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IMPACT OF IRON DUST ON PROPERTIES OF CONCRETE

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Abstract:- The noteworthy use of any waste material depends upon it being economically competitive with the alternate natural material. Replacement of waste materials will protect diminishing of resources, and will circumvent the ecological and environmental damages produced by digging and exploiting of the raw materials for the production of cement. It will help to resolve the problem to some magnitude, otherwise experienced in dumping of wastes. The purpose of this paper is to discover the use of Iron Dust in concrete as a mineral admixture. In this laboratory study, Iron Dust was used as mineral admixture in concrete at 5%, 8%, 10%, 12% and 14% by weight of the cement content and a comparative study has been done between normal concrete and Iron dust concrete so as to explore and assess the possibility of using iron dust in concrete in terms of its strengthening properties.

Keywords: Iron dust; Concrete; compressive strength; flexural strength.

1. INTRODUCTION

Researchers and technologists are constantly on the lookout for materials which can be used as a replacement for conventional materials or which possess those properties which would qualify their use in designs and new innovations. Concrete containing substitute materials as components fall under the first group. The raw materials used for the production of cement and concrete are indispensably unlimited, since virtually almost all of the earth's crust can be exploited, if corresponding financial and energy requirements can be satisfied with. This course of action cannot be taken as there are other constraints that demand closer examination.

The successful exploitation of waste materials depends on its use being low-cost competitive with the conventional natural material. [1] These costs are essentially made up of managing, organizing and transportation. This form in which they are employed is broad and varied; they may be used as a as a partial replacement of conventional Portland cement; they may be used as a binder, as an admixture, or directly as aggregates in their natural or processed states. The stability and durability of concrete material products using waste materials over the expected life span is of utmost importance, particularly in relation to building and structural applications. Keeping all these considerations in mind and taking note of all required standard specifications, wherever possible this research aims at determining the use of IRON DUST in concrete as mineral admixture. The project will also examine ways to optimize the use of iron dust in concrete so that it will give maximum benefits to concrete.

Concept development of using Iron dust in Concrete:

The raw materials used for the manufacture of cement consist mainly of Lime, Silica, alumina and Iron Oxide.[2]

There is a wide variety of reinforcing mesh materials, ranging from chicken wire to welded steel mesh, expanded metal lath and punched or perforated sheets used in concrete. [3]

Ferrocement which consists of closely spaced wire meshes impregnated with rich cement mortar mix to produce a concrete that can undergo large strains. [4]

Water resistant floor finish is made by using iron fillings and iron chips mixed with the toppings. The rusting of iron fillings and chips increase in volume and thereby make the concrete dense giving the floor better wear resistance. [5]

Yu-Cheng et al observed that the compressive strength of heavy concrete increases with iron ore content, while the tensile strength declines. The concrete including 40% metallic aggregate content by volume performed higher compressive strength and fracture toughness. [6]
Cai et al. (2011) reported on tests where they used the fines from aggregate manufacturing as aggregate from mill tailings. They tested various concretes with mill tailing as fine aggregate, and additions of microfines from the manufacturing process. They worked with w/c ratios in the range of 0.37 to 0.43, and cement substitutions with fly ash and slag in the order of 35%. Their compressive strengths were in the 35 to 45 MPa range. They concluded that good concretes could be made with these material combinations. [7]
Yellishetty et al. (2008) reported the use of iron ore mineral waste of 12.5 and 20 mm size ranges as coarse aggregates in concrete. Their results indicate that the 28-day uniaxial compressive strength of concrete with iron-ore mineral waste as aggregates was 21.93 MPa while the equivalent compressive strength of concrete with conventional granite aggregates was 19.91 MPa. [8]
Negm and Abouzeid (2008) reported that coarse solid phosphate mill tailings could be used as coarse aggregates to prepare concrete with 240 kg/cm^2 to be used in construction of small buildings. [8]
Madany et al. (1991) reported the use of sand blasting grit waste (copper slag) as replacement of sand in the preparation of concrete blocks. The compressive strength of the concrete blocks with grit waste was 12 N/mm2 and higher than the Bahrain specification for precast concrete blocks. [8]

II. OBJECTIVES OF THIS RESEARCH

In this research work, Iron Dust has been used as mineral admixture in concrete at 5%, 8%, 10%, 12% and 14% by weight of the cement content and a comparative study has been done between normal concrete and Iron dust concrete so as:

- To explore and assess the possibility of using iron dust in concrete in terms of its strengthening properties.
- To compare the 7 days and 28 days compressive strengths of plain concrete and Iron dust concrete.
- To compare 7 days and 28 days flexural strengths of normal concrete and Iron dust concrete.

III. Iron Dust- (As Mineral Admixture)

Iron dust is an aggregate of iron particles of size approximately 20-200 µm. It is treated as a powder using the particle size distribution, apparent density etc. as indexes. Its properties differ depending on the production method and history. Commercial iron powders are classified in three types:

- Reduced Iron dust.
- Atomized Iron dust.
- Electrolytic Iron dust

Depending on production method and are used in various applications, taking advantage of their respective properties. Figure 1 shows the appearance of single particles of a representative reduced iron dust. Although there is little difference in the external appearance, the cross- sections differ greatly. Fig 1 shows the iron dust used in the project. Table 1 and Table 2 shows the chemical and physical properties of Iron dust.

Figure 1: Iron dust

Table:1. Chemical Composition of Iron dust:

Component	Percentage
Iron(Fe)	99 - 99.95

Table:2. Properties of Iron

Atomic Number	26
Atomic Weight(g/mol)	55.845
Apparel density(g/cm^3)	7.874
Electronegativity	1.83
Melting Point(^{o}C)	1538
Boiling Point(^{o}C)	2862
Magnetic Ordering	Ferromagnetic
Poisson Ratio	0.29
Young's Modulus(GPa)	211

IV. Observation and Analysis

Iron dust procured was sieved to remove any impurities. The specimens (cubes and beams) were tested for compressive and flexural tests. The tests were carried after curing period of 7 and 28 days with the help of UTM (Universal Testing Machine) and Compression Testing Machine (CTM).
Mix of concrete = (1 : 1.539 : 2.591) (Design Mix of M 20)
Water/ Cement Ratio = 0.45
Coarse aggregate = 20 mm maximum size
Fine aggregate sand = zone II
Size of specimen:
1. Cube : (150×150×150) mm
2. Beam : (500×100×100) mm

Tests Results on cement: Ordinary Portland Cement (OPC) 43 grade (Khyber Cement) has been used for this project. Various tests conducted on this cement are as under Table 3:

Table 3

Tests Results on Cement	**Value**
Fineness Value	0.553
Standard Consistency	30% by weight
Initial Setting time	2 hrs
Final setting time	5 hrs 10 min
Soundness test	1.67 mm expansion
Compressive Strength(28 days)	45.47 N/mm^2

Test results on Aggregates: Coarse aggregates of size 20 mm were produced from Ganderbal (Kashmir), India stone crusher. River sand was procured from Ganderbal. Test results are shown in Table 4. Sieve analysis graph of fine aggregates is shown in Fig 2.

Table 4

Tests on Aggregates	Value
Fineness Modulus of Course Aggregates	3.047
Grading zone of Sand	Zone -1

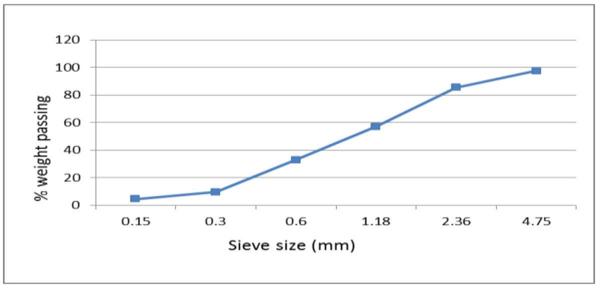

Fig.2: Sieve analysis graph obtained from fine aggregates.

Test results of Normal Concrete without any Iron dust (shown under Table 5)
Slump obtained = 25 mm
Compacting factor = 0.893

Table 5

Tests Results on Normal Concrete	Value(N/mm^2)
7 day Compressive Strength	17.57
28 day compressive strength	26.27
7 day flexural strength	4
28 days flexural strength	5.27

Test results of Normal Concrete with 5% Iron dust (shown under Table 6)
Slump obtained = 23 mm

Table 6

Tests Results on Concrete(5% iron dust)	Value(N/mm^2)
7 day Compressive Strength	19.70
28 day compressive strength	33.93
7 day flexural strength	5.15
28 days flexural strength	8.5

Test results of Normal Concrete with 8% Iron dust (shown under Table 7)
Slump obtained = 22 mm

Table 7

Tests Results on Concrete(8% iron dust)	Value(N/mm^2)
7 day Compressive Strength	23.11
28 day compressive strength	38.81
7 day flexural strength	6.58
28 days flexural strength	11.07

Test results of Normal Concrete with 10% Iron dust (shown under Table 8)
Slump obtained = 22 mm

Table 8

Tests Results on Concrete(10% iron dust)	**Value(N/mm^2)**
7 day Compressive Strength	25.18
28 day compressive strength	45.78
7 day flexural strength	7.40
28 days flexural strength	12.40

Test results of Normal Concrete with 12% Iron dust (shown under Table 9)
Slump obtained = 22 mm

Table 9

Tests Results on Concrete(12% iron dust)	**Value(N/mm^2)**
7 day Compressive Strength	20.44
28 day compressive strength	36.89
7 day flexural strength	6.27
28 days flexural strength	10.50

Test results of Normal Concrete with 14% Iron dust(shown under Table 10)
Slump obtained = 22 mm

Table 10

Tests Results on Concrete(14% iron dust)	**Value(N/mm^2)**
7 day Compressive Strength	20.44
28 day compressive strength	36.89
7 day flexural strength	6.27
28 days flexural strength	10.50

V. Comparison of result:

Fig 3 shows the comparison of results for 7 days of Normal concrete with varying percentages of Iron dust.

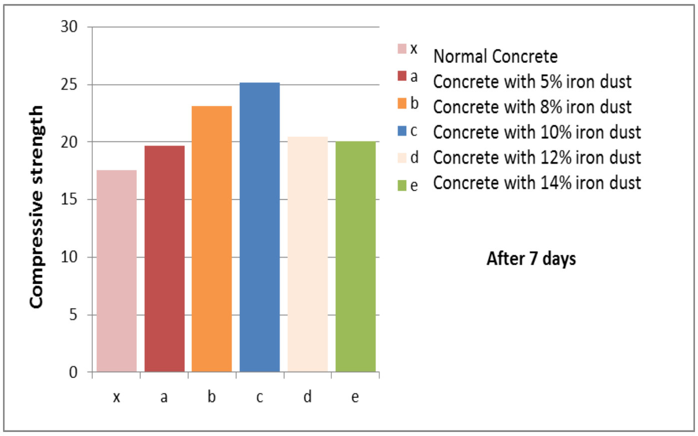

Fig.3: Comparison of Compressive strength comparison for 7 days

Fig 4 shows the comparison of results for 28 days of Normal concrete with varying percentages of Iron dust.

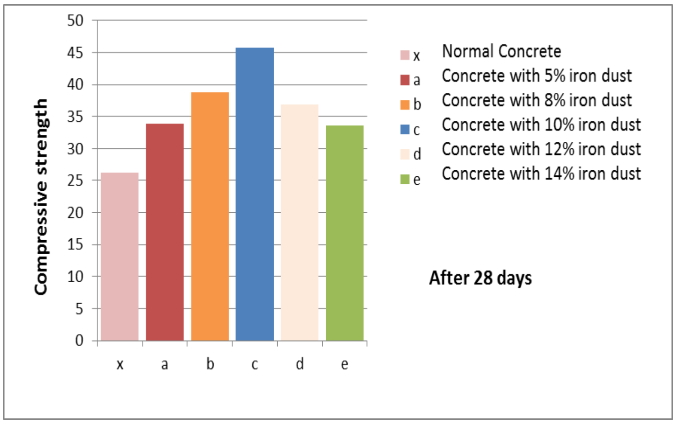

Fig.4: Comparison of Compressive strength comparison for 28 days

Fig 5 shows the comparison of results for 7 days and 28 days of Normal concrete with varying percentages of Iron dust.

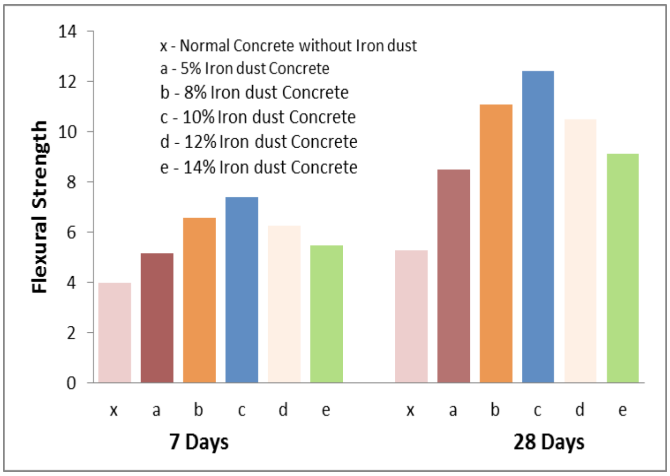

Fig.5: Comparison of Flexural Strength for 7 and 28 days

VI. Conclusions

After careful and elaborate study of the use of iron dust by different percentages of cement in concrete, it can be concluded that:

a) The addition of iron dust in concrete has resulted in general increase in 7 days compressive strength upto 10% of iron dust of the cement, also the long- term (28 days) compressive strength of Iron-Dust concrete is comparable to normal concrete.

b) 7 days flexural strength of Iron-Dust concrete has decreased after 10% of the iron dust of the weight of cement, same is the case with the 28 days flexural strength.

c) There is a progressive decrease in workability with increase in percentage of iron-dust in concrete.

d) Utilization of Iron-dust in concrete has provided us an excellent means of disposal of iron-dust.

VII. Acknowledgements

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