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Advancement of Improved M30 Grade Concrete with Red Mud and Iron Ore Slickens and their Classification

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Abstract: ***India is a developing country and in various developing countries like India economical construction along with economical construction material plays a vital role in the development of country. Waste material in construction can play tremendous role to make it economical and durable due to some of its specific properties relevant to construction materials. This dissertation shows comparative and experimental study on utilization of Red Mud and Iron Ore Slickens by replacement of Cement and fine aggregates in concrete. In this project red mud and Iron ore slickens are added in concrete by weight of cement and fine aggregate in the proportion of 1%, 2%, 3%, 4% & 10%, 20%, 30%, 40% respectively. Workability and compressive strength test are performed on concrete and their results are being evaluated and compared.***
Keywords: Red Mud, Iron ore slickens, Fine Aggregates, Cement, Concrete, Workability and Compressive Strength.

I. INTRODUCTION

Concrete is one of the major materials used in construction industry and also most important materials used in public works and structural construction project. Concrete is used in construction since ages now which implies that we have used tons of concrete and also will continue to use it. As concrete is widely used construction material but at the same time also it is not environment friendly material as it destroys and uses abundant quantity of natural resources and also it also has a environmental impact as after its use it is deposited in land as a filler material.

A. Red Mud

Red mud is the iron rich residue produced from the digestion of bauxite. It is one of major solid waste obtained from Bayer process of alumina production. In general, about 2-4 tons of bauxite is required for production of each tone of alumina (Al2O3) and about one tone red mud is generated. Since the red mud is generated in large quantities, it has to be stored in large confined and impervious ponds, therefore the bauxite refining is gradually encircled by the storage ponds. At present about 60 million tons of red mud is produced on an annual basis worldwide which is not being disposed or recycled satisfactorily.

B. Iron Ore Slickens

India is one of the biggest iron ore producers and exporter in the world. Mining plays an important role in harnessing natural ore, but during this operation a lot of waste is generated. Proper waste management and disposal of this waste is need of the hour so that it can cause minimal damage to the environment. Iron ore tailings (IOT) are such waste produced during mining of iron from its ore. The rapid growth in the surface mines led the production of Iron Ore tailings which remains as overburden. In future, the proportion of iron ore wastes produced is likely to increase due to higher demand for iron ore. Moreover, dumping leads to loss of valuable land.

Iron Ore Slickens Natural Sand

Figure 1: Comparison between natural sand and Iron Ore Slickens

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Figure 2: Red Mud

II. MATERIAL AND METHODS

A. *Cement*

Table 1: Properties of Cement

S. NO	Property	Value
1	Fineness	3.82%
2	Initial Setting Time	41 min
3	Final Setting Time	197 min
4	Specific Gravity	3.14
5	Soundness	2 mm
6	Compressive Strength	7 Days – 24.56 MPa
		28 Days – 37.84 MPa

B. *Water*

Consolidating water with a cementitious material a structural bond is developed by the procedure of hydration. The concrete glue ties the total together, fills voids inside of it, and makes it workable. A lower water-to-bond proportion yields more grounded, tougher cement, while more water gives workable cement with a higher droop. Tainted water used to make cement can bring about issues when setting or in creating untimely disappointment of the structure. Hydration includes various responses, frequently happening in the meantime. As the responses continue, the results of the concrete hydration handle slowly bond together the individual sand and rock particles and different segments of the solid to shape a strong mass. Water used for concrete should be free from injurious number of oils, acids, alkalis, salts, sugar, organic materials or other substances. Water which is used in this project is confirming to the specification of IS 456: 2000.

Coarse Aggregates

Table 2: Properties of Coarse Aggregate

S. No.	Property	Value
1	Crushing Value	14.90%
2	Impact Value	11.32%
3	Abrasion Value	12.54%
4	Specific Gravity	2.62
5	Water Absorption	0.64%

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6	Bulk Density	1680 Kg/m3	
7	Flakiness and Elongation Index	11.86%	
8	Gradation	Sieve No.	% Passing
		40 mm	100
		20 mm	92.25
		10 mm	9.64
		4.75 mm	1.23

Fine Aggregates

Table 3: Properties of Fine Aggregates

S. No.	**Property**	**Value**	
1	Specific Gravity	2.60	
2	Bulking	30.21%	
3	Water Absorption	0.92%	
4	Bulk Density	1590 Kg/m3	
5	Gradation	**Sieve No.**	**% Passing**
		10 mm	100.00
		4.75 mm	100.00
		2.36 mm	97.32
		1.18 mm	78.57
		600 microns	69.88
		300 microns.	16.40
		150 microns	0.32
		Conforming to grading zone II of IS 383-1997	

C. Red Mud

Table 4: Properties of Red Mud

S. No.	Property	Value
1	Specific Gravity	2.83
2	pH	11.5
3	Fineness	4.10%
Composition of Red mud		
S. No.	Components	Weight%
1	Al_2O_3	21-23
2	Fe_2O_3	38-43
3	SiO_2	12-17
4	TiO_2	1.5-2
5	CaO	1.5-2
6	Na_2O	3-5

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D. Iron Ore Slickens

Table 5: Properties of Iron Ore Slickens

S. No.	Property	Value
1	Specific Gravity	2.62
2	Relative density	1.24 gm/cc
3	Fineness Modulus	1.15
4	Water Absorption	10%

E. Mix design according to IS 10262: 2009

1) Target Mean Strength for Mix Proportion

= f_{ck}+ 1.65*standard deviation

Standard deviation is 5 according to table 1 IS 10262: 2009

= 30 + 1.65*5 = 38.25 MPa

2) Selection of Water Cement Ratio

As per IS 456, table 5 maximum water cement ratio for M 40 is 0.45. so selected water cement ratio is 0.45.

3) Selection of Water Content

From table 2, IS 10262: 2009, maximum water content for 20 mm aggregates is 186 liters for 50 mm slump.
Aggregate is angular so 30 liters of water is reduced.
Therefore, 156 liters of water is used for 50 mm slump and it is increased to 170 liters for 100 mm slump.

4) Calculation of Cement Content

Water – cement ratio = 0.45
Cement Content = 170/0.45 = 378 kg/m^3
378 kg/m^3> 320 kg/m^3 hence O.K.

5) Proportions of Volume of Course and Fine Aggregates

Form table 3, IS 10262: 2009,
Volume of coarse aggregate is 0.62
Correction for workability - +0.02
Final volume of Coarse aggregate = 0.64
Volume of fine Aggregate = 0.36

6) Mix Calculations

a) Volume of mix 1 m^3

b) Volume of cement

$\frac{378}{3.14} * \frac{1}{1000}$ = 0.12

c) Volume of water

$\frac{170}{1} * \frac{1}{1000}$ = 0.170

d) Volume of aggregates

= a-(b+c)

=0.710

e) Mass of Coarse Aggregate

= 0.710 * 0.64 * 2.62 * 1000

= 1190.52 kg

= 1190 kg

f) Volume of Fine Aggregate

= 0.710 * 0.36 * 2.60 * 1000

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= 664.56 kg
= 665 kg

7) *Final Mix Proportion*

Cement = 378 kg/m^3
Water = 170 kg/m^3
Fine Aggregate = 665 kg/m^3
Coarse Aggregate = 1190 kg/m^3

Red mud and iron ore slickens are added to the mix from 1% to 4% and 10 to 40% by weight of cement and fine aggregate respectively. Mix designation is given in table 6 and mix proportions in table 7.

Table 6: Mix Designation of Concrete

Material	Red Mud Content	Iron ore slickens content	Mix Name
Plane concrete	--	--	CC
Red Mud + iron ore slickens	1% (3.78 Kg)	10% (66.5 Kg)	RM11
	1% (3.78 Kg)	20% (133 Kg)	RM12
	1% (3.78 Kg)	30% (199.5 Kg)	RM13
	1% (3.78 Kg)	40% (266 Kg)	RM14
	2% (7.56 Kg)	10% (66.5 Kg)	RM21
	2% (7.56 Kg)	20% (133 Kg)	RM22
	2% (7.56 Kg)	30% (199.5 Kg)	RM23
	2% (7.56 Kg)	40% (266 Kg)	RM24
	3% (11.34 Kg)	10% (66.5 Kg)	RM31
	3% (11.34 Kg)	20% (133 Kg)	RM32
	3% (11.34 Kg)	30% (199.5 Kg)	RM33
	3% (11.34 Kg)	40% (266 Kg)	RM34
	4% (15.12 Kg)	10% (66.5 Kg)	RM41
	4% (15.12 Kg)	20% (133 Kg)	RM42
	4% (15.12 Kg)	30% (199.5 Kg)	RM43
	4% (15.12 Kg)	40% (266 Kg)	RM44

Table 7: Mix Proportion of Concrete Mix

Cement	378 kg/m^3
Water	170 kg/m^3
Fine Aggregate	665 kg/m^3
Coarse Aggregate	1190kg/m^3

Figure 3: Mix Proportion of Concrete Mix

III. EXPERIMENTS AND RESULTS

A. *Workability of mix Concrete*

Table 8: Workability of mix Concrete

S. No.	Mix ratio (Red Mud + Iron Ore Slickens)	Mix Name	Slump (mm)
1	0% + 0%	CC	76.2
2	1% + 10%	RM11	77.3
3	1% +20%	RM12	78.2
4	1% +30%	RM13	79
5	1% + 40%	RM14	80.2
6	2% + 10%	RM21	77.1
7	2% + 20%	RM22	78
8	2% + 30 %	RM23	79.5
9	2% +40%	RM24	80.6
10	3% +10%	RM31	77.6
11	3% +20%	RM32	79.1
12	3% +30%	RM33	80.3

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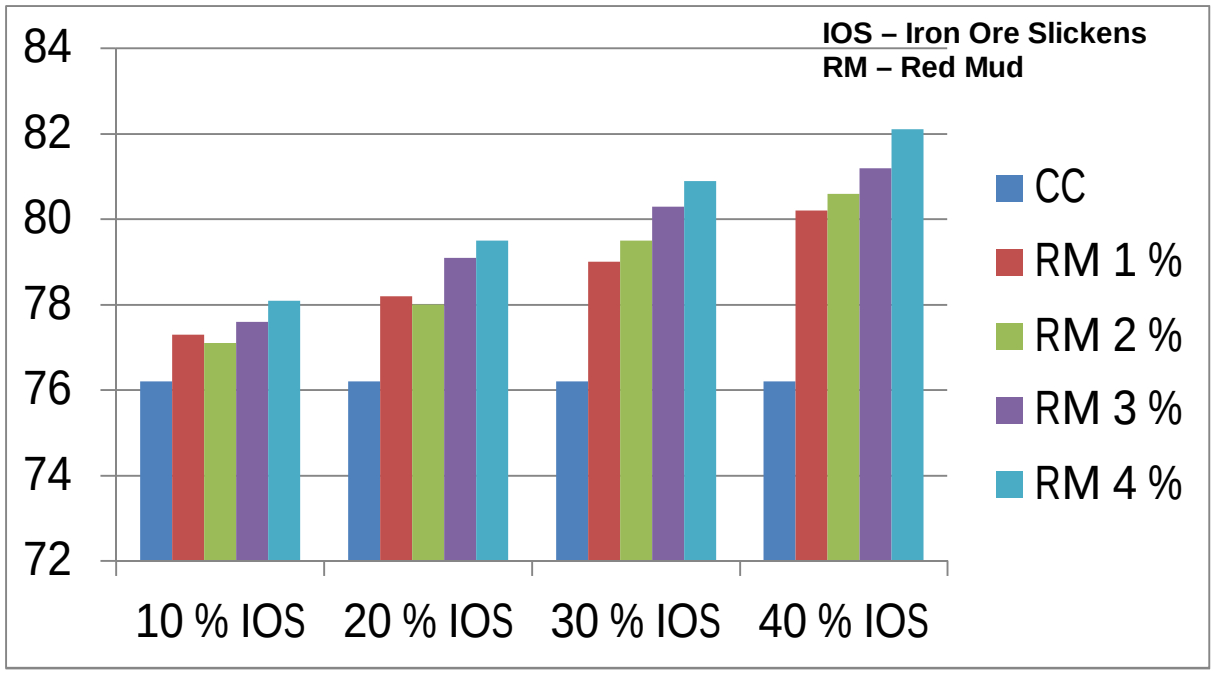
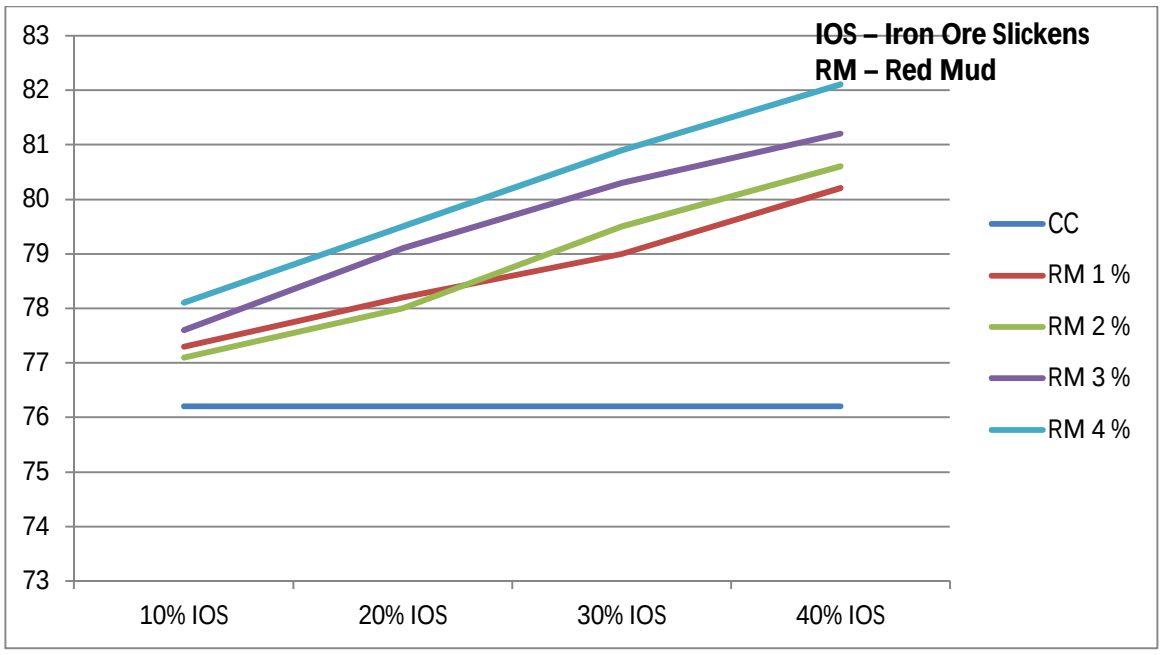
13	3% + 40%	RM34	81.2
14	4% + 10%	RM41	78.1
15	4% + 20%	RM42	79.5
16	4% + 30 %	RM43	80.9
17	4% + 40 %	RM44	82.1



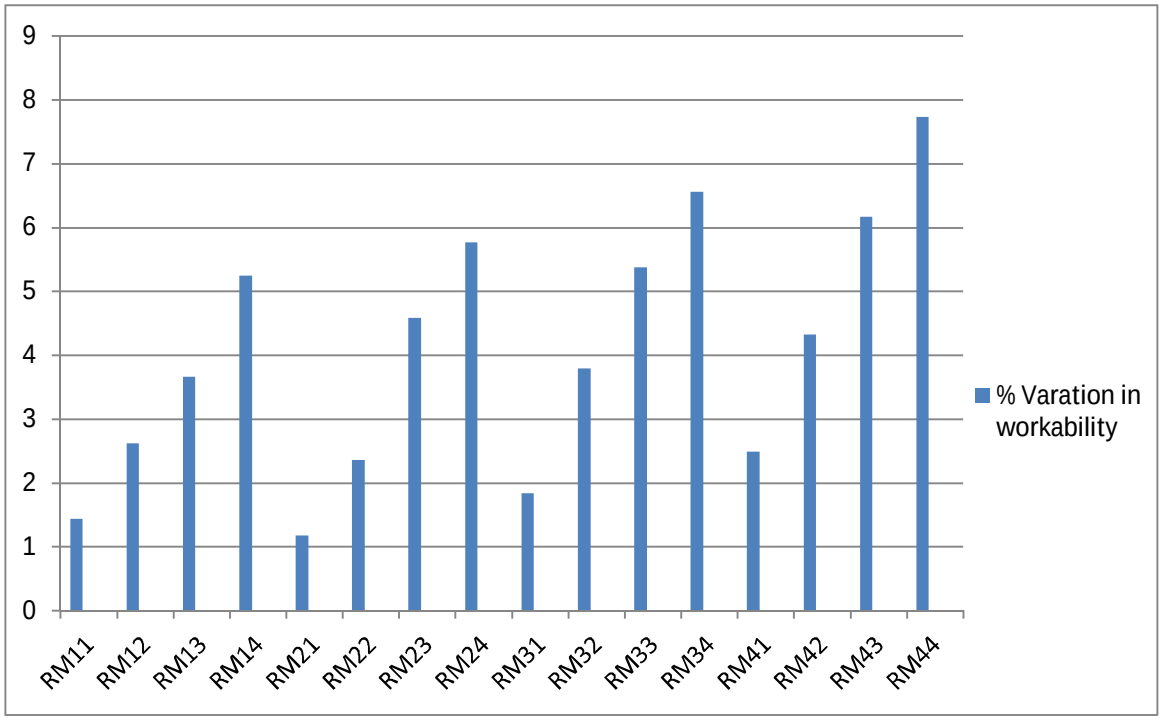
Graph 1: Workability of Mix Concrete (Bar Graph)



Graph 2: Workability of Mix Concrete (Line Graph)

Table 9: Variation in Workability of mix Concrete

S. No.	Mix ratio (Red Mud + Iron Ore Slickens)	Mix Name	Slump (mm)	% Variation
1	0% + 0%	CC	76.2	0%
2	1% + 10%	RM11	77.3	1.44
3	1% +20%	RM12	78.2	2.62
4	1% +30%	RM13	79	3.67
5	1% + 40%	RM14	80.2	5.25
6	2% + 10%	RM21	77.1	1.18
7	2% + 20%	RM22	78	2.36
8	2% + 30 %	RM23	79.5	4.59
9	2% +40%	RM24	80.6	5.77
10	3% +10%	RM31	77.6	1.84
11	3% +20%	RM32	79.1	3.80
12	3% +30%	RM33	80.3	5.38
13	3% + 40%	RM34	81.2	6.56
14	4% + 10%	RM41	78.1	2.49
15	4% + 20%	RM42	79.5	4.33
16	4% + 30 %	RM43	80.9	6.17
17	4% + 40 %	RM44	82.1	7.74



Graph 3: Variation in Workability of Mix Concrete (Bar Graph)

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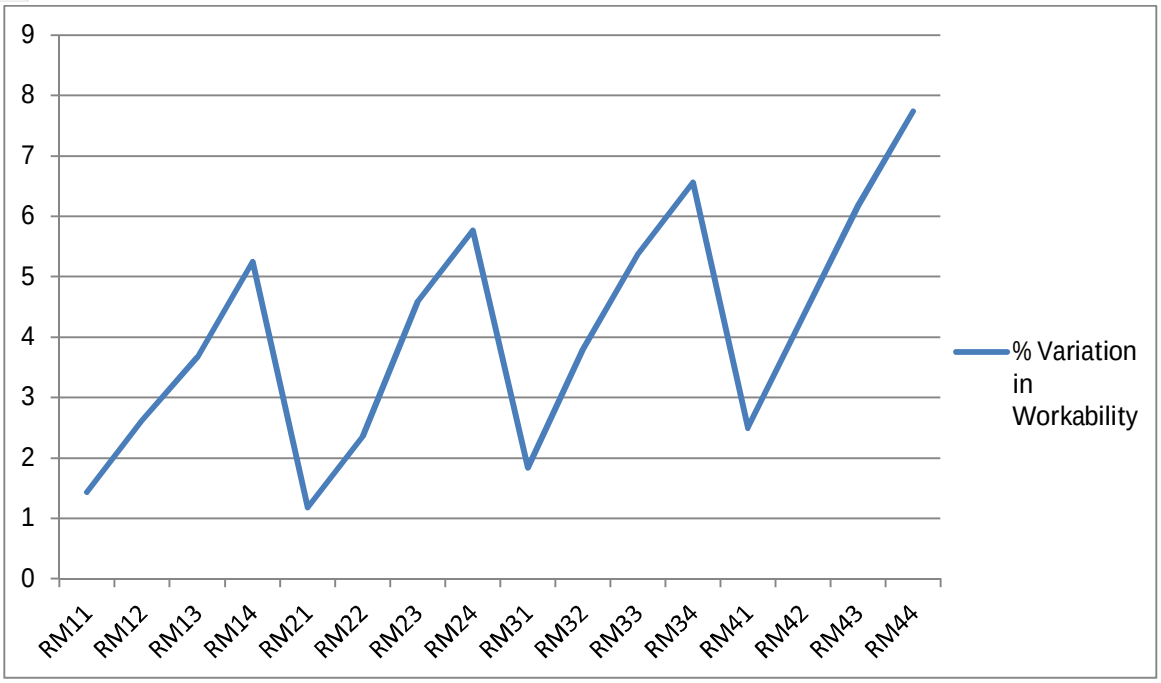


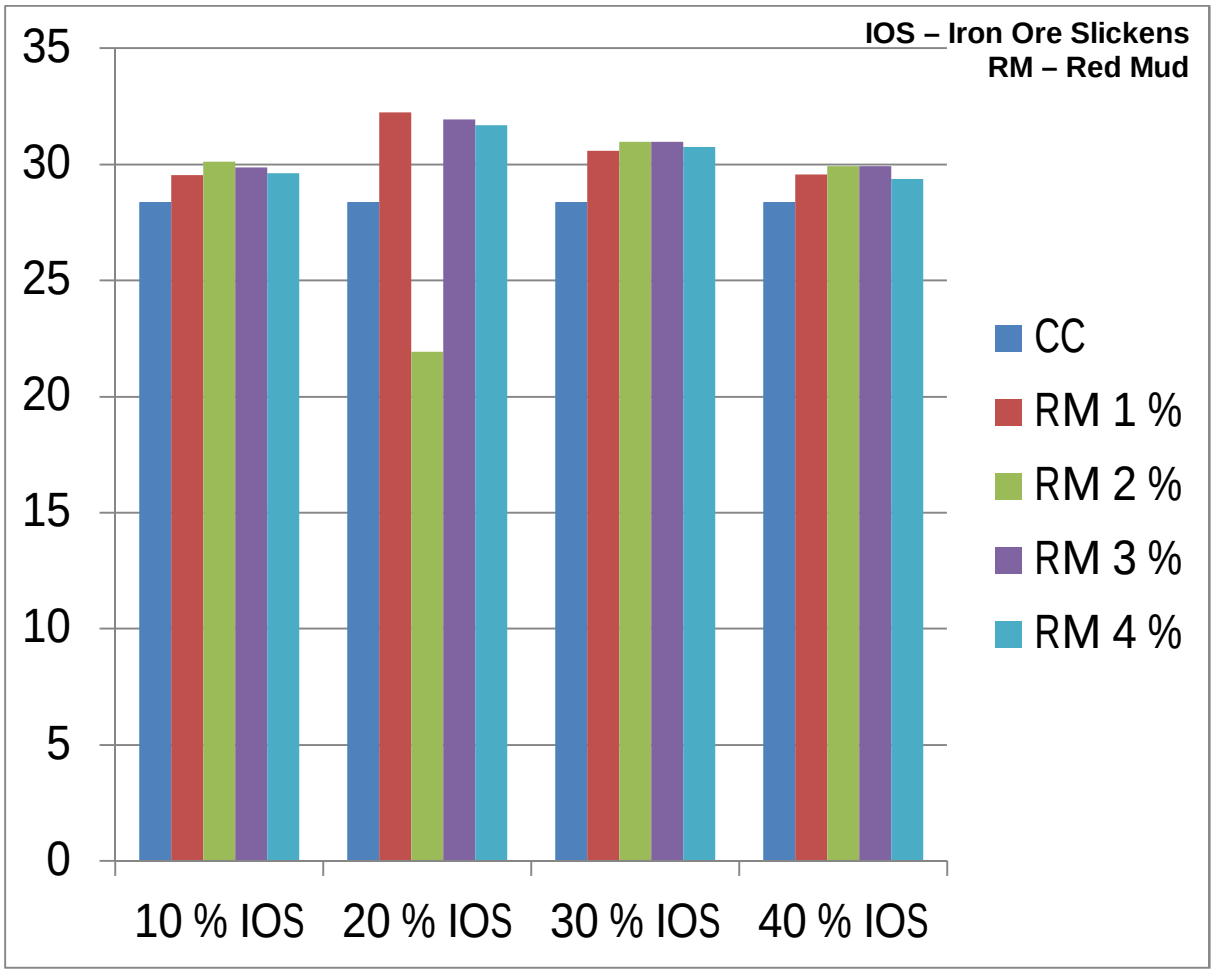
Graph 4: Variation in Workability of Mix Concrete (Line Graph)

B. Compressive Strength

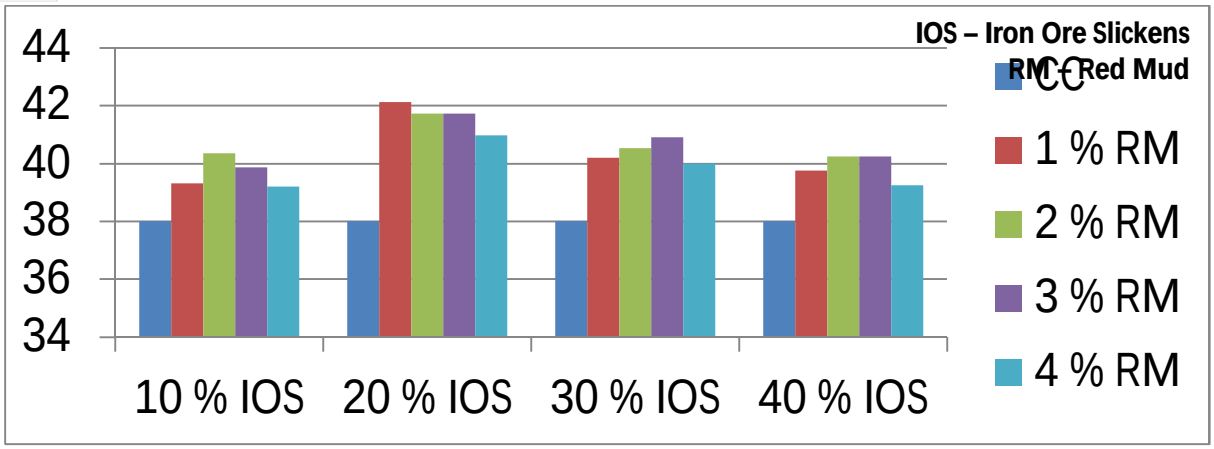
Table 10: Compressive Strength of Mix Concrete

S. No.	Mix ratio (Red Mud + Iron Ore Slickens)	Mix Name	7 Days Strength (Mpa)	28 Days Strength (Mpa)
1	0% + 0%	CC	28.37	38.01
2	1% + 10%	RM11	29.53	39.32
3	1% +20%	RM12	32.23	42.14
4	1% +30%	RM13	30.57	40.21
5	1% + 40%	RM14	29.55	39.77
6	2% + 10%	RM21	30.12	40.36
7	2% + 20%	RM22	31.93	41.54
8	2% + 30 %	RM23	30.97	40.91
9	2% +40%	RM24	29.92	40.25

10	3% +10%	RM31	29.86	39.87
11	3% +20%	RM32	31.93	41.74
12	3% +30%	RM33	30.97	40.91
13	3% + 40%	RM34	29.92	40.25
14	4% + 10%	RM41	29.61	39.21
15	4% + 20%	RM42	31.67	40.97
16	4% + 30 %	RM43	30.74	40.01
17	4% + 40 %	RM44	29.37	39.26



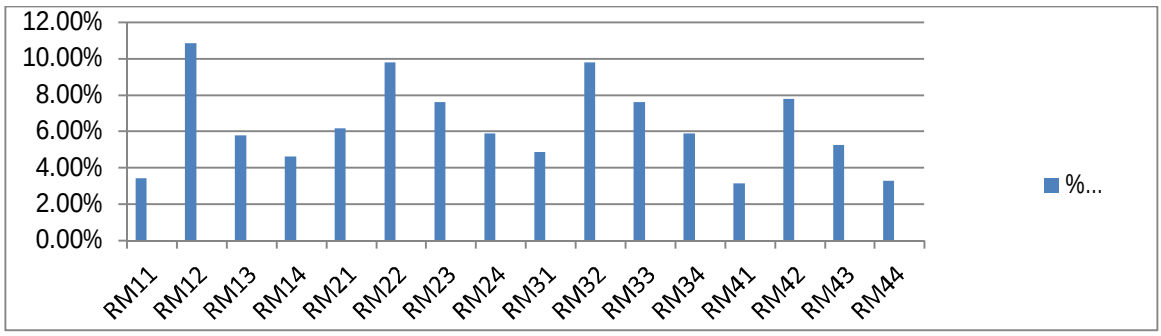
Graph 5: 7 Days Compressive strength of mix Concrete (Bar Graph)



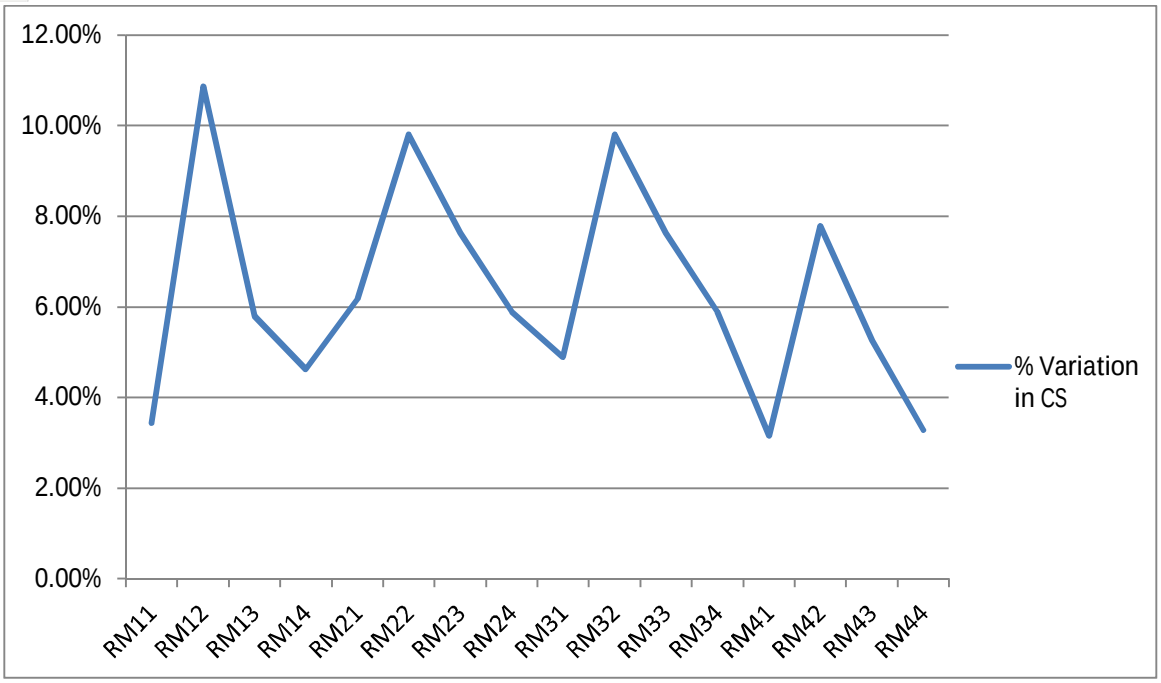
Graph 6: 28 Days Compressive strength of mix Concrete (Bar Graph)

Table 11: Variation in compressive strength of mix concrete

S. No.	Mix ratio (Red Mud + Iron Ore Slickens)	Mix Name	28 Days Strength (Mpa)	% variation in CS in 28 Days
1	0% + 0%	CC	38.01	0%
2	1% + 10%	RM11	39.32	3.44%
3	1% +20%	RM12	42.14	10.87%
4	1% +30%	RM13	40.21	5.79%
5	1% + 40%	RM14	39.77	4.63%
6	2% + 10%	RM21	40.36	6.18%
7	2% + 20%	RM22	41.54	9.29%
8	2% + 30 %	RM23	40.91	7.63%
9	2% +40%	RM24	40.25	5.89%
10	3% +10%	RM31	39.87	4.89%
11	3% +20%	RM32	41.74	9.81%
12	3% +30%	RM33	40.91	7.63%
13	3% + 40%	RM34	40.25	5.89%
14	4% + 10%	RM41	39.21	3.16%
15	4% + 20%	RM42	40.97	7.79%
16	4% + 30 %	RM43	40.01	5.26%
17	4% + 40 %	RM44	39.26	3.29%



Graph 7: Variation in Compressive strength of Mix Concrete (Bar Graph)



Graph 8: Variation in Compressive strength of Mix Concrete (Line Graph)

IV. CONCLUSION AND FUTURE SCOPE

A. *Conclusion*

When concrete is mixed with Red mud and Iron ore slickens it has been observed that there is an increase in both compressive strength and workability of concrete.

1) It is observed that compressive strength first increases upto 20 % iron ore slicken mix afterwards it starts decreasing.
2) By this study it is concluded that all the mix are usable but highest compressive strength is observed in RM32 mix.
3) It can also be concluded that all the mix ratios containing 20 % iron ore slickens are optimum.
4) By this study it is concluded that all mix are useable, but RM22, RM32 mixes gives better compressive strength. It is also concluded that RM32 is the optimum value for mix.
5) It is safe to say that red mud and iron ore slickens both can be used in concrete for replacement upto a certain limit.

B. *Future Scope*

1) There is also a scope of replacing cement with red mud in a higher percentage which can be taken into consideration.
2) There is a scope of using red mud with iron ore slickens for ground brick manufacturing.

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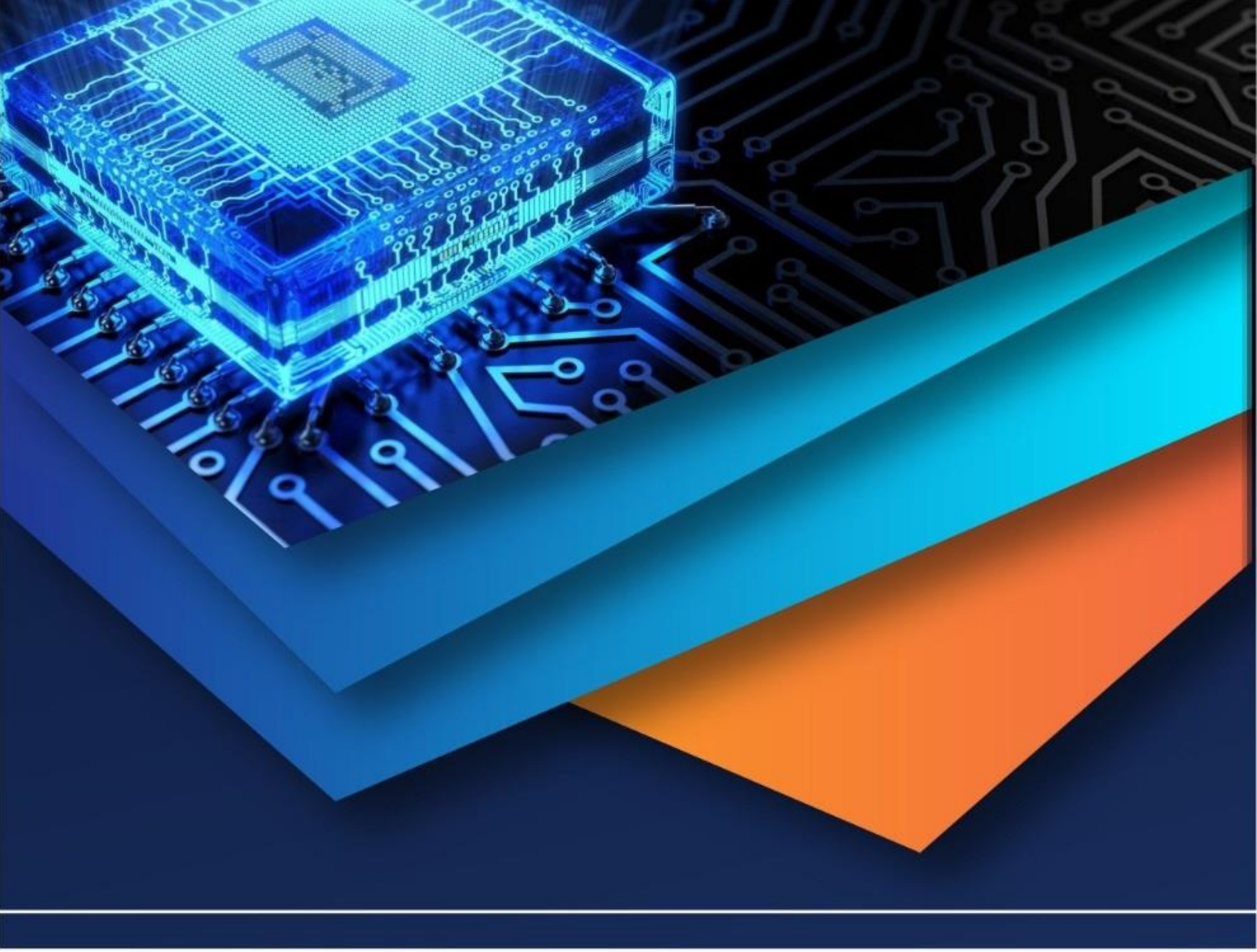

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