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INVESTIGATION OF IRON ORE TAILINGS IN PRODUCTION OF MASONRY BLOCKS

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ABSTRACT : THIS PAPER AIMS TO DEAL WITH UTILIZATION OFWASTE IRON TAILINGS IN BUILDING BLOCKS. THE EXPLOITATION OF MINERAL RESOURCES SUCH AS IRON ORE WOULD PROMOTE THE DEVELOPMENT OF ECONOMY AND SOCIETY, BUT IT GENERATES MASSIVE OVERBURDEN IN THE FORM OF IRON ORE TAILINGS, THAT MAY POLLUTE THE ENVIRONMENT. THEREFORE, COMPREHENSIVE UTILIZATION OF WASTE IRON TAILINGS IS IMPORTANT IN SAVING RESOURCES, IMPROVING SURROUNDINGS AND FOR SUSTAINABLE DEVELOPMENT. MASONRY UNITS MADE OF IRON ORE TAILINGS ARE WIDELY ACCEPTED AS ENERGY EFFICIENT ALTERNATIVES TO BURNT CLAY BRICKS. IN THIS STUDY, ATTEMPTS WERE MADE TO INVESTIGATE THE SUITABILITY AND RELIABILITY OF IRON ORE TAILINGS IN MANUFACTURE OF BUILDING BLOCKS.

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IndexTerms – Iron tailings, compressive strength, Quarry Dust, Alternative Material.

I. INTRODUCTION

Masonry is widely used to construct both small andlarge structures because of its structural versatility and attractive appearance. Masonry is of considerable volume in most of the structures and masonry units are consumed in bulk quantities. Compressive strength of masonry greatly depends on strength of the masonry units. In order to cater to the different needs of construction, various masonry units have been developed and used.

Masonry is the building of structures from individualunits laid in and bound together by mortar; the term masonry can also refer to the units themselves. The common materials of masonry construction are brick, stone, marble, granite, limestone, concrete block. Masonry is generally a highly durable form of construction. However, the materials used, the quality of the mortar and workmanship, and the pattern in which the units are assembled can significantly affect the durability of the overall masonry construction.

India has large reserves of metal bearing ore and it occupies sixth position in the world with regard to iron ore reserves. Further, India is one of the important iron ore producers and exporter in the world. However, the rapid growth in production, especially from large surface mines, have already caused ecological imbalance in their respective regions and emerge as the source of main environmental hazards. The waste/tailings that are ultra-fines or slimes, having diameter less than 150µm, are not useful and hence are discarded. In India approximately 1500 to 2000 million tons of such mined ore is lost as tailings. The safe disposal or utilization of such vast mineral wealth in the formultra-fines or slimes has remained a major unsolved and challenging task for the Indian iron ore industry.This work has been done to exploit the waste of industry mainly iron ore tailing and been used in concrete for their improvement in strength.

II. LITERATURE REVIEW

Need for Alternative Building Materials:

By using the Alternative materials instead ofconventional materials, we would not only be preserving the natural precious resources, but also solving the problems of disposal of waste generated from various industries, which has become a national problem. Since the need for alternative building materials is growing at an alarming rate, in order to meet the demand for new buildings, new ways and techniques must be evolved.

Manufacturing of building materials like brick, cement, steel, aggregates etc. which are consumed inbulk quantities, puts great pressure on natural resources and are highly energy demanding.

Therefore, the use of alternative materials for construction should be encouraged.

* High amount of decreasing building materials suchas sand, aggregate, top soil for brick, timber.
* Consumption of large amount of energy in building materials.Utilization of waste or recycled materials for environmental or health issues. The materials are Iron ore tailings, fly ash, agriculture waste, quarry dust, debris etc.
* High cost of building materials and greater the distance of transportation.
* Environmental friendly and cost effective construction purpose.

Energy in Building Materials and Building

Modern buildings have to achieve certain performance requirements in terms of safety, comfort and economy. These conditions demandconstruction activities that uses energy in one formor the other. Prior to Industrial Revolution, thesource of energy was man power and animal orbiomass energy. However, after industrial revolution, humans are depending on fossil fuel asmajor source of energy. Modern construction usessignificant amount of energy. The different categories of energy consumption in a Building are:

a) Embodied energy in building materials.
b) Energy consumed during building construction.
c) Energy utilized for maintenance during the lifespan of a building.
d) Energy spent in demolition of the building at theend of its life.

III. EXPERIMENTAL INVESTIGATION

MATERIALS: The properties of various materials used in making the concrete (M20) are discussed in the following sections:

i). Cement: Cement used was ordinary Portland cement of Grade 43 meeting the requirement of Indian Standard (IS 8112-1989). Ordinary Portlandcement of 43 Grade was used in the concrete mixture, which was stored in a cool dry place duringthe course of the experimentation. It should be free from lumps and fresh. Specific gravity of cement was 3.25.

ii). Iron Ore Tailings: We have used Kudremukh iron ore which has stored iron ore tailings to the tune of 150million tons in Bhadra dam. The waste/tailingsthat are ultra-fines or slimes, having diameter less than 150 µm, are not useful and hence are discarded.The safe disposal or utilization of such vast mineral wealth in the form ultra-fines or slimes has remaineda major unsolved and challenging task for the Indianiron ore industry. In future, the proportion of iron ore wastes generated is likely to increase due to higher demand for iron ore as a number of steel plants have been planned for future in many parts of the country.

iii).Quarry Dust: Quarry dust is one of the frequently criticized nuisances due to its health and environmental implications on surrounding community. It constitutes about 25% of the output ofeach crusher unit. Quarry dust consists mainly of excess fines generated from crushing, washing and screening operations at quarries.

The quarry dust, the by-product, was never used in India instead of river sand earlier because of the different quality. It has no uniformity and similarity to river sand. Although now it is used for manufacture of cement bricks the industry people are afraid to use it for concrete or such strong constructions due to the higher percentages of minerals other than quartz. Therefore, detailed studies on various quarry dusts are needed to find out their suitability. Properties of quarry dust mainly depend on the properties of the parent rock. As far as quarry dust quality is concerned, the most important property is the mineralogical composition. However, the weathered rocks of these rocks are not used for concrete or cement mixed constructions.

iv). Aggregates : Aggregate is the term used to describe the material used in concrete and masonry blocks other than paste, which is bonded to each other by the paste medium. 10 to 12mm down sized stones are one of the basic material for making building blocks. The coarse aggregate must be free from dust, deleterious materials and soft particles

.The coarse aggregate must be well graded. Aggregate should not contain oversize of flaky materials. Shall be angular, hard and of required grade size and shall be blackish or grey in colour.

v). Water: The water used was clean and free from deleterious matter. pH value should be well within 5.5 to 8.3 and Normal turbidity limit is 2000-2500

IV. RESULTS

SPECIFIC GRAVITY:

A. Cement: 3.15
B. Iron Ore Tailings: 2.88
C. Quarry Dust: 2.50
D. Aggregates: 2.456

WATER ABSORPTION:

Aggregates: 0.75%

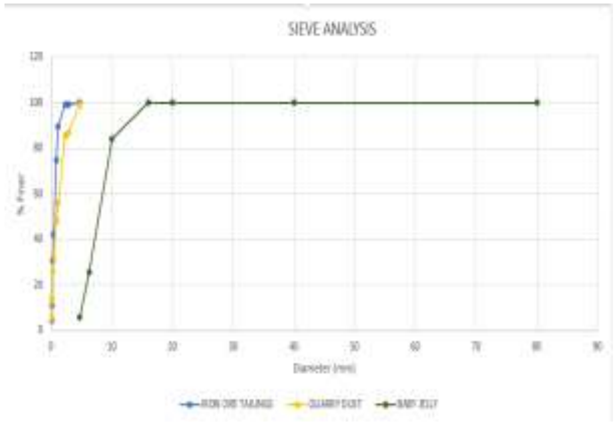
FINENESS MODULUS:

i). Iron Ore Tailings: 6.18

ii). Quarry Dust: 10.4

iii). Aggregate: 1.46

SIEVE ANALYSIS:



Proportioning: Two combinations of mixes were used, such as reference mix, modified mix withtailings. The aggregate makes 75% of the body of concrete and its influence is extremely important. Aggregate is classified as coarser and fine based on its size. The size of aggregate bigger than 4.75 mm is considered as coarse aggregate and the quarry (jelly) dust and iron ore tailings were used as fine aggregates and 6 to 8 mm down jelly (also called baby jelly) was used as coarse aggregates.. The proportion of the mix is by weight. However, water was added to maintain the required consistency

Table 1: Constituents used for different types ofmixes

Type Of Mix	Proportion By Weight			
Reference mix	1	2		4
	Cement	Jelly dust		Baby jelly
Modified mix with tailings	1	1	1	4
	Cement	Jelly dust	Iron ore tailings	Baby jelly

Mixes: Three mixes with different ratio of constituents were prepared from each type of mixtures (i.e. reference mix and modified mix with tailings). Six samples were prepared from each mix ratio. Table5 gives the ratio of composition for different types of mixes. Total 36 samples were prepared, out of which 18 samples were cured for 7days (taking 3 samples from each mix type) and remaining 18 samples were cured for 28 days.

Table 2: Ratio of composition for different types ofmixes

Reference mix		Modified mix with tailings	
Mix code	Ratio	Mix code	Ratio
1(RM)	1:1.5:3	1(TM)	1 : 0.75:0.75:3
2(RM)	1:2:4	2(TM)	1:1:1:4
3(RM)	1:3:6	3(TM)	1:1.5:1.5:6

The mixture is prepared as per weight batching and it is dried properly under sunlight. The ingredients were mixed in a mixer by adding proper quantity of water and immediately used for moulding using high density concrete building block making machine.

Casting: The blocks are produced on a smooth, level and hard surface of 30 mm. thick 1:3:6 cement concrete platform simultaneously finished smooth with 1:3 mortar. A base of brick soling of 12cm thicklean concrete 1:8:16 may be used as a sub grade. The platform shall be cast in bays of $2m^2$ to avoid random surface cracks. A casting platform of about $80m^2$ (10x8m preferably is required for production of 500blocks a day).Block Size: 400mmx200mmx150mm.

Curing: The test specimen is stored in place free from vibration. Blocks are stored at temperaturewithin the range of 22ºC to 32ºC .They should be marked for later identification for testing for 7 and 28 days. The clear water of temperature 24ºC to 30ºC should be used.

The blocks are covered with wet gunny bags for 28 days and water spraying on the blocks should be twotimes in the day. The blocks are kept in wet and not to be allowed to become dry at any time until they have been tested

Compression Test: Compression test of masonry blocks plays an important role in controlling and confirming the quality of building blocks. Compression test is most common test conducted onhardened concrete and also building blocks, partly because it is an easy test to perform, and partlybecause most of the desire characteristic properties of block are quantitatively relative to its compressionstrength.

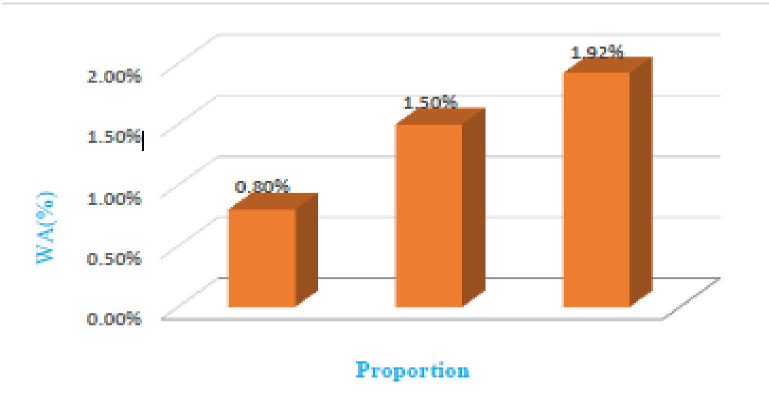
Three specimens (blocks) from each type of mix proportions, cured for 7 days and 28 days, the compression test is carried out on specimen cubical,cylindrical in shape and prism shape. The blockspecimen is of the size 200X150X400mm

Water Absorption Test: The absorption of block isnot directly related to the porosity. Some of the absorption maybe through the pores. Which permit air to escape in absorption tests but others are cue- de-sac or even completely sealed and in accessible to water under ordinary conditions. For these reasons it is seldom possible to fill more than about 75% of the pores by simple immersion in cold water and boiling method is adopted for measuring complete absorption. In both cold water test and boiling watertest. The specimen is dried in a ventilated oven at 1100C to 1150C till it attains a substantially constantmass and calculated as per the standard formula.

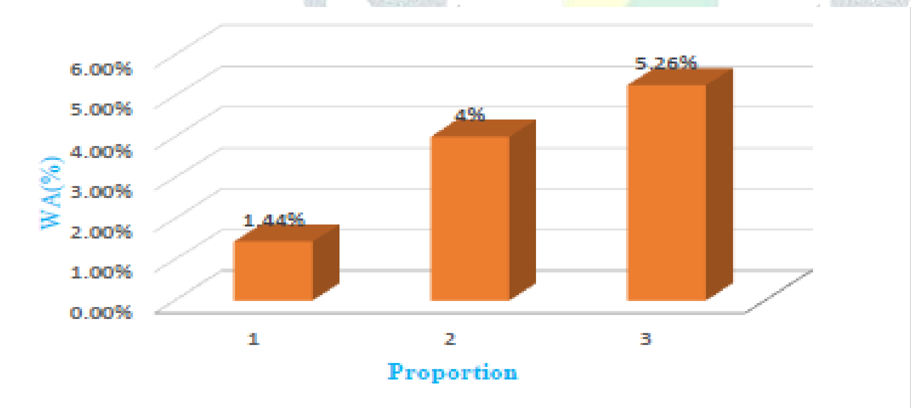
IV . RESULTS

i). WATER ABSORPTION:

Graph 1: Average Water Absorption of Reference Mixes



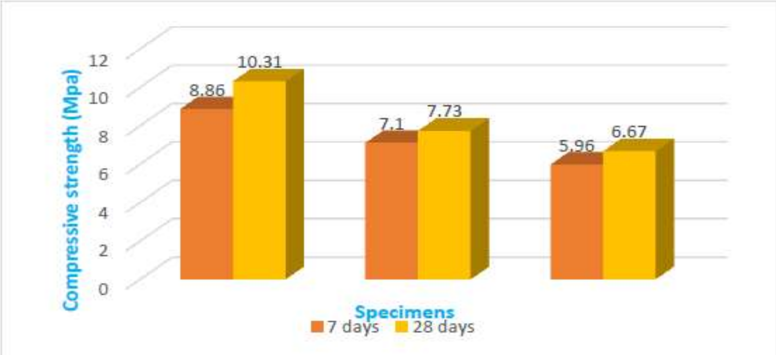
Graph 2: Average Water Absorption of Modified Mix



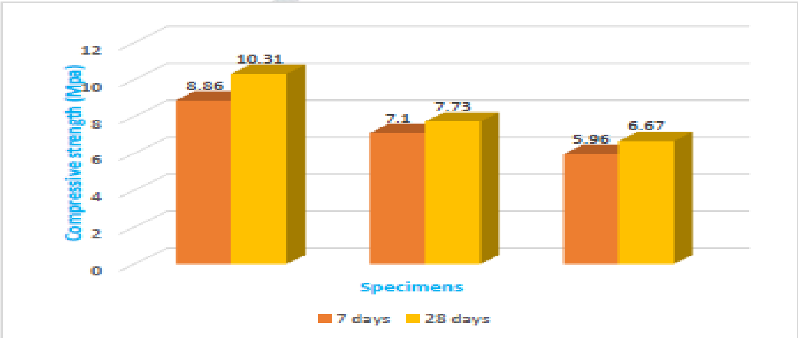
ii). COMPRESSIVE STRENGTH:

The compressive strength of reference mix was compared according to the leanness of the mix proportion and also with its respective modified tailings mix proportions.

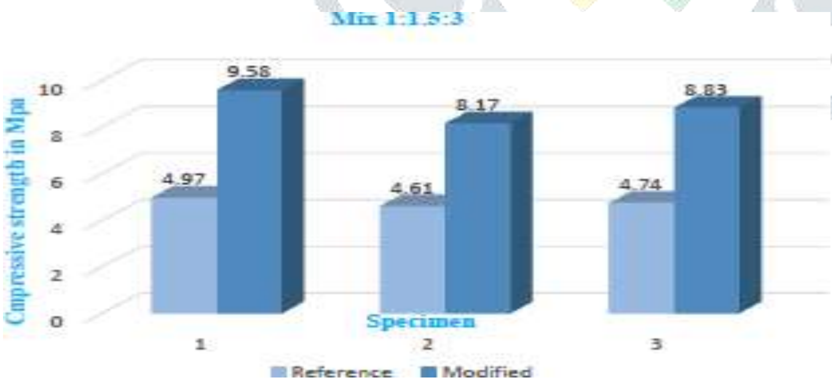
Graph 3: Comparison of compressive strengths ofreference mixes cured for 7 and 28 days.



Graph 4: Comparison of compressive strengths ofmodified mix with tailings cured for 7 and 28 days



Graph 5: Comparison of compressive strengths of reference mix (1:1.5:3) with respective modified mixiron ore tailings cured for 7days.

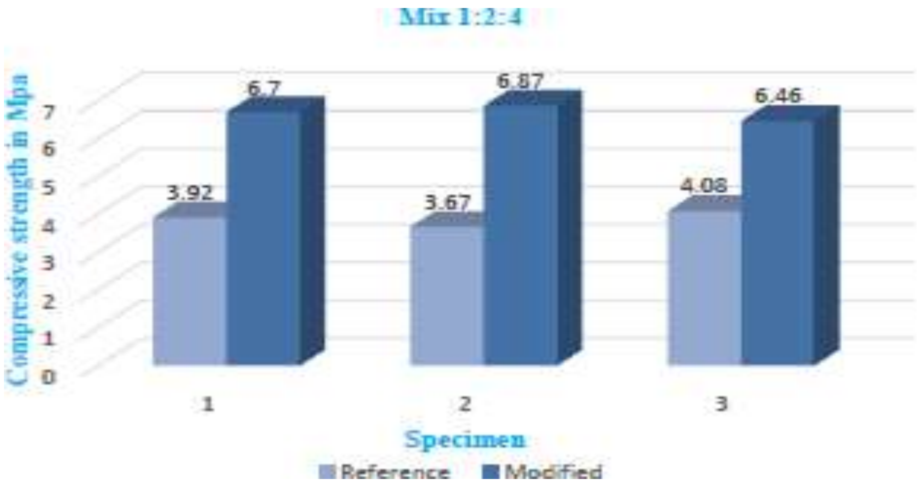


Graph 6: Comparison of compressive strengths of reference mix (1:2:4) with respective modified mix ironore tailings cured for 7days

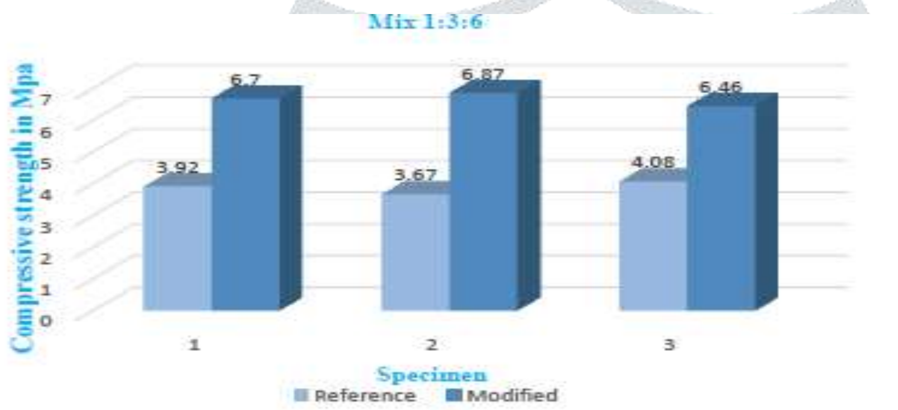
Graph 7: Comparison of compressive strengths of reference mix (1:3:6) with respective modified mix iron ore tailings cured for 7days.

Graph 8: Comparison of compressive strengths of reference mix (1:1.5:3) with respective modified mixiron ore tailings cured for 28 days.

Graph 9: Comparison of compressive strengths of reference mix (1:2:4) with respective modified mix ironore tailings cured for 28 days.



Graph 10: Comparison of compressive strengths of reference mix (1:3:6) with respective modified mix ironore tailings cured for 28 days



The total production of iron ore in India is expected to be 400 million tons within the next decade. The exploitation of mineral resources would promote thedevelopment of economy and society, but it will alsogenerate massive waste/tailings that may pollute the environment heavily and bring other issues such as land degradation, deforestation, acid mine drainage etc. Therefore comprehensive utilization of tailings is important in saving resources, improving surrounding and for sustainable development.

In the present study substitution of iron ore tailings and quarry dust shows better compressive strength without much change in water absorption. It is also revealed that the mix with tailings has the highest compressive strength for 28 days curing. By using these wastes instead of conventional materials, we would not only be preserving the natural precious resources, but also solving the problems of disposal of waste, which has become a national problem

V. CONCLUSIONS

Since the need for building materials is growing at an alarming rate, in order to meet the demand for new buildings, new ways and techniques must be evolved. Building blocks from mine waste are eco-friendly asit utilizes waste and reduces air, land and waterpollution. It is energy efficient and also cost effective.

Manufacturing of building materials like brick, cement, steel, aggregates etc. which are consumed in bulk quantities, puts great pressure on natural resources (rawmaterials) and are highly energy demanding. Manufacturing of building materials like brick, cement, steel, aggregates etc. which are consumed in bulk quantities, puts great pressure on natural resources and are highly energy demanding. Therefore, the use of alternative materials for brick construction should be encouraged. Mine wastes and tailings can be converted into bricks/paving blocks, which can meet the demand of bricks in metropolitancities for the next few decades. Also building blocksfrom mine waste also reduces air, land and water pollution.

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