Studies on Enhanced Strength of Concrete on use of Industrial Waste Blends like Red Mud and Iron Ore Slickens

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Abstract— Concrete is one of the most commonly known versatile building materials. The advantages of using concrete are to obtain high compressive strength, very good fire resistance, high water retention qualities, low maintenance requirements, and long service life/ durability. The disadvantages of using concrete include poor tensile strength, low strain of fracture and form work requirement. The major disadvantage is that concrete develops micro cracks during curing. The rapid propagation of micro cracks in concrete under application of stresses that are responsible for the low tensile strength of the material. Other disadvantages include relatively low strength per unit weight. The main reasons for adding steel fibres to concrete matrix is to improve the post- cracking response of the concrete by improving its tensile strength , i.e., to improve energy absorption capacity and apparent ductility of the material, and to provide resistance to cracks and hence causing crack control. The study aimed to identify the optimum percentage of steel fibre reinforcement as the replacement of cement in the M20, M30 and M40 grade of concrete mixes. The percentage at which the SFRC gives maximum workability were also determined in the study. It was observed that the optimum percentage for M20 grade of concrete is 1% as a replacement of cement, whereas its 1.5% for M30 and M40 grade of concrete.

Key words: SFRC (Steel Fibre Reinforcement Concrete), Optimum replacement, Flexural Strength, Compressive Strength, Fatigue, Workability

I. INTRODUCTION

As we know now a day’s many changes have taken place in conventional concrete, Concrete is the most utilized man-made construction material on the earth. The demand for concrete as a construction material has increased as the demand for infrastructure development has increased. However, the environment gets polluted by utilization of cement and raw materials (limestone) also get reduced. The manufacturing of ordinary Portland cement (OPC) requires the large quantities of fuel to be burned as well as the decomposition of limestone, resulting in significant emissions of CO₂.

For the manufacturing of a ton of OPC, nearly one ton of CO₂ is produced, depending on the production process adopted. Cement plants have been reported to emit up to 1.5 billion tons of CO₂ into the atmosphere annually.

As such, replacement of cement in concrete by red mud and partially replacing sand by iron ore slickens by different percentage so it could increase the strength of conventional concrete, because red mud and iron ore tailing are the waste which comes out from aluminum production plant & iron production plant. These have already caused ecological unevenness in their respective regions and appear as the main source of environmental hazards.

Aluminum is a light weight, high strength and recyclable metal. It plays amajor role in social progress and has a pivotal contribution in food, transportation, beverage packaging, building constructionand infrastructure, electronics and electrification, defense and aerospace. It is the third plentiful element in the earth's crust and is not found in the free state but in combined form with other compounds. The commercially excavated aluminum ore is bauxite, as it has the highest content of alumina with minerals like iron oxide, silica and other impurities in small or trace amount. The primary process of aluminum production consists of three stages: Mining of bauxite, followed by clean of bauxite to alumina by the Bayer process and finally fusion of alumina to aluminum. In the Bayer process, the indissoluble product generated after bauxite digestion with sodium hydroxide at raised temperature and pressure to manufacture alumina is known as red mud or bauxite residue. The waste product was given its color and name from its iron oxide content. As the bauxite has been undergo to sodium hydroxide treatment, the red mud is highly corrosive with a pH in the range of 10.5-12.5. Bauxite posing a very hazardous and alarming environmental problem.

The increasing demand for heavy construction material like iron and steel and ample reserve of iron ore in India has effected in the foundation of many iron ore mining companies. The residue left after extraction of concentrated iron from iron ore is in the form of slurry. This form the iron ore slickens (IOS) and the same is disposed of in the region of plant as waste material over large area of valuable land leading to water &land pollution. The production of IOS waste is about 18 million tons per annum in India. The safe disposal of large quantities of iron ore slickens is surely a difficult task and a matter of environmental concern, reuse of IOS eliminates/reduces the disposal problem.

II. LITERATURE REVIEW

A. Evaluation of the properties of Red Mud Concrete

The experimental investigation conducted by Ramesh R. Rathod , NageshT,Suryawanshi ,Pravin D. Memade (Civil Engg. dept.,S.B.Patil College of Engineering Indapur / Pune University ,India) that

Red mud is a waste material generated by the Bayer Process widely used to produce alumina from bauxite throughout the world. The aim of the present research work was to investigate the possibility of replacing the Portland cement by red mud. Because of storing issues, the waste negatively affects the environment. To solve this problem, Portland cement was replaced up to 40 % RM by wt of cement. And evaluating its compressive and splitting tensile
strength of red mud concrete. This study examines the effects of red mud on the properties of hardened concrete. The test results show that how its compressive strength & splitting tensile strength decreases with increase red mud content, it is concluded that Optimum percentage of the replacement of cement by weight is found to be 25%. By this percentage replacement we can have strength is equal to the strength of controlled concrete.

Following Conclusions were depicted:

- From experimental work it was found that increase in red mud content decreases the compressive as well as tensile strength of concrete.

- Optimum percentage of the replacement of cement by weight is found to be 25%. By this replacement results got are nearly equal to the results of controlled concrete.

- Concrete prepared by using red mud is suitable in ornamental works and gives aesthetically pleasant appearance.

- Workability of concrete may get affected with increase of red mud but it can be improved by adding superplasticizers.

- We use mixture of red mud & cement for non-structural work. There is future scope for the use of red mud concrete in structural point of view.

B. Pre-Concentration of Iron Ore Slime in Magnetic Separator

An experimental investigation conducted by Dr. Nithita Nayak, Dr. B. K. Pal (Asst. Professor, Department of Petroleum Engineering, UPES, Dehradun Professor, Dept. of Mining Engg. NIT, Rourkela) in 2015 that Indian iron ore is generally friable in nature that results in generation of significant quantity of fines (around 35%) during mining and processing in the country. The ratio of lumps to fines produced in the country is 2:3. During washing and sizing of the ore, slimes with less than 0.21 mm size are generated and discarded into the tailing pond. It is estimated that around 10 million tons of slimes are being generated in every year during the processing of hematite ore and lost as tailings containing around 48-62% of Fe. The slime sample collected from Barsua assaying 54% Fe, 8.3% SiO2 & 11.08% Al2O3 was studied for pre concentration of iron values adopting gravity techniques followed by magnetic separation. The results indicated that Magnetic separation is a better pre concentration technique compared to gravity.

A flow sheet involving classification, gravity separation, magnetic separation and flotation is developed with a view to achieve the grade at reasonably high yield. The hydro cyclone underflow product of test 2 (lower grade but higher yield) is treated by gravity separation technique using Wilfley Table to exploit the differences in specific gravity. It is observed that quality of the slime could be improved significantly. However the concentration grade is about 62.48% indicating the requirement of further concentration process. The Tabling results indicate that better grade product can be obtained. The grade improved substantially from 54.93% to 62%. However to make the concentrate grade for pellet making, further processing is required. In case of U/F product (Test2) the desired product is suitable for pellet making directly. No further processing is required. From the above discussion it may be concluded that a relatively simple flow sheet may be quite effective in producing pellet grade concentrate from such low grade iron ore slimes with a reasonable yield using desliming followed by magnetic separation.

C. Beneficiation of Iron Ore

An experimental investigation conducted by Sanjay Kumar Agarwal & Sudhanshu Kumar (DEPARTMENT OF MINING ENGINEERING NATIONAL INSTITUTE OF TECHNOLOGY) in 2014 that by looking at results indicated by characterization of the BHJ sample tests may be done using

1) Fundamental principles of separation namely:
   1) Magnetic separation
   2) Gravity Separation

Floatex gravity slime table is used for gravity separation and WHIMS (Wet high Intensity magnetic Separator) is used for carrying out magnetic separation.

Drawback in using WHIMS technology is that the grains of jasper may concentrate at high Intensities of gauss. Due to this problem separation by gravity using gravity spirals seems a more feasible and better option. Prior to gravity separation the sample may have to be subjected to pre concentration using wash waterless spirals. Different feed rates, pulp densities and splitter positions are used for conducting tests.

2) Iron ore slimes

The occurrence of Kaolinite causes high alumina content in the slime. Advancement in the field of beneficiation methods based on the principle of froth flotation/selective dispersion gravity separation, magnetic separation, and bio beneficiation can be used for the up-gradation of iron ore slimes in India. The enhanced low alumina ore can then be used in the main stream industry for sintering and pelletization. The waste management can be carried out using suitable techniques like, thermal conversion to iron and glass ceramics semi dry disposal, iron rich cements. Certain test need to be carried out to validate the effectiveness of the above techniques. Based on the results of the tests a suitable flow chart can be developed for the beneficiation of slime. The tests comprise floatation and WHIMS (Wet high intensity magnetic separator), hydro cyclone, spiral.

3) Hydro cyclone

For the up-gradation of Iron values as well as for de-sliming of slime particles present in the sample Hydro cyclone can be used. Samples contain large amount of slime materials Containing of particles falling in the sub-micron size category, de-sliming has to be carried out prior to flotation. The underflow and overflow constituents of the cyclone have to be collected at a steady state for a fixed time, dried, weighed and analyzed for the desired Iron and other constituents. Further analysis of overflow & underflow samples collected at finest operating conditions should be done.

4) Spiral

To enrich the Iron content of the classified sample (hydro cyclone underflow) a spiral concentrator of 100 mm diameter can be used. Advantage of using spiral is that it is an energy saving gravity equipment where large quantities of sample can be served for pre-concentrations. Iron ore
sample has to be fed to the centrifugal pump at the requisite solids consistency and the slurry has to be kept recirculating for a predetermined time in the spiral study. Complete concentrate and tailings are then to be collected after attaining the steady state. All the products thus achieved were dried, weighed and examined.

D. Wet High Intensity Magnetic Separation
The high gradient magnetic separator (HGMS) and wet high intensity magnetic separator (WHIMS) has been used at various magnetic field intensities to recuperate the fine iron values from the hydro cyclone overflow or spiral tailings. Different magnetic groves of width and matrix with movable currents to provide different magnetic intensities are provisions of both the separators. A desired concentration of solids has to be passed through the magnetic separator after this. Many a times the magnetic products have to be cleaned in second stage to enhance the superiority of the product from first stage separation.

1) Flotation
To select either direct or reverse flotation method to optimize reagent mixture and to generate the number of stages in the operations, batch flotation studies have to be carried out. Sub aeration flotation machine needs to be used for the batch flotation studies. Suitable frothing agent and Cationic and anionic reagents have to be used as collectors. To get good grade concentrate with high recoveries flotation condition needs to be optimized. After this column flotation studies have to be carried out by using glass column of appropriate diameter. At nominal capacity of 15kg approximately of Iron ore fines per hour with the help of a peristaltic pump the column has to be operated. After attaining the steady state and analyzed for Iron content both the concentrate and tailings are then to be collected separately. After the validation of the above mentioned tests a general flowchart for removal of alumina can be generated. The procedure may vary from place to place subject on the nature of ore, its alumina content and the beneficiation methods have to be adopted according to it.

E. Utilization of Iron Ore Tailings as Replacement to Fine Aggregates in Cement Concrete Pavements
An experimental investigation conducted by B N Skanda Kumar, Suhas R, Santosh Uttam Shet, J M Srishaila in DSCE, Bangalore, India that From the stage of quarrying the raw materials to the completion of project has resulted in stripping of earth for the use of exhaustible resources and has caused an adverse effect on the nature. This has resulted in an acute shortage of fine as well as coarse aggregates and the need to explore the replacement for these materials without compromising the quality, environmental and economic factors. In recent years, almost every mineral producing country is facing the problem of better utilization of mine waste because of its accumulation and lack of suitable storage space. In the present study Iron Ore Tailings (IOT) procured from Kudremukh Lakya Dam site (KIOCL Ltd.) are used as partial replacement to fine aggregates at levels of 10, 20, 30, 40, 50 percent and the basic material properties, strength parameters are studied. It is found that as the IOT percentage increases in the mix workability is reduced. At 40 percent replacement level the 28 days compressive strength is more than the reference mix and other replacement percentage mixes. Flexural strength is observed maximum for reference mix. Quality of concrete mixes is found good from Ultrasound Pulse Velocity test. Flexural fatigue analysis is carried out on mix with 40 percent IOT replacement at stress ratios 0.65, 0.7 and 0.75 compared with IRC model for number of repetitions using log normal distribution. Up to 0.7 stress ratio it showed more number of repetitions than IRC and at higher stress ratio mix with IOT achieved failure earlier.

From the tests conducted on materials for assessing properties and tests on hardened concrete to arrive at strength properties such as compressive and flexural the following conclusions are made.

As the IOT percentage increases workability of mix reduces hence for better workability needs use of super plasticizers is recommended.

Replacement of 40% IOT gives maximum compressive strength which is more than the reference mix (NC) and other replacement percentages.

Reference mix shows maximum flexural strength more than the IOT replaced mixes.

The number of repetitions to failure obtained for Mix4 is more than IRC (reference mix NC) up to 0.7 stress ratio. This shows that IOT replaced concrete can be used for pavements; in particular it is recommended for village roads with lower traffic loads.

E. Physical and Chemical Properties of Sintering Red-Mud and Bayer Red Mud and the Implication For Beneficial Utilization
An experimental investigation conducted by Ping Wang and Dong-Yan Liu of logistical Engineering University of PLA, Chongqing, China in 2012 that Performances of two common types of red mud, Bayer red mud and Sintering red mud, were investigated in this research. Their compositions, mechanical properties and microstructure characterization were measured through XRD, TG and SEM analysis. Their shear strength, particle size, density and hydraulic characteristics also had been performed. Huge differences between the basic mineral types of these two kinds of red mud also can be found. The comparison of compositions shows that CaCO3 content in Sintering red mud is higher, Bayer red mud has more hazardous elements such as As, Pb and Hg and both have a high concentration of radioactivity. The micro particle of Bayer red mud is finer and more disperse, but the Sintering red mud has a higher shear strength. Combining the TG and hydraulic characteristics analysis, it can be shown that Bayer red mud has a higher value of water content and Sintering red mud has higher hydraulic conductivity. The paper then illustrates that Sintering red mud can become the main filling material of supporting structure of red mud stockling yard. Bayer red mud has a high reuse value and also can be used as a mixing material of masonry mortar.

According to the measurements and discussions, the paper presents a comprehensive illustration of the main chemical and physical properties of red mud and gives some suggestions about the comprehensive treatment of red mud. The main conclusions are as follows:
The chemical and phase composition, mechanical properties, density and particle diameter, occurrence mode of water, hydraulic characteristics of the two kinds of red mud are different, which can determine the different chemical and physical properties.

Both kinds of red mud have the possibility of large scale application in the production of cement mixture. However, the influence of hazardous elements and radioactivity in red mud should be avoided when applying the red mud in the production of building material.

Sintering red mud, with its greater stability and hydraulic conductivity, can be the main filling material of supporting structure of red mud stocking yard. However, potential pollution of liquid pollutants to the surrounding environment should be prevented. Red mud has a high reuse value and can also be used as a mixing material of masonry mortar.

**G. Experimental Study on Partial Replacement of Cement By Neutralized Red Mud in Concrete**

An experimental investigation conducted by A. B. Sawant, M. B. Kunknekar, V. V. Diwan, K. G. Hiraskar in 2012 that Disposal of large quantities of red mud; a solid-waste generated at the Aluminum plants all over the world possess an increasing problem of storage, land cost & availability and pollution. 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. Due to industrialization, infrastructure development and soft housing policy of Government of India, the construction industry is in full boom due to which within short span of time there is a tremendous increase in the utilization of cement and concrete for various construction activities. It is expected that the same rate will continue in the next decade and this may invite the threat to the environment. Availability of raw material required for manufacturing of cement and production of concrete are limited in nature. This increased demand will lead to fast depletion of natural resources and will cause big threat to environment. So as to overcome this problem it is very much essential to utilize the industrial waste materials and by-products generated in manufacturing of cement and in concrete construction. In this paper the attempt is made to check the effectiveness of neutralized red mud as a partial replacement of Portland cement.

1) **Effect of Replacement of Cement by NRM on Standard Consistency and Setting Time**

Blended cement samples, five in number, are prepared with replacement of cement by NRM with increment of 5 percent (i.e. 5%, 10%, 15%, 20% & 25%), setting time with different percentage of NRM in cement. As seen that with the increase in NRM in the mix, the water required for standard consistency also increases and the relationship between the standard consistency and requirement of water for that is linear. As the NRM having small grain size, due to which surface area was increased and also the water required was increased. Beyond 10% replacement of cement by NRM the setting times are increased. It also interesting to observe that for 15% replacement of cement by NRM the setting time almost same or near to that of Vasavadatta Cement and after this further increase in the % replacement of cement by NRM, the setting time of the mix also increase.

2) **Effect of Replacement of Cement by NRM on Compressive Strength of Concrete**

For each grade of concrete design mix i.e. M 30, M 40 and M 50, there was an initial decrease in the compressive strength for 5 % replacement of cement by NRM. But from the next replacements i.e. 10 % and 15 % the compressive strength are increased with the increase in the % replacement of cement by NRM. Then after, for 20 % and 25 % replacement of cement by NRM there was a decrease in the compressive strength as the % replacement of cement by NRM increased.

Hence by observing all results of each grade of concrete design mix, it can be said that the 15 % replacement of cement by NRM gives the maximum compressive strength.

**H. Development of the Self Compacting Concrete by Industrial Waste (Red Mud)**

This experimental study is done by Mohan Kushwaha, Dr. Salim Akhtar, Survesh Rajput in 2013 that Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. Due to industrialization there is huge amount of red mud created. Red mud is industrial waste and causing threat to environment so the reduce the cost of the construction also to make structure more durable, reduce problem of this material the project has been undertaken so that it can be used for construction fashion of the concrete by blending or by replacing the cement by Red mud.

In India, HINDALCO’S aluminum refinery in Belgaum, Karnataka generates a voluminous quantity of industrial waste in the form Red Mud, almost 400,000 tons per annum. This is largely dumped at sites, which are referred to as red mud ponds. The volume of waste generated is large and its alkalinity has the potential to contaminate valuable surface and groundwater resources.

So this mix (Red Mud + SCC) should be used for the construction activity it will reduce the problem of environmental pollution at the same time it reduce the cost of the construction and add it makes the concrete high performing from the durability point of view.

It has been observed that the compressive strength of self-compacting concrete produced with the combination of admixtures such as (SP+VMA) goes on increasing up to 2% addition of red mud. After 2% addition of red, the compressive strength starts decreasing compacting is the compressive strength of self-compacting concrete produced with (SP+VMA) is maximum when 2% red mud is added. The percentage increase in compressive strength at 2% addition of red mud is + 0.11 thus, it is observed that maximum compressive strength of self-compacting with the
combination of admixtures (SP+VMA) may be obtained by adding 2% red mud.

The compressive strength of concrete increases with the addition of Red Mud up to 2% then reduces and comes to no increase at almost 4% addition. So it can be concluded that on addition of 4% may be made to SCC without any loss to its compressive strength.

I. Influence of Steel Fibers and Partial Replacement of Sand by Iron Ore Tailings on the Compressive and Splitting Tensile Strength of Concrete

This experimental investigation is conducted by Ananthayya M.B. Prema Kumar W. P. Bangalore that In this work, the effects of steel fibers and partial replacement of sand by iron ore tailings (IOT) on the compressive and splitting tensile strength of concrete are experimentally studied. Themix proportions used for concrete are 1:1.43:2.94. The percentages of steel fibers by weight of cement used were 0.0, 0.5, 0.7, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0. The sand replacement (by IOT) percentages used were 0, 5, 10, 20, 25, 30 and 35. Compressive strength tests were conducted on 150mm size concrete cubes and splitting tensile strength tests on 150 mm diameter and 300 mm length concrete cylinders as per Bureau of Indian Standards specifications. For concrete without steel fibers, the compressive and splitting tensile strengths were found to vary with the percentage of IOT and the maximum compressive and splitting tensile strengths were obtained for 35% of sand replacement by IOT. For concrete with steel fibers, the compressive and splitting tensile strengths were found to vary with both the percentage of steel fibers and percentage of IOT. Maximum compressive and splitting tensile strengths were obtained for 25% of sand replacement by IOT and 1.2% of steel fibers.

1) Compressive test results
It is seen that for concrete without steel fibers, the compressive strength varies with the percentage of IOT. Maximum compressive strength of 36.5MPa occurs for 35% of sand replacement by IOT (the compressive strength for zero percentage of sand replacement by IOT being 31.5MPa). It is also seen from Table 3 that for concrete with steel fibers, the compressive strength varies with both the percentage of steel fibers and percentage of IOT. Maximum compressive strength of 42.5 MPa was obtained for 25% of sand replacement by IOT and 1.2% of steel fibers (the compressive strength for zero percentage of sand replacement by IOT being 2.10 MPa).

2) Splitting tensile test results
It is seen from Table 4 that for concrete without steel fibers, the splitting tensile strength varies with the percentage of IOT. Maximum splitting tensile strength of 2.64 MPa occurs for 35% of sand replacement by IOT (the splitting tensile strength for zero percentage of sand replacement by IOT being 2.10 MPa). It is also seen from Table 4 that for concrete with steel fibers, the splitting tensile strength varies with both the percentage of steel fibers and percentage of IOT. Maximum splitting tensile strength of MPa occurs for 25% of sand replacement by IOT and 1.2% of steel fibers (the splitting tensile strength for zero percentage of sand replacement by IOT and zero percentage of steel fibers being 2.10 MPa).

For concrete without steel fibers, the splitting tensile strength varies with the percentage of IOT. Maximum splitting tensile strength of 2.64 MPa was obtained for 35% of sand replacement by IOT (the splitting tensile strength for zero percentage of sand replacement by IOT being 2.10 MPa).

For concrete with steel fibers, the splitting tensile strength varies with both the percentage of steel fibers and percentage of IOT. Maximum splitting tensile strength of MPa was obtained for 25% of sand replacement by IOT and 1.2% of steel fibers (the splitting tensile strength for zero percentage of sand replacement by IOT and zero percentage of steel fibers being 2.10 MPa).

The percentage of sand replacement by IOT that gives maximum splitting tensile strength varies with the percentage of steel fibers and lies in the range of 25 to 35%.

J. Compressive and Tensile Strength of Concrete Using Lateritic Sand and Lime Stone Filler as Fine Aggregate

This paper is part of a study investigating the structural characteristics of concrete using various combinations of lateritic sand and lime stone filler as complete replacement for conventional river sand fine aggregate by A. Jayaraman, V. Senthilkumar, and M. Saravanan. The lime stone filler obtained from limestone quarries. The concrete are made using varying contents of lateritic and lime stone filler as fine aggregate. The quantity of laterite is varied from 0% to 100% against lime stone filler at intervals of 25%. Samples of concrete (eg., cubes and cylinders) are made in three different grades, namely: M15, M20 and M25. It was found that 0.55 water/cement ratio produced higher compressive strengths, tensile strength and better workability for M20 mix, proportion. Specifically compressive and tensile strength ranged from 21.06 -35.2 N/mm² and 10.06 -15.5 N/mm² for the mixes considered. These results compare favorably with those of conventional concrete. The concrete.
was found to be suitable for use as structural members for buildings and related structures, where laterite content did not exceed 50%.

It can be seen from the results of this study that the combination of laterite and lime stone filler replaces the conventional river sand in the production of concrete for construction industry.

The compressive strength and tensile strength of concrete using lateritic sand lime stone filler are measured in the laboratory. Compressive strength and tensile strength is found to increase with age as for normal concrete. The 28 – day compressive and tensile strength is found 21.06 -35.2 N/mm2 and 10.06 -15.5 N/mm2 for different mixes. The above strength properties the proportion of 25% laterite to 75% lime stone filler produced higher values of compressive strength. For the same proportion of 25% laterite to 75% lime stone filler at 1:15:3 mix and 0.55 water cement ratio, a logarithmic model has been developed for predicting the compressive strength and tensile of concrete between 0 and 28 days. Further work is required to get data for other structural properties of the experimental concrete.

K. Mechanical Properties of Self-Compacting Concrete Reinforced With Polypropylene Fibers

This experiment is done by O. Gencel,, C. Ozel, W. Brostow and G. Martinez-Barrera on The properties of hardened concrete can be significantly improved by fibres. However, the addition of fibres to fresh concrete results in a loss of workability. Self-compacting concrete (SCC) is an innovative concrete that is able to flow under its own weight, completely filling formwork and achieving full compaction without vibration. In the present study, the workability and mechanical properties of SCC with fly ash reinforced with monofilament polypropylene fibres were investigated. Two cement contents at 350 and 450 kg m23 were studied as well with four fiber contents at 3, 6, 9 and 12 kg m23. The water/cement ratio, fly ash and super plasticizer contents were kept constant at 0?40, 120 kg m23 and 1% of cement content respectively. Slump flow, Jring, V funnel and air content tests were conducted for evaluating the fluidity, filling ability and segregation risk of the fresh concretes. Unit weight, compressive strength, splitting tensile strength, flexural strength, pulse velocity and elasticity modulus of concrete were determined. The materials used in this study exhibit no problems with mixing or workability when the fibre distribution is uniform. The polypropylene fibres enhance the strength of SCC significantly, without causing well known problems associated with steel fibers.

There are a variety of methods of reinforcing concretes and of modification of their properties.2,4–6,41–43 In the case of SCCs, the workability requirements for successful placement necessitate that the concrete exhibits good deformability and proper stability to flow under its own weight without segregation and blockage. The current study investigated the effects of monofilament PP fibers instead of steel fibre inclusion on the flow characteristics of SCC and certain mechanical properties. Two cement contents and four fibre contents were used in combination, and tests were performed in both fresh and hardened states. It was found that for all the mixture proportions there were no problems in mixing while the fiber distribution was uniform. The air content of concrete has increased depending on the increase in fiber content. Fiber inclusion up to 9 kg m23 has provided satisfactory results. While fibers in general cause loss of flow and workability, in all the mixtures, the fibers in this study have good flow and workability, even if some mixtures are somewhat below the limits of EFNARC. The authors recall that these limits have been suggested for conventional concretes. Adding PP fibers to concrete has decreased the unit weight of concrete and increased the compressive strength of concrete. Monofilament PP fibres can be used at much lower content than steel fibers; the lowest steel fiber content used is 60 kg m23. Compressive strength, splitting tensile strength and especially flexural strength and elasticity modulus have been increased by PP fiber inclusion – while pulse velocity has decreased. Future work is planned using monofilament PP fibers with admixtures (mineral and chemical) and possibly use of two different fiber kinds incorporated in the SCC mixes.

L. Experimental Study on Strength Characteristics on M-25 Concrete with Partial Replacement of Cement With Fly-Ash and Coarse Aggregate With Coconut Shell

This experimental study is done R. NAGALAKSHMI which is an attempt has been made to examine the suitability of replacing the 20% of fly ash obtained from V.T.P.S; Vijayawada is common for all mixes with cement and simultaneously by replacing 10%, 20% and 30% of coconut shell as coarse aggregate for concrete of grade M25. Examine strength characteristics such as compressive strength, split tensile strength and flexural strength of concrete mix are found for 7 days, 14 days, 28 days,65 days of curing period and results are analyzed and compared with the regular (conventional) mix. Test for grade as per specified procedure of IS codes. The materials are proportioned by their weight. The water cement ratio is obtained by conducting workability tests. The results found were comparable with that of conventional mix. The following conclusions can be drawn from the experimental investigation carried out

1) The slump of the concrete increased as the percentage of coconut shell increases and decrease in comparison with the conventional concrete.

2) The compaction factor increased as the percentage of coconut shell increases and increased in comparison with the conventional concrete.3. The specific gravity of coconut shell is low as compared to the coarse aggregate and the water absorption is high for coconut shell than coarse aggregate and hence the strength decreased in comparison with the conventional concrete.

3) The slump of the concrete increased as the percentage of coconut shell increases and decrease in comparison with the conventional concrete.

4) The compaction factor increased as the percentage of coconut shell increases and increased in comparison with the conventional concrete.

5) The specific gravity of coconut shell is low as compared to the coarse aggregate and the water absorption is high for coconut shell than coarse aggregate and hence the
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An experimental investigation conducted by Arvind Y Rana, Naresh A Sathe Student, Trinity College of Engineering & Research, Pune University, and Maharashtra, India that In India and worldwide, variety of waste is generated in different forms, shape and texture. These industrial wastes mostly possess threat to the environment and the society living nearby. Various researches has been done on this waste material to either degrade or to utilize it in some or the other way. One such hazardous waste generated by industry is Red mud. It is the residual waste generated by Bayer’s Process of aluminum extraction. Red mud is the most hazardous waste than the other waste mainly due to its high fineness and Ph. Steps have been taken to utilize this waste as partial replacement of cement in concrete without compromising the strength and economy. For this mortar cubes were casted using cement with varying percentage of red mud with the addition of lime and the same procedure followed for silica to find the optimum red mud replacement with addition of either lime or silica. After this test result showed that 10% red mud replacement with 20% silica to the weight of red mud can be added effectively in concrete without compromising the strength and also decreasing the cost of cement in concrete by 6.43% thereby achieving economy. This paper also speaks about the future possibilities of using red mud as a partial replacement in concrete for R.C.C work such as buildings, pavements, dams, etc after few more tests is conducted and various other parameters found on this optimized concrete.

Following were the conclusion drawn from the experimental work carried out. They are as stated below:

1) The result shows that the strength increases slightly for 4% Lime addition and there after strength decreases with increase in lime content. This can be explained by that the lime added may react with free reactive silica present in red mud and when the Silica gets exhausted, the extra lime added might have reacted with Alumina forming Calcium Aluminates (CaO.Al2O3) leading to more initial heat of hydration and thereby generating pores leading to decreased strength.

2) The result gives that addition of silica enhances strength of mortar and for 10% red mud with 20% silica of red mud addition gives the same strength as that of only cement. Hence, it can concluded that 10% red mud can be utilized with addition of 20% Silica of Red mud without compromising the strength of Mortar and Concrete respectively.

3) From the above two results it shows that compressive strength of the optimum red mud concrete increases by 4.6% and the tensile strength decreases by 8%. Overall it can be concluded that the results obtained for optimum red mud content shows that concrete can be used for R.C.C work after finding of other essential parameters of optimized concrete.

4) There is saving of 6.43% in cement cost by using optimum red mud concrete using silica per m3 of concrete.

N. Utilization of Iron Ore Tailing as Replacement of Fine Aggregates in Cement Concrete Pavements

An experimental investigation conducted by B N Skanda Kumar, Suhas R, Santosh UtamShet, J M Srishaila that From the stage of quarrying the raw materials to the completion of project has resulted in stripping of earth for the use of exhaustible resources and has caused an adverse effect on the nature. This has resulted in an acute shortage of fine as well as coarse aggregates, obligating to explore the replacement for these materials without compromising the quality, environmental and economic factors. In recent years, almost every mineral producing country is facing the problem of better utilization of mine waste because of its accumulation and lack of suitable storage space. In the present study Iron Ore Tailings (IOT) procured from KudremukhLakya Dam site (KIOCCL Ltd.) are used as partial replacement to fine aggregates at levels of 10, 20,30,40,50 percent and the basic material properties, strength parameters are studied. It is found that as the IOT...
percentage increases in the mix workability is reduced. At 40 percent replacement level the 28days compressive strength is more than the reference mix and other replacement percentage mixes. Flexural strength is observed maximum for reference mix. Quality of concrete mixes is found good from Ultrasound Pulse Velocity test). Flexural fatigue analysis is carried out on mix with 40 percent IOT replacement at stress ratios 0.65, 0.7 and 0.75 compared with IRC model for number of repetitions using log normal distribution. Up to 0.7 stress ratio it showed more number of repetitions than IOT and at higher stress ratio mix with IOT achieved failure earlier.

From the tests conducted on materials for assessing properties and tests on hardened concrete to arrive at strength properties such as compressive and flexural the following conclusions are made.

As the IOT percentage increases workability of mix reduces hence for better workability needs use of super plasticizers is recommended.

Replacement of 40% IOT gives maximum compressive strength which is more than the reference mix (NC) and other replacement percentages. Reference mix shows maximum flexural strength more than the IOT replaced mixes.

The number of repetitions to failure obtained for Mix4 is more than IRC (reference mix NC) up to 0.7 stress ratio. This shows that IOT replaced concrete can be used for pavements; in particular it is recommended for village roads with lower traffic loads.

**O. Mechanical Properties of Self Compacting Concrete Reinforced with Poly-Propylene Fibers**

An experimental investigation conducted by O. Gencel, C. Ozel, W. Brostow and G. Martinez-Barrera that The properties of hardened concrete can be significantly improved by fibres. However, the addition of fibres to fresh concrete results in a loss of workability. Self-compacting concrete (SCC) is an innovative concrete that is able to flow under its own weight, completely filling formwork and achieving full compaction without vibration. In the present study, the workability and mechanical properties of SCC with fly ash reinforced with monofilament polypropylene fibers were investigated. Two cement contents at 350 and 450 kg M-23 were studied as well as four fiber contents at 3, 6, 9 and 12 kg M-23. The water/cement ratio, fly ash and super-plasticizer contents were kept constant at 120 kg M-23 and 1% of cement content respectively. Slump flow, Jring, V funnel and air content tests were conducted for evaluating the fluidity, filling ability and segregation risk of the fresh concretes. Unit weight, compressive strength, splitting tensile strength, flexural strength, and pulse velocity and elasticity modulus of concrete were determined. The materials used in this study exhibit no problems with mixing or workability when the fiber distribution is uniform. The polypropylene fiber enhances the strength of SCC significantly, without causing well known problems associated with steel fibers.

There are a variety of methods of reinforcing concretes and of modification of their properties.2-4,6,41–43. In the case of SCCs, the workability requirements for successful placement necessitate that the concrete exhibits good deformability and proper stability to flow under its own weight without segregation and blockage. The current study investigated the effects of monofilament PP fibers instead of steel fiber inclusion on the flow characteristics of SCC and certain mechanical properties. Two cement contents and four fiber contents were used in combination, and tests were performed in both fresh and hardened states. It was found that for all the mixture proportions there were no problems in mixing while the fiber distribution was uniform. The air content of concrete has increased depending on the increase in fiber content. Fiber inclusion up to 9 kg M-23 has provided satisfactory results. While fibers in general cause loss of flow and workability, in all the mixtures, the fibers in this study have good flow and workability, even if some mixtures are somewhat below the limits of EFNARC. The authors recall that these limits have been suggested for conventional concretes. Adding PP fibers to concrete has decreased the unit weight of concrete and increased the compressive strength of concrete. Monofilament PP fibers can be used at much lower content than steel fibers; the lowest steel fiber content used is 60 kg M-23. Compressive strength, splitting tensile strength and especially flexural strength and elasticity modulus have been increased by PP fiber inclusion – while pulse velocity has decreased. Future work is planned using monofilament PP fibers with admixtures (mineral and chemical) and possibly use of two different fiber kinds incorporated in the SCC mixes.

**P. Reuse of Iron Ore Mineral Waste in Civil Engineering Constructions**

A case study This case study is done by Mohan Yellishetty , Vanda Karpe, E.H. Reddy, K.N. Subhash, P.G. Ranjitha Said that To make mining activities more eco-friendly, It is important to conduct mining operations in a manner that is more environmentally friendly, economically feasible and socially acceptable. The volume of solid waste generated, including tailings from mineral processing activities, is one of the main pollution concerns in the mining industry. In the tiny state of Goa (India), it is becoming increasingly difficult to find space for dumping these huge volumes. And therefore ways of utilizing mine waste need to be found. This paper examines the suitability of these wastes for use in construction. Studies by others were reviewed where it was found that these wastes contain acid producing mineral phases and high concentrations of heavy metals. The presence of such concentrations can jeopardize the environment, if management of these wastes is not addressed with due consideration and care. Particle size classification on these wastes suggests that mine wastes contain coarse grained rock, sand, silt and clays. A number of tests were then conducted on the aggregate part of mine wastes and the physico-mechanical properties were obtained. According to the results obtained the mean values of uniaxial compressive strength (UCS) of concrete cubes after 28 days of curing was found to be of the order of 21.93 and 19.19MPa with mine aggregate and granite aggregate, respectively. Through toxicity leaching procedure tests the study also confirmed that the hydraulic binder arrests metal mobility from these wastes. This paper does not discuss the economic aspects as that was beyond the scope of the
research. However, to some extent socio-economic perspective of mine waste utilization has been presented and discussed.

From the particle size analysis it was found that grain sizes of 12.5–20mm are suitable for use in concrete, which means approximately 50–60% by volume of total waste is consumed. Fine aggregates between 12.5 and 4.75mm can be used as sand for various construction works. The finer particles below 4.75mm may be used for brick making. This is nearly 10–15% by volume. These mine wastes should be seen as resources, and may be useful as aggregates for road construction, building materials, and the fine clays may be used for brick making. From the results reported, it is evident that the aggregate component of mine waste conforms to the IS specifications for quality standards of aggregates. This technical evidence is very encouraging and further research into this important aspect of waste utilization is imperative. There is a need to establish the technical skills to commercialize the benefit from bringing a higher percentage of mine waste into standard construction processes. Further reduction of 50–60% by volume of waste may result in high returns. Also, this will open up many downstream economic activities and thereby enhance the employability of rural communities.

Q. Study of the Possibilities of Using Red Mud as an Additive in Concrete and Grout Mortar

This study is done by Luping Tang, Chalmers University of Technology in 2014. This report presents the results from a study of the possibilities of using red mud, a waste product derived from the digestion of bauxite with a versatile mineralogical composition, as additive in concrete, grout mortar and cement paste. Two types of red mud from China were used in the experiments. Concrete in which 0–30% of the mass of the binder was replaced by red mud were cast for investigating the effect of red mud addition on the compressive strength and dry shrinkage of concrete. Grout mortars in which 0–30% of the mass of the binder was replaced by red mud were cast for investigating the effect of red mud addition on the flexural and compressive strengths, dry shrinkage and water permeability of mortar. Cement paste in which 0–30% of the mass of the binder was replaced by red mud were cast for investigating the effect of red mud addition on the capacity of Cs adsorption and ionic leaching. The results show that addition of red mud does not contribute to nor impair the strength of the concrete or grout mortar but instead acts as inert filler. The decrease in compressive strength of concrete with addition of red mud is mainly due to the increased water-cement ratio. There is no significant increase in dry shrinkage of concrete with addition of red mud, but there is a certain increase in dry shrinkage of grout mortar, especially when more than 20% of the binder is replaced by red mud. Addition of red mud in grout mortar significantly increases the water permeability of the mortar due to the increased water-cement ratio. Owing to the fluctuant results from the adsorption test, it is difficult to draw a conclusion of the adsorption capacity for Cs by addition of red mud in concrete. However, the preliminary results from a quick adsorption test indicated a good adsorption behavior of cement with the addition of red mud, especially at a low initial Cs concentration.

This study reports on how the material properties are influenced by the addition of red mud to concrete, grout mortar and cement paste. It has been shown that:

Red mud does not contribute to nor impair the strength of the concrete or grout mortar but instead acts as inert filler. The decrease in compressive strength of concrete with addition of red mud is mainly due to the increased water-cement ratio.

There is no significant increase in dry shrinkage of concrete with addition of red mud, but there is a certain increase in dry shrinkage of grout mortar, especially when more than 20% of the binder is replaced by red mud.

Addition of red mud in grout mortar significantly increases the water permeability of the mortar. This can also be explained by the increased water-cement ratio in the material, which led to the formation of more and larger capillary pores for water permeation.

No clear trend of Cs adsorption is found from the adsorption test carried out in Chinese universities, probably due to the uncertainty of Cs-analysis used in this study and also due to the relatively high alkalinity in the pore solution.

The Cs-adsorption at lower initial concentrations increases with the addition of red mud from the quick adsorption test carried out at Chalmers University of Technology, indicating a promising use of red mud in concrete for increasing immobilization of radio nuclides. Based on these results the following conclusions can be made:

Red mud is not chemically active in the hydration process and the decrease in compressive strength of concrete with the addition of red mud is mainly due to the increased water-cement ratio.

The increase in water permeability can be explained by that the water-cement ratio is increased when a portion of the cement is replaced by the inert red mud. Owing to the fluctuant results from the adsorption test, it is difficult to draw a conclusion of the adsorption capacity for Cs by addition of red mud in concrete. However, the preliminary results from a quick adsorption test indicated a good adsorption behavior of cement with the addition of red mud, especially at a low initial Cs concentration. Because the adsorption behavior of red mud is strongly dependent on the alkalinity (Apak et al. 1995), in the future work the addition of red mud in concrete and grout with low alkalinity should be investigated. It may include:

Addition of red mud in the concrete with high silica fume content. The alkali in the red mud can in the short term accelerate the hydration of silica fume and in the long term leach out to give more adsorption sites for radio nuclides.

Development of low alkali binders using e.g. slag is activated with near neutral salts as immobilization binders for radio nuclides.

Adsorption test on the aged specimens with addition of red mud.

As a summary, red mud can be used in concrete and grout at least as a part of fine aggregate. The preliminary results show that its good adsorption behavior can potentially be utilized for immobilization of radio nuclides in the nuclear wastes.
R. Mechanical Properties of Iron Ore Tailing Filled Polypropylene Composites

This experimental study done by Segun Mathew Adedayo1, Modupe Adeoye Onitiri department of Mechanical Engineering, University of Ilorin, Ilorin, Nigeria in 2012 on Iron ore tailings filled polypropylene (PP) composites were produced using the compo-indirect squeeze casting (C-ISC) process. Particle sizes 150, 212 and 300 μm were considered for different volume fractions of 5% to 30% at intervals of 5%. The tensile and impact behavior of the produced composites were investigated, experimentally, by carrying out uniaxial tensile and izod impact tests to obtain tensile strength, elongation at break, modulus of elasticity and impact strength. Empirical data were compared with results obtained from models proposed by Nielsen, Bigg and Einstein. The experimental results show that elongation at break for iron ore tailings filled PP reduces with increasing 150 μm particle sizes. Tensile strength reduces with increasing filler. The Bigg equation exhibited improved predictability with decreasing particle size of filler in PP while the Einstein equation which assumes poor adhesion gives the best prediction of modulus of elasticity with increasing particle size in PP. Izod impact strength decreases with particle size but increases with increasing volume content of iron ore tailings from 5% to 25% for each particle size considered.

Nielsen’s model shows better predictive capability with the smallest particle size and decreasing volume ratio for ITR-PP. The predictability of the Nielsen’s model can be enhanced by addition of binding agents to improve interfacial adhesion. The Bigg equation shows improved predictability with decreasing particle size of filler in PP while the Einstein equation which assumes poor adhesion gives the best prediction of modulus of elasticity with increasing particle size in PP. The least volume content of iron ore tailings that can be predicted by the Einstein equation which assumes perfect adhesion is 5%. Izod impact strength increased with increasing volume of 150 μm iron ore tailings except at 10% volume content of iron ore tailings.

III. OBJECTIVE OF STUDY

The objective of the study was:
1) To find the strength properties of concrete for 7, 28 days.
2) Partial replacement of cementitious material with red mud.
3) Partial replacement of iron ore slickens with the conventional sand.

IV. MATERIAL

- Cement
- Aggregates
- Red Mud
- Iron Ore Slickens

V. METHOD

<table>
<thead>
<tr>
<th>Mix Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC</td>
<td>without red mad and iron ore slickens</td>
</tr>
<tr>
<td>1RM10IOS</td>
<td>1% red mad + 10% iron ore slickens</td>
</tr>
</tbody>
</table>

Table 1: concrete mix designation

<table>
<thead>
<tr>
<th>Water</th>
<th>Cement</th>
<th>Fine aggregate</th>
<th>Nominal coarse aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>191.6</td>
<td>446 Kg</td>
<td>500 Kg</td>
<td>1300 Kg</td>
</tr>
<tr>
<td>0.43</td>
<td>1</td>
<td>1.1211</td>
<td>2.920</td>
</tr>
</tbody>
</table>

Table 2: Nominal Concrete Mix Proportions

VI. OBSERVATION

All the concrete mixtures were made up with the controlled mix as well as with RM and IOS to check the compressive strength at 7 and 28 days after curing. Every mix which had been replaced with RM and IOS has achieved higher strengths as compared to the normal concrete mix. At 28-days, the control normal concrete mixture (0% RM, 0% IOS) achieved a compressive strength of 39.4 MPa. The mix with 2% RM along with 30% IOS achieved the highest strengths. The mixes which had 2% Red mud had relatively more strengths as compared to other mixtures at 28 days.
VII. CONCLUSION
In India, HINDALCO’S aluminum refinery in Renukoot, Uttar Pradesh generates a voluminous quantity of industrial waste in the form of Red Mud, approximately 400,000 tonnes per annum. This is largely dumped at sites, which are known as red mud ponds. The volume of waste generated is large and its alkalinity has the potential to pollute valuable surface and groundwater resources.

1) The compressive strength achieved for all the mix is more than the control mix.

2) So this mix (Red Mud + IOS) should be used for the construction activity it will reduce the problem of environmental pollution as well as it will decrease the cost of the construction and add it makes the high performance concrete from the durability point of view.

3) It has been observed that the compressive strength of concrete produced with the combination of RM & IOS goes on increasing. But The maximum compressive strength and split tensile strength was achieved at 2% RM with 30% IOS.

4) The compressive strength of concrete increases with the addition of Red Mud up to 2% & iron ore slickens 30% then reduces and but higher than normal concrete mix.

5) The optimum strength for each test was achieved at 2% RM for every IOS replacement level.

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