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Effect of Partial Replacement of Fine Aggregate by Mill Scale on the Properties of Concrete

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Abstract - - *Concrete is the most versatile construction material in the world. Natural aggregate is a major constituent of concrete which is mined and processed every year, which leaves a significant mark on the environment. Efforts are being done to use appropriate recycled materials as substitutes for aggregate. Such as recycled concrete aggregate, post-consumer glass, fiber material etc. But one waste material which has not been extensively studied yet is mill scale. Mill scale is magnetic material consisting of iron formed in steel manufacturing factories. This paper reviews on usage of mill scale in Portland cement concrete as a partial replacement for natural fine aggregates With this addition absolutely properties of concrete will change. To conclude these changes Cement concrete of M20 grade to be prepared with varying the mill scale content of fine aggregate form 0% to 50% for determination of compressive, tensile strength and flexural strength of concrete cubes keeping water/cement ratio 0.5 for all mix proportions. Compression testing machine utilize for determination of Compressive strength of concrete cubes. Tensile strength of concrete determine by indirect method (splitting tensile test) using UTM machine and 2 point loading test to be performed for determining flexural strength of concrete. Results need to be compared for different mill scale content and optimum mill scale content is find out for highest strength value.*

Key Words: Mill scale, Compressive strength, tensile Strength, splitting tensile test, flexural strength.

1. INTRODUCTION

Concrete is an artificial stones like material used for various structural purposes. It is made by mixing cementitious and inert material such as aggregate with water and allowing the mixture to be hardened by hydration. Due to growing environmental concern innovations have been directed towards utilization of waste material as replacements of natural material. The paper investigation deals with similar concept of using mill scale industrial waste in cement concrete as a partial replacement of fine aggregate. Billons of tones industrial waste produced every year which is casing so many environmental problems. The non-decaying solid waste material causes a waste disposal crisis .The problem of waste accumulation exist worldwide specially in densely populated country like India. Most of the material are left as stockpiles, landfill material or illegally dumped in selected areas. Hence to overcome the above said the waste product should be employed as construction material. On the other hand use of river sand as fine aggregate In the concrete leads to exploitation of natural recourses, lowering of water table and erosion of river bed. If fine aggregate replaced by industrial waste by optimum percentage it will trim down the usage of fine aggregate in construction purposes thereby reducing the above ill effects. An experimental study to be done to understand the behavior of concrete in terms of strength when mill scale waste is replaced in different proportion with fine aggregates.

1.1 NECESSITY OF STUDY

Mill scale industrial waste material produced in tones every year and causing adverse environmental effects. Several studies have been done for using industrial solid waste as a replacement of conventionally used construction material. But usage of mill scale and its outcomes in concrete is not yet studied extensively. Mill scale is available without difficulty in steel manufacturing industries at zero cost, only transportation cost need to give for it. Usage of mill scale as substitute of natural aggregates gives quite a lot of environmental benefits also cost of construction is lowered. Mill scale is a magnetic material contains iron so it might have a significant effect on strength properties of concrete. This study aims to compare the strength of concrete for different mill scale content and hence to obtain an optimum content of mill scale for maximum strength.

1.2 OBJECTIVE

Based on the above problem statement, the objectives of this study are as follows:-

1. To obtain optimum mill scale content in proportion of fine aggregate for maximum strength.
2. To investigate variation in compressive strength of cement concrete with varying mill scale content.
3. To investigate change in tensile strength of cement concrete with varying mill scale content.
4. To investigate change in flexural strength of cement concrete with varying mill scale content.
5. To study workability of concrete with different mill scale content.

6. To study density of modified concrete formed by using mill scale in different proportion.

Fig -1: Mill Scale

2. LITERATURE REVIEW

Y.I.Murty (2012) it deals with the evaluation of the mechanical properties of black cotton soil mixed with mill scale in varying proportions and comparing the same with the results of pure black cotton soil. The mechanical properties of mill scale and black cotton soil are individually determined first and then the two are combined in varying proportions. The properties like plastic limit, CBR and Permeability of the same are evaluated. It is found that mixing mill scale in varying proportions increases the permeability of the soil, strength characteristics and decreases the plasticity. following conclusions were drawn: i)The CBR value of black cotton soil mixed with 15% mill scale increased three times that of plain black cotton soil. Ii)The permeability value of black cotton soil increased manifolds by increasing the percentage of mill scale. Iii)The plasticity of the black cotton soil decreased from 35.71% to 30.60% by adding 12% of mill scale.

Al-Otaibi (2008) investigated the possibility of recycling steel mill scale in cementitious materials as aggregate, analyzing cement mortars with levels of 0%, 20%, 40%, 50%, 70% and 100% replacement. Values of compressive strength analyzed for all ages (3, 7 and 28 days) increased with the replacement of up to 40% replacement, also with a reduction of drying shrinkage with 70% of mill scale steel. The results of another study conducted by Pereira et al. (2011) on the use of mill scale as fine aggregate in concrete have shown that mill scale demands greater water content to maintain the workability. The results indicated that concretes with water/cement ratios of 0.55 and 0.65 have higher compressive strength and greater water absorption as the mill scale content increase.

Anupam Singhal et al (2015) aims to evaluate the use of mill scale in Portland cement concrete, as a replacement for natural fine aggregates. Cement mortars with mix proportioning 1:3 were prepared varying the mill scale content of fine aggregate form 0% to 100%, for determination of compressive and tensile strength. The water/cement ratio used was 0.5 for all mix proportions. The compressive strength at different proportions did not give a general trend and two peaks were obtained at 60% replacement and 100% replacement. Maximum tensile strength was observed at 60% replacement of standard sand. A mix design was also done for M35 grade of concrete by the IS method. OPC of 43 grade was selected and sand replacement was done with mill scale varying from 0% to 80% with a suitable water cement ratio of 0.40. The compressive strength was measured after 28 days of completion of curing. Maximum strength was obtained for 40% sand replacement. Moreover, concrete with mill scale has demanded greater water content to maintain the workability.

Shivam Nema, et al investigated effect of mill scale and fly ash wastes as a replacement of fine aggregate generally natural sand on the performance of cement mortar. Utilization of fly ash and mill scale in cement mortar production not only provides significant environmental benefits but also enhances performance of the cement mortar when used at optimum amounts. It looked at the feasibility of mill scale and fly ash waste inclusion as partial aggregate replacement in normal cement mortar. Properties of cement mortar incorporating fly ash and mill scale waste as partial substitution for natural aggregate were investigated. The study involves six replacement levels of mill scale and fly ash wastes into cement mortar for each mix design. Mortar cubes are tested for strength, & water absorption. The partial replacement of fine aggregate by M(3,30), M(5,30), M(8,30), M(10,30), M(12,30), M(15,30) mix of mill scale & fly ash %) improves the properties of normal mortar. In the design mix of industrial wastes produced, percentage of fly ash was kept constant (30 %) and mill scale was varied from 0 to 15 % by weight of natural sand. The test results indicated that the mechanical properties of mill scale and fly ash modified mortar were improved to a great extent, whereas the water absorption was reduced as compared to that of plain mortar. They concluded that the effect of addition of fly ash and mill scale wastes in cement mortar was studied and conclusions based on the results obtained in the experiments as follows. :i)Due to inclusion of mill scale and fly ash waste as fine aggregate replacement, the mortar made was found to light weight in nature. ii)The compressive strength was observed to increase up to 10% mill scale and 30% fly ash Replacement, as compared to normal mortar, than as the percentages of wastes increases the Compressive strength decreases iii) The water absorption of mortar formed by addition of fly ash and mill scale wastes was found to be higher than normal mortar & it increases by increasing the percentage of wastes in cement mortar. iv)The mortar formed by addition

of fly ash and mill scale wastes was found to be economical than normal mortar.

3. METHODOLOGY

For experimental analysis methodology is as follows:-

Step 1: preparation of concrete specimen for testing by mixing of cement, fine aggregate and coarse aggregate in the ratio of 1:1.5:3 with varying mill scale content from 0% to 50% of fine aggregates.

Step 2: Determine the Workability of concrete with different mill scale content during preparation of specimen.

Step 3: Allowing the specimen to get hardened by keeping it into water for 7, 14 and 28 days of curing period at required temperature.

Step 4: Determine the density of various specimen before testing and compare the results for the same.

Step 5 Determine the compressive strength of various concrete specimens by performing compression test using CTM machine for 7, 14 & 28 days of curing period.

Step 6: Determine the tensile strength of various concrete specimen by indirect method (splitting tensile test) using UTM machine for 7, 14 & 28 days of curing period.

Step 7: Determine the flexural strength of various concrete specimen by 2 point loading test for 7, 14 & 28 days of curing period.

Step 8: Preparation of graphs and tables showing changes in the above said property of fresh and hardened concrete at different mill scale content.

Step 9: Determining optimum mill scale content in percentage replacement with fine aggregate which give maximum strengths.

4. EXPECTED OUTCOMES

Following are expected outcomes:-

1) Workability requirement of modified concrete.
2) Mill scale content corresponding to maximum compressive strength.
3) Mill scale content corresponding to maximum tensile strength.
4) Mill scale content corresponding to maximum flexural strength.
5) Change in density of modified concrete.
6) Tendency of change in strengths with percentage replacement of fine aggregate with mill scale.

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