Experimental Study on Compressive Strength of Plain Concrete partially replacing Fine Aggregate and Coarse Aggregate by Ironite and Ceramic Waste

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Abstract- *CONSTRUCTION and Demolition (C&D) wastes contribute the highest percentage of wastes worldwide. Furthermore, ceramic materials, which include brick walls, ceramic tiles and all other ceramic products, contribute the highest percentage of wastes within the C&D wastes. The current option of disposal for this type of waste is landfill. Unavailability of standards, avoidance of risk, lack of knowledge and experience led to there being no active usage of ceramic wastes in construction. Waste utilization is common practice in today's construction industry. Some researchers are involved in recycling the waste product as ceramic waste and Ironite chips. Metals waste materials create serious environmental problems, mainly owing to the inconsistency of the wastes streams. Ironite chips are very small pieces of iron that look like a light powder. They are very often used in science demonstrations to show the direction of a magnetic field. The purpose of this paper is to evaluate the possibility of using ironite chips as one of the component of concrete mix. Three different percentage of ironite were added to concrete mix together with ceramic waste also to measure the variation which may be obtained in compressive strengths after 28 days. A 30 Nos. standard cubes were performed and tested in this study using 0% (control), 10, 20, 30, 40 and 50 and 0%, 10%, 20%, and 30% of ironite and ceramic waste prepared coarse aggregate in concrete mix. It is concluded that, Concrete compressive strength increased gradually when ironite and ceramic waste is used at 40% and 20% replacement respectively added to the concrete mix.*

Keywords- Ceramic Waste, Ironite Chips, Compressive strength, waste materials.

I. INTRODUCTION AND PREVIOUS WORKS

Waste utilization is an attractive alternative to disposal in that disposal cost and potential pollution problems are reduced or even eliminated along with the achievement of resource conservation. Nevertheless, the utilization strategy must be coupled with environmental and energy considerations to use available materials most efficiently. Steel slag, the by-product of steel and iron producing processes, started to be used in civil engineering projects during the past 12 years [1-6].

The second waste from steel is the iron filing, which is produced locally in great amounts from steel workshops and factories. This product has a negative impact on the environment when disposed from this reason the research project started. Most of the previous researches were concerned with steel slag where a rare of it was concerned with iron filing established in a number of applications in the civil engineering industry. Some of researches performed in this field can be summarized as follow:

Alizadeh et al. [7] carried out a research to evaluate the effect of using electric arc furnace steel slag on hardened concrete. Experimental results indicated that such steel slag aggregate concrete achieved higher values of compressive, tensile and flexural strength and modulus of elasticity, compared to natural aggregate concrete.

Shekarchi et al. [7,8] conducted comprehensive researches on the utilization of steel slag as aggregate in concrete. They concluded that the use of air-cooled steel slag with low amorphous silica content and high amount of ferric oxides is unsuitable to be used in blended cement. On the other hand, utilization of steel slag as aggregate is advantages when compared with normal aggregate mixes.

Maslehuddin et al. [9] presented a comparative study about steel slag aggregate concrete and crushed limestone concrete. In the study, only part of the coarse aggregate was replaced by slag aggregate. The study concluded that the compressive strength of steel slag aggregate concrete was marginally better than that of crushed limestone aggregate concrete. Moreover, the improvement in the tensile strength of steel slag concrete was not significant.

Manso et al. [10,11] presented a study in which electric arc furnace slag was used to obtain concrete of better quality. It was concluded that arc furnace slag can be used to enhance concrete properties. However, according to the authors, special attention must be paid to the fine aggregate of steel slag concrete mixes, which can be obtained by mixing fine slag with filler material.

I.M. Asi [12] presented a study in indirect tensile stiffness modulus test results he concluded that the stiffness modulus values of the mixtures containing steel slag coarse aggregate were higher than mixtures with limestone coarse aggregate at all testing temperatures, especially at 20 ◦C. In terms of creep stiffness, the values of steel slag mixtures are substantially higher than that of the control mixtures. The higher creep stiffness of the mixtures with steel slag coarse aggregate indicates better rutting resistance.

Y. Huang et al. [13] studied waste glass, steel slag, tyres and plastics are selected for this study, which reviews standards and literature for technical requirements, as well as the performance of asphalt pavements constructed using such recycled materials. Waste arising and management indicates that although there is a large potential for supplying secondary materials, a few factors have effectively depressed such recycling activities.

Weiguo Shena et al. [14] prepared a new type of steel slag-fly ash-phosphogypsum solidified material totally composed with solid wastes to be utilized as road base material. The mix formula of this material was optimized, the solidified material with optimal mix formula (fly ash/steel slag = 1:1, phosphogypsum dosage = 2.5%) results in highest strength. The strength development, resilience modulus and splitting strength of this material were studied comparing with some typical road base materials, the 28- and 360-day strength of this material can reach 8MPa and 12MPa, respectively, its resilience modulus reaches 1987MPa and splitting strength reaches 0.82MPa, it has higher early strength than lime-fly ash and lime-soil road base material, its long-term strength is much higher than cement stabilized granular materials, the solidified material has best water stability among those road base materials, it can be engineered as road base material with competitive properties.

Anitha Selva Sofia S.D et al.[15] carried out an investigation on quarry dust concrete with chemical admixture. They reported that the quarry dust improves the mechanical properties of concrete when used along with super plasticizers and also usage of quarry dust it will also reduce the cost of concrete because it is a waste material from quarries.

II. EXPERIMENTAL WORK

Two different tests were conducted in this experimental program. A total of 36 tests conducted to study the effect of additing ironite and ceramic waste as a percentage from aggregate in concrete mix design. The main groups of specimens were standard cubes. The first group of concrete tests performed to study the effect of ceramic waste in concrete compressive strength, where the second concrete investigation was concerned with studying the effect of ironite with ceramic waste in concrete strength. In each case of study four different percentage of ironite and ceramic waste were used as 0% (control), 10, 20, 30, 40% and 50% and 0% (control), 10%, 20%, & 30% respectively.

A. Materials

The materials for the experimental program were procured locally wherever possible. This was to retain the regional flavor of materials and in situ casting practices. Ordinary locally-available Portland cement having a specific gravity of 3.15 was employed in the casting of the specimens. Locally-available sand having a fineness modulus of 2.54 and a specific gravity of 2.62 was used. Crushed granite coarse aggregate of 20 mm maximum size having a fineness modulus of 7.94 and specific gravity of 2.94 was used. Water conforming to the requirements of water for concreting and curing as per IS: 456-2000 was used throughout. The average standard 28-days compressive strength of concrete cubes was approximately 25 MPa with a mix ratio of cement: sand: gravel: water at1:1:2. Further for experimentation we are using crushed ceramic tiles for aggregate sizes from 4.75mm to 20 mm. While Ironite chips ranging from 4.75 mm to 8mm is used. Ceramic tiles were obtained from building construction sites. For this Experiment a Varmora Verified tiles was used. Its bulk density and water absorption were 2.35 gm/cc and 0.08% respectively.

III. PROCEDURES AND RESULTS DISCUSSION

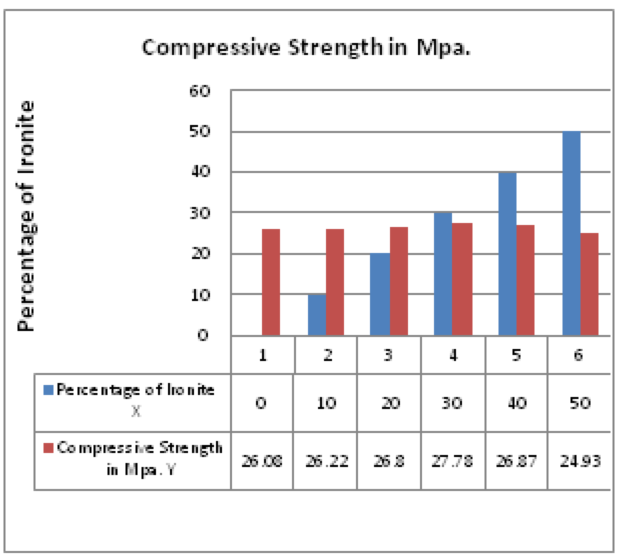
A. Effect of ceramic waste in concrete compressive strength The compression tests were carried out according to I.S. 516, on standard cubes (15 x 15 x 15 cm) as shown in figure 1(a). Concrete mix with ceramic waste was designed, treated, and controlled under the same conditions of concrete mix without ironite. The constituents were mixed in a dry state for about one minute to ensurethe uniformity of the mix. Mixing water was added gradually and was followed by the addition of workability admixtures. All contents were mechanically mixed for an extra two minutes. The consistency of fresh concrete was measured by the conventional slump test. The temperature degree was measured as well. For each concrete mix, 150-mm cube specimens were prepared for testing in compression after 28 days. To ensure full compaction of concrete, a vibrating table was used during placing of concrete. The cube specimens were demoulded after 24 hours and then submerged under water until tested.

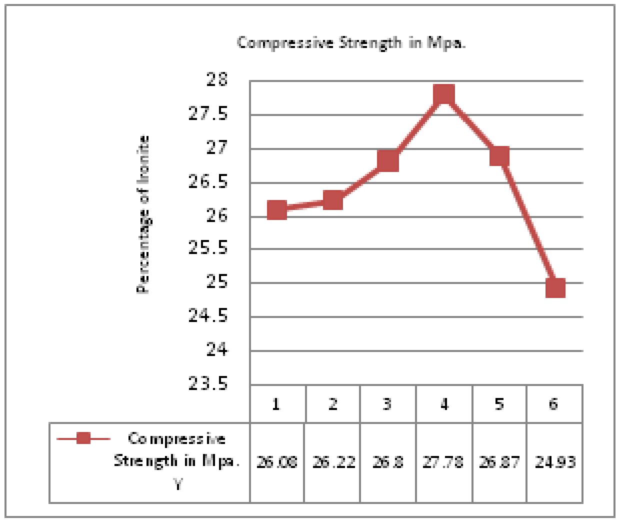
Eighteen cubes were cast from each mix and cured in clean water for 28 days. The crushing load was recorded to determine the compressive strength of concrete sample using universal hydraulic testing machine of capacity 2000 KN as shown in figure 1 (b). In this part of study, a total of 36 cubes were tested to study the effect of ironite in the mechanical properties of concrete. The main variable was considered in this study was the percentage of ironite. Four different ratios were performed 0% (control), 10%, 20% and 30%. The total numbers of cubes divided in four group each group represented by 12 cubes with different percentage of ceramic waste and ironite. The compressive tested performed for mix at ages 28 days. In each age of concrete 3 cubes were tested.

28 Days Compressive Strength of Cube for deferent composition

Sl. No	Quantity	28 Days Compressive Strength in MPa
1	For 0% Ironite and 20% Ceramic waste	26.08MPa
2	For 10% Ironite and 20% Ceramic waste	26.22 MPa
3	For 20% Ironite and 20% Ceramic waste	26.80 MPa
4	For 30% Ironite and 20% Ceramic waste	27.78 MPa
5	For 40% Ironite and 20% Ceramic waste	26.87 MPa
6	For 50% Ironite and 20% Ceramic waste	24.93 MPa

The results obtained from the compressive strengths conducted for 36 cubes after 28 days are listed in table1 and table 2 which shows the reading based on mixing of Ceramic waste and Ceramic waste plus Ironite chips. The average strength for each case of study was indicated in this table.





The results obtained from the concrete tensile strengths conducted for 24 cubes after 28 days are listed in table2. The average strength for each case of study was indicated in this table. Figure 4 shows a graph plotted to represent the relation between average strength and percentage of ironite and ceramic waste in concrete mix. This graph represent the effect of ironite and ceramic waste in concrete after 28 days.

IV. SUMMARY AND CONCLUSIONS

This research work is concerned with studying the effect of ceramic waste and ironite in concrete compressive strength.

Four different percentage of ceramic waste and ironite were added to concrete mix to measure the variation which may be obtained in compression concrete strengths after 28 days. From this study it is concluded that:

Concrete compressive strength increased gradually when ironite is added after the addition of ceramic waste to the concrete mix.

Compressive Strength of cube of the 27 days with upto 40% F.A. /- (coarse sand) is replaced by Ironite along with 20%. Ceramic Waste is increasing thereafter If we increase the percentage of Ironite it decreases while using ceramic tiles as a parts of replacement of coarse aggregate work ability decreases.

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