

Experimental Investigation on Engineering Properties of Red Mud

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ABSTRACT: The main aim of this project is to study and then utilizing the aluminium industrial waste product known as red mud. Red mud is generated from alumina production and its disposal is currently a worldwide problem. Large quantity of red mud is derived from bauxite calcination method and is being discharged annually, and its utilization has been an urgent topic. So in our project we have investigated the possibility of replacing the Portland cement by red mud in concrete as well as production of cement stabilized red mud brick. Portland cement has been replaced up to 30% red mud by weight of cement. This study examines the effects of red mud on the properties of hardened concrete. The test results show that its compressive, splitting tensile and flexural strength decreases with increase in red mud concrete. The optimum percentage of the replacement of cement by weight is found to be 20%. By this replacement we can get the strength of red mud concrete nearly equal to the controlled concrete. We have also produced red mud bricks using sand, red mud and cement in the ratio of 5:4:1. Here we obtained very high compressive strength of red mud bricks as compared to the normal bricks.

KEYWORDS: Red mud, aluminium waste.

I. INTRODUCTION

Concrete is a composite construction material, composed of cement and other cementitious material such as fly ash and slag, aggregate (generally coarse aggregate made of gravel or crushed rocks such as limestone, granite plus fine aggregate such as sand) water, and chemical admixtures. There are many types of concrete available, created by varying the proportions of the main ingredients below. In this way or by substitution for the cementitious and aggregate phase, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties. Aluminium is a light weight, high strength and recyclable structural metal. It plays an important role in social progress and has a pivotal contribution in transportation, food and beverage packaging, infrastructure, building and construction, electronics and electrification, aerospace and defence. It is the third abundant element in the earth's crust and is not found in the free state but in combined form with other compounds. The commercially mined aluminium ore is bauxite, as it has the highest content of alumina with minerals like silica, iron oxide, and other impurities in minor or trace amount. The primary aluminium production process consists of three stages: Mining of bauxite, followed by refining of bauxite to alumina by the Bayer process and finally smelting of alumina to aluminium. In the Bayer process, the insoluble product generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure to produce alumina is known as **red mud** or bauxite residue. The waste product derives its colour and name from its oxide content. As the bauxite has been subjected to sodium hydroxide treatment, the red mud is highly caustic with a pH in the range of 10.5 to 12.5. Bauxite posing a very serious and alarming environmental problem.

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II. MATERIALS AND METHODS

The material used for this experimental work are cement, sand, water, steel fibers, and super plasticizer.

Cement

Ordinary Portland cement (OPC) is by far the most important type of cement. Prior to 1987, there was only one grade of the OPC which was governed by IS 269-1976. After 1987 higher grade cements were introduced in India. The OPC was classified into three grades, namely 33 grade, 44 grade and 55 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988. Ordinary Portland cement of 53 grade manufacture by ADITYA BIRLA (Ultratech) cement conforming to the IS8112-1989 specification. If the 28 days strength is not less than 53N/mm^2 , it is called 53 grade cement.

Fine aggregate

Fine aggregate used was crushed dust is collected from quarry. Fine aggregate is formed from IS 383-1970 specification. The sieve analysis, water absorption, specific gravity test were conducted in laboratory. It is the important ingredient for cement.

Coarse aggregate:

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.64 and fineness modulus of 7 was found out 12.5mm.

Water

Portable water of good quality was used in mixing concrete it should be free from alkalis, organic matter. The chlorine content in the water must not high. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement.

Red mud

The red mud is the one of the major solid wastes coming from Bayer process of alumina extraction. At present about 3 million tones of red mud is generated annually, which is not being disposed or recycled satisfactorily. The conventional method of disposal of red mud in ponds has often adverse environmental impacts during monsoon. The waste may be carried by run-off to the surface water courses and result of leaching may cause contamination of ground water and also destroy the fertility of soil. Further disposal of quantities of red mud dumped, poses increasing problems of storage.

Physical properties of red mud

Specific gravity of red mud is found to be 2.35.

Its pH is found 10.5; hence it is alkaline in nature.

Moisture content is 20% and above

Cohesion of red mud is found to be 0.13144N/mm

Chemical properties of red mud

Red mud is composed of 6 major oxides; Al_2O_3 , Fe_2O_3 , Na_2O , SiO_2 , CaO , TiO_2 . It indicates that the percentage of CaO is very less hence it has no cementitious properties but when react with water and cements it starts gaining cementitious properties. Also percentage of silica available, contribute to strength.

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CHEMICAL COMPOSITION OF RED MUD AND ORDINARY PORTLAND CEMENT

OXIDES	COMPOSITION %(RED MUD)	COMPOSITION %(OPC)
CaO	1-2	60-70
SiO ₂	10- 15	17-15
Al ₂ O ₃	19- 22	3-8
Fe ₂ O ₃	40- 45	0.5- 6
Mgo	-----	0.1-4
Alkalies	6-7	0.4 -1.3
So ₃		1.3- 3

III. TESTING METHODS

To determine the hardened properties of concrete standard tests like compression test on cubes for compressive strength, split tensile test on cylinders for tensile strength and flexural test on beams for flexural strength of concrete were carried out at 7days and 28days of curing.

NUMBER OF SPECIMENS CASTED

MIX TYPE M20 GRADE	COMPRSSION SPECIMEN	SPLIT TENSILE SPECIMEN	FLEXURAL SPECIMEN	TOTAL
NORMAL CONCRETE	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
5% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
10% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
15% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
20% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
25% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES
30% OF RED MUD	6 SAMPLES	6 SAMPLES	6 SAMPLES	18 SAMPLES

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COMPRESSIVE STRENGTH OF CONCRETE CUBES

COMPRESSIVE STRENGTH OF CUBE FOR 7 DAYS

% replacement	Compressive Strength (N/mm ²)	Avg. Compressive Strength (N/mm ²)
Nominal Concrete	18.67	18.67
	19.56	
	17.78	
5	28.89	27.81
	26.67	
	27.87	
10	25.68	24.48
	24	
	23.78	

% replacement	Compressive Strength (N/mm ²)	Avg. Compressive Strength (N/mm ²)
15	21.33	21.67
	22.67	
	21.02	
20	19.56	18.84
	18.31	
	18.67	

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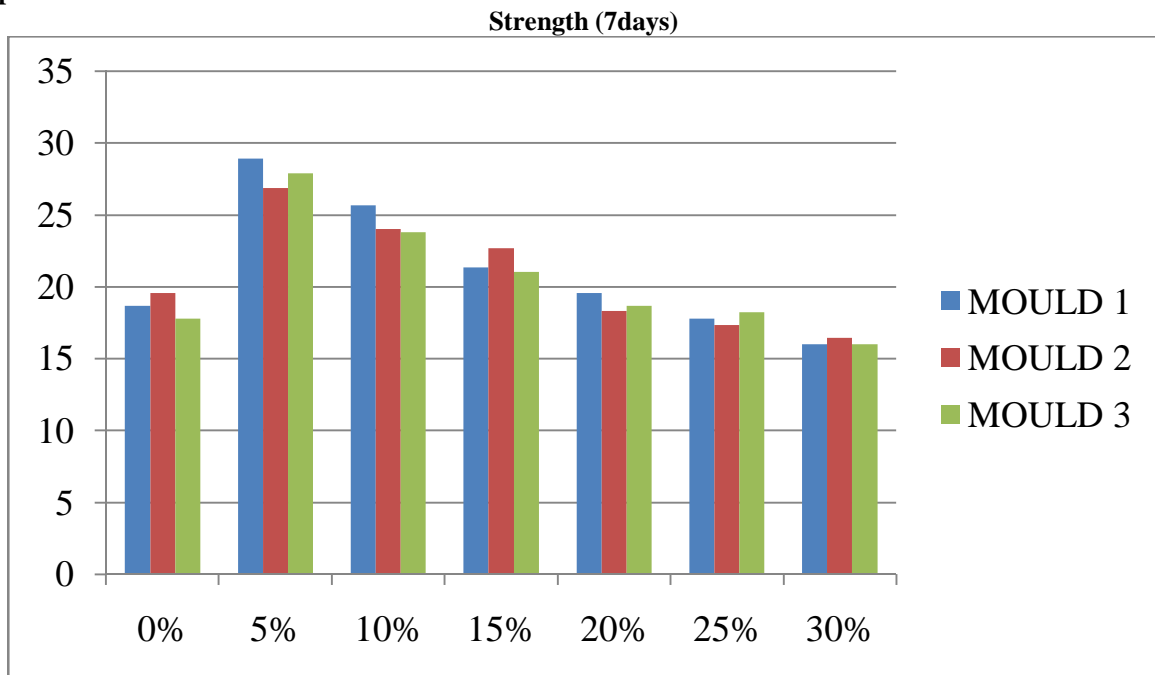
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25	17.78 17.33 18.22	17.78
30	16.00 16.45 16.00	16.148

Compression



7.2 COMPRESSIVE STRENGTH OF CUBES FOR 28 DAYS

% replacement	Compressive Strength (N/mm ²)	Avg. Compressive strength (N/mm ²)
Nominal Concrete	27.11 26.67 27.78	27.185

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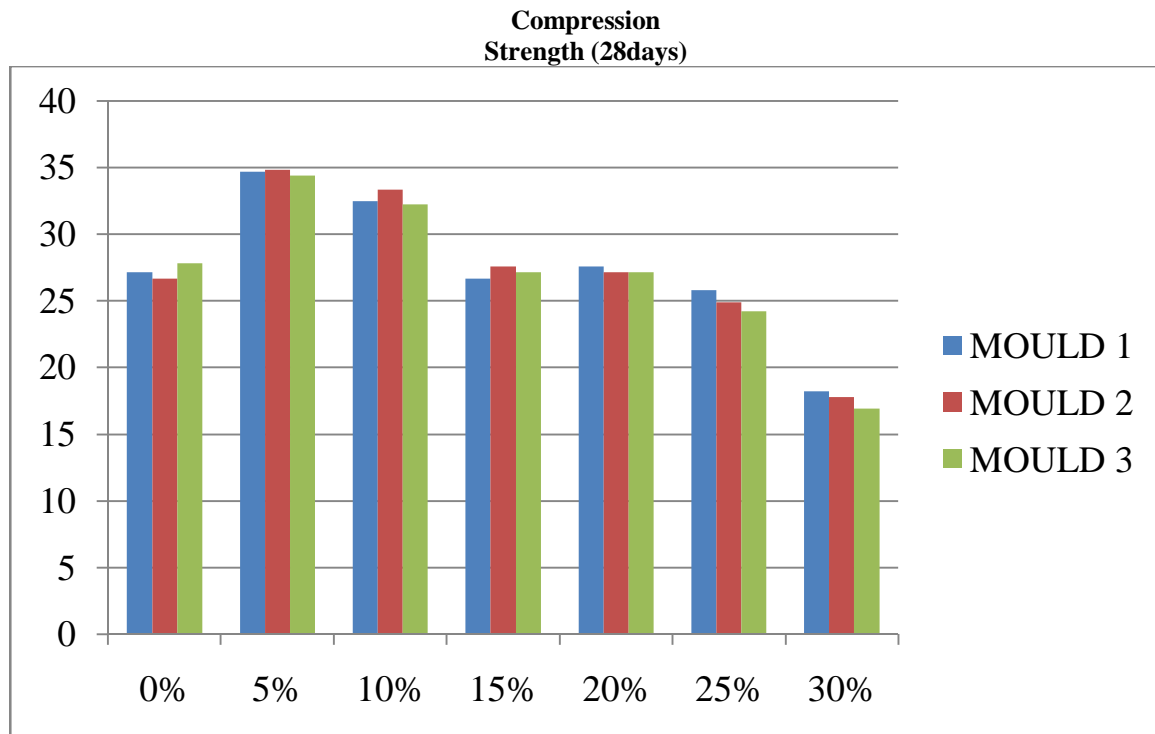
% replacement	Compressive Strength (N/mm ²)	Avg. Compressive strength (N/mm ²)
5	34.67 34.8 34.4	34.62
10	32.44 33.33 32.22	32.67
15	26.67 27.55 27.11	27.11
20	27.56 27.11 27.11	27.25
25	25.78 24.89 24.22	24.96
30	18.22 17.78 16.89	17.62

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SPILT TENSILE STRENGTH OF CONCRETE CYLINDERS

TENSILE STRENGTH OF CYLINDER FOR 7 DAYS

% replacement	Tensile Strength (N/mm ²)	Avg. Tensile Strength (N/mm ²)
Nominal Concrete	1.846 1.687 1.782	1.771
5	2.36 2.29 2.38	2.343
10	2.06 1.97 2.005	2.011

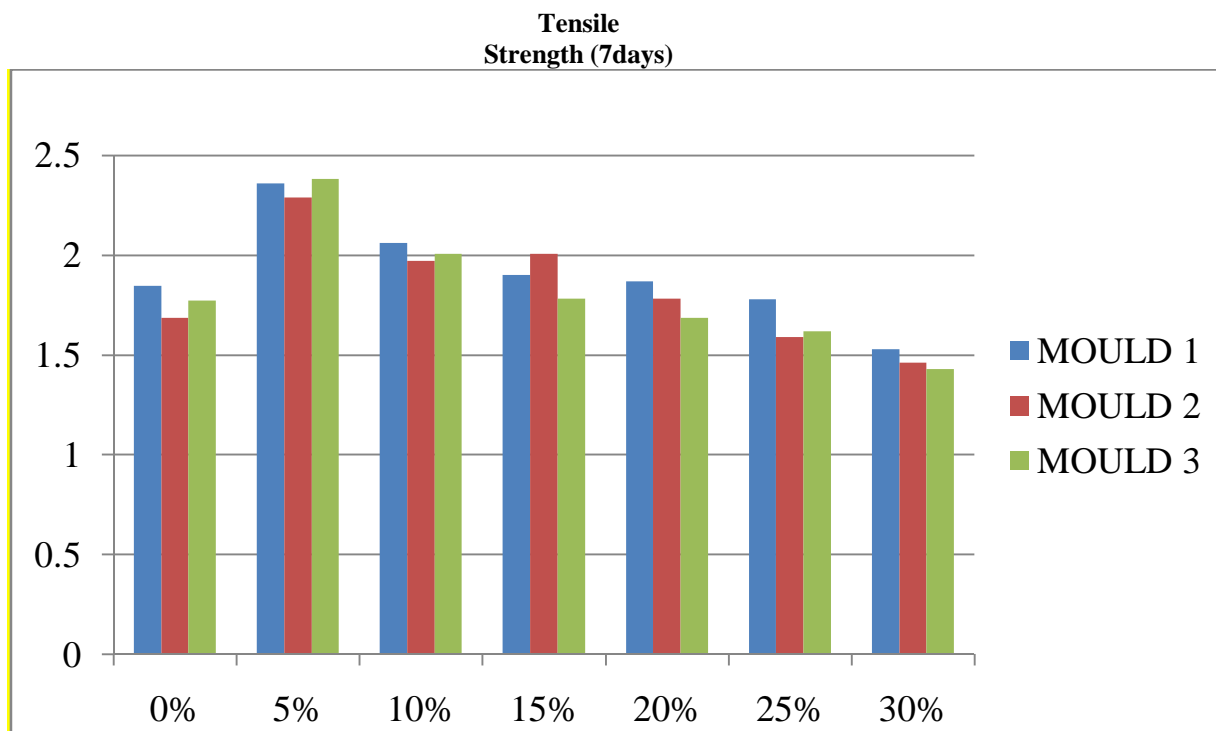
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% replacement	Tensile Strength (N/mm ²)	Avg. Tensile Strength (N/mm ²)
15	1.90 2.005 1.782	1.89
20	1.87 1.782 1.687	1.77
25	1.78 1.59 1.62	1.66
30	1.53 1.46 1.43	1.47



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8.2 TENSILE STRENGTH OF CYLINDER FOR 28 DAYS

% replacement	Tensile Strength (N/mm ²)	Avg. Tensile Strength(N/mm ²)
Nominal Concrete	3.183 2.546 2.495	2.74

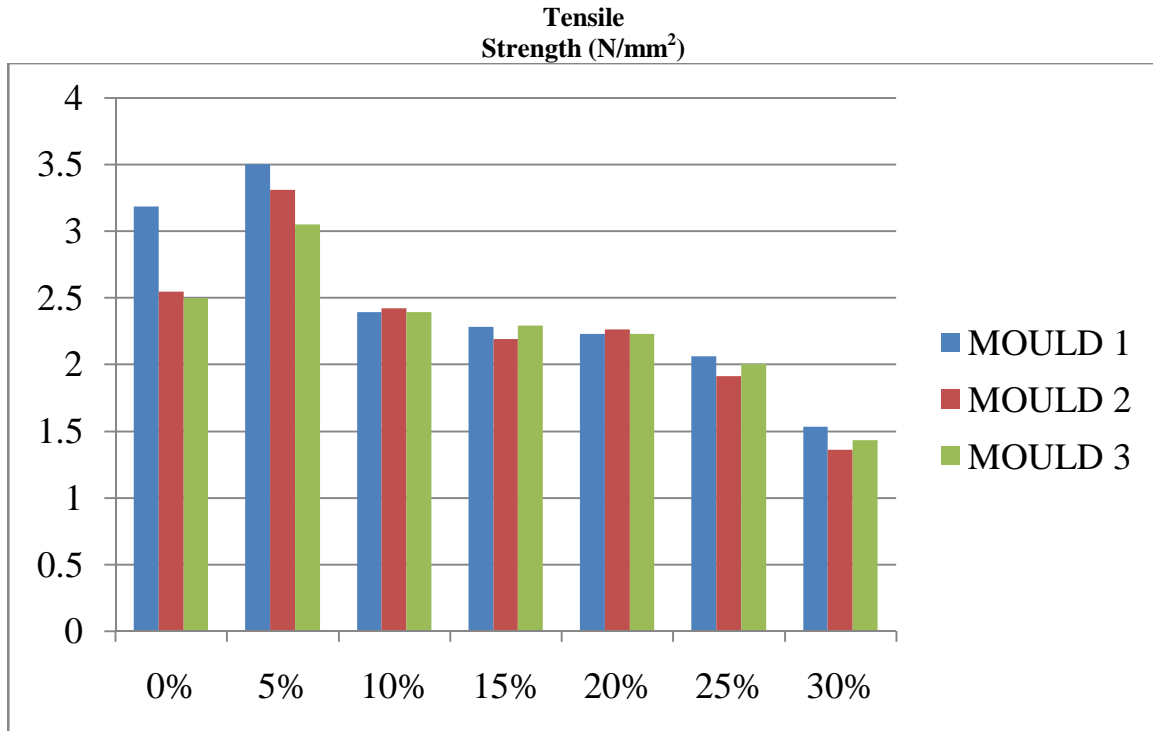
% replacement	Tensile Strength (N/mm ²)	Avg. Tensile Strength(N/mm ²)
5	3.50 3.31 3.05	3.28
10	2.39 2.419 2.39	2.391
15	2.28 2.19 2.29	2.24
20	2.23 2.26 2.23	2.34
25	2.06 1.909 2.00	1.99
30	1.53 1.36 1.432	1.442

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FLEXURAL STRENGTH OF CONCRETE BEAMS

FLEXURAL STRENGTH OF BEAM FOR 7 DAYS

% Replacement	Flexural Strength (N/mm ²)	Avg. Flexural Strength(N/mm ²)
Nominal Concrete	6.83 7.575 7.96	7.455
5	8.019 8.01 8.38	8.136
10	7.862 8.39 8.16	8.13

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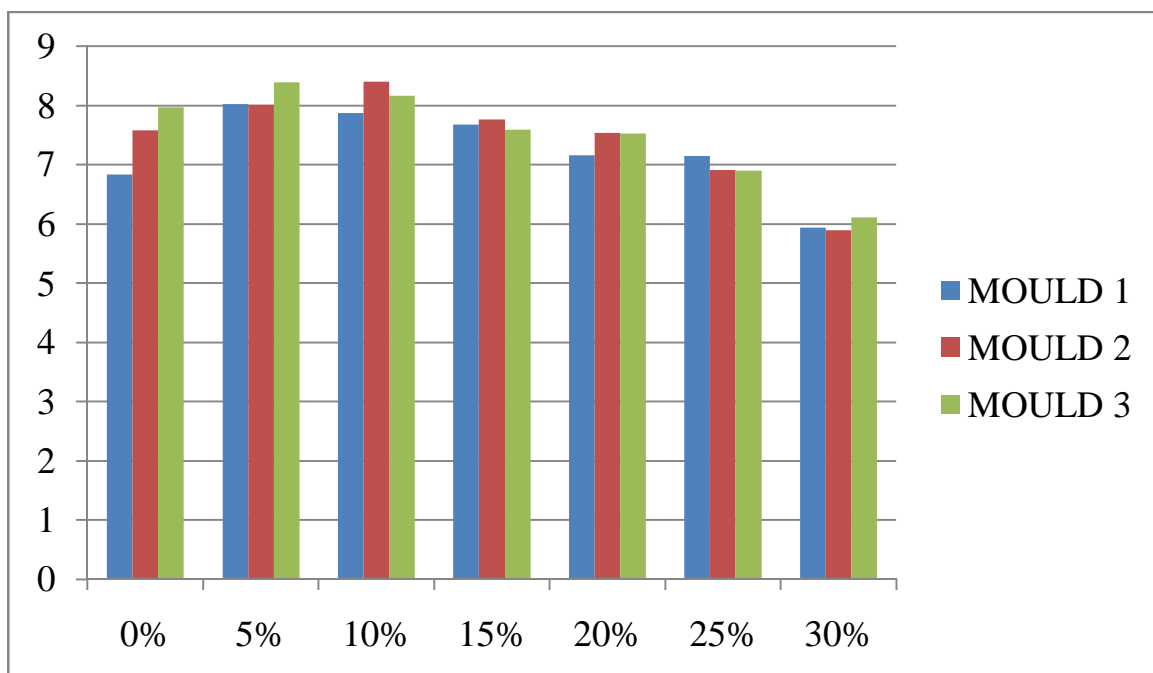
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% Replacement	Flexural Strength (N/mm ²)	Avg. Flexural Strength(N/mm ²)
15	7.67 7.76 7.58	7.67
20	7.15 7.53 7.52	7.4
25	7.14 6.90 6.89	6.97
30	5.936 5.89 6.10	5.97

Flexural Strength (7 days)



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9.2 FLEXURAL STRENGTH OF BEAM FOR 28 DAYS

% Replacement	Flexural Strength (N/mm ²)	Avg. Flexural Strength(N/mm ²)
Nominal Concrete	10.152 10.952 9.655	10.24
5	10.42 10.05 8.07	9.51
10	9.679 9.75 8.708	9.37

% Replacement	Flexural Strength (N/mm ²)	Avg. Flexural Strength(N/mm ²)
15	8.416 8.46 8.178	8.351
20	10.33 10.05 8.87	9.75
25	8.54 8.204 8.236	8.32
30	7.73 7.585 7.362	7.558

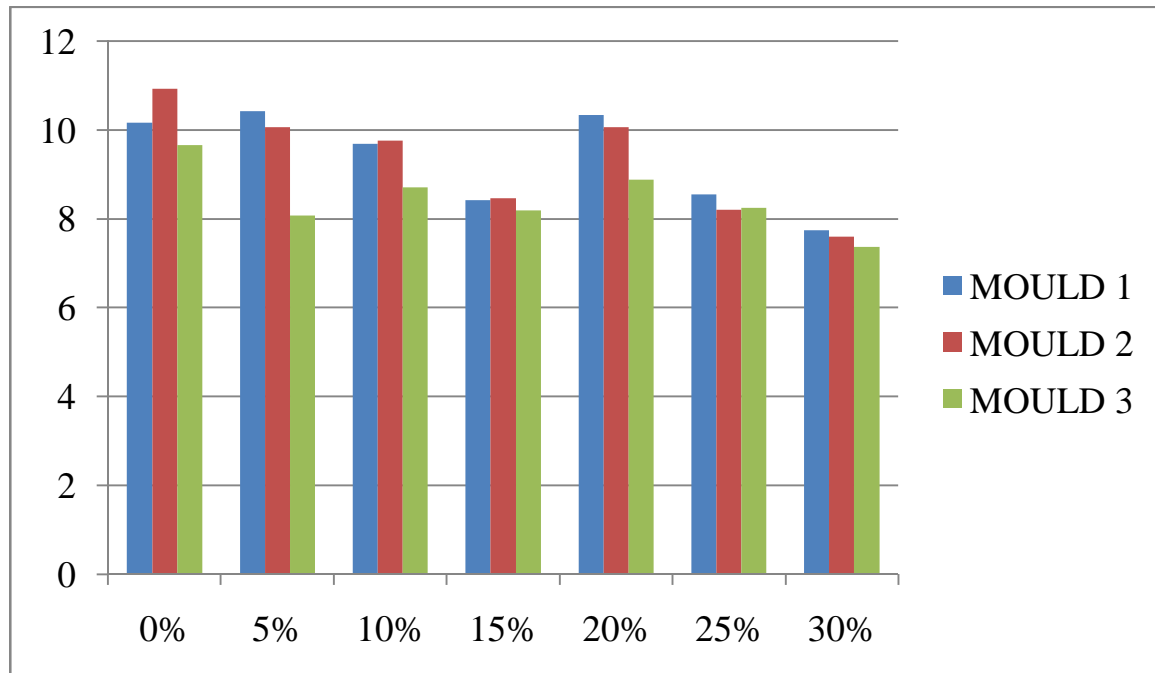
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Flexural Strength (28 days)



IV. CONCLUSION

- The strength of concrete decreases with increase in red mud concrete. It has been observed that initial addition of red mud increases the strength and then decreases continuously.
- The optimum percentage of the replacement of cement by red mud is found to be 20%. At which the strength of red mud concrete is found equal to the controlled concrete.
- The compressive strength of controlled concrete at 28 days is found to be 27.18N/mm², while of red mud concrete is found to be 27.25N/mm².
- The splitting tensile strength of controlled concrete at 28 days is found to be 2.74N/mm², while of red mud concrete is found to be 2.34N/mm².
- The compressive strength of controlled concrete at 28 days is found to be 10.24 N/mm², while of red mud concrete is found to be 9.75N/mm².
- The compressive strength of red mud brick is found to be 5.3N/mm².

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