Stabilized Iron-ore Tailings Blocks An- Environmental Friendly Construction Material

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ABSTRACT

The use of any industrial waste in the construction acts as an environmental friendly project. These industrial wastes always cause pollution and their disposal is a problem for the concerned authorities, because either they occupy lot of space for their storage or they pollute the media in which they are discharged. Iron-ore tailings, is a waste material obtained in the Iron mines, after the extraction of Iron concentrate from the ore. Some trace percentage of Iron will be left in the ore after the extraction process is completed. This, Iron-ore tailing is produced in large quantity in the Iron ore mines. Disposing of this Iron-ore tailing from the mines premises is a big head ache for the concerned authorities. In this experimental work an attempt has been made to study the suitability of iron ore tailings in the preparation of building blocks by stabilizing it through cement. Different percentages of cement are being used for the stabilization. Dry compressive strength, wet compressive strength, water absorption and erosion resistance were found out on the prepared specimens. The results show that the stabilized blocks of Iron ore tailing with 7% replacement of iron ore tailing by cement show the maximum compressive strength and with advantage in other properties.

Key Words
Iron ore tailings, Dry Compressive strength, Wet Compressive strength, Water absorption, Erosion resistance

1.0 INTRODUCTION

The use of stabilized mud blocks is an alternative to burnt bricks, where soils in being stabilized with the stabilizers like cement, lime, molasses etc., and pressing them under high compaction, hence avoid burning. In avoidance of process of burning, saves a lot of energy and hence it, becomes economical [2, 3 and 4].

The question of economy and conservation energy arises, when burnt bricks are invariably used. The alternative, effective remedy is the use of STABILIZED BLOCKS. Soil stabilization techniques have been used for improving the properties of soil viz., compressive strength, Erosion resistance, absorption etc. The stabilizers used are cementitious admixtures like cement, lime…etc. The process of compaction can further improve the properties of stabilized soil. The process of compaction leads to higher densities, there by higher compressive strength, better erosion resistance, lesser water absorption and permeability.

The stabilized mud blocks can be used for wall construction, as an alternative to conventional walls [2, 3 and 4].

The main aim of this experimental work was to make an attempt to utilize the Iron-ore tailings for preparing and testing the blocks where Iron-ore tailings being utilized instead of soil and stabilized with various percentages of cement. ITGE-VOTH machine (Block making machine using man power) was used for preparing stabilized mud blocks of standard size.

The above approach not only offers significant saving in fuel, energy consumption and conversion of materials, but also involves lower capital investment per ton of cement and provides solution to ecological problems created by disposal of waste [2, 3 and 4].

The stabilized Iron-ore tailing blocks can serve the better purpose of re-placing burnt bricks and building blocks upto some extent in around Chitradurga district, Karnataka.

Thus, the advantages of using the industrial wastes in the construction can be listed as below.

1. Use of industrial wastes in construction reduces the environmental pollution.
2. Use of industrial wastes in construction will save the natural resources.
3. Use of some industrial wastes in construction may even improve the performance of the material.
4. Use of industrial wastes in construction solves the problem of dumping area.
5. Some time saving in energy and saving in cost can also be achieved by the use of industrial wastes, thus achieving economy.

Iron-ore tailings are waste material obtained in the Iron mines, after the extraction of Iron from the ore. Iron tailings are red colored waste material. The Iron tailings are alkaline in nature with a pH value of 7.0 - 8.5, which is unfit for farming and make the land barren.

2.0 EXPERIMENTAL WORK

The main aim of this experimentation work was to stabilize the Iron-ore tailings by using cement and preparing the building blocks for construction purpose. A different percentage of cement was used for the stabilization of Iron-ore tailings.

2.1 MATERIALS USED

Cement: The cement used in the experimentation was ordinary Portland cement-53 grade, which satisfies the requirements of IS: 12269-1987 specifications. The physical properties of tested cement are given in Table No.2.1.1

Iron-ore tailings: The tests were conducted on the Iron-ore tailings obtained from the Iron Bhimasamudra mines; place which is situated at a distance of 25 to 30 Kms from Chitradurga, Karnataka. The properties of Iron-ore tailings are given in Table No.2.1.2 and Table No.2.1.3

Water: Ordinary potable water (pH = 7.60) free from organic content, turbidity and salts was used, for mixing and curing throughout the investigation.

Table 2.1.1: Physical properties ordinary Portland cement-53 grade (IS: 12269-1987)

Properties	Results	Permissible limit as per IS: 12269-1987
Fineness	30.3 m^2/N	Should not be more than 22.5 m^2/N
Normal consistency	33%	-
Specific gravity	3.09	-
Setting Time a. Initial b. Final	 40 Min. 190 Min.	 Should not be less than 30 Min Should not be more than 600 Min
Soundness test a. Le-chat expansion b. Auto clave%	 2 0.09	 10mm maximum 0.8% maximum
Compressive strength of mortar cubes for a. 3days. b. 7days. c. 28 days	 35.5 N/mm^2 47.0 N/mm^2 55.6 N/mm^2	 Should not be less than 27 N/mm^2 Should not be less than 37 N/mm^2 Should not be less than 53 N/mm^2

Table 2.1.2: Physical properties of Iron-ore tailings

Properties	Test results
Specific gravity	3.49
Sand content	50.00%
Silt content	23.75%
Clay and Gravel Content	26.25%
Moisture Content	3.6%
PH	7.0-8.5
Maximum dry density	2.13 g/cc
Optimum moisture content	10.00%

Table 2.1.3: Chemical Composition of Iron-Ore Tailings

Constituents	Percentage
Fe	26.8 - 61.2
Sio_2	2.30 - 51.2
Alo_3	1.82 - 9.88
Mno	0.03 - 0.12
Cao	0.09 - 0.14
Mgo	0.04 - 0.07
LOI	2.34 -7.40

2.2 EXPERIMENTAL PROCEDURE

The Iron-ore tailings were stabilized by replacing tailings by the cement in different percentages like 4%, 5%, 6% and 7%, with such stabilized Iron-ore ore tailings, the blocks of size 229mm x 178mm x 102mm were prepared by using ITGE-VOTH machine wherein a pressure of 1.8 N/mm^2 was applied. The prepared Iron-ore tailing blocks were cured by spraying water thrice a day, for 7, 14 and 21 days. After curing the blocks were tested for dry compressive strength, wet compressive strength, water absorption, erosion resistance.

The erosion test was conducted in the following manner.
The test involves using a normal shower rose of 90mm dia, with water flowing at a pressure of 1 KSC (1 N/mm^2). The spray jet, which is horizontal, is then allowed to impinge on the surface of a pressed block. The shower rose has 226holes of an average dia of 1.15mm, with a density of 3.2 holes/ Sq. cm. It can be seen that the flow rate are such that the amount of water flowing in one minute is equal to a precipitation of 566mm.This means that a majority of blocks would be completely eroded by, the spray in less than 2 hours.
The erosion of the blocks may be expressed in mm after drying, by visual observation. Also, Erosion Ratio, ER = d / 566 t
Where, d = Average depth of erosion in mm
t = test duration in minutes (5 minutes)

3.0 EXPERIMENTAL RESULTS

The test results of stabilized blocks of Iron-ore tailings by replacing the tailings by 4%, 5%, 6% and 7% of cement are given in Table No.3.0.1
The percentage economies of Iron-ore tailing stabilized cement blocks with concrete solid blocks are given in Table No.3.0.2

Table 3.0.1: Test results of stabilized Iron-Ore ore tailings blocks with different percentage addition of cement

Percentage addition of cement	Dry compressive strength N/mm^2			Wet compressive strength N/mm^2			Water absorption percentage			Erosion ratio (ERx10^{-4}) mm		
	Curing period in days			Curing period in days			Curing period in days			Curing period in days		
	7	14	21	7	14	21	7	14	21	7	14	21
96IT4C	4.57	5.06	5.55	4.00	4.25	4.66	5.46	3.20	1.90	0.000350	0.000265	0.00017
95IT5C	4.90	6.54	6.70	4.08	5.23	5.31	4.70	2.65	1.80	0.000265	0.000170	0.00017
94IT6C	5.39	7.11	7.27	4.57	5.64	5.88	4.25	2.26	1.73	0.000170	0.000088	0.00000
93TT7C	5.80	7.93	8.50	5.31	6.13	7.52	3.78	1.98	1.35	0.000880	0.000000	0.00000

4.0 OBSERVATIONS AND DISCUSSIONS

Based on the experimental results the following observations were made

1. In the developing countries like India, the increase in population has created problems for shelter. As the cost of the building materials such as cement, brick, tiles etc are very high, and it is beyond the reach of the common man for construction of shelter.
2. The above problem can be solved up to some extent by the utilization of waste material like Iron-ore tailings, in the form of STABILIZED–IRON ORE TALINGS BLOCKS, an alternative to burnt bricks in and around Chitradurga District.
3. The percentage economy determined can be considered seriously, since the masonry work costs above 28% of estimated cost of the construction.
4. As the stabilized Iron-ore tailings blocks posses sufficient erosion resistance, only pointing sufficient, there by economizing the construction cost by 10%, by avoiding the plastering. Also, there will be a saving of 10% of mortar consumption in masonry.

5.0 CONCLUSIONS

The following conclusions can be drawn from the results obtained from the experimental work carried out.

1. The stabilized blocks of Iron-ore tailings show an increasing trend in the erosion resistance with the increase in the curing period and stabilizer percentage.
2. The stabilized blocks of Iron-ore tailings show a decrease in absorption with the increased stabilizer percentage and curing period.
3. The ratio of wet to dry compressive strength lies between 0.50 and 0.73
4. The stabilized blocks of Iron-ore tailing with 7% replacement of tailings by cement shows maximum compressive strength (refer Table No.3.0.1). The increase in the strength as cement may act just as a filler material.

6.0 DURABILITY ASPECT

The Iron-ore tailing cement blocks are recommended for super structure. They are not recommended for sub structure, because the acids and alkalis present in the soil

may react with the manganese content of the block and they may affect the strength. However, when these come in contact with continuous moisture, the exposed surface of the block may become slightly soft. Applying waterproof compound can rectify this.

7.0 COST COMPARISON

Table 3.0.2: The Percentage economies of Iron-ore tailing cement blocks with concrete solid standard blocks.

Percentage economies of one Iron-ore tailing cement block having same size 375mm*200mm*200mm with 7% Iron ore tailing replaced by cement.	28%

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