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Pavement Stabilization Using Iron Ore Waste

Zahoor Ahmad Bhat[1], and Mr. Ashish Kumar[2]

[1]M.Tech Scholar, Department of Civil Engineering, RIMT University, Gobindgarh, Punjab, India
[2]Assistant Professor, Department of Civil Engineering, RIMT University Mandi Gobindgarh, Punjab, India

Correspondence should be addressed to Sunjay Raina; bhatzahoorahmad04@gmail.com

ABSTRACT- Pavement stabilization using iron ore waste is a technique for improving the strength and durability of road surfaces. The process involves mixing iron ore tailings, a waste byproduct of iron ore extraction, with traditional pavement materials such as asphalt or concrete. This creates a composite material that is stronger and more resistant to wear and tear compared to traditional pavements. The process of using iron ore waste in pavement stabilization has several benefits. Firstly, it helps to reduce the amount of waste that is generated from the mining industry, by repurposing it for road construction. Secondly, the use of iron ore tailings improves the overall quality of the road surface, making it more durable and long-lasting. This leads to a reduction in maintenance costs and an improvement in road safety. Finally, the use of iron ore waste in pavement stabilization can help to reduce the carbon footprint of road construction, as it reduces the need for virgin materials and reduces the amount of waste sent to landfill sites. Overall, pavement stabilization using iron ore waste is an effective and sustainable solution for road construction, offering a range of benefits to both the environment and road users.

KEYWORDS- Pavement, Stabilization, Pavement, Stabilization, Iron ore waste

I. INTRODUCTION

Concrete is a key and effective building material that has been used for years. The use and usage of the material is very prevalent in the construction industry, for example, as a pavement foundation. With technological advances and increased economic growth, the building sector has improved at a dizzying pace every day . The present demand for concrete requires a substantial production boom in building[1].Because of the amount of concrete needed, significant quant it ie s of high-quality raw materials were necessary to manufacture concrete. The primary components of concrete are usually natural resources like aggregates and sand, with the exception of cement. Human beings now use the second-largest amount of natural resources in the form of concrete, yet natural resources that create concrete are becoming less common as time goes on. It is crucial to find some alternative materials that may be used to make concrete that has the same characteristics as the standard product. Concrete is a substance that is complicated and multifaceted. The technocrat must now figure out the precise elements that satisfy this job. As technology develops, the utilisation of waste materials in the creation of concrete is one of the concepts being explored. [2]. Blast furnace slag is among the numerous types of waste materials. Blast furnace slags are a kind of industrial waste produced by smelting metal. Different kinds of slag were produced by the steel and iron industries. Iron manufacturing process produces blast furnace slag as a by-product.[5] The manufacture of large quantities of iron ore has created difficulties for the environment and disposal. Blast furnace slag use in civil engineering applications is far more efficient than regular materials when it comes to slag disposal, but it also offers a cost-effective alternative to traditional materials in road building. The reason for this is because it is essential to understand blast furnace slag and to establish their engineering characteristics in order to discover their potential uses in the building sector. The use of iron ore in the manufacture of concrete may be determined based on the programme of systematic experimental trials. By revealing fresh knowledge about the waste material's potential use in concrete manufacturing, the findings provide a foundation for technic al progress.[3]

The use of iron ore in the production of cement was recognized for decades in the cement industry. As a result of advances in flash utilization technology, the usage of iron ore in the cement industry has been significantly [8] reduced in recent years.A literature study showed that IRON ORE is often not included in the cement mix unless it is utilized as a partial substitute for cement powder. This was done in order to use complete replacement rather than only partial replacement. [9] Iron ore tailings (IOTs) are a form of solid waste produced during the beneficiation process of iron ore concentrate. Among all kinds of mining solid waste, IOTs are one of the most common solid wastes in the world due to their high output and low utilization ratio.[10]

II. METHODOLOGY OF MATERIAL

In the process of he researche that is in the process of IRON-ORE was collected from different source of steel processing units in and around Raj-kot city. Raw materials for concrete production i.e. ultra tech brand of cement, coarse aggregates of 20mm down size up to 4.75mm, fine aggregates (sand) ranging of size 4.36 to 15Dmicron, H2o and other material s were gained from locality portable H2o was used in the process for the formation & generation of concrete material during the whole process.[4] A well & fully foliated lab was utilized during this research work for the calculation from the engineering point of view of the IRON ORE, [12]as well as the chemical/physical tests for the aggregates present in the said material.by doing the various processes I,e practical works [6].Maximum number of the experiments/practical works were falling under the IS & the remaining solution practical were falling under the different Country Codes.[7].

III. ANALYSIS OF RESULTS

A. *Compressive Strength Test*

The cubes used in this test were cast, and their dimensions were 150 * 150 * 150 mm. First mold was constructed with a normal concrete mix using the M25 mix design. A second identical-sized cube was made with 0% ,10%,20%& 30% iron-ore waste. With the same mix proportion, the third cube included. While the final cube was made using a mix design with the equal amounts of 0% ,10%,20%& 30% iron-ore waste as shown in table 1 and fig 1 and 2.

Table 1: Compressive Strength Test Of iron ore waste concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix 0% with 0% iron ore mix	26.67	34.67
2	Mix 1 at 10% iron ore mix	24.32	38.20
3	Mix 2 at 20 % iron ore mix	26.67	36.44
4	Mix 3 at 30 iron ore mix	18.22	22.65

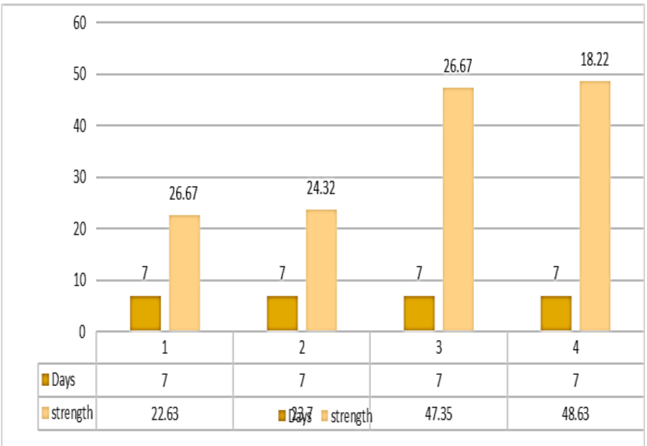

Figure 1: Compressive strength in 7 days

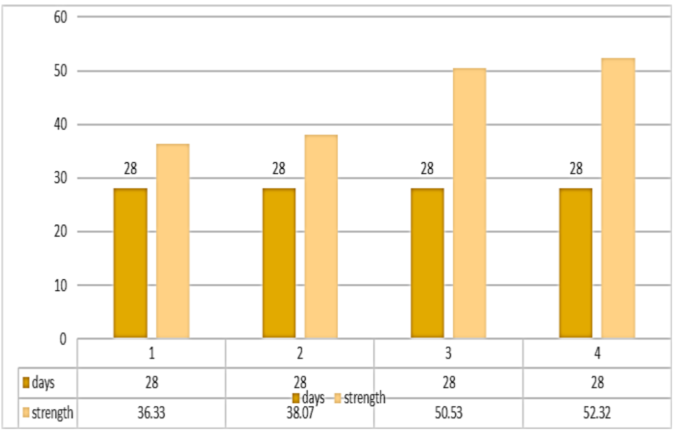

Figure 2: Compressive strength in 28 days

B. *Procedure for Compressive Strength Test*

- Remove the specimen from the 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.

C. *Flexural Strength Test*

Beam samples with dimensions of 100x100x500 mm were cast for the flexural strength test. These types of dynamic forces were tested under loading of four points according to the I.S. 516-1959, using a universal test machine. In this experiment the required mold tools are used in the distribution of the sample, the tampered rod for tamping purpose and the flexural test machine.The test sample was created by adding three layers of concrete to the mold that were almost the same size. First mold was constructed with a normal concrete mix using the M25 mix design. The same-sized second cube was made with 10%,20%,30% While the last cube was constructed with a composite design by combining iron-ore waste with the same percentages 10%,20%,30%. respectively shown in table no. 2 and figure no.3 and 4.

Table 2: Flexural strength test of iron-0re waste concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix	13.94	17.32
2	Mix 1 at 10% of iron ore waste	14.82	17.65
3	Mix 2 at 20% of iron ore waste	14.01	16.95
4	Mix 3 at 30% of iron ore waste	13.24	16.25

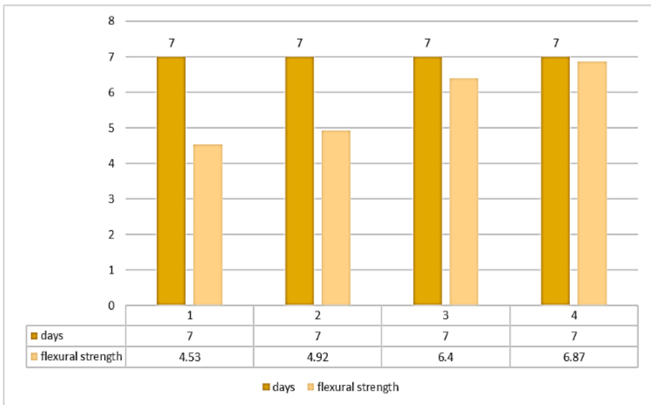

Figure 3: Flexural Strength test in 7 days

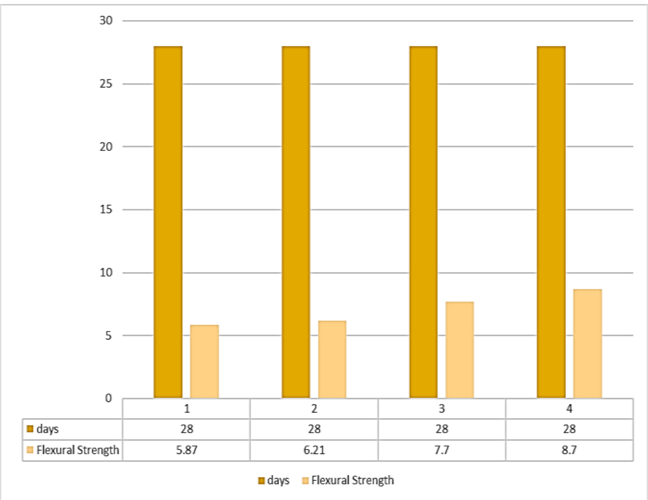

Figure 4: Flexural Strength in 28 days

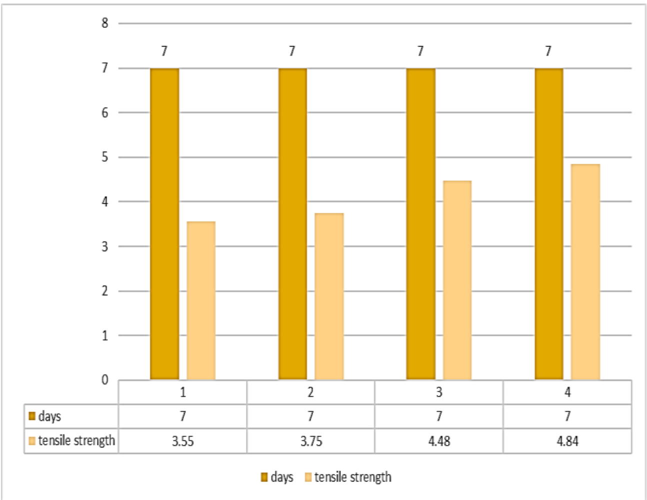

Figure 5: Split tensile strength in 7 days

D. Procedure of Flexural Test on Concrete

- The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline flexural strength.
- Place the specimen on the loading points. The hand finished surface of the specimen should not be in contact with loading points. This will ensure an acceptable contact between the specimen and loading points.
- Center the loading system in relation to the applied force.
- Bring the block applying force in contact with the specimen surface at the loading points.
- Applying loads between 2 to 6 percent of the computed ultimate load.

E. Split Tensile Strength Test

A cylinder that is 15 cm broad and 30 cm high will be used as the sample in this test. The employed metal mold has an inner diameter of 15 cm +/- 0.2 mm and a height of 30 cm +/- 0.1 cm. To stop the concrete from sticking to the molds, a small layer of mold oil was applied before usage. The 4 different concrete mixtures were all molded into 5 cm-thick layers. Each layer was manually put together. The outside concrete was levelled with the top of the mold using a trowel after packing the top layer, and it was then covered with aluminum foil to stop water leakage. Test samples were kept for 24 hours at a temperature of 27 ° +/- 2 ° C. Following this, the samples were removed from the mould and submerged for 28 days in pure, clean water. As shown in table number 3 and figure 5 & 6 respectively.

Table 3: Split tensile strength test of iron ore waste concrete

S. No.	Description	7 days Avg. (N/mm2)	28 days Avg. (N/mm2)
1	Normal Concrete Mix	4.15	4.5
2	Mix 1 at 10% of iron ore waste	2.92	4.96
3	Mix 2 at 20% of iron ore waste	3.98	4.75
4	Mix 3 at 20% of iron ore waste	4.50	5.7

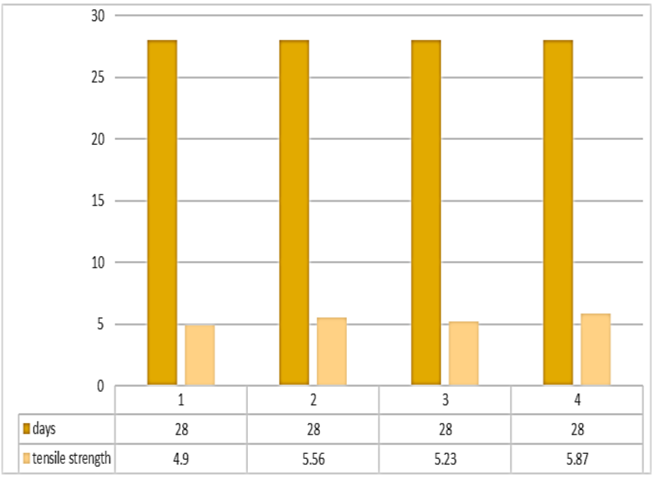

Figure 6: Split tensile strength in 28 days

F. Procedure for Tensile Strength Test

- Before starting the test for tensile strength, the specimen needs to be prepared in advance. The specimen can be cut using a Dumbbell cutter. Once the mold is whole, the sample will take on the shape of a slim dog bone or dumbbell.
- The tester needs to change the settings on the software before starting the test. This is because each test requires the correct settings according to the test standards. This setting also depends on the type of test to be performed and also depends on the type of material.
- To begin the tensile stress test, slowly separate the tensile clamps at a constant speed. Depending on the size and shape of the material. The tensile testing would often take five minutes or less for the material to fracture.
- After the fracture, unlatch the specimen piece from the tensile clamps. The tester should check the test record to ensure the results obtained are correct and accurate. In addition, the tester must ensure that the test equipment is in good condition after the test is completed. The test area needs in clean condition. Finally, organize your data and complete the test report.

IV. OBJECTIVES OF THE STUDY

Following are the objectives of this research work:

- Characterization of IRON ORE as fine aggregates (IRON ORE-FA) by determining its engineering properties by sampling from different dumping site
- Experimental assessment of the effect of IRON ORE-FA in the properties of fresh and harden pavement concrete
- Study the long-term behavior and durability aspect of pavement concrete with IRON ORE-FA
- Development of guidelines to utilize the IRON ORE-FA in pavement concrete.

V. CONCLUSION

Based on the research work carried out, the following conclusions can be drawn:

- All results obtained in terms of densities and compressive strengths for the control test reveals consistency, satisfying the standard requirements for grade 30 (G30) concrete as specified in BS 1881, 1978 method of testing concrete. Other results relating to percentage replacements of fine aggregate with the ore waste at 10%, 20%, 30% were also established at various curing ages. Studying these results, there are variations in the compressive strengths of all concrete cubes produced under these replacement conditions indicating an increase in strengths at 10% and 20% when compared with the control test results at 28days curing age. Generally, densities of concrete cubes remain consistent but increases slightly, notably at 10% and 20% of waste replacement, this increment is proportional to the curing ages. At 30% waste replacement, there was reduction in compressive strengths at 28days curing age and this reduction remains proportional as the percentage.
- The flexural strength of reinforced concrete beams is in no way impaired by replacement of sand by iron ore tailing. On the other hand, there is enhancement of flexural strength for all percentages of sand replacement. The increase in flexural strength is not very substantial. The mix with 10% 20% & 30% IOT performed better in terms of flexural strength with higher than the flexural strength of the control mixes respectively. It is feasible to produce cost effective concrete, possessing acceptable 7 days and 28 days strength by partial replacement of IOT.
- This study evaluated the possibility of completely replacing conventional aggregates in concrete with iron ore waste produced to attain the same or better outputs for technical specifications. In the study, both conventional and waste aggregates were used for comparison. Concrete mix design Based on the results from this study, The split tensile strength exhibited by the concrete with tailings aggregates at 28 days and this is slightly lower than concrete with conventional aggregates higher quantity of fines in the iron ore tailings as compared with the natural sand in the control mix. However, the tensile strength increased favorably with ageing and there was still 4.8% improvement on the tensile strength as compared with similar study reported earlier.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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