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Experimental Study on the Mechanical Properties of Concrete using Iron Waste as Partial Replacement of Fine Aggregate

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Abstract

Plenty of Iron waste is available from steel plant, Sohar and it will affect the environment when it is dumped in soil. Also, every year huge quantity of concrete is used for building construction in Oman. In this project work, iron waste was collected from Sohar steel plant and was mixed with concrete. The aim of this study is to determine the mechanical properties of concrete with iron waste to be compared with normal concrete. The percentages of iron waste can be added to concrete as 0%, 10%, 15% and 20% were based on literature review. For experimental work, cubes were casted with iron waste. Also, slump test was conducted to measure the workability of fresh concrete. Furthermore, density of concrete with and without iron waste was determined. Finally, compressive strength test of concrete cubes was done for C30 grade concrete. Test result shows that compressive strength is reducing by increasing iron waste percentage.

Keywords: Iron Waste; Slump Test; Density; Workability; Compressive Strength.

1. Introduction

The industrial sectors in Sultanate of Oman have been increased which was increased the destruction work and waste of Industry and concrete requirement is list. There are a lot of things as wastes in the word of industry site for example: iron waste, woods, blocks, concrete, aggregate, steel, aluminum etc. The steel materials like Iron the more waste percentage in the site of the construction that impose the engineering to find solution by study this case. There are many research works carried out to dispose all these hazardous wastes. The major sources of the waste irons are from the construction of buildings, industry wastes and manufactory of steel. In addition the manufacture of the steel or iron and the source of this waste come by the product of steel due to the particular of the iron are not meet the standard, therefor it was disposed as scrap or waste, because not possible to be fixed again.

The concrete always is the main element in construction activities and its expansive material, and instead of throwing the steel we can use the unwanted iron to mix with concrete same case to be reducing the costly of the concrete also to be recycle the iron waste to reduce the effect on our environment. Therefore, the quality of this mixture concrete is the most important, that is impose to studying evaluate of it as grade /type of iron waste which can be chose and the suitable amount of steel required to get good strength of concrete. Also the result should be environmentally friendly and economic. In this experiment, three numbers of cube (150×150×150 mm) were used and strength and workability and density to check absorption test. After 28 days compressive strength test was done. The aim of the present study is to study the Mechanical properties of high density concrete by adding iron waste using Iron waste as partial replacement of fine Aggregate.

The main objectives of this project are to, to calculate mix ratio of high density C30 grade concrete, to evaluate the compressive strength of concrete with iron and without waste, to conduct slump test to determine workability of concrete with iron and without iron waste, to conduct compressive strength test on concrete with and without iron waste and to compare the properties of concrete with and without waste iron.

There were many experiments and studies were conducted using iron waste in the concrete mixture to evaluate and study the properties of the concrete with iron waste.

Pacheco, F (2009) has studied compressive strength and durability properties of iron wastes based concrete. Sahil Goya Keshay et al (2015) have studied on the partial replacement of sand with iron ore tailing on compressive

strength of concrete. Gunalan. V (2016) has done a research work on studying performance on used of iron sand as concrete admixture. Harshavardhan, C. & Balamurugan, S (2016) have done experimental study on high density concrete reinforced with steel fiber at elevated temperature.

2. Materials and Methodology

2.1 Concrete Ingredients

Ordinary Portland cement (OPC) was used for the preparation of concrete cubes. Crushed rock with size less than 5 mm was used as Fine Aggregate (FA). Sieve analysis test was carried out to determine the fineness modules of fine aggregate. Coarse Aggregate (CA) with maximum size 20 mm was used for concrete. Water free from organic materials or acids, oils, alkalis, salts, sugar and or any other foreign matter was used for mixing. Figures 1, 2 and 3 show the cement, fine and coarse aggregate respectively. Based on sieve analysis results, fineness modulus of fine and coarse aggregate are 3.91 and 4.178 respectively.

Fig 1: Cement

Fig 2: Fine Aggregate

Fig 3: Coarse Aggregate

2.2 Iron Waste

Iron waste has been collected from the Sohar steel plant, Oman and added with concrete as partial replacement of fine aggregate. Figure 4 shows iron waste and sieved into the size less than 5 mm and mixed with concrete.

Fig 4: Iron Waste

2.3 Casting and curing

In total, 8 cubes were cast for the comparative study. Size of cubes were used for casting are 150 × 150 × 150 mm. Iron waste mixed with concrete in percentages, 10, 15 and 20%. All cubes were kept in water for curing.

2.4 Slump test

While casting slump test was carried out to check the workability. In the slump test that used the different concrete mixed in four type. The table and graph depict the test results. Figure 5 shows the conduction of slump test. Table 1 shows the slump test results.

Table 1. Slump Test results			
Sl. No.	**Iron Waste %**	**Slump value in mm**	**Type of slump**
1	0	10	True
2	10	0	True
3	15	9	True
4	20	28	Shear

Fig 5: Slump Test

Figure 6 shows the slump values for all the four mixes

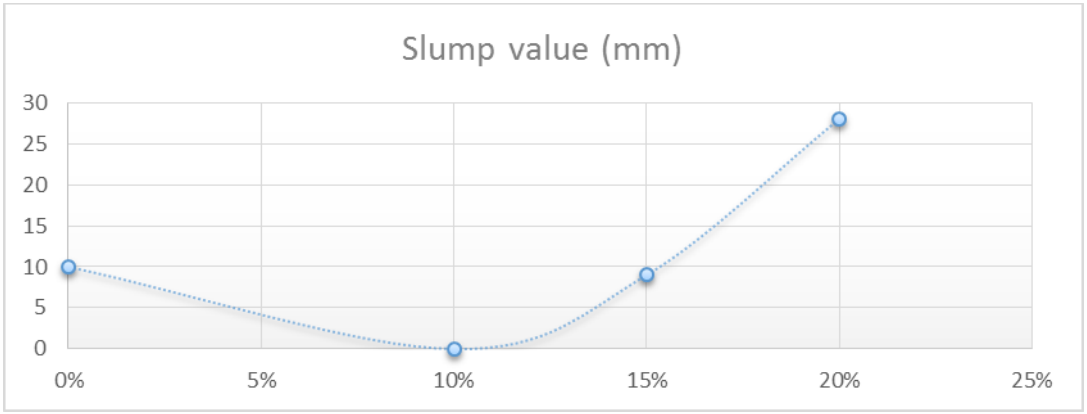

Fig 6: Slump test results

3. Experimental Tests

After casting and curing, compressive strength tests were carried out for all the cubes using 100 Tonne Universal Testing Machine (UTM). **Table 2.** Figure 7 shows the cubes after the compressive strength test. Figure 8 shows the compressive strength test results of concrete cubes with various percentages of iron waste.

Table 2. Average compressive strength of concrete with and without Iron waste		
Sl. No.	**Iron Waste %**	**Average compressive strength in MPa**
1	0	37
2	10	34.48
3	15	30.56
4	20	27.38

Fig 7: Compressive strength test on concrete

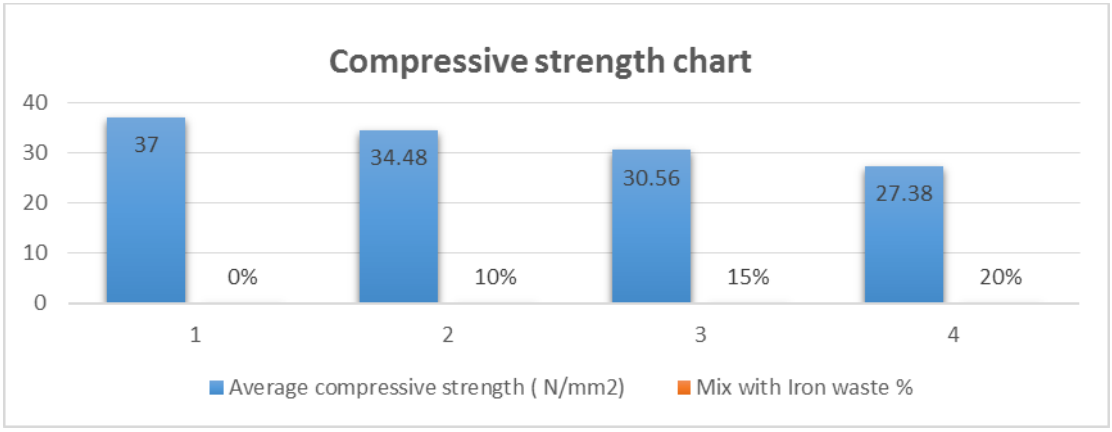

Fig 8: Compressive strength test results on concrete

4. Results and discussions

The following discussion was made based on the experimental test results.

- Mix design was done based on American Concrete Institute (ACI), and based on that, mix ratio was 1: 1.71: 2.15 for C30 grade concrete with water cement ratio of 0.46.
- Sieve analysis was conducted for both fine and coarse aggregates and the fineness modulus for FA and CA are 3.91 and 4.18 respectively.
- Slump test results revealed that, the maximum value of slump is 28 mm for concrete with 20% iron waste as partial replacement of fine aggregate. Type of slump for normal concrete and concrete with 10 and 15% iron waste are true. Also, type of slump for concrete with 20% iron waste is shear.
- Compressive strength of concrete with 10% iron waste is reduced by 7.31% when compared with normal concrete. Compressive strength of concrete with 15% iron waste is reduced by 21.07% when compared with normal concrete. Compressive strength of concrete with 20% iron waste is reduced by 35.14% when compared with normal concrete.

5. Conclusions

The following conclusions were made based on the experimental works.

- Slump test was conducted to measure the workability of fresh concrete. The range for slump test was between 0-28mm.
- Based on the compressive strength of the concrete test, strength is decreasing when iron waste content is increasing.
- Compressive strength of concrete with 10% iron waste is reduced by 7.31% when compared with normal concrete. Compressive strength of concrete with 15% iron waste is reduced by 21.07% when compared with normal concrete. Compressive strength of concrete with 20% iron waste is reduced by 35.14% when compared with normal concrete.
- When the iron is added with concrete, compressive strength is decreasing and hence it cannot be used for reinforced concrete work.
- Using concrete with waste iron it may be helpful in the environmental and economic concepts. Waste iron is harmful to the environment and when it is added with the concrete, it may be helpful to reduce environmental pollution.

List of abbreviations

OPC – Ordinary Portland cement

FA – Fine Aggregate

CA – Coarse Aggregate

UTM – Universal Testing Machine

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