

Mechanical Characterization of Red Mud based-Cementitious Materials

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Abstract – The mechanical characterization of red mud based-cementitious materials has been studied. The parameters of the process studied is compressive strength of cementitious materials i.e., red mud stabilized with 5, 7, 9, 11 and 13 % of lime or cement with sand and curing at 7, 14 and 21 days respectively. It has been verified from the mechanical strength that 13% lime or cement with 21 days of curing shows higher result as compared to other trial mix, which is considered as the optimum mix suitable for pavement blocks. The compressive strength value of block made with red mud-lime is more in comparison with red mud-cement block.

Key Words: Red Mud, Compressive Strength, Cementitious materials, lime, cement

1. INTRODUCTION

During the alumina production through Bayer's process, a waste is generated known as Red mud. Generally 0.8 to 1.76 tons of red mud generated by each 1 ton of alumina produced. Red mud is a mixture of compounds originally present in the parent mineral, bauxite and other compounds formed during the Bayer's process. During the investigation of development of pozzolanic pigment from red mud by calcinations in the range of 600 to 800°C, around 20% of Ordinary Portland Cement (OPC) replacement is possible by calcinated red mud [1]. Studies reported that the use of red mud did not affect the mineralogical characteristics of Portland cement clinker. However, the physio-mechanical test shows the addition of red mud did not negatively affect the quality of cement produced [2]. Nivetha et al. [3], Studied the strength and behaviour of red mud bricks. From the study, it was observed that by the replacement of 15% red mud shows more strength. Cablik [4], investigated on calcinated red mud as a pigment for use in building material industry. After testing the blocks for compressive strength by curing for 7, 14 or 28 days at room temperature between 18 to 23°C, the strength results were found as 14.83 to 27.77 MPa of the blocks that contained 1 to 32 % red mud. However, the investigation related to addition of cement and lime for increasing the strength of red mud cube is rarely found in the open literature.

Therefore, this paper evaluates the addition of percentage of cement and lime for increasing the strength of red mud cube. The validation of results and comparison between the results of moulds made with addition of cement and lime are also reported.

2. MATERIAL AND METHODS

In the present study, different trial mixes are prepared to study the compressive strength after curing with water from consistency of cement test. The main ingredients like Red mud, Sand, Cement, Lime and Water are used to study the strength properties of the mixes. The properties of Red mud are evaluated by considering IS 2720 and SP 36 (Part-1) which are presented in Table-1.

Table -1: Detail of test results of various properties of Red mud

SL. No.	Properties	Test Results
1	pH value	11.3 (Alkaline)
2	Specific Gravity	3.43
3	Liquid Limit	24.76%
4	Plastic Limit	17.4%
5	Plasticity Index	7.23%
6	Volumetric Shrinkage	1.6%
7	Linear Shrinkage	5.22%

The properties of lime and Cement were tested by considering IS 6932-1973 and IS 269-2013. However, the properties of sand was tested as per IS 2386 (Part-3)-1963. The test results are coming under specified limits given in codal provision.

2.1 Sample Preparation

For the moulding of cube using red mud, cement or lime and sand in a specific mould of size (70.6x70.6x70.6) mm³ were prepared to know the compressive strength after curing with water from the consistency of cement test, 33% of water is added for preparation of mix. The trial mixes of various cube compressive strength are presented in Table-2.

Table -2: Summary of Trial Mixes

SL. No.	Mix Code	Constituents
1	MIX 1	Red mud, Sand 30%, Cement 5%, Water 33%
2	MIX 2	Red mud, Sand 30%, Cement 7%, Water

		33%
3	MIX 3	Red mud, Sand 30%, Cement 9%, Water 33%
4	MIX 4	Red mud, Sand 30%, Cement 11%, Water 33%
5	MIX 5	Red mud, Sand 30%, Cement 13%, Water 33%
6	MIX 6	Red mud, Sand 30%, Lime 5%, Water 33%
7	MIX 7	Red mud, Sand 30%, Lime 7%, Water 33%
8	MIX 8	Red mud, Sand 30%, Lime 9%, Water 33%
9	MIX 9	Red mud, Sand 30%, Lime 11%, Water 33%
10	MIX 10	Red mud, Sand 30%, Lime 13%, Water 33%

After preparation of the above mix, cubes are moulded and kept for curing in water for 7, 14, 21 days. After the respective curing period, the compressive strength tests are conducted for observation. The results of 7, 14, and 21 days compressive strength for all the mixes and the comparison graph of cement and lime percentage versus compressive strength (N/mm²) are plotted(Chart-1,2,3).

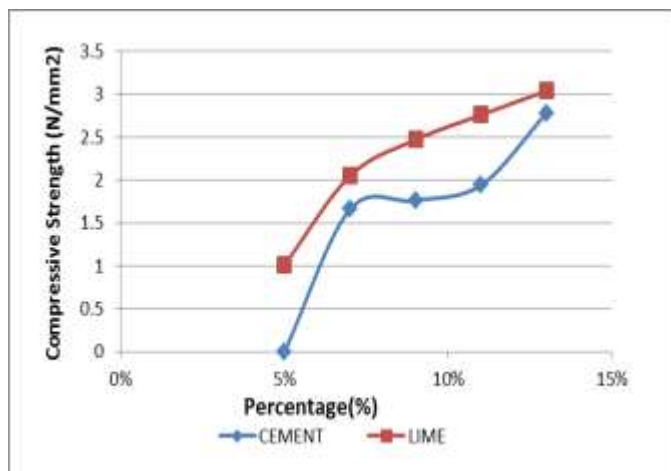


Chart -1: Strength Comparison between Cement Cube and Lime Cube for a Curing Period of 7 days

Chart-1 illustrates the strength comparison between cement cube and lime cube for a curing period of 7 days. It is found that with varying percentage of cement and lime with red mud, 30% of sand, 33% of water and lime gives better strength as compared to cement for curing period of 7 days. This is due to the high percentage of Calcium oxide content in lime.

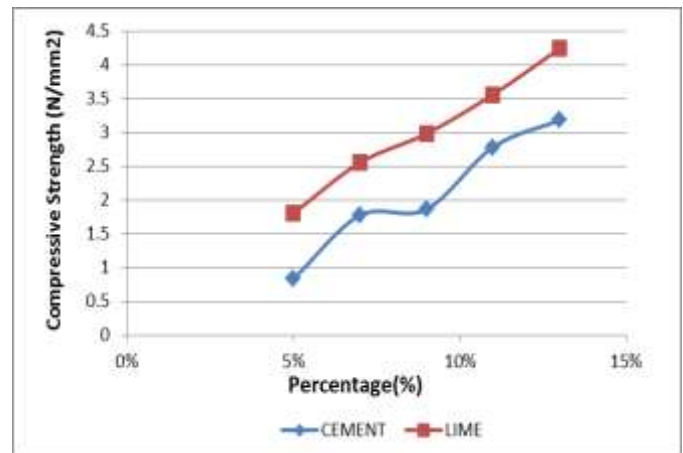


Chart -2: Strength Comparison between Cement Cube and Lime Cube for a Curing Period of 14 days

Chart-2 demonstrates the strength comparison between cement cube and lime cube for a curing period of 14 days. It is found from the observations that with varying percentage of cement and lime with red mud, 30% of sand, 33% of water and lime gives better strength as compared to cement for curing period of 7 days which is again due to the higher percentage of CaO content in lime.

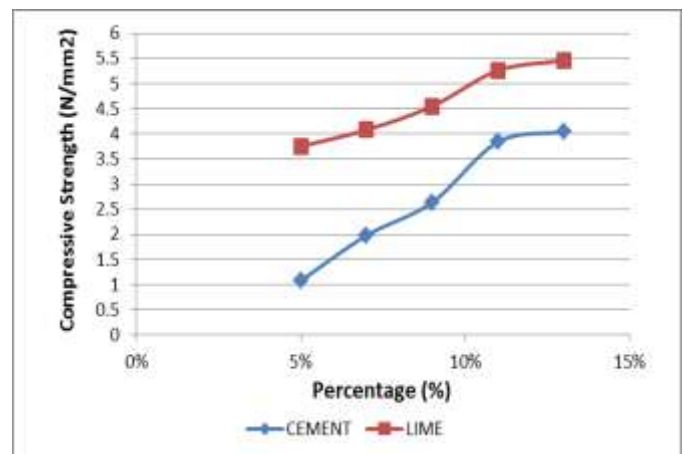


Chart -3: Strength Comparison between Cement Cube and Lime Cube for a Curing Period of 21 days

Chart-3 shows the strength comparison between cement cube and lime cube for a curing period of 21 days. It is found from the observations that with varying percentage of cement and lime with red mud, 30% of sand, 33% of water and lime gives better strength as compared to cement for curing period of 7 and 14 days.

3. CONCLUSIONS

From the above study it is concluded that:

- The compressive strength increases with increase in number of days.

- **Optimum:** The compressive strength of mix 10, gives 5.46 N/mm², which is suitable for pavement block for low to medium volume traffic.
- With addition of higher percentage of lime has shown higher values up to 10% addition further addition of lime does not play any vital role in increasing the strength of red mud lime mix.
- At 21 days of curing period the mix has shown maximum values at all percentages of lime addition.
- As the percentage of lime increases the water content required for stabilization is more.

BIOGRAPHIES



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