Experimental studies on concrete utilizing red mud as a partial Replacement of cement

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ABSTRACT

This research investigates experimentally behavior of red mud with concrete. In this study, the cement replaced with various percentage of red mud in concrete and checked out various mechanical properties. Red mud replace with cement start to 16 % to 24% .at one percent interval. That is checked for different three grades of concrete M20, M-25 and M-30. The mechanical properties investigated in current study include compressive strength, split tensile strength, flexural strength and study on durability.

Keyword: *Red mud, Cement, industrial waste, mechanical properties of concrete.*

1. INTRODUCTION

Concrete is one of the most important construction materials, the improvement of concrete is needed and essential in order to increase the performance and sustainability. Concrete as a economic building material is very popular, It is widely used in many types building around the world. High impact resistance and greater energy absorption capacity are desirable properties of concrete. Concrete is brittle material with high rigidity, high impact resistance and more energy absorption capacity are required in many application. The components works together to resist many types of loading. Concrete resists compression and steel reinforcement resists tension forces.

The Bayer Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and it results in the production of significant amounts of dust-like, high alkalinity bauxite residues known as red mud. Red mud is a waste material generated by the Bayer Process widely used to produce alumina from bauxite throughout the world.

2. EXPERIMENTAL PROGRAM

2.1 Material

In this various material used for study, their properties, test conducted and result are discussed. This section also explains the mix proportion used for thee study.

2.1.1 Cement

IS 12269 - 1987 conforming of Ordinary Portland Cement (OPC) of 53 grade cement was used.

Table -1: Physical Properties of Cement

Sr. No.	Property`	Test Result
1	Specific Gravity	3.15
2	Fineness	308 m^2/kg

3	Standard Consistency	28%
4	Initial Setting Time	140 min
5	Final Setting Time	195 min

2.1.2 Fine Aggregate

Natural Fine Aggregate used for study as conforming to zone I of IS: 383-1987. Natural fine aggregate size less than 4.75mm

Table -2: Physical Properties of Fine Aggregate

Sr. No.	Property`	Test Result
1	Specific Gravity	2.66
2	Fineness modules	2.74
3	Water Absorption	0.122
4	Surface Moisture	0.137

2.1.3 Coarse Aggregate

Natural coarse aggregate size is maximum 20mm used for study as conforming to IS: 383- 1970.

Table -3: Physical Properties of Coarse Aggregate

Sr. No.	Property`	Test Result
1	Specific Gravity	2.62
2	Fineness modules	5.36
3	Water Absorption	0.028
4	Surface Moisture	0.04

2.1.4 Red Mud

The Bayer Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and it results in the production of significant amounts of dust-like, high alkalinity bauxite residues known as red mud.

Table -4: Physical Properties of Red Mud

Sr. No.	Property`	Test Result
1	Specific Gravity	2.98
2	Fineness	2600 sq.cm/gm
3	pH	11.8
4	Particle size	<300 Micron

2.2 Concrete Mix Proportion

In this study conventional batch of M-20, M-25 and M-30 was casted and compare with percentage replacement of red mud with cement.

Table -5: Concrete Mix Proportion

Mix Design	Cement Kg/m^3	Water Kg/m^3	NCA Kg/m^3	NFA Kg/m^3
M-20	439	199	1079	672
M-25	449	199	1094	647
M-30	457	193	1106	643

The present study was to replacement by red mud for different percentage (0%, 16%, 17%,18%, 19%, 20%, 21%, 22%, 23%, 24%) by weight.

3. EXPERIMENTAL RESULT AND DISCUSSION

3.1 Slump Test

It is very essential for concrete to have good workability so that entrapped air can be easily removed by minimum effort of compaction. In field conditions it is mostly observed that workability may vary from batch to batch due to many reasons. The most common reasons being batching error of water, presence of surface moisture on aggregates and absorption of water by dry aggregates. Slump test for workability is the simplest test and is most often used at construction sites and must be carried out using the apparatus complying to IS: 7320-1974.

Table -6: Slump result

MIX	% Replacement	Slump		
		M-20	M-25	M-30
1	0	82	74	62
2	16	82	75	64
3	17	83	75	64
4	18	84	76	65
5	19	85	76	66
6	20	85	77	66
7	21	86	77	67
8	22	86	78	68
9	23	87	78	68
10	24	89	79	70

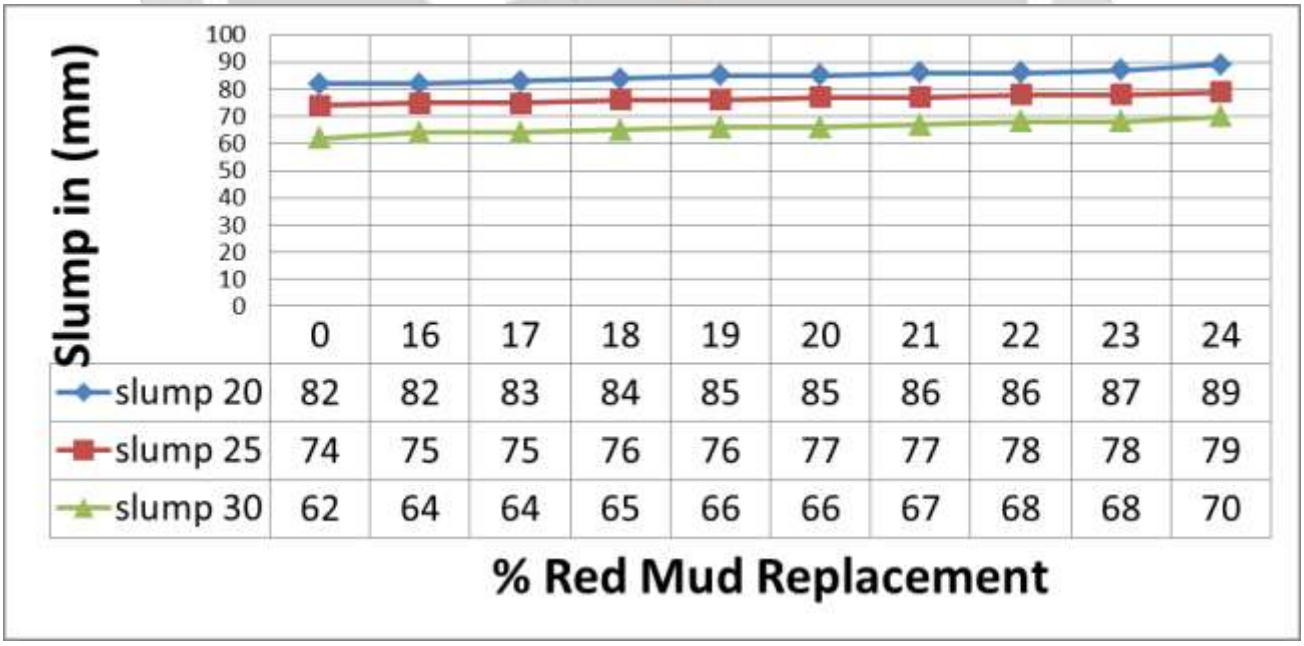

Fig -1: Slump value

3.2 Compressive strength

Evaluation of compressive strength of concrete specimen is carried by 2000 kN capacity hydraulic testing machine. According to IS : 516 – 1959 sample size of 150 mm x 150 mm x 150 mm for finding out the compressive strength of the sample.

Table -7: compressive strength

MIX	% Replacement	compressive strength		
		M-20	M-25	M-30
1	0	24.65	26.22	32.53
2	16	29.44	30.67	33.10
3	17	31.02	32.68	33.82
4	18	33.02	34.30	35.64
5	19	30.36	30.93	33.19
6	20	28.99	30.50	31.91
7	21	28.37	30.28	31.81
8	22	27.76	28.21	30.79
9	23	27.26	27.57	29.69
10	24	26.16	26.41	28.09

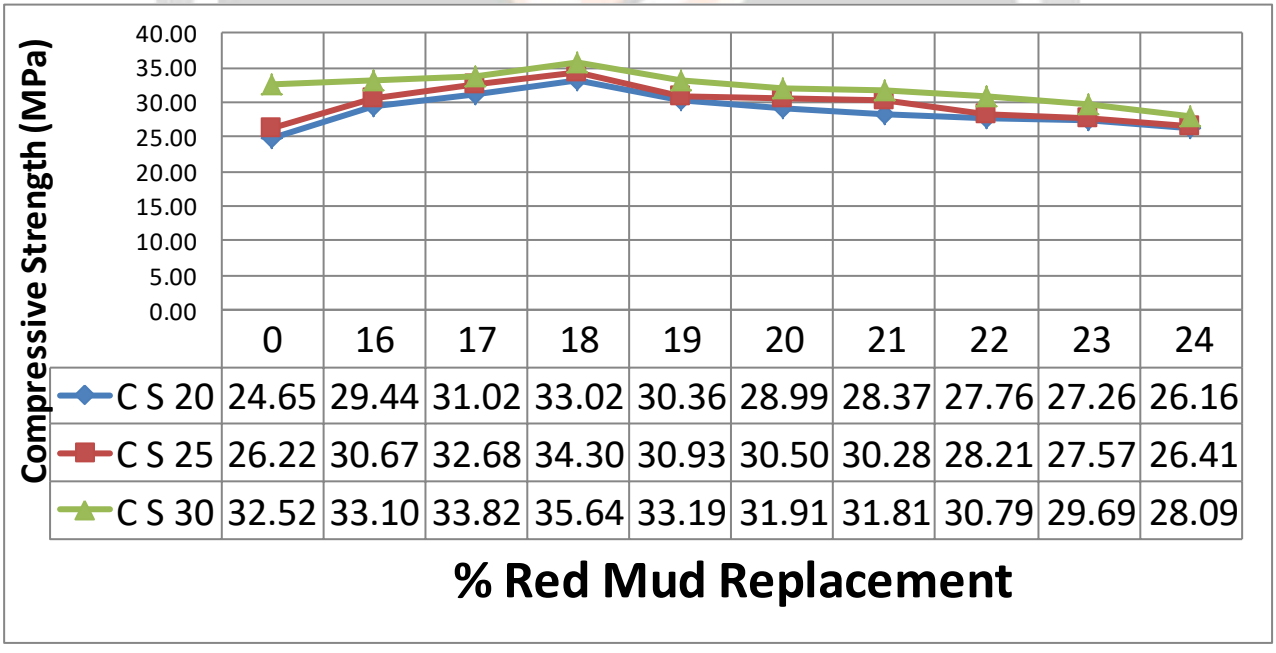

Fig -2: Compressive strength value

3.3 Flexural strength

Evaluation of flexural strength of concrete specimen is carried by 250 kN capacity hydraulic testing machine. According to IS: 516–1959 sample size of 100 mm x100 mm x 500 mm for finding out the modulus of rupture of the sample.

Table -8: Flexural Strength

MIX	% Replacement	Flexural Strength		
		M-20	M-25	M-30
1	0	3.76	4	4.24
2	16	4.41	4.41	4.53
3	17	4.57	4.63	4.77
4	18	4.91	5	5.15
5	19	4.21	4.23	4.24
6	20	4.09	4.09	4.16
7	21	3.97	4.04	4.15
8	22	3.84	3.88	4.07
9	23	3.81	3.83	3.97
10	24	3.64	3.81	3.81

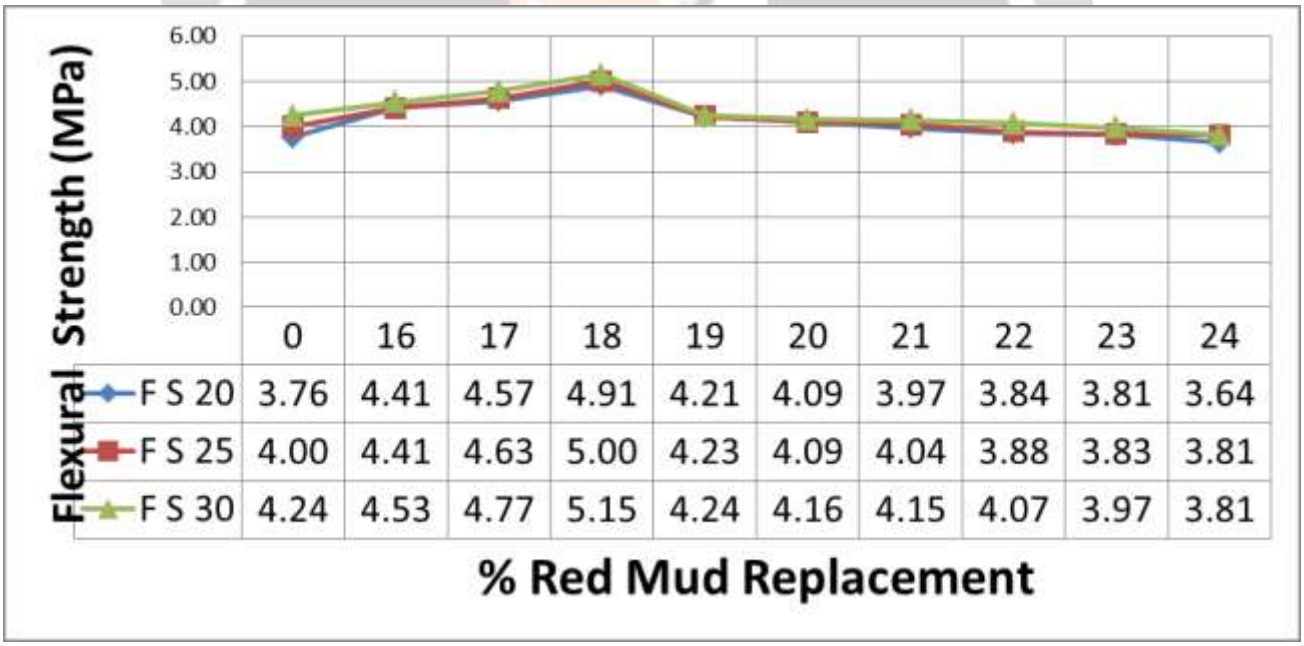

Fig -3: Flexural strength value

3.4 Tensile strength

Evaluation of tensile strength of concrete specimen is carried by 2000 kN capacity hydraulic testing machine. According to IS: 5819 – 1999 sample size of 150 mm x 300 mm for finding out the tensile strength of the sample.

Table -9: Tensile Strength

MIX	% Replacement	Tensile Strength		
		M-20	M-25	M-30
1	0	2.27	2.85	2.93
2	16	2.97	3.16	3.47
3	17	3.03	3.18	3.54
4	18	3.34	3.51	3.75
5	19	2.87	3.14	3.45
6	20	2.85	2.97	3.43
7	21	2.77	2.83	3.41
8	22	2.75	2.82	3.26
9	23	2.57	2.76	3.24
10	24	2.54	2.65	2.93

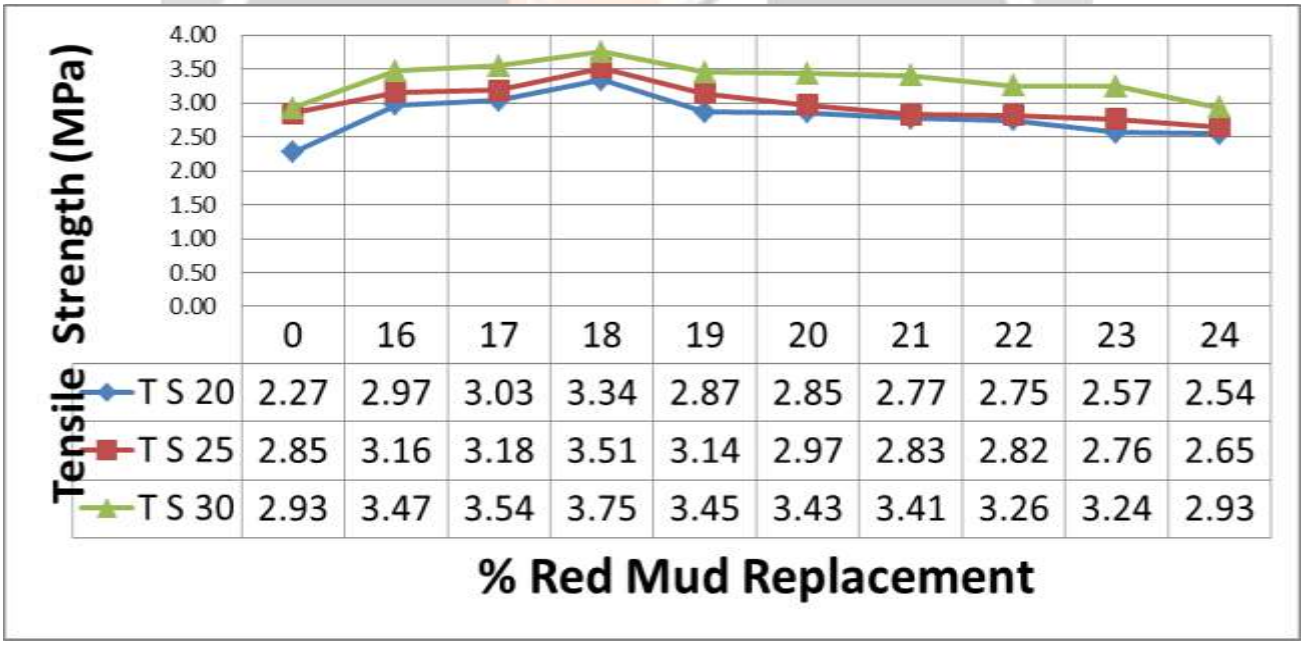

Fig -4: Tensile strength value

3.5 Durability

Acid attack is one of the most important aspects for consideration when we deal with the durability of concrete. Acid attack is particularly important because it is responsible to causes corrosion of reinforcement. By the indication of statistics over, 40 percent of failure of structures is due to corrosion of reinforcement.

Table -10: Durability

MIX	% Replacement	Durabillity		
		M-20	M-25	M-30
1	0	22.92	24.00	28.93
2	16	27.38	28.07	29.45
3	17	28.83	29.90	30.09
4	18	30.71	31.38	31.67
5	19	28.22	28.30	29.44
6	20	26.96	27.90	28.40
7	21	26.39	27.72	28.30
8	22	25.81	25.82	27.35
9	23	25.21	25.35	26.33
10	24	24.15	24.34	24.93

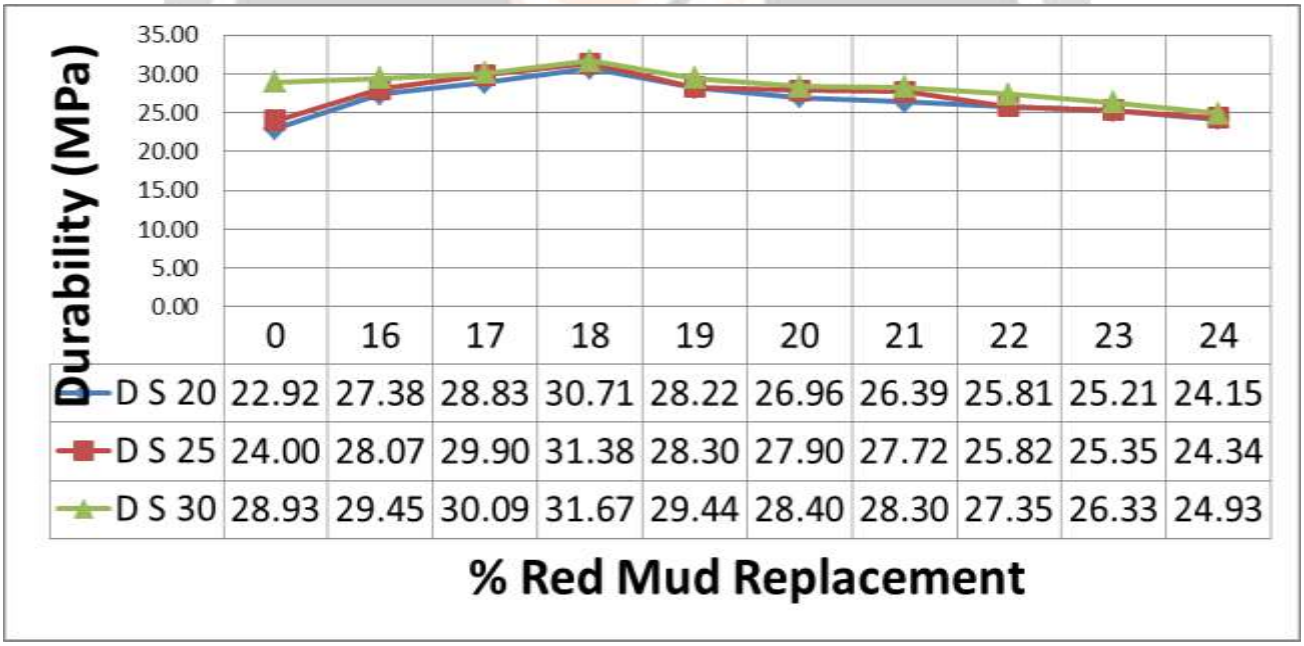

Fig -5: Durability value

4. CONCLUSIONS

The M20 grade of concrete increased with increasing content of Red Mud up to 18% replacement was about 33.95% than after compressive strength decreasing with increasing content of Red Mud.
In Compressive Strength, Splitting Tensile Strength, Flexural Strength and durability, Optimum result are obtain by using Red Mud content of 18%.

The M25 grade of concrete increased with increasing content of Red Mud up to 18% replacement was about 30.81% than after compressive strength decreasing with increasing content of Red Mud.
In Compressive Strength, Splitting Tensile Strength, Flexural Strength and durability, Optimum result are obtain by using Red Mud content of 18%.

The M30 grade of concrete increased with increasing content of Red Mud up to 18% replacement was about 9.59% than after compressive strength decreasing with increasing content of Red Mud.
In Compressive Strength, Splitting Tensile Strength, Flexural Strength and durability, Optimum result are obtain by using Red Mud content of 18%.

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