International Journal For Technological Research In Engineering
Volume 5, Issue 7, March-2018 *ISSN (Online): 2347 - 4718*

AN EXPERIMENTAL STUDY OF A REDMUD ON A PARTIAL REPLACEMENT OF CEMENT WITH AND WITHOUT HYDRATED LIME

Deepthi Vemuri[1], Ms.S.Snigdha[2]
[1]M. Tech, Usha Rama College of Engineering, JNTUK.
[2]Asst Professor, Department of Civil Engineering, Usha Rama College of Engg. and Tech Telaprolu,.

Abstract: The Experimental study was conducted to check the properties of concrete by victimization red mud as replacement of cement in concrete. The Empirin method for the assembly of corundum from mineral ore is characterized by low energy potency and it leads to the assembly of great amounts of dust-like, high pH scale mineral residues called red mud. Presence of chemical compound aluminum oxide and Iron oxide in red mud compensates the deficiency of constant parts in limestone that is that the primary material for cement production.Experiments are conducted below laboratory condition to assess the strength characteristics like compressive strength, split tensile strength and flexural strength of concrete and also to know the workability of concrete slump cone test and compaction factor tests are also conducted in this experiment. The replacement percentages are 0%, 5%, 10%, 15%, 20% of red mud with cement in every series in M40 and M50 grade concrete. To realize Pozzolanic property of red mud, hydrated lime was accessorial. In this experiment the comparison of strength characteristics of red mud concrete with and without hydrated lime was studied. The red mud concrete specimens are casted and cured at ambient temperature for 28 days and tested for compressive strength. The optimum value of the compressive strength of red mud concrete was observed at 10% red mud replacement. The compressive strength is more in red mud concrete with hydrated lime compare to red mud concrete without hydrated lime. The project work focuses on the quality of red mud obtained for construction.This paper points out another promising direction for the correct utilization of red mud.

Key Words: Red mud, Compressive strength,Aluminium oxide, Iron oxide.

I. INTRODUCTION

Red mud is the economic waste generated for the duration of the production of alumina. According to the grade of raw cloth bauxite and the production process of alumina, red mud may be divided into Bayer red mud and sintering red mud based on gift technology, there's 0.8t~ 1.76t red muds generated via every 1t alumina produced. it is said that, there are up to three million tons of pink dust produced with the aid of china‘s biggest 3 alumina production bases (guizhou, Shandong and Henan) the main response that happens within the Bayer technique (the conversion of bauxite to sodium aluminate) can be schematized as follows:

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

a. red mud produced in Bayer processing.
b.red mud produced in Sinter processing

1.1.1 Bayer process:

In 1888, Karl Josef Bayer advanced and patented a system, which has grow to be the cornerstone of the aluminum production enterprise worldwide. the Bayer manner, as it has emerge as recognized, is used for refining bauxite to smelting grade alumina (aluminum oxide), the precursor to aluminum. Generally, relying upon the excellent of the ore, between 1.9 and 3.6 tons of bauxite is required to provide 1 ton of alumina. The Bayer system is a cyclic one and is regularly called Bayer cycle. it involves four steps: digestion, rationalization, precipitation ,and calcinations

1.1.2 Sinter process:

Sintering is a thermal treatment, beneath the melting temperature of the primary constituent fabric, which transforms a steel or ceramic powder (or a powder compact) right into a bulk fabric containing, in most cases, residual porosity.

The system of sintering brings approximately positive bodily as well as chemical modifications within the material. the chemical changes can be illustrated as:

- exchange in composition or decomposition
- new phase formation or decomposition observed by phase trade
- new segment formation because of chemical adjustments

Physical properties of red mud:

The following are the bodily properties of the dust powder.

S.NO	PROPERTIES	TEST RESULT
1	SPECIFIC GRAVITY	2-51
2	FINENESS OF SQ.CM/GRAM	1000-3000
4	PH	10.5-12-5

COMPONENTS	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	CaO	Na_2O
WEIGHT %	20-22	40-45	12-15	1.8-2.0	1-2	4-5

Composition of red mud

II. LITERATURE REVIEW

Prasad N Bishetti, Leeladhar Pammar (2014)‖EXPERIMENTAL STUDY ON UTILIZATION OF INDUSTRIAL WASTE IN CONCRETE‖ he has studied that the rapid industrialization leads to the most discharge of waste merchandise which reasons environmental risks. Those wastes may be used in conventional fabric, in construction. Red mud is a waste product came from aluminum enterprise in a Bayer‘s method. Results of red mud are relatively caustic and reasons ground water infection ends in health dangers. Through taking cementitious Behaviour of red mud into consideration, red mud is partially changed via the cement with different percentagesThe check has accomplished in this test is compressive strength, cut up tensile strength of concrete. For M30 grade of 0%, 5%,10%,15%,20%,25%, red mud replaced by means of cement at 20% the compressive strength is increase and then decreases the best cost is 20% of red mud changed through cement. For spilt tensile strength is reducing while growing the %of red mud. This experiments changed into suggests that, that is used for construction with low cost and red mud may be revolutionary supplementary.

Aravind Y Rana,Naresh A Sathe (2015)‖ANALYSING THE POTENTIAL SUBSTITUTE OFRED MUD IN CONCRETE ADDING LIME AND SILICA he studied that in worldwide, lot of waste is generated in distinct forms, these industrial wastes are mainly environmental dangerous. many researches has executed on this waste fabric to both degrade or to make use of it in a few or the other manner in that red mud is one of the commercial waste it is generated by using bayer‘s system of aluminum extraction in this test red mud is changed by using cement and additionally including lime and silica thinking about with the weight of red mud taken by using replacement of cement. on this red mud is taken 10%,15%,20%,25%, partially replaced through cement in conjunction with lime is taken 0%,4%,8%,12%, addition with the load of red mud and additionally like that silica is taken 0%,10%,20%, addition with the load of red mud for m30 grade.

The tests were done in this experiment is compressive strength of concrete for 7&28 days and split tensile strength for cylinders and additionally cost analysis accomplished through the top-rated cost of red mud .The end result indicates that the compressive strength barely increases in addition of lime and there after strength decreases with increase in lime content. This may be explained through that the lime introduced may additionally react with loose reactive silica found in red mud and when the silica gets exhausted, the greater lime brought would possibly have reacted with alumina forming calcium aluminates main to greater initial warmth of hydration and thereby producing pores main to decreased strength. The result offers that addition of silica enhances strength of mortar and for 10% red mud with 20% silica of red mud addition gives the identical strength as that of best cement. Subsequently, it could conclude that 10% red mud may be applied with addition of 20% silica of red mud without compromising the strength of mortar and concrete respectively. from the above two results it suggests that compressive strength of the most advantageous red mud concrete will increase and the tensile strength decreases .overall it can be concluded that the outcomes obtained for maximum red mud content shows that concrete may be used for r.c.c work after finding of other critical parameters of optimized concrete.

Mohan Kushwaha,Dr. Salim Akhtar,Survesh Rajput ―DEVELOPMENT OF THE SELF COMPACTING CONCRETE BY INDUSTRIAL WASTE (RED MUD) he has studied that red mud is used in self-compacting concrete is an innovative concrete that doesn't require vibration for compaction. It is able to go with the flow below its own weight absolutely filling formwork and attaining full compaction. Even in presence of congested reinforcement. With the aid of partial alternative of cement with red mud it is able to be used for construction to make shape long lasting and additionally value of structure is decreases. red mud is taken 0%,1%,2%,3%,4%,5%,6%,7%, 8%,10%, 12%,15%, 16%, partial replacement of cement and additionally mix proportions with great plasticizer was added to concrete and viscosity modifying agent is to be introduced to the cementitious fabric. On this only compressive strength check has completed in this at 2%, red mud the maximum strength is obtained after which strength is decreased with the combination of super plasticizer and viscosity modify agent strength is most at 2%, of red mud changed by using cement.

Ramesh R.Rathod,Nagesh T.Suryawanshi,Pravin D.Memade ―EVALUATION OF THE PROPERTIES OF RED MUD CONCRETE‖ he has studied that red mud is wastes fabric generated from bauxite produce alumina. This waste is negatively outcomes on environment to clear up this red mud is in part replaced by means of cement in concrete with this we can lessen some waste and additionally cannot affect to environment by using this replacement. the odds varying 0%,5%,10%,15%,20%,25%,30%,40%, for m30 grade with the aid of using is:10262:2009. in this assessments has be achieved with the aid of the replacement of cement with red mud for 28 days curing the exams are compressive strength, break up tensile strength through this from the 0% to 40%, the compressive strength price is decreases even as increasing the proportion of red mud. The highest quality percent is 25% barely changes in strength. and also break up tensile strength top-rated cost is 25%, of red mud replaced by cement it's miles tremendous with the taken grade it's far appropriate for ornamental works and used in nonstructural works.

III. MATERIALS

CEMENT:

Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most

important types of cement are used as a component in the production of mortar in masonry, and of concrete which is a combination of cement and an aggregate to form a strong building material.

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 properties of the cement were determined as per IS: 4031-1968 and are presented in table.

S.NO	CHARACTERSTICS	VALUES
1	Standard consistency	53
2	Fineness of cement as retained on 90 micron sieve	3%
3	Initial setting time	30 minutes
4	Specific gravity	3.15

FINE AGGREGATES:

It is the aggregate most of which passes 4.75 mm IS sieve and contains only so much coarser as is permitted by specification. According to source fine aggregate may be described as:

- Natural sand-it is the aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies.
- Crushed stone sand-it is the fine aggregate produced by crushing hard stone.
- Crushed gravel sand-it is the fine aggregate produced by crushing natural gravel.

COARSE AGGREGATES:

It is the aggregate most of which is retained on 4.75 mm IS sieve and contains only so much finer material as is permitted by specification. According to source, coarse aggregate may be described as:

- Uncrushed Gravel or Stone– it results from natural disintegration of rock
- Crushed Gravel or Stone– it results from crushing of gravel or hard stone.
- Partially Crushed Gravel or Stone– it is a product of the blending of the above two aggregate.
- Hard crushed granite stone, coarse aggregates confirming to graded aggregate of size,10mm as per IS:383-1970 was used in the study.

WATER:

Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard. Combining water with a cementations material forms a cement paste by the hydration. A cement paste glues the aggregate together fills voids within it, and makes floor freely.

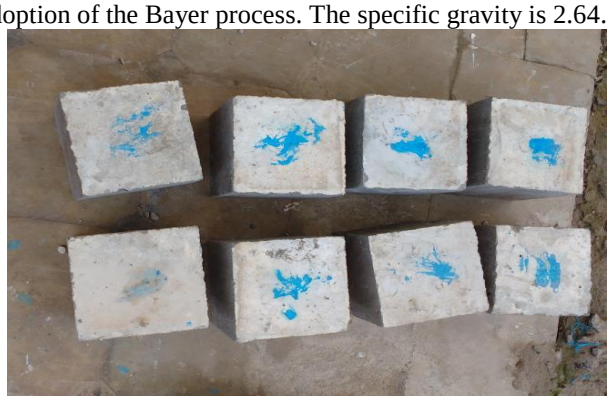
Hydrated Lime:

We are known as a hydrated lime manufacturer, hydrated lime suppliers in India. Hydrated lime, also known as calcium hydroxide. Pure hydrated lime power is popularly known as calcium hydroxide or slaked lime. The controlled slacking of quicklime with water gives us white dry power then the released heat of reaction is captured and the extra slaking water is evaporated. The chemical formula of our pure hydrated lime is $Ca(OH)_2$.

Hydrated lime having higher percentage of calcium hydroxide (90%) over low grade (65% purity) hydrated lime. Hydrated lime is a type of dry powder made from limestone. It is created by adding water to quicklime in order to turn oxides into hydroxides. Combined with water and sand or cement, hydrated lime is most often used to make mortars and plasters. Its chemical name is calcium hydroxide, or $Ca(OH)_2$.

Red Mud:

A solid- waste generated at the Aluminum plants all over the world .In Western countries; about 35 million tons of red mud is produced yearly. Because of the complex physico-chemical properties of red mud it is very challenging task for the designers to find out the economical utilization and safe disposal of red mud. Disposal of this waste was the first major problem encountered by the alumina industry after the adoption of the Bayer process. The specific gravity is 2.64.



Concrete cube specimens of 150x150x150

For split tensile strength:

To check the split tensile strength of red mud concrete cast the cube specimens of 150mm diameter and 300mm height cylinders with volume of $5.3x10^6$ mm^3.

For flexural strength of concrete:

To check the flexural strength of red mud concrete cast the prism specimens of 500mmx100mmx100mm with volume of $5x10^6$ mm^3.

Mix proportion for M40 grade

Material	Cement	FA	CA	Water	admixture
Proportion	1	1.52	2.21	0.4	1% of Cement
Quantities	250kg	370 kg	560 kg	97 liters	2.5 liters

Mix proportion for M50 grade

material	cement	FA	CA	Water	admixture
proportion	1	1.33	2.552	0.35	1% of cement
quantities	216kg	425kg	460kg	92litr	2.61litr

Slump cone test:
Procedure:

- Clean the internal surface of the mould and apply oil.
- Place the mould on a smooth horizontal non- porous base plate.
- Fill the mould with the prepared concrete mix in 4 approximately equal layers.
- Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
- Remove the excess concrete and level the surface with a trowel.
- Clean away the mortar or water leaked out between the moulds and the base plate.
- Raise the moulds from the concrete immediately and slowly in vertical direction.
- Measure the slump as the difference between the height of the moulds and that of height point of the specimen being tested.

Compaction factor test:
Procedure:

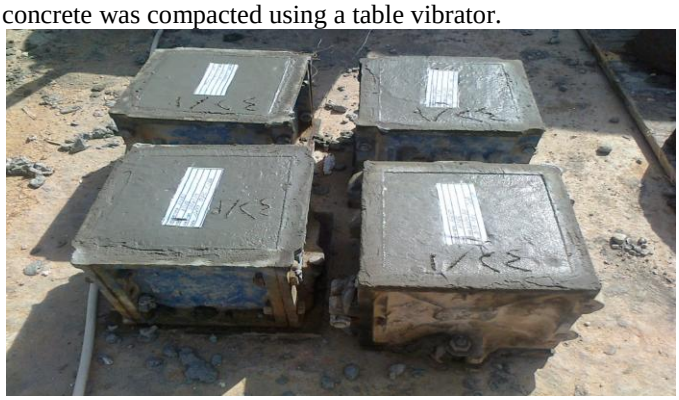
- The internal surface of the hoppers and cylinder shall be thoroughly clean and free from Superfluous moisture and any set of concrete commencing the test.
- The sample of concrete to be tested shall be placed gently in the upper hopper using the scoop. The trap door shall be opened immediately after filling or approximately 6 min after water is added so that the concrete fails into the lower hopper. During this process the cylinder shall be covered.
- Immediately after the concrete has come to the rest the cylinder shall be uncovered, the trap door of the lower hopper opened and the concrete allowed falling to into the cylinder.
- For some mixes have a tendency to stick in one or both of the hoppers. If this occurs the concrete shall be helped through by pushing the tamping rod gently into the concrete from the top.

- The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the cylinder, at the same time keeping them
- pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean.

- This entire process shall be carried out at a place free from vibration or shock.
- Determine the weight of concrete to the nearest 10 g. This is known as "weight of partially compacted concrete", Wp.
- Refill the cylinder with concrete from the same sample in layers approximately 50 mm depth. The layers being heavily rammed with the compacting rod or vibrated to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off and finished level with the top of the cylinder. Clean up the outside of the cylinder.
- Determine the weight of concrete to the nearest 10 g. This is known as "weight of fully compacted concrete", Wf.

IV. TEST PROCEDURE

COMPRESSIVE STRENGTH
Test Specimens:
Totally 120 cubes (60 for M_{40} +60 for M_{50}) of size 150 mm x 150 mm x 150 mm and were cast to study the compressive strength of red mud concrete. Standard cast iron moulds were used for casting the test specimens. Before casting, machine oil was smeared on the inner surfaces of moulds. Red mud concrete was mixed using a horizontal pan mixer machine and was poured into the moulds in layers. Each layer of concrete was compacted using a table vibrator.



Casting of specimens

Test Procedure:
For the evaluation of compressive strength, all the cube specimens were subjected to a compressive load in a digital Compression Testing Machine with a loading capacity of 2000kN. Specimens were tested as per the procedure given in Indian Standards I.S.516. The maximum load applied to the specimen was recorded. The compressive strength of the specimen was calculated by dividing the maximum load applied to the specimen by the cross-sectional area.

PROCEDURE:

- Remove the specimen from water after specified curing time and wipe out excess water from the surface.

- Take the dimension of the specimen to the nearest 0.2m
- Clean the bearing surface of the testing machine
- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously till the specimen fails
- Record the maximum load and note any unusual features in the type of failure.
  As per IS 516:1959

Compressive strength of specimen = P/A
P= maximum load applied on the specimen
A=area of the specimen

SPLIT TENSILE STRENGTH

Test Specimens:
Totally 60 cylinders (30 for M_{40} and 30 for M_{50}) having a diameter of 150 mm and 300 mm length were cast to evaluate the split tensile strength of red mud concrete. Standard cast iron moulds were used for casting the test specimens. Before casting, machine oil was smeared on the inner surfaces of moulds. Red mud concrete was mixed using a horizontal pan mixer machine and was poured into the moulds in layers. Each layer of concrete was compacted using a table vibrator.
Instrumentation and Testing Procedure:
In order to evaluate the splitting tensile strength of red mud concrete composites, all the cylinder specimens were subjected to split tensile test in a 2000 KN digital Compression Testing Machine. Specimens were tested as per the procedure given in Indian Standards I.S.5816. The maximum load applied to the specimen was recorded and the split tensile strength of the specimen was calculated.
Procedure of Split Tensile Test:

- Take the wet specimen from water after 28 days of curing
- Wipe out water from the surface of specimen
- Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
- Note the weight and dimension of the specimen.
- Set the compression testing machine for the required range.
- Keep are plywood strip on the lower plate and place the specimen.
- Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
- Place the other plywood strip above the specimen.
- Bring down the upper plate to touch the plywood strip.
- Apply the load continuously without shock at a rate of approximately.

Note down the breaking load(P)
As per IS 5816:1999
Split tensile stress=$2P/\pi DL$
Where
P=the compressive load on the cylinder.
L=length of the cylinder
D=diameter of cylinder

FLEXURAL STRENGTH
Test Specimens:
Totally eighteen prisms of size 500mmx100mm x100 mm were cast to study the flexural strength of red mud concrete. Standard cast iron moulds were used for casting the test specimens. Before casting, machine oil was smeared on the inner surfaces of moulds. Red mud concrete with glass fibers was mixed using a horizontal pan mixer machine and was poured into the moulds in layers. Each layer of concrete was compacted using a table vibrator.

Instrumentation and Testing Procedure:
Flexural strength of red mud concrete composites was determined using prism specimens by subjecting them to two point loading in Universal Testing Machine having a capacity of 1000kN. Specimens were tested as per the procedure given in Indian Standards I.S.516. The maximum load applied to the specimen was recorded and the flexural strength of the specimen was calculated.
Procedure:

- Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer.

- Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers.

- Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be 3d and the distance between the inner rollers shall be d. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.
- The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers.

For moulded specimens, the mould filling direction shall be normal to the direction of loading.

- The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

As per IS: 516:1959
Flexural strength = pl/bd^2
P= Maximum load applied to the specimen
L=length of the specimen
b=measured width of the specimen
d=measured depth of the specimen at the point of failure

V. RESULTS AND DISCUSSIONS

S.No	% of red mud used	slump value for M40 without hydrated lime	slump value for M40 with 5% hydrated lime
1	0%	23	25
2	5%	25	26.5
3	10%	26	27
4	15%	27	28
5	20%	29	29

slump cone test results for M40 grade of concrete

S.No	% of red mud used	slump value for M50 without hydrated lime	slump value for M50 with 5% hydrated lime
1	0%	25	27
2	5%	27	28.5
3	10%	28	30
4	15%	30	32
5	20%	32	34

Slump cone test results for M50 grade of concrete

S.No	% of red mud used	Compaction factor value for M40 without hydrated lime	Compaction factor value for M40 with 5% hydrated lime
1	0%	0.78	0.86
2	5%	0.81	0.88
3	10%	0.83	0.91
4	15%	0.85	0.93
5	20%	0.87	0.94

Compaction factor value for M40 grade of concrete

S.No	% of red mud used	Compaction factor value for M50 without hydrated lime	Compaction factor value for M50 with 5% hydrated lime
1	0%	0.79	0.87
2	5%	0.82	0.89
3	10%	0.84	0.91
4	15%	0.86	0.93
5	20%	0.88	0.95

Compaction value for M50 grade of concrete

S.No	% of red mud used	split tensile strength of concrete without hydrated lime	split tensile strength of concrete with 5% hydrated lime
1	0%	5.1	5.3
2	5%	5.3	5.4
3	10%	5.4	5.6
4	15%	4.4	4.8
5	20%	3.8	4.2

split tensile strength of concrete of M40 grade for 28 days

S.No	% of red mud used	Split tensile strength of concrete without hydrated lime	Split tensile strength of concrete with 5% hydrated lime
1	0%	6.2	6.3
2	5%	6.3	6.4
3	10%	6.6	6.6
4	15%	5.8	5.2
5	20%	5.2	4.8

Split tensile strength of concrete of M50 grade for 28 days

VI. CONCLUSION

From this research the following conclusions are:

- The slump value is increasing with increase in the percentage of red mud in concrete for 5% hydrated lime. Due to increase in the red mud leads to decrease in the quantity of cement results in increase in the workability of concrete.
- The compressive strength of M40 for 28 days is 51 kn/m2 at 0% ,53 kn/m2 at 5%, 55 kn/m2 at 10% red mud replacement till now the compressive strength increases and 44 kn/m2 at 15%, 38 kn/m2 at 20% red mud replacement the compressive strength decreases.
- The compressive strength of M50 for 28 days is 62 kn/m2 at 0% ,63.5 kn/m2 at 5%, 66 kn/m2 at 10% red mud replacement till now the compressive strength increases and 58 kn/m2 at 15%, 52 kn/m2 at 20% red mud replacement the compressive strength decreases.
- The compressive strength of M40 with 5% hydrated lime for 28 days is 53 kn/m2 at 0%, 54 kn/m2 at 5%, 56 kn/m2 at 10% red mud replacement till now the compressive strength increases and 48 kn/m2 at 15%, 42 kn/m2 at 20% red mud replacement the compressive strength decreases
- The compressive strength of M50 with 5% hydrated lime for 28 days is 63 kn/m2 at 0%,64 kn/m2 at 5%, 66kn/m2 at 10% red mud replacement till now the compressive strength increases and 52 kn/m2 at 15%, 48 kn/m2 at 20% red mud replacement the compressive strength decreases
- The optimum value of the compressive strength of red mud concrete for 7 days curing was observed at 10% red mud replacement. And also for 28 days compressive strength observed at 10% red mud replacement .The compressive strength of concrete using 5% hydrated lime is more as compared with the concrete without hydrated lime.
- The optimum value of split tensile strength by using hydrated lime and without using hydrated lime are observed at 10% red mud replacement. And also split tensile strength is high for 5% hydrated lime concrete.
- The optimum value of flexural strength was observed at 0% replacement of red mud concrete for both using hydrated lime and without using hydrated lime at 28days of curing. The percentage economy is increased with the increase in the grade of concrete but at the same time there is a reduction in the percentage increase in the Compressive Strength.
- Red mud can be effectively used as replacement material for cement and replacement enables the large utilization of waste product. Red mud did not effect of the cement properties, rather improved the cement quality by way reducing the setting time & improved compressive strength. Physical parameters of red mud are affected by calcination process
- The surface area and the unitary mass decrease and the specific gravity increases, T he results of pozzolanic activity by chemical and physical methods were very satisfactory and indicate the feasibility of red mud use as a pozzolanic, in addition to Portland cement.

REFERENCE

[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] Sneha Samal, Ajoy K. Ray, Amitava Bandopadhyay, ―Proposal for resources, utilization and processes of red mud in India‖, International Journal of Mineral Processing, volume 118 pp. 43–55, 2013.

[3] Mohan Kushwaha1, Dr. Salim Akhtar, Survesh Rajput, ―Development of the Self Compacting Concrete By Industrial Waste (Red Mud)‖, Research and Applications (IJERA)

[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 Properties 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] Effect Of Soil-structure Interaction In Seismic Analysis Of Framed Structures Using Ansys By 1Aarlin K Mathew,2 Sat Kumar Tomer,3lovely K M

[7] Seismic Analysis And Soil Structure Interaction Of Multistoried Building With Different Types Of Footing Miss. Anjali B &Dr. Raji.
[8] Finite Element Analysis Of Frame With Soil Structure Interaction By Gaikwad M.V1, Ghogare R.B2 , Vageesha S. Mathada3
[9] A Criterion For Considering Soil-structure Interaction Effects In Seismic Design Of Ductile Rc-mrfs According To Iranian Codes By Massumi 1 And H.R. Tabatabaiefar 2
[10] Soil Structure Interaction In The Analysis And Seismic Design Of Reinforced Concrete Frame Buildings Julio A. García 1
[11] SSI Analysis Of Framed Structure Supported On Pile Foundations - With And Without Interface Elements Dr. Sushma Pulikanti*1, Prof. Pradeep Kumar Ramancharla.
[12] Terrain evaluation and influence of soil-structure interaction on seismic response of structures in urban environs S.R.K.Reddy
[13] Seismic response of RC building by Considering soil structure interaction. Jinu Mary Mathew, Cinitha , Umesha P , Nagesh R Iyer and Eapen Sakaria
[14] Seismic Analysis of buildings with underground stories considering soil structure interaction. Nithya Chandran J, Abhilash Rajan, Soni Syed,
[15] Effect of Soil Structure Interaction on Response of Multi-storey Building. Vaishali Tormal, Dr. K.B. Ladhane, Prof. V. R. Rathi
[16] "Design procedure for dynamically loaded foundations" Whiteman.R. V,Richart.F.E
[17] "Soil-structure interaction effects on seismic response of multi-story buildings on raft foundation" Shehata E.Abdel Raheem, Mohamed M. Ahmed and Tarek M.A.Alazrak
[18] Raju P.S.N, Reddy S.R.K, Raju K.R.K,(2004): Influence of soil-structure interaction on response of structures against earthquake forces. STTp on disaster resistant design and construction of structures.
[19] Bureau Of Indian Standards Is 1893 (Part I): 2002. Criteria For Earthquake Resistant Design Of Structures. Part I General Provisions And Buildings, 2002.
[20] IS 13920 (1993)"Ductile detailing of reinforces concrete structures subjected to earthquake forces"
[21] IS 456:2002"Plain and Reinforced Concrete-Code of practice"
[22] Soil Mechanics and Foundation Engineering by Dr. K R ARORA

