International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 8, August-2018

Comparison of Strength Parameters of M40 Grade of Concrete with partial Replacement of cement with Red Mud and Hydrated Lime

G. Sandhya rani[1] and I. Praveen Kumar Reddy[2]
[1]G.Sandhya Rani, M.Tech in Structural Engineering,Dept. of CivilEngineering,Vidya Jyothi Institute of Technology (Autonomous) Aziz Nagar Gate, Telangana, India,
[2] I. Praveen Kumar Reddy, Assistant Professor, Dept. of Civil Engineering, Vidya Jyothi Institute of Technology (Autonomous) Aziz Nagar Gate, Telangana, India,

Abstract

The examination was directed to contemplate the characteristics of cement by utilizing red mud as substitution of bond in concrete. The Bayer Process for the generation of alumina from Bauxite metal is described by low vitality proficiency and it results in the creation of critical measures of residue like, high alkalinity bauxite deposits known as red mud. Right now red mud is delivered nearly at parallel mass proportion to metallurgical alumina and is arranged into fixed or unlocked fake impoundments (landfills), prompting critical natural issues.

It contains oxides of iron, titanium, aluminum and silica alongside some other minor constituents. Nearness of Alumina and Iron oxide in red mud repays the insufficiency of similar segments in limestone which is the essential crude material for bond creation. Nearness of pop in the red mud which when utilized as a part of clinker creation kills the sulfur content in the pet coke that is utilized for consuming clinker enrooted concrete generation and adds to the bond's setting attributes. In light of financial matters and ecological related issues, tremendous endeavors have been coordinated worldwide towards red mud administration issues i.e. of usage, stockpiling and transfer. Distinctive roads of red mud use are pretty much known however none of them have so far turned out to be monetarily practical or industrially doable.

Tests have been directed under lab condition to survey the quality attributes of the aluminum red mud. The undertaking work centers around the reasonableness of red mud acquired for development. Five test bunches were constituted with there situation rates 0%, 10%, 20%, 30% of red mud and 10% of hydrated lime with bond in every arrangement in M40 review concrete. To accomplish Pozzolanic property of red mud, hydrated lime was included. This paper calls attention to another promising heading for the best possible usage of red mud.

Key words: *Cement mortars, Red mud, hydrated lime, Compressive strength, Split tensile strength, Durability, M40 etc*

I.INTRODUCTION

Red mud is the financial waste produced for the term of the production of alumina. As indicated by the level of crude material bauxite and the development strategy for alumina, Red mud may likewise be isolated into Bayer Red mud and Sintering Red mud built up on introduce advancements, there might be zero.8~1.76 t red mud created by utilizing every last 1t alumina delivered. It is articulated that, there are up to 3 million tons of red mud delivered by China's biggest three alumina creation bases the main response that happens inside the Bayer technique (the change of bauxite to sodium aluminates``) can be schematized as takes after

$$2NaOH + Al_2O_3 .3H_2O \rightarrow Na_2O.Al_2O_3 + 4H_2O + \text{Red Mud}$$

As there's a pleasant deal of commercial alkali, fluoride, heavy metals and different skills pollutants in Red mud, long-term stockpiling would no longer only occupy scarce land assets, but in addition without difficulty result in serious pollution of the encompassing soil, air and Ground water.

In addition, the steady growing of stockpiling yard peak may result in skills geological failures. Studies on the physical and chemical houses and comprehensive utilization of purple mud have end up a focus of associated substances within science and engineering fields. By means of a number of measurements, Liu et al. proved that pre therapy reminiscent of particle dimension classification of red mud is a method for the recycling of Red mud. Paper described the physical and chemical traits of Red mud at special temperatures and offered a theoretical foundation for the activation of red mud. Nevertheless, the one-of-a-kind morphology and structure of Bayer and Sintering purple mud check the particular physical and chemical houses of Red mud. Accordingly, it is essential to distinguish the predominant traits corresponding to chemical residences, mechanical performances, particle, morphology and structure for the comprehensive utilization of Red mud. In the gift research, the characteristics of Sintering purple mud and Bayer crimson mud were measured by way of a couple of pursuits evaluation approaches within the field of substances science and engineering comparable to XRD, SEM, TG, shear strength checking out, particle size measurement and hydrodynamic characteristics checking out. The paper then gives some recommendations for the comprehensive utilization of Bayer red mud and sintering Red mud individually.

Characteristics of Red Mud:-

Physical Characteristics of Red Mud

The next are the physical characteristics of the mud powder. As a rule fineness of Red mud is varies between a 1000-3000 cm2/gm. Its PH is varies in between 10.5 to 12.5 thus alkaline in nature. Specified gravity of Red mud is found to be 2.51.

Chemical characteristics of Red Mud

Synthetic characteristics of Red mud are appeared in underneath work area it demonstrates that level of Cao is run significantly less as an outcome it has no cementitious Characteristics yet when it responds with water and concretes it starts increasing cementitious Characteristics. What's more, in like manner to help this property we including the upgraded level of lime (10%).

Red mud collection

Objectives of the Study:

The main objectives of the study were:

1) To determine the production of the red mud concrete for M40 grade of concrete.
2) To exhibit the skills of strength received by means of red mud usage together with hydrated lime.
3) To extend and to know the strength gained by red mud using hydrated lime.

To develop the process for production of cubes for durability parameters such as saturated water absorption, acid attack and alkaline attack tests.

II.LITERATURE REVIEW

P. Ashok et., al. (2010) have examined the Bayer Process for the generation of alumina from Bauxite mineral is portrayed by low vitality productivity and it results in the creation of huge measures of residue like, high alkalinity bauxite buildups known as red mud. Presently red mud is delivered nearly at parallel mass proportion to metallurgical alumina and is arranged into fixed or unlocked counterfeit impoundments (landfills), prompting imperative ecological issues. It contains oxides of iron, titanium, aluminum and silica alongside some other minor constituents. In light of financial aspects and also ecological related issues, tremendous endeavors have been coordinated worldwide towards red mud administration issues i.e., of usage, stockpiling and transfer. Diverse roads of red mud use are pretty much known however none of them have so far ended up being monetarily suitable or financially achievable. Investigations have been directed under research center condition to evaluate the quality attributes of the aluminum red mud. The venture work centers around the appropriateness of red mud got for development. Five test bunches were constituted with the substitution rates 0%, 5%, 10%, 15%, 20% of red mud and 5% of hydrated lime with bond in every arrangement. To accomplish Pozzolanic property of red mud, hydrated lime was included. This paper calls attention to another promising course for the best possible usage of red mud.

From this exploratory investigation following focuses can be drawn: After testing of 5 mixed concrete examples (5% to 25 % substitution of Cement by NRM) with an augmentation of 5 %, one might say that the ideal utilization of NRM is 15% as a halfway substitution of bond by NRM. The cost of M30 review NRM Concrete (i.e. 15% Replacement) is around 7.48 % not as much as the Conventional Concrete, with an expansion up to 21.712 % in the 28 days Compressive quality. The rate economy is expanded with the expansion in the review of cement yet in the meantime there is a diminishment in the rate increment in the Compressive Strength Considering all the above point it is fascinating to state that the ideal use of Neutralized Red Mud in concrete is 15 % as an incomplete substitution of bond by NRM. Red mud can be viably utilized as trade material for concrete and substitution empowers the extensive use of waste item. Red mud did not impact of the bond characteristics, rather enhanced the concrete quality by way diminishing the setting time and enhanced compressive quality. Utilized for street development as a bank landfill is an appealing alternative with a high potential for huge volume reuse. Substitution of 20%OPC by asserted red mud is hence conceivable. Calcinations of red mud at 7000c prompt a pozzolanic material basically responsive at early ages. In Building material industry as a crude material in fabricate of building and asphalt squares and street surfacing.

Sucharita Patel et. al. (2015)I have contemplated that Red mud is a strong buildup Produced amid the alumina generation by the Bayer procedure from bauxite. The red mud produced by this procedure is exceptionally antacid with pH typically running from 10 to 13. Because of its unsafe destructive nature it's representing an intense and disturbing ecological issue. All inclusive there are around 90 million tones of red mud being created each year. In excess of 4 million tons of red mud is created every year in India as it were. The measure of the red mud created per ton of the alumina prepared, shifts enormously with the kind of the bauxite mineral utilized. Because of its risky nature it is an extraordinary test to scientist to grow new techniques for the utilization of red mud. Different research work continuing for the capacity, transfer and use of the red mud in everywhere throughout the world. This paper audits the present status and future pattern of the red mud portrayal, transfer, different balance strategies and use in world and also in Indian setting.

In this survey article it was demonstrated that the Red mud is an exceedingly complex material having gathering of materials because of various bauxites utilized and the diverse procedure parameter. The red mud has an extensive variety of use from building material to metal recuperation. The monetary assessment of a particular procedure to recuperate metal of critical esteem relies upon the red mud structure. Extensive exertion has been used in discovering application for bauxite deposit however various key components influence the achievability and financial aspects of its selection.

III.COLLECTION OF THE MATERIALS

1. Cement: Ordinary Portland Cement (53 Grade) confirming to IS: 269-1976 was used throughout the investigation. Different tests were performed on the cement to ensure that it confirms to the requirements of the IS specifications. The physical characteristics of the cement were determined as per IS: 4031-1968.

2. **Fine Aggregates:** Fine aggregates are the natural sand which has been washed and sieved to take away debris larger than 5mm and coarse combination is gravel which has been beaten, washed and sieved so that the particles vary from 5 up to 50 mm in length. The fine and coarse mixture are introduced separately.

3.Coarse Aggregates: According to size coarse aggregate is defined as graded combination of its nominal length i.e. 40 mm, 20 mm, 16 mm and 12.5 mm and so on. For instance a graded mixture of nominal length 20 mm approach an aggregate maximum of which passes 20 mm IS sieve.

4.Water: Crisp and clean water is utilized for throwing and restoring of example. The water is generally free from natural issues, sediment, oil, sugar, chloride and acidic material according to prerequisites of Indian standard.

5. Hydrated Lime: Pure hydrated lime power is popularly known as calcium hydroxide or slaked lime. The controlled goldbricking of oxide with water provides us white dry power then the free heat of reaction is captured and also the further slaking water is gaseous. The formula of our pure calcium hydroxide is $Ca(OH)^2$ .Hydrated lime having higher proportion of hydrated oxide (90%) over low grade (65% purity) calcium hydroxide.

6.Red Mud: A strong waste created at the Aluminum plants everywhere throughout the world .In Western nations; around 35 million tons of red mud is delivered yearly. The red shade is caused by the oxidized iron present, which could make up to 60% of the mass of the red mud.

Chemical characteristics of the Red Mud contains major amount of Ferric oxide (Fe_2O_3)with 48.50 %, and Aluminum Oxide with the next position of 14.14%, and silicon dioxide with the percentage of 11.53 %. and other chemical with traces .

7. SuperPlasticizer (Comp last Admixture RP264): Retarding and water diminishing admixture. Consents to IS: 9103 - 1999 and ASTM C494 .To expand the usable presence of cement and lessen the outcomes of over the top temperatures on putting. Enhance the adequacy of water in a solid blend, permitting increased qualities and more reasonable toughness at surest bond substance.

Characteristics of the comp lastAdmixtureRP264:specific gravity is 1.20 at 30^o, Air entrainment is Less than 2% additional air entrained at normal dosage rate, and chloride Content is less than the 0.05 % by its weight.

IV. MIX DESIGN AND SAMPLE PREPARATION

STEP 1: Determining the Target Strength for Mix Proportioning

$F_{ck} = f_{act} + 1.65\ XS$

Where,

F_{ck} = Target average compressive strength at 28 days

F_{ck} = Characteristic compressive strength at 28 days

S = Assumed standard deviation in N/mm^2 = 5 (as per table -1 of IS 10262- 2009)

$= 40 + 1.65 * 5.0 = 48.25\ N/mm^2$

STEP 2: Selection of water-cement ratio

From Table 5 of IS 456, Maximum water-cement ratio = 0.40

TABLE 2: Water Cement Ratio as Per IS 456:2000

STEP 3: **Choice of Water Content**

Greatest water content for 20 mm chips = 186 Kg (for 25 to 50 slump)

We are focusing on a slump of 100mm, we have to build water content by 3% for each 25mm over 50 mm i.e. increment 6% for 100mm slump

I.e. Evaluated water content for 100 Slump = 186+ (6/100) * 186 = 197litres

Water content = 197 liters

As super plasticizer is utilized, the water substance can be lessened up 20 percent or more. In view of preliminaries with super plasticizer water content lessening of 29 percent has been accomplished.

The arrived water content =197 * 0.71 =139.87 liters say 140 liters

STEP 4 : Figuring of Cement Content

Water-Cement Ratio (w/c) = 0.40

Water content from Step – 3 i.e. 140 liters

Cement Content = Water content / "w-c ratio" = (140/0.40) =350 kgs

STEP 5: Estimation of Concrete Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

Volume of concrete = 1 m^3

1. Volume of cement = (Mass of cement / Specific gravity of cement) * (1/1000)

   = (350/3.14) * (1/1000) = 0.11147 m^3

2. Volume of water = (Mass of water / Specific gravity of water) * (1/1000)

   = (140/1) * (1/1000) = 0.14 m^3

3. Volume of admixture (2 % of cement mass) = (Mass of super plasticizer/specific gravity of water) * (1/1000) = (7/1.21) * (1/1000) = 0.0057 m^3

4. Total Volume of Aggregates = 1- (b+c+d) =1- (0.111+0.14+0.0057) = 0.742m^3

5. Mass of coarse aggregates = d *(Volume of Coarse Aggregate)*(Specific Gravity of Coarse Aggregate)*1000

= 0.742 *0.60 * 2.80 * 1000

= 1246.56 kg/m^3say 1247 kg/m^3

6. Mass of fine aggregates = d * Volume of Fine Aggregate *

Specific Gravity of fine Aggregate * 1000 = 0.742 * 0.40 * 2.70 *1000 = 801.36 kgs/m^3 say 802 kg/m^3

STEP-6: Concrete Mix Proportions for Trial Number 1:

Cement = 350 kg/m^3

Water = 140 kg/m^3

Super plasticizer (@ 2 .0% of cement weight) = 7 kg/m^3

Fine aggregates = 802 kg/m^3

Coarse aggregate = 1247kg/m^3

Water-cement ratio = 0.40

Final trial mix for **M40** grade concrete is **1:2.29:3.56 at w/c of 0.40**

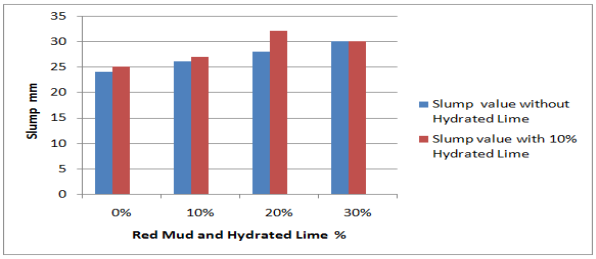
Grade of Cement Concrete	Cement OPC 53 (Kg/m^3)	Red Mud (Kg/m^3)	Hydrated Lime (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Water Content (Kg/m3)	Admixture (Kg/m3
M40	253.60	56.35	16.093	737.808	1145.904	130	7
Addition of Extra10%	278.96	61.985	17.7023	811.59	1260.50	143	8.8

IV.RESULTS AND ANALYSIS

1. TEST ON THE FRESH CONCRETE

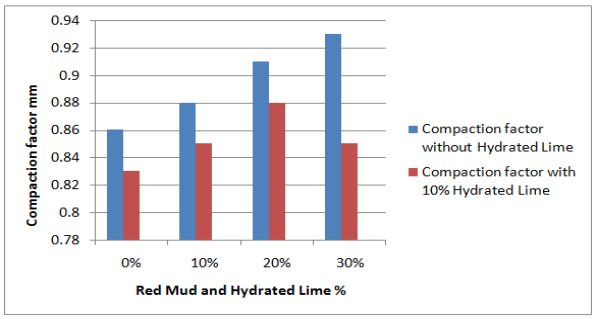
Slump Cone Test:

S.NO	% REPLACEMENT	SLUMP VALUE WITH OUT HYDRATED LIME	SLUMP VALUE WITH 10% HYDRATED LIME
1	0%	24	25
2	10%	26	27
3	20%	28	32
4	30%	30	30



2. Compaction factor test

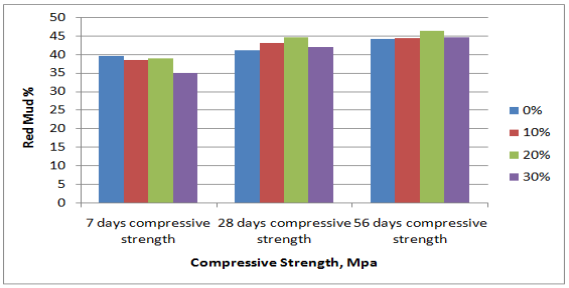
S.no	% Replacement	Compaction factor with out hydrated lime	compaction factor with 10% hydrated lime
1	0%	0.86	0.83
2	10%	0.88	0.85
3	20%	0.91	0.88
4	30%	0.93	0.85
5	40%	0.94	0.86
6	50%	0.95	0.86
7	60%	0.95	0.88



2. TESTS ON THE HARDENDED CONCRETE

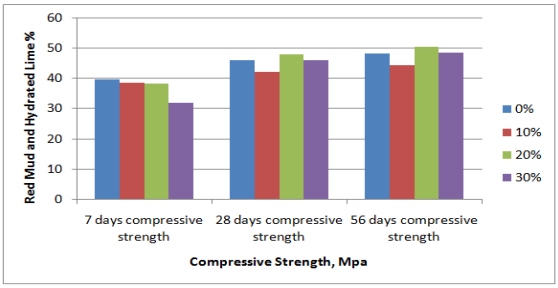
Compressive Strength of Concrete without Hydrated Lime

Sl. No	%replacement	7 days compressive strength	28 days compressive strength	56 days compressive strength
1	0%	39.5	41	44.2
2	10%	38.5	43	44.25
3	20%	38.8	44.5	46.25
4	30%	35	42	44.5



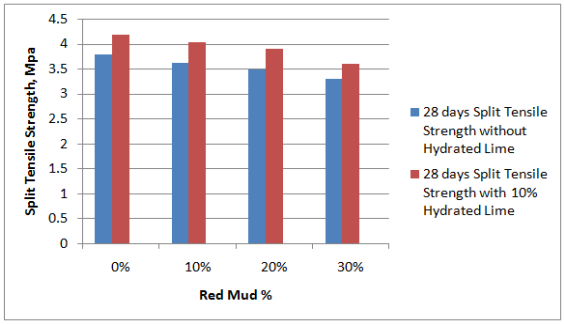
Compressive Strength of Concrete With 10% Hydrated lime

S.no	%replacement Of red mud	7 days compressive strength	28 days compressive strength	56 days compressive strength
1	0%	39.5	46	48.2
2	10%	38.4	42	44.25
3	20%	38.2	48	50.25
4	30%	32	46	48.5



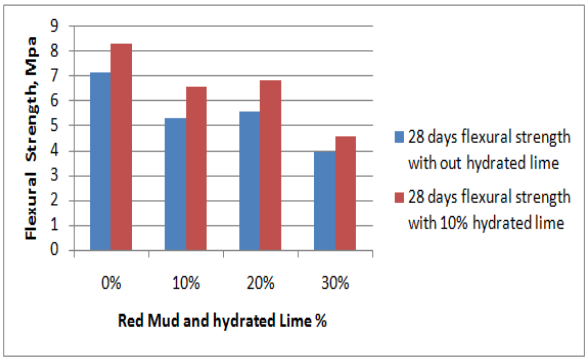
Split Tensile Strength of Concrete

S.no	% Replacement of red mud	28 days split tensile strength with out hydrated lime	28 days split tensile strength with hydrated lime
1	0%	3.8	4.2
2	10%	3.63	4.05
3	20%	3.5	3.92
4	30%	3.3	3.62



Flexural Strength of Concrete

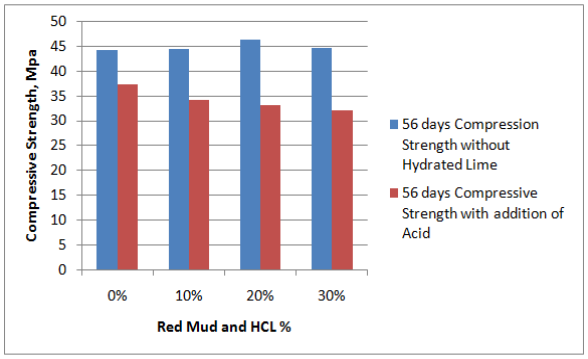
Sl.No	% Red mud used	28 days flexural strength without hydrated lime	28 days flexural strength with 10% hydrated lime
1	0%	7.12	8.26
2	10%	5.26	6.54
3	20%	4.61	5.82
4	30%	3.91	4.56

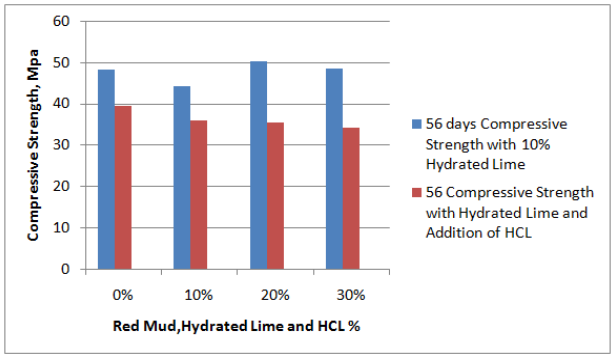


Durability tests

Acid Attack Test

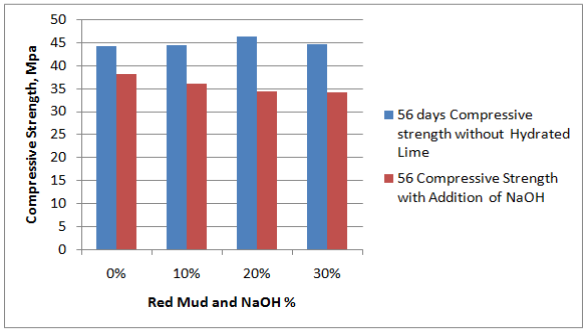
Sl.no	% replacement	Initial weight of cube after 56days curing in grams	Final weight of cubes after 56days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 56days without Hydrated Lime curing	Compressive strength of cubes after 56days With 10% Hydrated Lime Curing
1	0	2261	2240	0.93	37.2	39.4
2	10	2340	2312	1.2	34	37
3	20	2351	2318	1.4	33	36
4	30	2234	2194	1.8	32	32

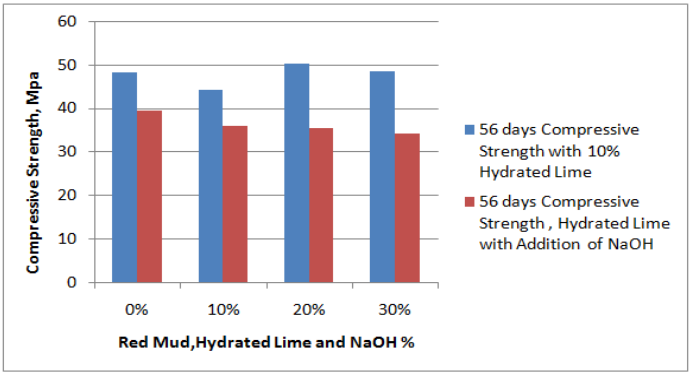




Alkaline Attack Test

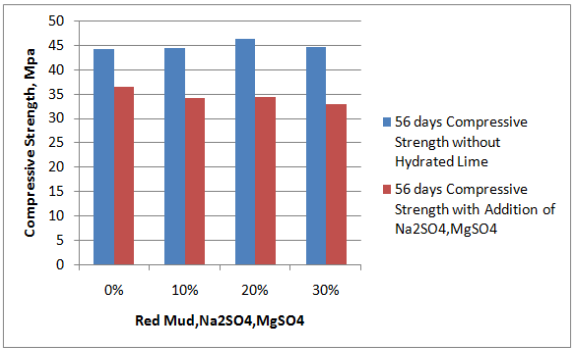
Sl.no	% replacement	Initial weight of cube after 56days curing in grams	Final weight of cubes after 56days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 56days without Hydrated Lime curing	Compressive strength of cubes after 56days With 10% Hydrated Lime Curing
1	0	2261	2240	0.93	37.2	39.4
2	10	2340	2312	1.2	34	37
3	20	2351	2318	1.4	33	36
4	30	2234	2194	1.8	32	32

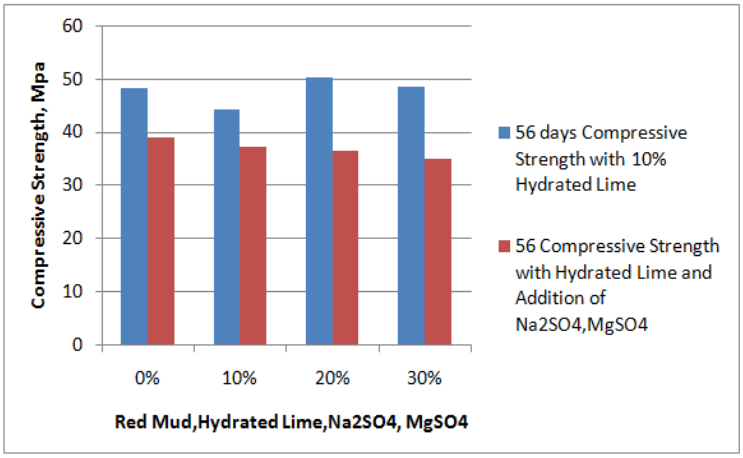




Sulphate Attack Test

Sl.no	% replacement of red mud	Compressive strength of cube after 56 days without Hydrated Lime curing	Compressive strength of cubes after 56 days with 10% Hydrated Lime Curing
11	0.00%	36.4	39
2	10.00%	34.13	37.12
3	20.00%	34.37	36.3
4	30.00%	32.82	35





V.CONCLUSIONS

From this research the following conclusions are made

1. The material characteristics of the concrete, coarse totals, and fine totals are inside as far as possible henceforth postulations materials are reasonable for the examination.

2. The droop estimation of solid increments with expanding in the level of red mud in concrete.

3. The compaction factor estimation of cement is additionally increments with expanding in the level of red mud.

4. Compressive quality of cement is more for the solid utilizing hydrated lime.

5. Compressive quality estimation of red mud concrete is diminish with increment in the level of red mud and is most extreme for 28 days quality in both without utilizing hydrated lime and with utilizing hydrated lime.

6. Also split elasticity of red mud concrete is diminishes with increment in the level of red mud in concrete

7. The flexural quality of red mud solid declines with increment in the level of red mud.

8. The quality qualities are high with utilizing 10% hydrated lime than without utilizing hydrated lime.

9. The loss of compressive quality in the antacid assault increments with increment in level of red mud increments

So the substitution of 20% of Red Mud is by and large helpful for better quality qualities in M40 review of cement.

Future Scope of Study:

- Using hydrated lime and red mud as a powder with bond looking at whether the base quality required for M50 and M60 evaluations of cement can be accomplished.
- Our venture is constrained to Hydrated lime and red mud with substitution of bond in concrete yet in addition can discover by supplanting coarse total by other supplanting materials and aides in making green cement.

REFERENCES

1.Gawu.S.K.Y, Amissah.E.E, Kuma.J.S, ―The proposed Alumina Industry and how to Mitigate against the red mud Footprint in Ghana‖ Journal of Urban and Environmental Engineering, volume 6, pp.48-56,2012.

2.SnehaSamal, Ajoy K. Beam, AmitavaBandopadhyay, ―Proposal for assets, use and procedures of red mud in India‖, International Journal of Mineral Processing, volume 118 pp. 43– 55, 2013.

3.Mohan Kushwaha1, Dr. SalimAkhtar, Survesh Rajput, ―Development of the Self Compacting Concrete By Industrial Waste (Red Mud)‖, Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, pp. 539-542, 2013

4.Sawant.A.B, Kumthekar.M.B, SawantS.G, ―Utilization of Neutralized Red Mud (Industrial Waste) in Concrete‖ International Journal of Inventive Engineering and Sciences (IJIES) ISSN: 2319– 9598, Volume-1, pp 9-13, 2013.

5.Ping Wang, and Dong-Yan Liu, ―Physical and Chemical Characteristics of Sintering Red Mud and Bayer Red Mud and the Implications for Beneficial Utilization‖, doi: 10.3390/ma5101800, volume 5,pp 1800-1810, 2012.

6.Mohan Kushwaha1, Dr. SalimAkhtar, Survesh Rajput, ―Development of the Self Compacting Concrete By Industrial Waste (Red Mud)‖, Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, pp. 539-542, 2013.

7. Prasad N Bishetti, LeeladharPammar,(2014),Experimental think about on use of mechanical waste in concrete,International diary of specialized research and applications e-ISSN:2320-8163,VOLUME2,ISSUE 4(July-Aug 2014),pp,49-52.

8.Harekrushnasutar,Subash Chandra Misra,Santhosh Kumar Sahoo et.al(2014),Progress of Red Mud use :an overview,American synthetic science journal,4(3),255-279,2014.