y. Agrawal, and K. S. Kanya, “Properties of sustainable concrete containing red mud: a review,” Journal of Scientific Research & Reports, vol. 1, pp. 15–26, 2021.

[9] A. M. Arun Mohan, S. Bharathi, L. Kokila, E. Ponrooban, L. Naveen, and R. Prasanth, “An experimental investigation on utilization of red soil as replacement of fine aggregate in concrete,” Psychology and Education, vol. 58, no. 2, pp. 8398–8403, 2021.

[10] A. B. Sawant, N. S. Parsekar, and N. S. Mane, “Experimental study on utilization of industry

waste (red mud) in concrete," International Research Journal of Engineering and Technology (IRJET), vol. 6, 2019.

[11] Er. Vedpal Nain, Er. Mohd. Usman Er. Ajay Kumar, Er. Sanjay Sangwan. "Properties of Red Mud Admixed Concrete" International Journal for Research in Applied Science & Engineering Technology (IURASET).

[12] Renuka. R, Sowmya Shree. T, Soumya Shri. R, Chetana. M (2018), "Partial Replacement of fine aggregate with laterite soil" Journal for research, Vol.4.