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Strength and Uniaxial Water Penetration Characteristics of Concrete Made with Ferrochrome Slag

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ABSTRACT

The Ferrochrome slag is a waste material obtained from the manufacturing of high carbon ferrochromium alloy. This slag is formed as a liquid at 1700 ℃ and its main components are SiO2, Al2O3 and MgO. Additionally it consists of chrome, ferrous/ferric oxides and CaO is used as replacement of both sand and cement depending on size of slag. Present study will provide better understanding of mechanical and uni axial water absorption properties of concrete in which cement is partially replaced with ferrochrome slag. It was found that with increase in amount of ferrochrome slag the workability of concrete decreases. It was also found that ferrochrome slag concrete strength more compare to control mix, but as the age increases they show good improvement in strength. Optimum dosage is observed to be 10-15% ferrochrome slag which shows more strength compared to control mix at 28 days.

Keywords: - ferrochrome slag, design mix, workability, tensile strength, compressive strength, ISAT.

1. INTRODUCTION

For the construction of any engineering structure like, buildings, roads, airports etc. require lot of building materials. For such activities large quantity of natural resources are required. This leads to depletion of natural resources. To overcome this, researchers have started searching for suitable other alternative materials for the conventional ingredients of concrete so that the existing natural resources are saved for future generations. Ferrochrome slag products are mainly utilised in the building materials industry, in civil engineering, in road construction, for construction works in underground coal mining as well as for re-cultivation and restoration purposes in open caste mining. They are used as a replacement of natural resources.

2. LITERATURE REVIEWS

Thangaselvi (2015) considers on warming and condition obliteration have turned into the real issue lately. Emanation of green house gases from businesses has affect on environmental change. Keeping the exhaustion of characteristic assets and improving the use of waste materials has turned into a test to the researcher and specialists. Various investigations have been directed concerning the assurance of regular assets, aversion of ecological contamination and commitment to the economy by utilizing this waste material. The real side-effects of industry are slag. To tackle the issue in compelling way slag is use in cement by supplanting normal coarse total. In this examination, the supplanting was finished with coarse total by steel slag for various extents of 0%, 20%, 40%, 60%, 80% and for a M40 review of cement is utilized for a water concrete proportion of 0.40.Tests on compressive quality, split rigidity, flexural quality at 7 days and 28 days are led on examples. The ideal quality is gotten on 60% substitution of coarse total bysteel slag. **Suri (2016)** studies on Concrete are the second most astounding utilizing material in this world. Nonstop usage of coarse and fine totals for solid we are confronting distinctive issues like absence of accessibility of these totals with great quality. To conquer this issue supplanted the totals with eco-sand and steel hang. The essential goal of the undertaking is to build the quality of the solid by supplanting coarse total by steel slag and furthermore 30% substitution of eco sand as fine total. As of from writing steel slag is swapped for 0,15,30,45,60,75,90 % which for sure gives us 7 blends (M1, M2, M3, M4, M5, M6, M7) completely. In the wake of leading different tests we can land to finishes of blends M1, M2, M3, M4 are generally great quality than ordinary blend. Especially the blends M3, M4 which comprises of 30 and 45 % of slag has high quality in all tests. It is clear that 50 % or more isn't practical as the quality found is low contrasted with customary blend. **Islam et al. (2021)** Ferrochrome slag (FCS) possesses promising properties that promote its use as an alternative to natural aggregates in concrete production. The effect of high-temperature exposure on the characteristics of concrete incorporating FCS aggregate is still a source of concern. As a result, the qualities of FCS concrete after being exposed to elevated temperatures must be evaluated for durability and structural fire safety. The effect of FCS fine aggregate on the physical and mechanical properties of concrete at room and increased temperatures (i.e., 2001000 ℃) is investigated in this study. SEM-EDS analysis was also used to assess microstructural characteristics at high temperatures. The mechanical properties of concrete with FCS fine aggregate were found to be better

than those of ordinary concrete. The concrete incorporating FCS fine aggregate demonstrated less degradation in strength characteristics and mass after being exposed to high temperatures than conventional concrete. The chemical composition and surface texture of the FCS aggregate allow for such enhancements in mechanical and physical qualities. When exposed to high temperatures, microstructural inspection and ultrasonic pulse velocity revealed that FCS concrete experienced less damage. Furthermore, the impact of high temperatures on the strength qualities of FCS concrete follows the codes' guidelines (Eurocode 2 and ACI 216.1).

3. MATERIALS AND METHODOLOGY

3.1 Cement

Throughout the experiment, ordinary Portland cement (OPC) from a single lot was used. The cement's physical qualities as established by various tests in accordance with Indian Standard IS: 1489-1991 (Part-1). All of the tests were carried out in accordance with IS: 4031-1988 guidelines. Cement was properly stored to avoid its characteristics from deteriorating due to moisture interaction. Fineness of cement is obtained as 3%. Standard consistency is obtained to be 32%. Initial setting time is 66 minutes and final setting time is 316 minutes.

3.2 Fine aggregate

River sand was used as fine aggregate. The specific gravity and fineness modulus was 2.56 and 2.96 respectively and it belongs to zone II of grading.

3.3 Course Aggregate

Crushed angular granite from a local source was used as coarse aggregate. The specific gravity was 2.66, flakiness index of 4.57 percent and elongation index of 3.95.

3.4 Ferrochrome slag

Ferrochrome slag from nearby iron production factories is used in this study. In this study we used two types of ferrochrome slag.

- Original ferrochrome slag without grinding is used in first set.
- Ferrochrome slag that is grinded in Los Angeles abrasion test for 30 minutes is used in second test.

4. RESULT AND DISCUSSIONS

4.1Workability

The workability of concrete mixes was found out by slump test as per procedure given in chapter 3. w/c ratio was kept constant 0.45 for all the concrete mixes. The workability results of different concrete mixes were shown in Table 4.1

Table 4.1 Workability values for different concrete mixes

Mix No	Description	Slump (mm)
1	100%OPC+0%OFS+0%GFS	106
2	90%OPC+10%OFS+0%GFS	100
3	80%OPC+20%OFS+0%GFS	96
4	70%OPC+30%OFS+0%GFS	92
5	90%OPC+0%OFS+10%GFS	100
6	80%OPC+0%OFS+20%GFS	94
7	70%OPC+0%OFS+30%GFS	90

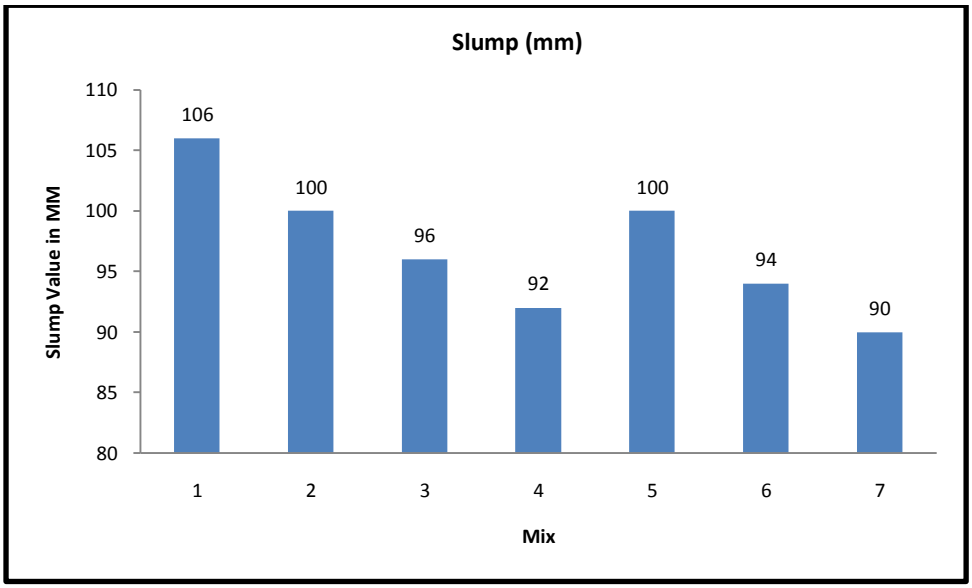

Figure. 4.2 Variation of slump value

In comparison to the control mix, Table 4.1 demonstrates that as the percentage of cement replaced by slag increases, the workability of the concrete mix diminishes. It also demonstrates that the addition of grinding slag reduces workability more than ordinary slag.

4.2 Compressive strength test results of concrete

This section presents and discusses the results of compressive strength tests performed on concrete specimens of various mixes cured at various ages. The compressive strength test was performed at 7, 14, and 28 days after curing. Table 4.5 shows the compressive strength test results for all of the mixes at various curing ages. Figure 4.2 depicts the variation in compressive strength of all the mixes cured at 7, 14, and 28 days. After 7, 14, and 28 days, the compressive strength of concrete mixes compared to the control mix is shown in Fig. 4.2.

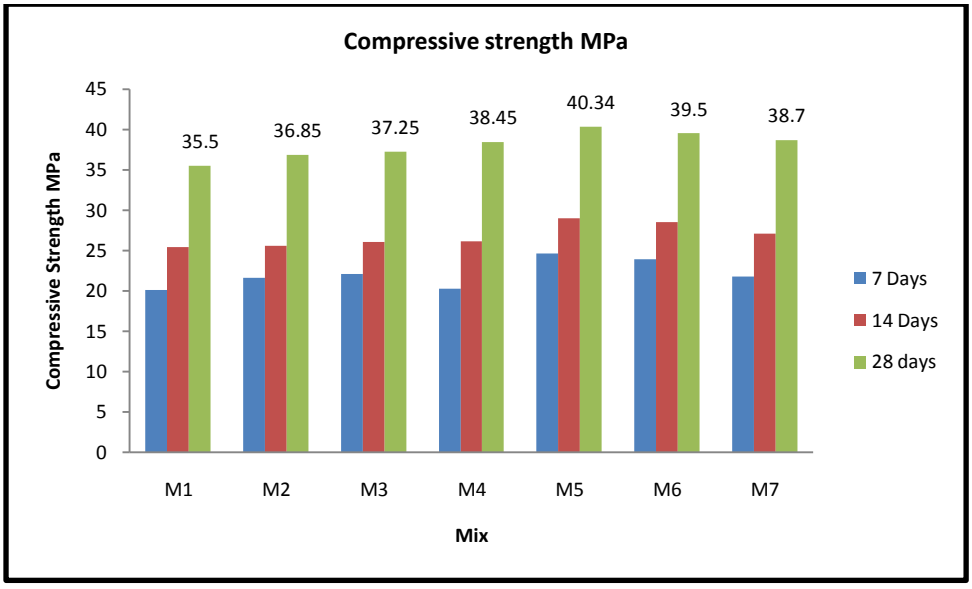

Figure. 4.2 Compressive strength of concrete at different age

4.3 Split tensile strength Test

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, 28 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 4.5. Variation of compressive strength of all the mixes cured at 7, 14, 28 days are also shown in Fig. 4.2. Fig. 4.2 shows the variation of compressive strength of concrete mixes w.r.t control mix after 7, 14, 28 days respectively.

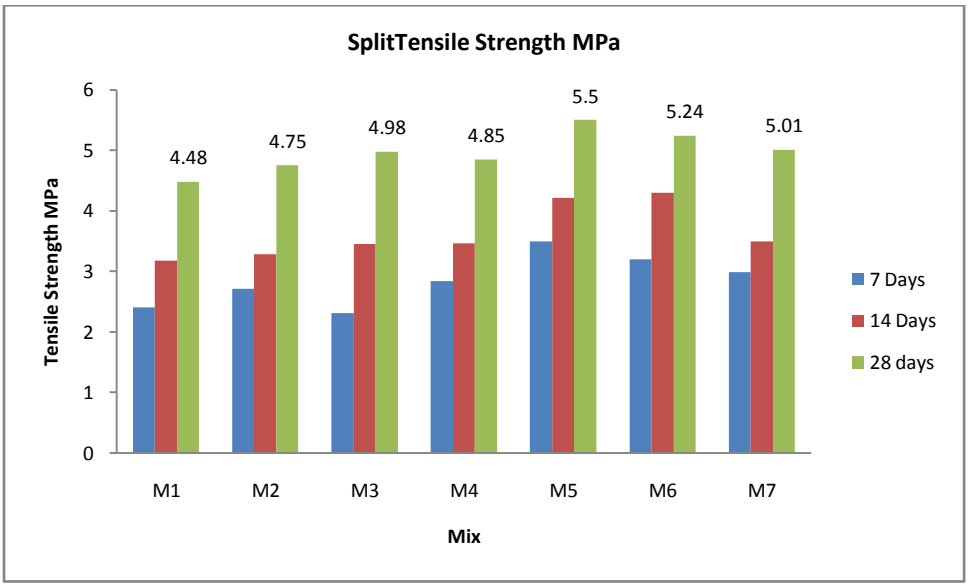

Figure. 4.3 Tensile strength of concrete at different age

4.5 ISAT

The ISAT was carried out in order to gain a better understanding of concrete water infiltration, particularly at the concrete surface. In comparison to the internal microstructure, the concrete cover is the weakest, most permeable, and absorptive component of the concrete matrix. Due to the relative mobility of cement paste and aggregates during the compaction of fresh concrete and bleeding of mix water in the early phases of cement hydration, the near-surface concrete is very heterogeneous in character.

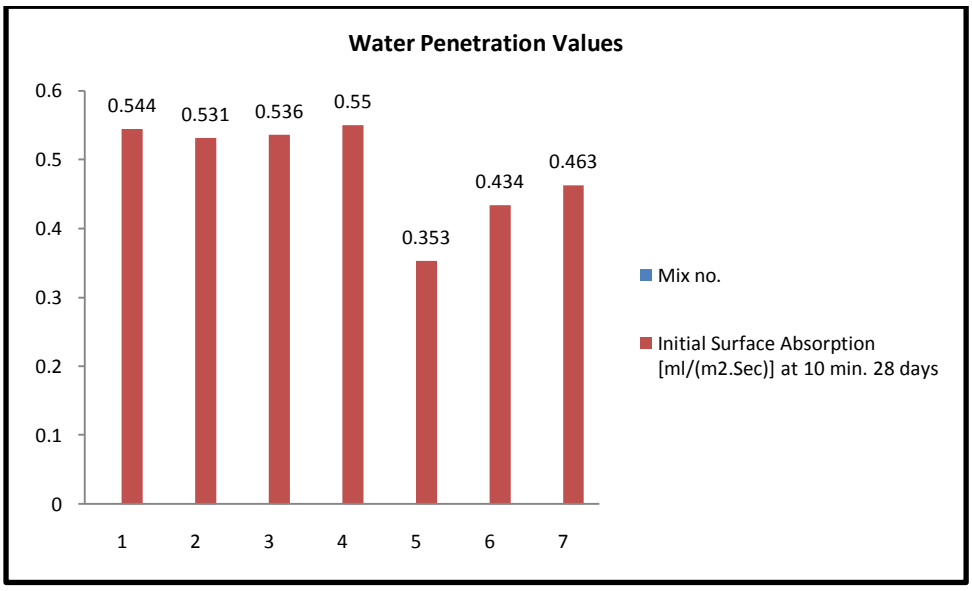

Figure. 4.4 water absorption of concrete at different age

5. CONCLUSIONS

- It was found that as the ferrochrome slag content increases in the concrete workability decreases. For the both type of ferrochrome slag mix in concrete.
- It was observed that addition of grinding ferrochrome slag gives more strength compared to ordinary ferrochrome slag concrete at all the ages. Addition of 10% grinding ferrochrome shows more strength compared to control mix at 28 days.
- It was observed that optimum dosage of grinding slag was found to be 10 % at which the maximum tensile strength was found compare with normal mix.
- It was observed that rate of water absorption minimum with grinding ferrochrome slag use in concrete compare with normal and ordinary slag.
- It was find that grinding ferrochrome slag more strength obtained to the ordinary ferrochrome slag

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